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Opening Remark and Speech by Dr Aung Win,
Rector of University of Myitkyina

Good Morning,

Chief Minister of Kachin State, speakers from Japan, Malaysia, Vietnam and Myanmar Pro-rectors of Myitkyina University, Professors. University Teachers and students from Myitkyina University, invited guests and all participants.

I am very pleased to welcome all of you to the first Myanmar International Science and Culture Conference 2019 (MISCC 2019) organized by University of Myitkyina. The main aim of this conference is to promote, strengthen and expand the networking among local researchers and international researchers. First of all, I wish all of you to be in health of body and peace of mind. I would like to extend a welcome to every to this special occasion. Firstly, I'd like to express the brief history of University of Myitkyina. The Aged University of Myitkyina was first opened on the 14h July 1958. Myitkyina College was changed into the regional college of Myitkyina on 23 of May 1977 Myitkyina College was upgraded into Myitkyina Degree College on 12 February 1986 and Myitkyina Degree College was developed into Myitkyina University in 1998. The area of the campus is 220.788 acres. There are 14 academics departments, 294 teaching staff and 260 office staff at University of Myitkyina. The courses offered by University of Myitkyina are B.A, B.Sc., M.A and M.Sc. Degrees.

Secondly, as you all know, Today's world is called a global village and IT age. I am glad to hear there are over 200 papers that are going to be presented to MISCC 2019. It is hoped that participants who are going to present their respective papers related with Natural Science, Life Science and Social Science, and Culture and Linguistics will contribute a lot of benefits to our society. Because research is the life blood of Universities Finally, I's like to say, "No research, no good result at University Campus". I am sure this conference will make us beneficial to some extend so I would like to remind all the participants to take part in this conference actively.

Thank you very much.

29th November 2019

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GEO 002

Outcrop nature and petrographic data of igneous rocks exposed around the road section from Waingmaw Township to Sadon Waterfall Area, Kachin State; Criteria for Petrogenesis

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Abstract

The Kachin State is one important segment of SE Asia as a result this area is interesting not only for petrogenesis but also for tectonic point of view for many decades. The main objective of this research is to recognize outcrop nature and petrographic data which is criteria for petrogenesis of igneous rocks. This research operates two methods: first is field trip to know outcrop nature and second is thin section to get petrographic data. The igneous rocks comprise in the area are pegmatite, hornblende granite, granodiorite, diorite, monzonite, dolerite, gabbro and peridotite. Field data and petrographic criteria suggest the igneous rocks may be formed as continental arc which related to India-Eurasia subduction during the Mesozoic and Early Cenozoic time. The magma source may be formed by partial melting of subduction oceanic plate that produces primary magma. Fractional crystallization and contamination occurred when it travels through the crust. Some granite and pegmatite probably formed by partial melting of lower or middle crust.

Keywords: petrogenesis, continental arc, subduction

Introduction

The Waingmaw village to Sadon waterfall area, eastern part of Kachin State, is situated about 5km (3miles) east of Myitkyina Township. It is situated between Latitude 25°21' to 25°24' N and Longitude 97°25'30" to 97°48' E in UTM maps (2597-07, 11 and 15). The main rock units exposed at the study area are intrusive and extrusive igneous rocks together with metamorphic and sedimentary rocks. The Myitkyina-Kanpetii car road runs across the study area in east-west direction. The whole area except the road site is rather difficult to access because of dense forest, highly mountainous nature and sparse population, and so well outcrop nature can be found along the road section and stream section. Although the study area and its environs are one of the best areas for searching trace to reconstruct evolution of SE Asia, well known petrology of the area have not been yet. Therefore, the main intention of this research is the outcrop nature and petrography of igneous rocks which are the fundamental facts for petrology. The location map of the study area is shown in figure (1).

Purposes of Research

The fundamental data for petrology such as outcrop nature and petrography of igneous rock of the study area are still lacking so the main objectives of this research are: (1) to study the distribution and outcrop nature of the major rock units, (2)to express the petrographic data of igneous rocks and (3)to describe the petrogenesis of igneous rocks.

Method of Study

The various kinds of literatures concerning with this research area and the regional geological map were studied to the lead of the field trip. During field trip, the locations of the outcrops were accurately recorded by GPS (Global Positioning System) navigator and checked by bearing and intersection method. The field data are plotted on Google Earth and UTM map linked with GPS data to describe the distribution of rock units. In the laboratory, the representative specimens collected from the field were prepared more than (30) thin sections to distinguish the rock types.

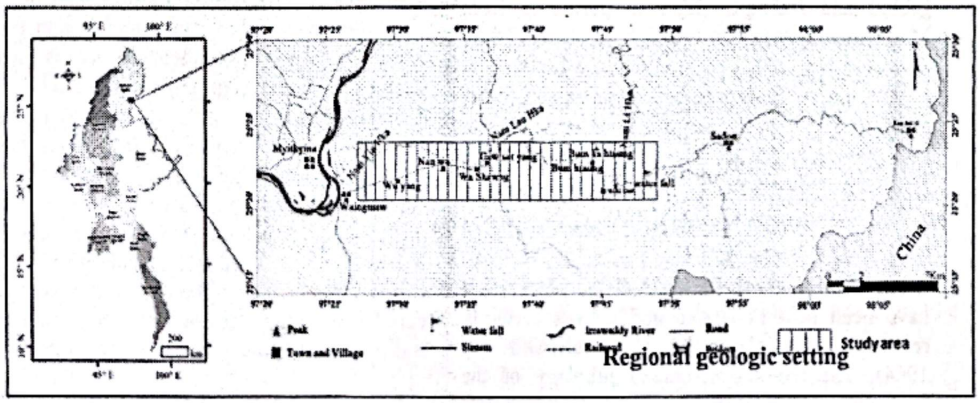

Fig. (1) Location map of the study area.

The Kachin State, northern part of Myanmar, is also a key place to search the trace for the tectonic evolution of SE Asia. Geologically, it comprises six main places from west to east; Jade Mine Uplift (JMU), Nanyaseik diopside-phlogopite-ruby marble, granite (Na), Kumon Range (KR), Katha-Gangaw Range (KGR), Tagaung-Myitkyina Belt (TMB) and Mogok Metamorphic Belt (MMB). An ophiolite belt of Myanmar, Early Jurassic ophiolite continuation of Yarlung Zone, also falls within the TMB (Mitchell et al., 2007). The study area situates not only at the eastern part of the Kachin State but also within the northern continuation of TMB and MMB. The rock units exposed in the study area and its environs are mainly of undifferentiated metamorphic rocks together with intrusive and extrusive igneous rocks. They are trending nearly N-S with eastern and northeastern dip. The regional geologic setting of Myanmar including the study area is shown in (2).

Rock Sequence

The main rock units exposed in the study area are igneous and metamorphic with minor amount sedimentary rocks. Although the rock units exposed from the study area are recognized as the TMB and MMB, the age of the protoliths of the metamorphic rocks, the formation age of igneous rocks and their related tectonic history are still controversial.

Geological investigation of the Kachin State can be traced back as early as to 1941, when Clegg described the peridotite, diorites and gabbro were associated with tuffs in consequence of post-Cretaceous to early Eocene igneous activity in the Katha and Myitkyina area. Recently, Yang et al. (2012) reported zircon U-Pb dating on different rock types from Myitkyina-Sadon area (including pyroxenite, hornblende gabbro, diorite and granodiorite) and Myitkyina ophiolite (including andesitic basalts, leucogabbros, pyroxenites and plagiogranites), which obtain Middle Jurassic ages of ~166–177 Ma and ~166–176 Ma, respectively. Maung et al., (2014) pointed Latest Jurassic radiolarian fauna from the Chinghkran area. Liu, et al., (2016b) have conducted zircon U-Pb dating on gabbro and rodingite dikes in peridotite from Myitkyina-Myitsone area, which yield ca173 Ma. Zhang, et al., (2018) pointed that the Myitkyina-Mogok ultramafic-diorite belt contains peridotite, andesite, hornblende gabbro, diorite, granodiorite and plagiogranite, all suggest arc geochemical signatures and ages of 177–166 Ma.

For MMB, the Mogok metamorphics to be equivalent of Precambrian to Jurassic rocks of the Shan Plateau and that the metamorphism must have been post Paleozoic and almost certainly related to the Himalayan Orogeny (Searle and Haq, 1964). The pre-metamorphosed lithology of the Shantaung-U-Thandawmywet area is Carboniferous in age according to its relict fossils (Maung Thein and Soe Win, 1973). The metamorphic rocks from Mogok-Thabeikkyin-Singu-Madaya area were metamorphosed from sedimentary sequence of the Lower Paleozoic of the western Shan Plateau region (Myint Lwin Thein et al., 1990). In 2001, Barley et. al. mentioned the magmatic age of the protolith of orthogneisses from the Mandalay hill and Kyanikan was Jurassic (170 ± 1Ma) which were recrystallized during an Eocene (~43Ma) high-grade metamorphic event.

According to field criteria, their lithostratonomic characters and previous authors' radiometric dating result, the protolith of metasedimentary rocks may be correlated with Lower Paleozoic age sedimentary sequence of the Shan Plateau region and Jurassic for metaigneous. The igneous are estimated to be Mid Jurassic to Cretaceous in age. On the basic of field criteria, the rock sequence of the study area is subdivided into thirteen major rock types as shown in table (1).

Table (1) Rock sequence of the study area

Lithologic Unit		Age
Sedimentary Units		
Alluvium		Quaternary
Siltstone and silty sandstone		Paleocene to Eocene
Igneous Units		
Pegmatite/Aplite		Early Cenozoic
Hornblende granite		Cretaceous to Jurassic
Granodiorite		
Diorite		
Monzonite		
Gabbro		
Dolerite		
Lherzolite		
Pyroxenite		
Metamorphic Units		
Hornblende-biotite gneiss	Metaigneous	Jurassic
Biotite gneiss	Metasedimentary	Lower Paleozoic
Migmatitic gneiss		

Outcrop nature and types of Igneous Rocks

The main rock units in the study area are intrusive and extrusive igneous rocks associated with metamorphic and sedimentary rocks. The types of the rock units, outcrop nature and their relation are rather complicated. Although the Myitkyina-Kanpetii car road runs across the study area, the whole area except the road site is rather difficult to access. Therefore, almost all of the locations were taken on both sides, ca 100ft, of the road because well outcrop nature can be found along the road section and some stream section. The distribution map of the study area is shown in figure (3). The topography of the study area is different from east to west, i.e., the western part has low relief with soil cover and the eastern part has medium to high relief with rugged terrain. In the western part, highly oxidized zone is found after soil cover area especially at GPS references (N 25° 23' 30.6" and E 97° 38' 17.3") and (N 25° 23' 37.7" and E 97° 39' 10.2"). The oxidized zone displays very friable nature and one and half miles in width. Based on the texture, constituent minerals and field

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Fig. (4) Photograph showing sausage nature pegmatite vein in granodiorite.

(Loc. N 25° 21' 36.10"; E 97° 47' 0.7")

Fig. (5) Photograph showing small semicircular bodies with exfoliation nature in hornblende granite.

(Loc. N 25° 21' 36.10"; E 97° 47' 50.7")

criteria, igneous rocks can be divided into nine types; pegmatite/aplite, hornblende granite, granodiorite, diorite, monzonite, dolerite, gabbro, lherzolite and pyroxenite. The contact between these rocks are quite complex. Almost all of the igneous units possess semi-circular to batholiths outcrop nature.

Pegmatite/aplite occurs as veins and small dykes and they are 1inch to 10inches in width and they intruded into metamorphic and igneous units. The main constituent minerals are quartz and feldspar with minor amount tourmaline. Almost all of the dykes are unmappable and some veins show sausage nature due to brittle-ductile deformation (Fig. 4).

The dominant igneous rocks exposed in the study area **hornblende granite and granodiorite** which cropped out two third of the whole area. They exhibit complex nature, i.e., change from granitic to granodioritic composition within a batholith. They occur as small semi-circular bodies and boulder nature especially found around the Wuyan village (N 25° 21' 36.1" and E 97° 47' 50.7"), Bum-Taung (N 25° 22' 54.8" and E 97° 44' 7.7"), In-want-Kaung (N 25° 21' 35.2" and E 97° 45' 27.1") and Sadon waterfall (N 25° 21' 36.60" 97°

Fig. (6) Photograph showing oval shape and sharp margin mafic microgranular enclaves in granite. (Loc. N 21' 35.8"; E 97° 45' 30.1")

47' 34.5"). They exhibit light grey to white on fresh surface while dark grey color on weather surface. Some semi-circular granite bodies show exfoliation nature and domal surface (Fig.5). **Hornblende granite** possesses fine to medium-grained texture and composed mainly of quartz, feldspar, hornblende and biotite. **Granodiorite** shows medium grained texture and has more mafic minerals and plagioclase feldspar than granite. Various sizes of ellipsoidal shape mafic microgranular enclaves are found in granitoids (Fig. 6). Their size ranges from 2cm to 3ft and are generally in sharp contact with the surrounding granitoids. They are composed mainly of plagioclase, K–feldspar, hornblende and biotite with minor quartz and accessory pyroxene. The presence of these enclaves suggests the introduction of mafic magma into the magma chamber and its subsequent cooling following incomplete mixing. Some enclaves possess chill margin which represents large temperature difference from the host granitoids.

Monzonite is rarely found at Wuyan village (N 25° 22' 16.1" and E 97° 30' 25.7") and its exposure width is about 30ft. It has medium-grained texture and is composed chiefly of quartz, feldspar and biotite with hornblende. It occurs as small semi-circular bodies and shows yellowish brown color when weathered. (Fig. 7).

Diorite is found at the GPS references (N 25° 23' 47.7"; E 97° 37' 14.9") and (N 25° 22' 28"; E 97° 44' 10") and their exposure is about 80ft in width and 40ft in thickness. This rock shows dark grey to greenish grey on weathered surface (Fig. 8) and dark green colour when fresh. It possesses medium to coarse grained texture and is mainly composed of plagioclase and hornblende with biotite. Some enclaves contain same mineral composition as the host diorite; however, the texture is different, i.e., very fine grained.

Good exposure of **dolerite** dyke is found at GPS references (N 25° 23' 2.8"; E 97° 40' 27.7"),

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(N 25° 22' 37.3"; E 97° 40' 59.2") and (N 25° 22' 48.8"; E 97° 41' 34.1"). It is fine-grained, hard and compact nature (Fig. 9). It is dark greenish grey colour on weathered surface and dark grey color when weathered. Texture changes, i.e., basalt to dolerite, occur within the same body. The outcrop nature is small dyke to massive with highly jointed which is rather weathered and mostly epidotized. Small dyke width is 4.6m (15ft) with trending NW-SE.

Limitedly outcrop of **Gabbro** is found at the bank of the Nant-Myin-Hka stream under the Nant-Myin-Hka bridge (N 25°22' 47.9" and E 97° 34' 44"). It occurs as small boulder nature and its extent is about 30ft in width (Fig. 10). It displays dark grey on weathered surface and dark green on fresh. It is hard and compact nature, medium to coarse grained texture and chiefly composed of pyroxene, plagioclase hornblende with minor amounts of amphibole and olivine.

Lherzolite and pyroxenite are found near the Inwang Kaung Bridge especially at GPS references (N 25° 21' 51.5"; E 97°45' 31.8"), (N 25° 21' 28.8"; E 97°45' 25") and (N25° 21' 51"; E 97°45' 32"). They are grey green to dark green color on fresh surface and dark grayish green color when weathered. They have coarse-grained texture and are composed mainly of olivine and pyroxene. They possess hard and compact nature and expose as sheeted dyke (Fig. 11).

Fig. (7) Photograph showing yellowish brown colour weather surface on monzonite. (Loc. N 25° 22' 16.1"; E 97° 30' 25.7")

They occur as rather complex nature, i.e., lherzolite to pyroxenite, within a same boulder. Partial or complete serpentinization is well observed on weather surface. Various size of pegmatite and aplite veins are intruded into metamorphic and all igneous units, indicating that these veins are the youngest igneous unit of the study area

Fig. (8) Photograph showing greenish grey colour weathered surface in massive diorite. (Loc. N 25° 23' 47.7"; E 97° 37' 14.9")

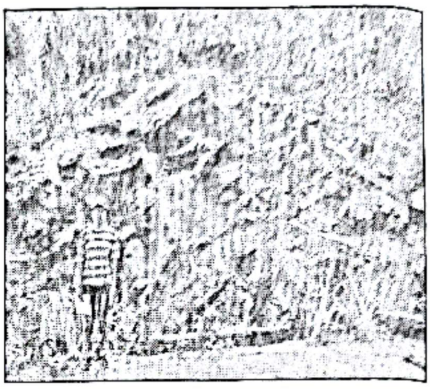

Fig. (9) Photograph showing hard and compact nature of dolerite. (Loc. N 25° 21' 28.8"; E 97°45' 25")

Fig. (10) Photograph showing dark grey weather colour in gabbro. (Loc. N 25°22' 47.9"; E 97° 34' 44")

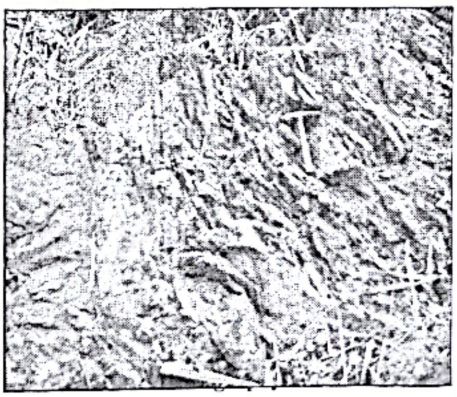

Fig. (11) Photograph showing small sheeted dyke nature of peridotite and pyroxenite.

(Loc. N 25° 21' 28.8"; E 97°45' 25")

The petrographic analysis is based on thin sections that were prepared from representative specimens of the different igneous rocks collected in the study area. Plagioclase compositions were examined by the Michel Levy's method. Modal compositions were estimated not only on thin sections but also in hand-specimens.

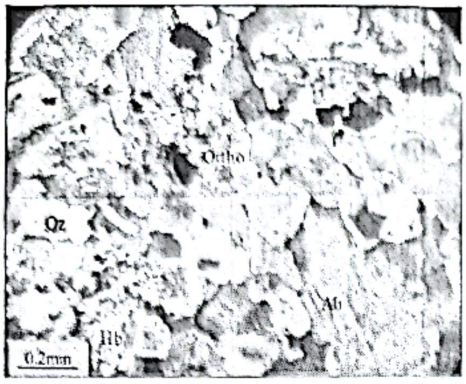

Fig. (12) Photomicrograph showing cloudy appearance and untwinned nature orthoclase, anhedral quartz and hornblende in hornblende granite. (Between X.N)

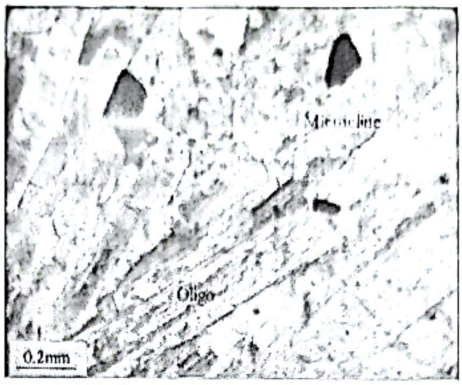

Fig. (13) Photomicrograph showing Cross-hatched twin in Microcline and poly-synthetic twining in oligoclase of the granodiorite. (Between XN)

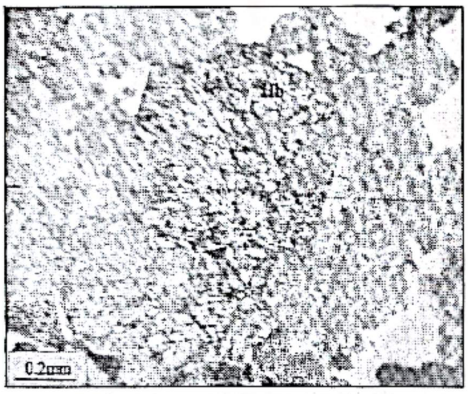

Fig. (14) Photomicrograph showing chloritization occur around the margin of hornblende in diorite. (Between X.N)

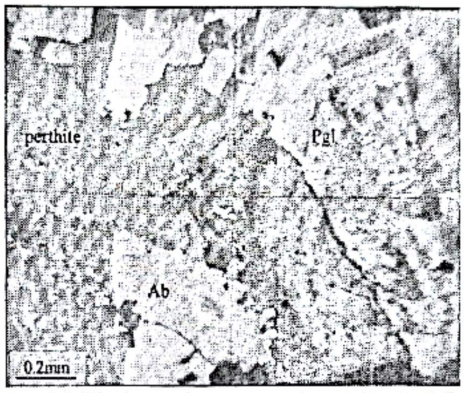

Fig. (15) Photomicrograph showing speckled appearance in the core of zonned plagioclase and flame-shaped perthitic exsolutions of albite in monzoite. (Between XN)

Under microscope, **pegmatite** composed mainly of quartz and feldspar that displays hypidiomorphic-granular texture. **Aplite** exhibits allotrimorphic-granular texture and it characterized by very small grain size which infrequently exceeds 2mm.

Microscopically, **hornblende granite** (Fig. 12) exhibits holocrystalline, hypidiomorphic to xenomorphic-granular texture and consists of potassium feldspar (35–45 %), quartz (30–35 %), plagioclase (10 %), hornblende (5–10 %) and biotite (~ 5 %). Accessory minerals include titanite, allanite, apatite, zircon and iron-oxides. More than half of the feldspar in this rock is potassium feldspar especially orthoclase and microcline. Microcline is clearly identified by its cross-hatched twinning and their size ranges from of 0.5 to 3 mm in length. Myrmekites are rarely found. Compositional zoning is quite common. Quartz occurs in anhedral nature and their size ranges from 0.1 to 3 mm in diameter. In plagioclase, An_{10}-An_{20} in composition, albite and carlsbad twinned is rather common. Most of the crystals show some alteration and the crystal grains range in size from 1 to 5 mm in length. Hornblende has anhedral to subhedral form and the maximum size reach up to 3 mm in length. It is rather altered to form pale green to grey green chlorite at its rims or along its cleavages. Biotite occurs as tabular habit and their size ranges from 0.3mm to 2mm in length. It has abundant inclusions of titanite, zircon and opaque.

Microscopically, **granodiorite** exhibits hypidiomorphic granular texture and composed of plagioclase feldspar especially oligoclase (30–40 %), potassium feldspar (15–20 %), quartz (25-30 %) and mafic minerals especially hornblende (5–10 %) and biotite (~5 %). Accessory minerals include sphene, apatite and iron-oxides. Plagioclase, An_5-An_{20} in composition, shows subhedral to euhedral outline and measures from 0.5 to 5 mm in length. Some grains exhibit zoning and albite, carlsbad and polysynthetic twinning. Plagioclase alteration to sericite is common. Subhedral to anhedral potassium feldspar

especially orthoclase and microcline are the major components. Cross-hatched microcline twinning is easily recognizable and their size ranges from 2 to 5 mm in length (Fig.13). Quartz usually occurs as separate crystals (0.1 to 3 mm) or as irregular aggregates with very variable sizes, filling interstices between the feldspar crystals. Hornblende occurs as subhedral to anhedral crystals and their maximum grains size reach up to 3mm. Brown hornblende resembles biotite, but the second has better cleavage. Biotite has subhedral to anhedral nature and range from 0.2 to 2 mm in length. Zircon is found as inclusions in biotite and displays brownish or purplish pleochroic halos.

Under microscope, **diorite** exhibits hypidiomorphic to xenomorphic granular texture and composed mainly of plagioclase feldspar especially andesine (50–75 %), hornblende (10–15 %), biotite (5-10 %) and quartz and orthoclase (~5%). Tiny sphene, apatite and magnetite are present as accessories. Plagioclase, An_{30}-An_{50} in composition, shows roughly equal subhedral nature and their size ranges from 1.5 and 3 mm. They often exhibit zoned and twinned character. Hornblende has strong pleochroism and their size ranges from 1mm to 3mm in length. Some crystals have cleavage in two directions that intersect at approximately 56° and 124°. It is partly altered and replaced by chlorite (Fig.14). Pyroxene especially clinopyroxene occurs as anhedual grains ranging from1mm to 5 mm in size. Intergranular quartz displays undulose extinction and their grain boundaries are irregular nature.

Microscopically, **monzonite** consists potassium feldspar (35–45 %), plagioclase (35– %), quartz (~5 %) and hornblende and biotite (10 %). Accessory minerals include opaque oxide apatite and sphene. Plagioclase, An_{30}-$An_{}$ composition, exhibits subhedral to euhedral outlin and ranging in size from 1 to 4mm in length. Th are oligoclase to andesine and some grains exhib zoning . The speckled appearance in the core i caused by fine inclusion of mica, quartz and apatit Potassium feldspar occurs as subhedral lath shaped with a maximum length of 3 mm. Flame-shaped and rarely string perthitic exsolutions of albite ar observed (Fig.15). Quartz fills intragranular crack

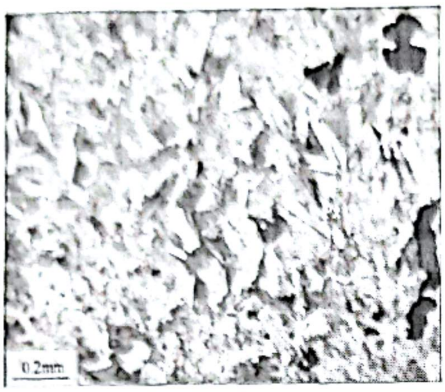

Fig. (16) Photomicrograph showing ophitic texture in dolerite. (Between X.N)

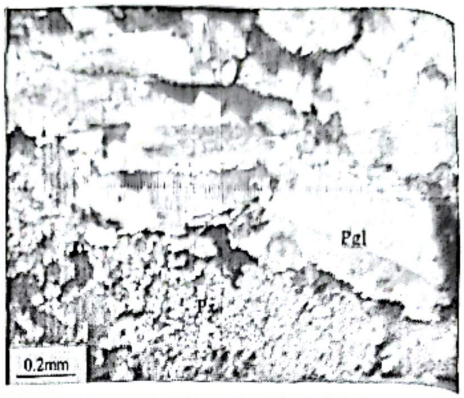

Fig. (17) Photomicrograph showing albite twin in plagioclase of gabbro. (Between XN)

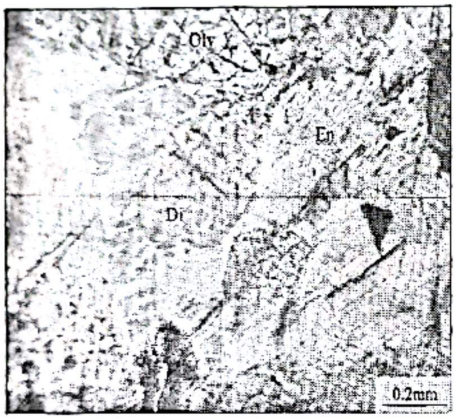

Fig. (18) Photomicrograph showing olivine, diopside and enstatite minerals in lherzolite. (Between X.N)

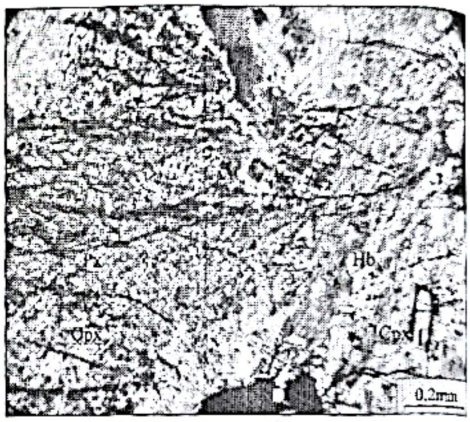

Fig. (19) Photomicrograph showing orthopyroxene and clinopyroxene minerals in pyroxrnite. (Between X.N)

in feldspars. Hornblende displays subhedral to anhedral nature and the maximum grain size exceeds 0.3mm. Subhedral to anhedral biotite can be recognized by its distinctive pleochroism and their size never exceeds 0.5 mm in length.

Microscopically, **dolerite** displays ophitic texture in which plagioclase especially labradorite (white grain with dark striping as a result of crystal twinning) are partly to completely enclose by pyroxene and olivine grains (coloured grains). It consists of labradorite (45–55 %), pyroxene especially augite and enstatite (35–45 %) and olivine (~5 %). Opaque oxides, apatite and sphene include as accessories amount. (Fig.16)

Microscopically, **gabbro** shows hypidiomorphic granular texture and composed mainly of plagioclase (50–60 %), pyroxene (20–30 %) and olivine and hornblende (1-5 %). Magnetite and ilmenite present as accessory minerals. Plagioclase, An_{40}-An_{70} in composition, commonly labradorite occurs as euhedral to subhedral nature and their size ranges from 2mm to 4mm in length. They can be recognized by the presence of albite twin, polysynthetic twin and display zoning (Fig. 17). Some grain shows speckled appearance in the core due to fine inclusion of mica. Untwinned grains display cloudy appearance due to alteration, sericitization and kaolinization. Orthopyroxene usually diopside is more influence than clinopyroxene. In some grains, the grain boundaries alter amphibole mineral which indicates fractional crystallization process. Their size ranges from 1mm to 3 mm in diameter. Olivine displays subhedral to anhedral nature and the maximum size reached up to 2mm in diameter. Under microscope, **lherzolite** (Fig.18) and **pyroxenite** (Fig.19) show coarse-grained, halocrystalline and hypidiomorphic to allotriomorphic granular texture. Lherzolite is composed of olivine (35–50 %), orthopyroxene (20–35 %) and clinopyroxene (20–35 %). Pyroxenite is composed mainly of pyroxene especially enstatite (50–65 %) and clinopyroxene (20–35 %). Accessory minerals include chromite, ilmenite and magnetite. Olivine occurs as anhedral nature with polygonal outline. Irregular fractures common and their size ranges from 2mm to 3mm in diameter. Serpentinization is frequently found at the cracks of the crystal. Orthopyroxene especially enstatite occurs as subhedral nature and their size reach up to 3mm in diameter. Tiny anhedral grains of chromite are concentrated within the enstatite. Clinopyroxene usually diopside occurs in subhedral crystals of short prismatic habit. Chromite, ilmenite and magnetite occur as opaque nature and varied sizes. It is rather altered to tremolite-actinolite.

Petrogenesis of igneous rock

The study area comprises composite igneous bodies, consisting of different outcrop nature and different composition. The main aim of this research is the outcrop nature and petrography of igneous rocks, from which to get the criteria for petrogenesis of igneous rocks. Therefore, petrogenesis is described on the basis of previous published literature, field data and petrographic criteria. The following facts are the jointly suggest the petrogenesis of igneous rocks from the study area as follows:

1. According to the extent of whole outcrop area, from eastern part of Washawng to Sadon waterfall area, complex mixture of hornblende granite and granodiorite comprise **40 to 60 %**, diorite **1 to 5%**, dolerite **5 to 25%** and gabbro and peridotite **1 to 5%** (Fig.3). Textural changes occur in some places, i.e., basalt to dolerite occur within a dolerite outcrop but pillow structure is not found. Rhyolite and dacite exposure are well observed at the northeastern part of the area. The composition ranges from **basalt to rhyolite** in volcanic is corresponding by the **peridotite-gabbro-diorite-granodiorite-granite** plutonic sequence. This igneous suite is rather similar to the Cordilleran-Type batholiths which exposed along the American Cordillera. Therefore, the igneous rocks from the study may be formed by plumbing system feeding the continental arc volcanic.
2. Repeated alternation of extension and compression occurred throughout the Mesozoic, presumably in response to fluctuations in global spreading rates. Extensional periods probably promoted upwelling and extrusion, whereas compressional periods inhibited magmatic rise, providing sufficient crustal residence time for magma ponding and fractionation. (Winter, 2001, p.332)
3. Palaeozoic and Mesozoic evolution involved the rifting and separation of three collages of continental terranes from eastern Gondwana and the opening and closure of three successive ocean basins, the Palaeo-Tethys (Devonian–Triassic), Meso-Tethys (Permian–Cretaceous) and Ceno-Tethys (Late Triassic–Cenozoic). The West Sumatra and West Burma blocks were accreted to the Sundaland core in the Late Permian–Early Triassic. (Metcalfe, 2011)
4. The Shan-Thai or Sibumasu Terrane extends from Malaysia, through peninsular Thailand, Myanmar, West Yunnan, to Lhasa.(Source: Wikipedia)
5. According to rock associations, petrological and geochemical features and Sr-Nd isotopic ratios, Zhang, et. al suggested that the Myitkyina-Mogok ultramafic-diorite belt, within the Cimmerian continental sliver, was generated in a Jurassic continental margin arc, which extended southwards to the Kyanigan Hills (18 km northeast of Mandalay), Mandalay Hill and Padatchaung, along the western Shan-Thai Plateau. (Zhang, J.E. et. al., 2018)
6. Mostly discordant and some concordant structural relations to the country rocks. The chilled border zones are present. Enclaves are rather common in granitoids. Mafic microgranular enclaves in granitoid pluton of the study area indicate the process of partial melting and fractional crystallization of basic magma, and enclaves are trapped blobs of basic initial magma.
7. Under the microscope, cross-hatched twin are frequent in alkali feldspar. Zoning and twinning are common in plagioclase.
8. Dolerite exhibits ophitic texture that indicates the minerals crystallized out of the magma to in a certain order: first plagioclase, then pyroxene.
9. Temperature of country rock from the study area may be greater than 450°C. The country rock belongs to amphibolite facies.

The above facts jointly suggest that the igneous rocks from the study area may be formed as **continental arc** which related to India-Eurasia subduction during the Mesozoic and Early Cenozoic time. The magma source of igneous rocks may relate the partial melting of subduction oceanic plate generates primary magma and then at the base of the less dense crust where assimilation and the solidification of a gabboric crustal

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underplate process may take place. Subsequent partial melting of this mafic underplate may result from heat carried upward by subsequent basaltic magma. Fractional crystallization and contaminated by continental crust materials occurred when it travel through the crust. Some granite and pegmatite probably formed by partial melting of lower or middle crust.

Conclusion

The study area is situated about 11 km east of Myitkyina Township, Kachin State. The igneous rocks exposed in the study area are pegmatite/aplite, hornblende granite, granodiorite, diorite, monzonite, gabbro, dolerite, lherzolite and pyroxenite. Various sizes of mafic microgranular enclaves are found in granitoids. In accordance with microscopic criteria, these igneous rocks display medium to coarse-grained, hypidiomorphic to xenomorphic-granular texture for intrusive and subophitic and porphyritic texture in extrusive. Petrographic criteria reveal . fractional crystallization process, i.e. the minerals crystallized out of the magma to in a certain order. Field data and petrographic criteria jointly suggest that the magma source of igneous rocks may communicate the partial melting of subduction oceanic plate generates primary magma and then at the base of the less dense crust where assimilation and the solidification of a gabbroic crustal underplate process may take place. Subsequent partial melting of this mafic underplate may effect from heat passed upward by subsequent basaltic magma. Fractional crystallization and contaminated by continental crust materials occurred when it travel through the crust. All of the above facts collectively suggest that the igneous rocks from **the study area may be formed as continental arc** which related to India-Eurasia subduction during the Mesozoic and Early Cenozoic time. To know more detail tectonic history for SE Asia and to explore the precious materials of Kachin State, many researchers should make researches in Kachin State.

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GEO 003

Plagiogranite from the Ophiolite Complexes in Kyaukphyu and Webaung Areas

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Abstract

Geochemical data of plagiogranites associated with ophiolite complexes Kyaukphyu and Webaung Ophiolite are presented. Plagiogranites occur as dykes or intrusive bodies in the upper part of the gabbrodolarites or diabase section in the ophiolite sequence. On the basic of normative An-Ab-Or diagram, most of studied plagiogranites are classified as tonalite and tronhdjemite. They are typically low in K_2O, FeO and MgO. They also contain low to moderate Al_2O_3 but light SiO_2 and Na_2O. Their ocean ridge granite normalized patterns of trace elements displaying low contents of HFS and high contents of LIL elements are very similar to those of the volcanic arc granites. But assuming that in trace element pattern elevated K_2O and Rb contents are result of alteration. The using of Peacock index reveals that they are characterized by calcic character what is typical for supra-subduction ocean ridge granite. The studied plagiogranites are probably formed in extensional conditions above a subduction zone and in terms of their origin the most probably related to crystal-liquid differentiation processes.

Keywords: plagiogranites, supra-subduction ocean ridge granite, crystal-liquid differentiation

Introduction

All ophiolite complexes in small volume are high SiO_2, low K_2O leucocratic rocks of hypabyssal type. They usually occupy the upper section of the ophiolite sequence and are related with layered or massive gabbro. Since these leucocratic rocks contain potassium feldspar only in very rare instances, the term plagiogranite is used as a general descriptive term. The term plagiogranite describes a leucocratic rock made primarily of plagioclase and quartz, with minor ferromagnesian minerals, virtually devoid of K-feldspar and with very low bulk K_2O typically around 0.2 % [in7]. Small volume of felsic magmatic rocks associated with ophiolitic complexes has compositions ranging from granite, through trondjemites, albite granites, albitites, quartz diorite and tonalite to diorite. [in7] proposed that the name oceanic plagiogranites for the plagiogranites associated with ophiolites to avoid the confusion with the same rock types originated in the continental environment.

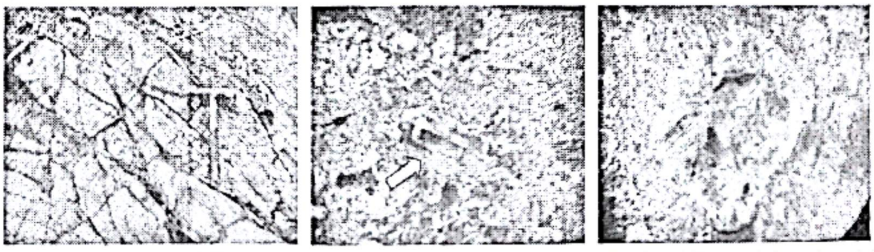
Three different processes have been suggested for the origin and development of plagiogranites in the oceanic environment. The formation of oceanic plagiogranite has been featured primarily to either:

1. Crystal-liquid differentiation process from primitive basic magma or
2. Liquid immiscibility in silicate melts and
3. Partial melting of basic rocks under hydrous conditions [in 4].

However, the most common process of formation of plagiogranites in the ophiolites is fractional crystallization [in 7]. It is obvious that a single process is not responsible for the formation of plagiogranites but a combination of two or more processes. Generally felsic/intermediate rocks with a similar chemistry and petrography to plagiogranites are also relatively common occurrence in modern, and analogous, ancient oceanic settings such as mid-ocean ridges, island arcs, and back-arc basins [7].

Field relations and petrography

Leucocratic acid and intermediate rocks are found some localities in ophiolitic complexes of Kyaukphyu-Webaung area. They usually occur as vein, dikes or small intrusive bodies in the upper part of the gabbrodolerite or diabase section in the ophiolite sequence. Sometimes they also intrude the mantle peridotite parts of the ophiolite sequences. The thickness of the dikes is commonly in the range of centimeter to meters. Investigated plagiogranites encompass a wide spectrum of rock types as granite, granodiorite, tonalite and tronhdjemite. The textures of the plagiogranites are determined by the position in the ophiolite sequence. They vary from allotriomorphic and



(a) (b) (c)

Figure (1)(a) Plagiogranite exposure at the base of Ayo Taung on the west bank of Nansein Chaung (Loc.: 23° 12′ 01.5″ N, 96° 07′ 23.8″ E), (b) Oscillatory zoning in plagiogranite and (c) Sericitization observed in plagioclase feldspar, under XPL

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hypidiomorphic granular types to subporphyritic type being characterized by the micrographic, myrmekitic or granophytic groundmass. The plagiogranites generally exhibit more or less cataclastic deformation (Fig.1, a).

The principal minerals in plagiogranites are quartz, albite or acidic plagioclase and sporadically amphibole Accessory minerals are represented by apatite, zircon, rutile and magmatite. The rocks are always more or less altered containing different secondary minerals such as actinolite, chlorite, epidote, coisite, prehnite, muscovite, sericite and sphene. Quartz commonly occurs as anhedral, smaller interstitial grains which display wavy extinction. Plagioclase observes as subhedral to anhedral crystals which display extinction and zoning is sometimes present in albite. Oscillatory zoning is also noted (Fig.1, b). Most plagioclase crystals are partially altered to sericite along the twin planes and cleavage traces (Fig.1, c).

Geochemistry

Analytical techniques

Major elements and the trace elements of the four samples were measured by wavelength-dispersive X-ray fluorescence spectrometry in the URC (University Research Center) of Mandalay University and Kyusu University of Japan. The major oxides of the plagiogranites in ophiolite suite are shown in table (1) and minor and trace elements are in table (2).

Table (1) Major oxides of Plagiogranite in Ophiolite suite

Sample No.	On Graph	SiO_2	TiO_2	Al_2O_3	Fe_2O_3	FeO	MnO	MgO	CaO	Na_2O	K_2O	P_2O_5	H_2O	Total
26086	◇ 1	75.91	0.35	12.82		1.91	0.03	1.60	1.07	3.80	0.35	0.05	2.04	99.94
2903	△ 2	74.51	0.60	12.44		3.99	0.11	2.02	0.43	3.93	0.09	0.09	1.75	99.94
2902b	+ 3	73.75	0.71	11.88	2.43	1.62	0.12	2.03	1.39	3.76	0.15	0.15	1.96	99.95
2804	× 4	69.23	0.48	13.85		4.59	0.13	2.50	1.62	3.57	0.81	0.10	3.11	99.99

Table (2) Minor and Trace Elements of Plagiogranite in Ophiolite Suite

		Incompatible (ppm)						LIL (ppm)				HFs (ppm)				Compatible (ppm)			
Sample No.	On Graph	Ni	Co	Cr	Cu	Zn	V	Rb	Ba	Sr	Pb	Zr	Nb	Ta	Y	S	As	Mo	Cl
26086	◇ 1	8	43	0	2	0	46	3	28	218	0	152	3	0	28	114	5	5	
2903	△ 2	7	17	0	3	19	48	0	0	106	0	210	4	0	40	133	2	5	
2902b	+ 3	6	28	0	23	54	52	0	62	108	0	172	3	0	48	141	0	1	
2804	× 4	3	35	0	5	87	39	12	46	77	0	147	4	0	44	161	2	2	

Bulk Rock Geochemical Results

The K_2O content of plagiogranites from the investigated area is low (0.09-0.81 wt %). The content of Na_2O is very high (3.57-3.93 wt %) and the Al_2O_3 content is moderate to high (11.88-13.85 wt %), whereas SiO_2 content yields high values (69.23-75.90 wt %). The higher content of Al_2O_3 in the plagiogranites is likely due to plagioclase accumulation [7].The contents of iron and magnesium oxides are also generally low. All of these factors are typical for plagiogranite from ophiolite complexes all over the world [4].

Classification

According to SiO_2 vs. $Na_2O + K_2O$ diagram, the plagiogranite samples in the study area fall in the granite filed with exception one sample which falls in granodiorite field (Fig. 2).

In the Ab-An-Or normative triangle of [8], the plagiogranite falls in the tonalite field and trondhjemite field (Fig.3 A). In CaO -Al_2O_3 - Na_2O+K_2O plot [12] the plagiogranite sample is included in the peraluminous field (Fig. 3 B).

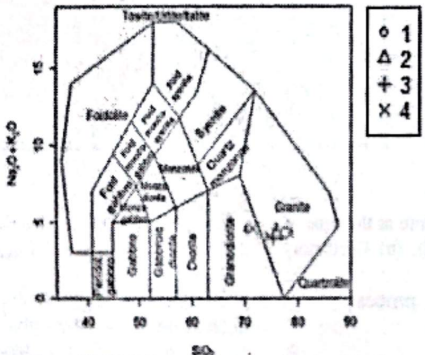
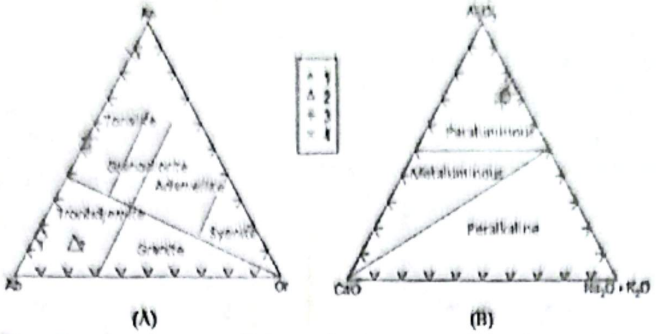


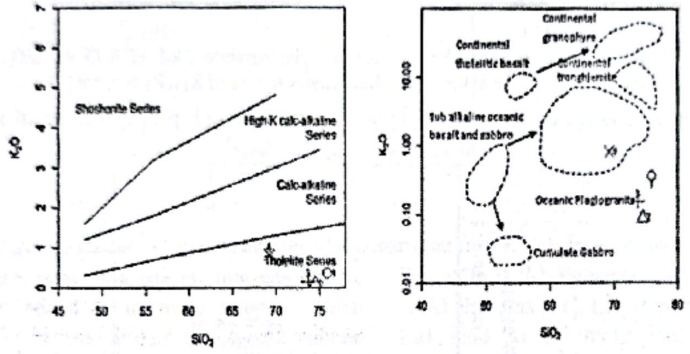
Figure (2) TAS diagram showing the classification and nomenclature of plutonic rocks [6].



(A) (B)

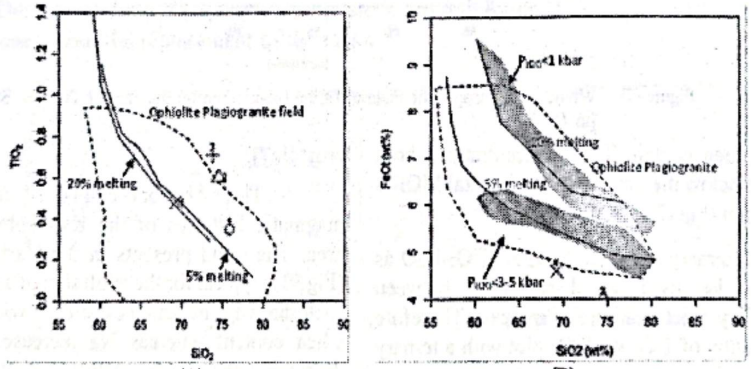
Figure (3) (A) Normative Ab-An-Or diagram for plagiogranites of the study area which fall in the tonalitic field and in the trondhjemite field [8]; (B) Ternary plot of CaO- Al_2O_3-Na_2O+K_2O diagram showing the plagiogranites in peraluminous field [12]

The SiO_2 vs. K_2O diagram of [10] indicates that the plagiogranites have the oceanic character (Tholeiite Series) (Fig.4A). Moreover, the same plot of [2] shows that the plagiogranite samples fall in the oceanic plagiogranite field (Fig.4B). It also demonstrated that the nature of extreme low potassium content in these rocks.



(A) (B)

Figure (4) The SiO_2 vs. K_2O diagrams of (A) Peccerillor and Taylor, 1976 showing the plagiogranites in tholeiitic series (B) [2] indicates the plagiogranite falls in the oceanic plagiogranite field.



(A) (B)

Figure (5) (A & B) SiO_2 versus total TiO_2 and SiO_2 versus total FeO diagrams showing the environment of plagiogranite rocks [15].

The use of SiO_2 versus TiO_2 and total FeO diagrams indicates that the plagiogranites fall in ophiolitic plagiogranite field (Fig. 5A & B).

Petrogenesis of Plagiogranite

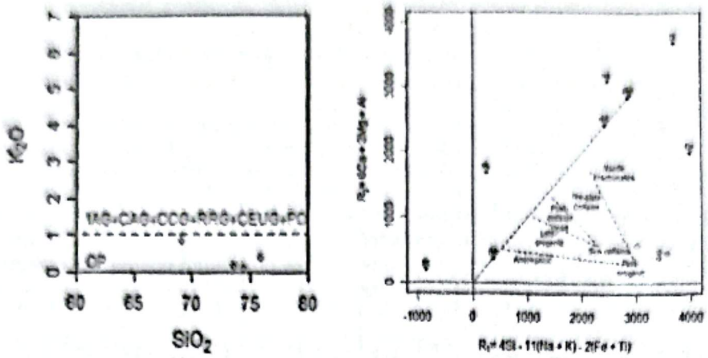
SiO_2 - enriched plutonic rocks within the lower oceanic crust, diorites and quartzdiorites are believed to be generated by magmatic processes similar to those active in present-day mid-oceanic ridges. But few others have indicated that plagiogranites may represent partial melts and thus means more complex set of processes. Recently accepted the idea of partial melting implies that the low pressure melting of hydrated oceanic gabbro produces plagiogranite melts.

The petrogenetic studies of plagiogranites of ophiolite suites are complicated by post-magmatic structural, mineralogical and chemical changes. Plagiogranites from the ophiolite suites are commonly associated with layered or massive gabbro at the top of the cumulate portion of ophiolites, which represent sections of former oceanic crust.

Ophiolite assemblages commonly bear evidences of hydrothermal alteration, due to

intensive seawater circulation in sub-sea floor environment, brecciation and later off-axis metamorphism. The high Na_2O and low K_2O in plagiogranites are due to exchange with seawater or late magmatic vapour-phase transport, and removal of K_2O [in 7]

In the K_2O vs. SiO_2 diagram of [5] the line dissected into oceanic plagiogranite and other granitic rocks of other tectonic provinces. According to this diagram, the most plagiogranite are plotted in oceanic plagiogranite field (OP) (Fig.6 A). According to R_1 vs. R_2 diagram of [1] indicates that the plagiogranites are formed at the mantle fractionated regime (Fig.6 B). It can be concluded that the plagiogranites of the study area are formed at the oceanic volcanic arc (island arc) of mantle fractionated regime.



(A) (B)

Figure (6) (A) All samples lie within the oceanic plagiogranite filed of K_2O vs. SiO_2 diagram [5]; (B) lie in the mantle fractionates regime of R_1 vs R_2 diagram [1].

The rocks investigated from Kyaukphyu-Webaung area contain TiO2 concentrations both above and below the limit for experimental MORB fractionation (Fig. 7).

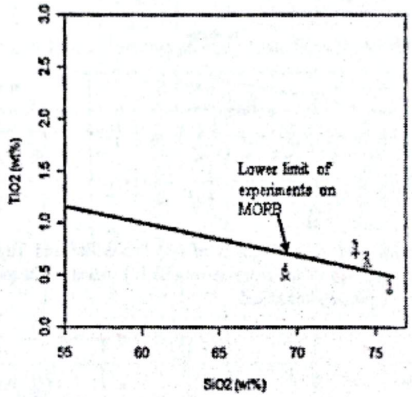


Figure (7) Whole rock petrogenetic discrimination (plagiogranite) diagram of TiO_2 vs. SiO_2 [in 7]

A ternary plot with $SiO_2/50$-TiO_2-K_2O as apex can be used to discriminate between immiscibility, fractionation and anatexis. Therefore, a combination of TiO_2 vs. SiO_2 plot with a ternary plot using this diagram can be used to discriminate on the origin of natural plagiogranites [in7].

The ternary plots of AFM and TiO_2-K_2O-$SiO_2/50$ diagram proposed by [in 7] (Fig.8A & B) indicate that the plagiogranites are calc-alkaline in character. Most of the samples overlap both fractionation crystallization of MORB and hydrous partial melting of mafic oceanic crust.

However, a distinctive compositional feature identified in experimental partial melts of hydrated gabbro and diabase in low TiO_2 concentration (<~ 1 wt% at SiO_2>~ 55 wt %), a diagnostic indicator of natural plagiogranite formed through partial melting of mafic oceanic crust [in7].

The Harker diagrams indicate the magmatic histories of the Kyaukphyu-Webaung area. The trend presents in the Harker diagrams (Fig.9) is typical for the evolution of a magma suite such that Mg, Fe and Ti decrease with increasing silica content whereas Na increase. Al and K decrease with increasing silica content. K would be expected to increase with increasing silica content. This transition from K enrichment to K depletion for the Kyaukphyu-Webaung samples may represent a change in the dominant fractionating phase which controls K such that a K-rich phase began fractionating at 69 and 75 % SiO_2.

Na_2O appears to increase with increasing silica content rapidly above 75 % SiO_2. Alternatively, partial melts of a source rock could have been initially poor in K and rich in Na until a K-rich phase began late melting when the magma fractionating or partial melting phases with minor or trace elements.

Multi-element diagrams commonly show a large number of peaks and troughs due to the differences in behavior between the large ion

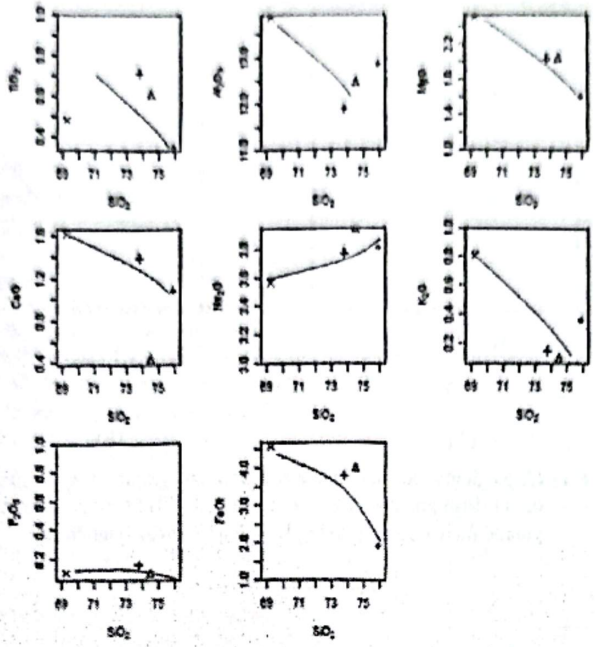
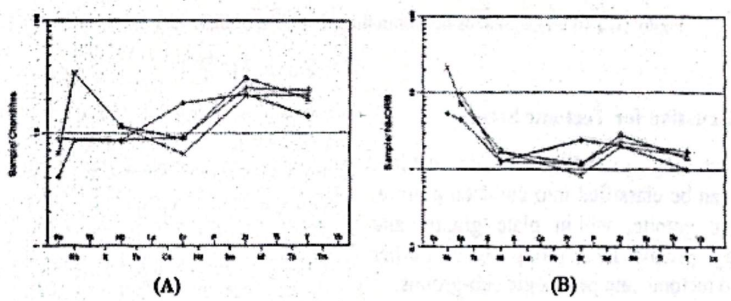


Figure (9) Harker's variation diagram of plagiogranites from Kyaukphyu-Webaung area.

became SiO_2 rich. This late melting could have temporarily added K to some magma, which subsequently became diluted as the melt volume increased, relatively lowering K and Na concentrations along with SiO_2. Regardless of mechanism, something clearly changed in the evolution of these magmas at approximately 73-75 % SiO_2. This may be due to the loss of an important Si-rich mineral and the replacement of the major

lithophile (LIL) elements and high field strength (Hfs) elements [11]. LIL elements (e.g. Cs, Rb, K, Ba) tend to be more mobile which causes concentrations to be affected by aqueous fluids, whereas Hfs elements (e.g. Y, Zr, Nb) tend to be immobile and controlled by the melt source and petrogenetic processes such as fractional crystallization [11].



(A) (B)

Figure (10) Spider plots of (A) chrondrite normalized composition of plagiogranite [14]; (B) NMORB normalized of trace element composition of [13].

Chondrite-normalized plots for the plagiogranite rock samples are shown in figure (10 A) and figure (10 B) shows trace elements normalized to NMORB with a combination of LILEs and HFSEs. The normalized patterns of plagiogranite rocks display enrichment in Ba, Rb but Sr is enriched in sample no. 1 and depleted in sample no. 2, 3 and 4, and depleted in Nb and Y, whereas Zr is enrichment.

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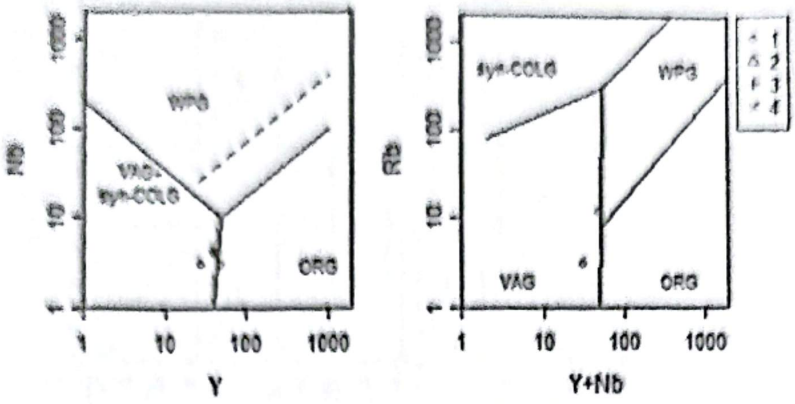
According to above mentioned, it can be concluded that the plagiogranites of the Kyaukphyu-Wehaung area are tentatively interpreted as being resulted from MORB fractionation and anatexis.

The plagiogranite from normal and anomalous subduction-unrelated ridges plot into alkali-calcic field, those from normal back-arc ridges into calc-alkali feldspar, whereas plagiogranites from SSZ ridges plot into calcic



(A) (B)

Figure (11) (A)plagiogranite plot in the volcanic arc granite + syn-collision granites and ocean-ridge granites of Nb vs. Y after [9]; (B) Plagiogranites fall in volcanic arc granite filed according to log Rb – log (Y +Nb) diagram [9].

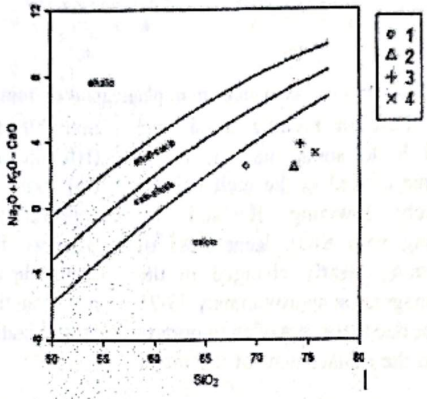


Figure (12) all plagiogranites lie within the calcic filed of SiO_2 vs. $Na_2O + K_2O$-CaO [2].

Discussion for Tectonic Setting

According to [9]'s tectonic setting, granitoids can be classified into collision granite, volcanic arc granite, within plate granite and oceanic ridge granite. Each group can be further divided into tectonic and petrologic sub-groups.

Oceanic plagiogranites are assumed to have formed at ocean ridge. They could be formed not only at subduction-unrelated ocean-ridge, but also at subduction-induced ocean ridge. The former are named as 'normal' if their main volcanic product is an N-type MORB and 'anomalous' if dominated of E-type MORB [in 4].

The subduction-induced oceanic ridges could also be 'normal' if their associated basalts are N-type MORB, but they are described as 'Supra-subduction zone' (SSZ) if their volcanic product has an island arc tholeiite or boninite character [in 4].

field [in 4].

Plotting on the discrimination diagram (Fig. 11 A) of Nb vs. Y three samples fall in the field of VAG + Syn-COLG (volcanic arc granite and syn-collision granites) and one sample plots in the field of ORG (ocean-ridge granite) of [9]. However, in the log Rb – log (Y +Nb) tectonic discrimination diagram [9], the studied plagiogranites plot in the volcanic arc granite field (Fig. 11 B).

Using the [2] reveals that the plagiogranites of the present area have calcic character (Fig.12), which is typical for supra-subduction ocean ridge granite [in 4].

CONCLUSION

The plagiogranites of the investigated area are tonalities and trondhjemites. Their petrographic and geochemical characteristics closely resemble volcanic arc granites having low contents of HFS and high contents of LIL

elements. Using the AFM, the TiO_2-K_2O-SiO_2/50 diagram, and the spider diagram, they are resulted from MORB fractionation and anatexis. However, the characteristics of plagiogranites from Kyaukphyu-Webaung area are peraluminous, tholeiitic, calcic, oceanic and ophiolitic at volcanic arc and mantle fractionated. Therefore, it can be concluded that they could belong to supra subduction oceanic ridge granites.

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Stratigraphy and Structure of the Rock Units Exposed along the Bank of the Ayeyarwady River, at the First Defile Area, Sinbo Township, Kachin State

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Abstract

The purpose of this research is to investigate the stratigraphy and structure of the rock units exposed along the bank of the Ayeyarwady River, at the first defile area. The presented results are mainly based on the field observations and petrographic analyses. This area is situated in the northern part of the Tagaung-Myitkyina belt of the Ayeyarwady province. The predominant rock types of the study area are peridotite (harzuburgite, lherzolite and wehrlite), serpentinite, and gabbro. The phyllitic slates are occurred at the basal part of the ultramafic rocks. The dyke units, pillow basalt, greywacke, radiolarian chert (red and green) and Orbitolina rich limestone are minor rock units. They are exposed in close proximity to one another within a small and narrow region. All these associated rocks are highly deformed by tectonism. The major fault thrust up the mafic and ultramafic body to form high lands rising above low level plain and trending N-S direction. These rock sequence and structure of the study area lead to a deformed and dismembered ophiolite suite.

Keywords: ultramafic, mafic, serpentinite, ophiolite, Orbitolina

Introduction

The study area is located about 73 km Southeast of Myitkyina and 60.7 km Northwest of Banmaw, in Sinbo Township, Myitkyina District, Kachin State. This area is bounded by North Latitudes from 24° 39' to 47' and East Longitudes 97° 01' to 06', vertical grids 012 to 080 and horizontal grids 280 to 430, of the UTM map (2417 1-2). This area is situated in the northern part of the Tagaung-Myitkyina belt of the Ayeyarwady province Mitchell (1981). The purpose of this research is to investigate the stratigraphy and structure of the rock units exposed along the bank of the Ayeyarwady River, at the first defile area.

Materials and Methods

The study carried out for achieving the desired goals and objectives included two stages: field studies and laboratory studies. The data collected and checked, both in the field work and combined to prepare the fairly detailed geological map. The representative rock samples were taken off the different rock units in the area. Field observations were with the petrographic examination of 100 thin sections for the identification of detailed mineralogical character, textural features and other structural features. The classification and naming followed the IUGS classification and William, Turner & Gilbert (1982) for igneous and metamorphic rock and Kerr (1959), for optical mineralogy study. Sedimentary rocks are mainly based on Tucker (2001), Raymond (1995) and Danham (1963).

Results and Dissusion

Regional Geologic Setting

The study area is a northern continuation of the Tagaung-Myitkyina Belt of Upper Ayeyarwady Province of Mitchell (1981). It is situated along the western rim of Sino-Burman Ranges extending from, Sumprabon in the north through Myitkyina area and Banmaw, Shwegu and Tagaung in the south. The study area lies in the Eastern Ophiolite Belt of Hutchison (1975) and Hla Htay (2006).

Structure

The mafic and ultramafic rocks of ophiolite suite in the study area are mostly forming as inliers and oceanic rock units as outliers. In this area, mainly peridotite and partly dunite and pyroxenite are partially to wholly alter to serpentinites. Serpentinites are originally related with tectonic movements, and mostly found near the contact of faults and thrust fault. Nearly all ultramafic rocks react to shallow tectonism by brittle fracture and characteristically exhibit a cubic set of joints. These joints control the invasion of water into the peridotite and develop the serpentinite mesh structure down to the olivine grains (Coleman, 1977) (Fig.1).

Ophiolite igneous cumulates show systematic variation in the crystallization sequence of minerals corresponding to the petrologic diversity of the underlying peridotite mantle. The ultramafic and mafic units are shown faint layering suggestive of cumulate structures at some places (Fig.2). Most of them are layered and the individual thickness of these layers about 3cm. Some layers are tilting at high angles as toward SW.

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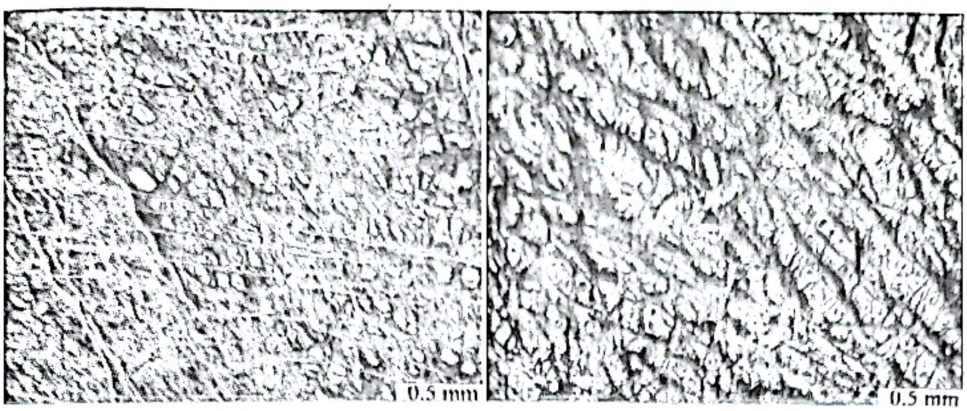

Figure 1 Photomicrograph showing (a) well-developed mesh textures found in serpentinite (N 24° 44' 32.1" & E 97° 03' 29.0", XN) (Ol= olivine, An= antigorite)

Figure 2 Photomicrograph showing cumulate texture in serpentized dunite. (N 24° 45' 50" & E 97° 03' 41", XN) (Ol = Olivine, Ser = Serpentinite).

Pyroxenite dyke which intrude ultramafic body near southern part of Weigyi village and trending NW-SE direction (Fig.3). The mafic sheeted dykes, dolerite and basaltic dykes act as feeders for the overlying pillows (Figs.4, 5, 6 & 7). In some places they are also intruding phyllitic slate and ultramafic body at (N 24°39' 53" and E 97°05' 27").

Foliation can only be seen in metamorphic units of phyllitic slate and Hornblende gneiss. Phyllitic slates are highly folded and jointed. Locally, they show recumbent fold with westerly dipping axial planes. The slump folded limestones indicated the marine slope area between shelf and basin (Fig.8).

Generally, most rock units in the study area are trending NNE-SSW and dipping toward SW. The contacts of all rock units are sharp and faulted contact. Characteristic features of tectonic movements are also observed as slicken side and drag folds in some places.

The western and southern part of the study area is bounded by north-south trending regional fault (Sagaing fault). To the east and south-east is covered with highly deformed Mogok Metamorphics. And compressive force of subduction zone has been exerted since Mesozoic era. Therefore, the rocks of the area are highly deformed and disturb. The ultramafic and mafic body is thrust up to form high lands rising above low level plain.

The east dipping major thrust fault in the present area is situated along the western margin of ultramafic body parallel to the Ayeyarwaddy River. The prominent joint sets developed in these rocks are trending nearly NW-SE. According to this joint pattern the force direction may be nearly N-S.

Stratigraphy

Six main rock units were occurred in the research area. All these associated rocks are highly deformed by tectonism. They are exposed in close proximity to one another within a small and narrow region. Stratigraphically and structurally, the rock suite of the study area belongs to the ophiolite suite. The sequence of the rock units mapped in this area is shown in Table 1& 2 and (Fig 9).

Ultramafic and related rocks: The main rock units of the ultramafic body are peridotite (harzburgite, lherzolite and wehrlite) and serpentinite with minor dunite. They are yellowish-brown to dark-brown, medium to coarse - grained units and well-exposed around the Wegyi village. Pyroxenite most probably occurs as dykes which intrude ultramafic body and trending to the NW-SE direction. They can be observed at N24° 46' 09" and E 97° 04' 37" near southern part of the Wegyi village with layering within the ultramafic rocks. Most of them are pale-whitish to deep-green with vitreous lustre which attracts local people's fancy as synthetic jade. Serpentinites are the alteration product of ultramafic rocks and show green color with soapy feel and waxy texture on their surface (Figs.10&11).

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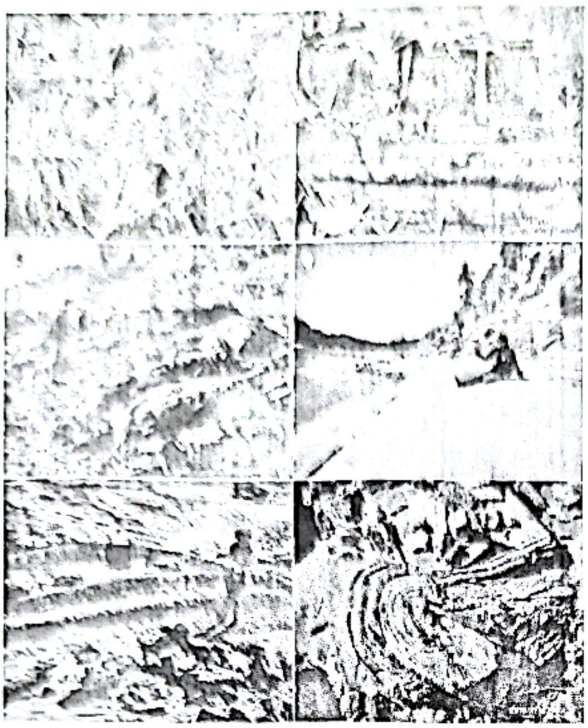

Figure 3 Photograph showi
pyroxenite dyke in the outcrop.
24 45'46" & E 97 03'35")

Figures 4 and 5 Photographs
Gabbroic rocks (a) showing massi
(b) layered structure. (N 24'44'35
& E 97 03'27.5") and (N 24'46'35
& E 97 03'27.5")

Figure 6 Photograph showin
doleritic dyke intruded in gabbroi
rock complex and phyllitic slate.
24'42'52.5" & E 97'04'17.3")

Figure 7 Photograph showing basalti
dyke intruded in phyllitic slate and
sedimentary units. (N 24'44'32" &
97'03'30")

Figure 8 Photograph showing slum
folded limestones indicated the
marine slope area. (N 24'40'03" &
97'05'22.8")

Mafic and related rocks: Gabbroic complex is found as leucogabbro and olivine gabbro. Leucogabbro are coarse-grained, light to dark-grey in color and highly jointed. Olivine gabbros are dark grey in color, medium to coarse-grained, hard and compact. In generally, both of these units are showing boulder structure but some are showing layer structure (Fig.12).

Mafic sheeted dyke complex: As mafic sheeted dyke complex, the dolerite dykes occur in the lesser portion of ultramafic body and it is intruded into sandstone unit of Jurassic in age so that it may probably be Jurassic in age. They are fine to medium-grained and showing exfoliation characters in some places. The intrusive basaltic dykes are greenish-grey to dark-grey in color and found as perpendicular to the river section (Figs.3, 4, 5& 6).

Metamorphic rocks: They are composed of hornblende gneiss and phyllitic slate. Near Weigyi village, hornblende gneiss is medium-grained, thin- to medium-bedded, dark-grey on weathered surface and grey-green on fresh surface. It is generally gneissose which only occurs in a contact shear zone at the base of the ultramafic body. Phyllitic slate is fine-grained, thinly foliated and well fissible. This unit show buff to grey-color, highly folded, jointed and brecciated at the southern part of the study area (Figs.13&14).

Ngapyawdaw Chaung Formation: The present study follows up the name "Ngapyawdaw Chaung Formation" is used for the combining of greywacke (feldspathic lithic greywacke), chert, pillow basalts and Orbitolina limestone. Greywacke in the area is greenish to dark-grey in color, fine to medium-grained, and medium to thick-bedded (Fig.15). Radiolarian bearing cherts are thin to thick-bedded and fine-grained texture (Fig.16). Both red and green chert can be observed in the study area. Generally, they are well-bedded (bedded chert) but massive in someplaces. Chert and chalcedonic quartz are interbedded and well-exposed with green chert at the Pashaw area. The trends of the units are NW-SE. The Late Jurassic age of the greywacke, the red chert and the green chert are situated in sequential order which can be correlated with those rock sequence exposed in Myitsone area and Ngapyawdaw Chaung Formation of Tagaung Taung Area (La Ja, 1984 and Hla Htay, 2006). Basalts are exposed along the western bank of the Ayeyarwady River (Fig.17). The types of basalt are amygdaloidal basalt, pillow basalt ad massive basalt. They are bluish-green to dark-green in color, very hard and compact. *Orbitolina* sp. rich limestones are medium to thick-bedded, grey to bluish-grey color on the weathered surface and its fresh surface is bluish grey colour (Fig.18). Locally, they are found as massive and calcite vein are also common. They overlie the greywacke and the age may be early Cretaceous (Hamedanian *et al*, 2017) The unit is nearly NE-SW with dip of about 23°/290°. At the present area, greywacke, chert, limestone and mélange are found as alternating sequence.

Melange: They are found on both sides of the Ayeyarwady River and are found as alternating sequence with other units such as chert, limestone and greywacke. Several sizes of clasts are found in the melange zone. It can be found as massive boulder and crinkly texture is also observed. Their morphological features are rough on their surface just like megaporphyritic texture and all the clasts are not well rounded and sorted. The entire rock unit in the study area is present as clasts in this unit (Fig. 19). It may be correlated with Pleistocene age of the Myitsone area.

Alluvium and gravel bed: Recent alluvial and gravels (Quaternary) occurred wide spreadly in

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the study area especially east and west banks of the Ayeyarwady River. Recent river terraces are also found as conglomeratic bed. This unit occurs as distinct fan-shaped bodies in low-lying area. This fanglomerate consists of pebble to boulder size of the other surrounding units and appear as wedge shaped in stream section (Figs. 20 & 21).

Correlation and Age

The possible stratigraphic position and age are determined regarding on the field observations, petrographic analyses, lateral continuity to the established lithostratigraphic units and lithologic correlations. Correlations with neighboring area are shown in Table. 2.

The following descriptions are used to postulate the possible age for ultramafic and related rocks of the study area.

Ophiolitic rocks from near Myitkyina were studied by Yang *et al* (2012) who described late lower to early middle Jurassic from zircon U-Pb ages. Rock units in the present area are lithologically similar and laterally continuous to those of the rock near Myitkyina area.

Maung Maung *et al* (2014) in Myitsone confluence of Myitkyina area assigned interbedded mustone, greywacke, siliceous tuff, rare chert and thin limestone to the Ngapyawdaw Chaung formation. The red chert and red clays contain radiolarian of Middle to Upper Tithonian (latest Jurassic) age.

Hla Htay (2006) noted that metamorphic rocks associated with ophiolite suite and Cretaceous limestone of Myitsone Area (confluence of Ayeyarwady, northeastern part of the study area, are equivalent of Ngapyawdaw Chaung Formation of Triassic to early Cretaceous age.

From above mentioned criteria, ophiolite and related rocks of in the study area are tentatively assigned as the age of late Triassic to Pleistocene.

Conclusions

The rock types exposed in the study area are ultramafic- mafic and related rocks, the dyke units, pillow basalt, greywacke, radiolarian chert (red and green), Orbitolina rich limestone and phyllitic slates. They are exposed in close proximity to one another within a small and narrow region. All these associated rocks are highly deformed by tectonism. The major fault thrust up the mafic and ultramafic body to form high lands rising above low level plain and trending N-S direction. These rock sequence and structure of the study area lead to a deformed and dismembered ophiolite suite.

Figure 10 Photograph showing outcrop of peridotite (Harzburgite). (N 24°47' 07" & E 97°04' 37")

Figure 11 Photograph showing smooth shining, dark greenish color and soapy feel surfaces of serpentinite (N 24°44'32" & E 97°03'30")

Figure 12 Photgraph showing highly jointed serpentinized gabbroic rock in outcrop. (N 24°44'2.4" & E 97°03'32.5")

Figure 13 Photograph of Phyllitic Slate showing (a) highly jointed and nearly vertical dip (b) highly folded in nature (N 24°40'29.9" & E 97°04'35.7")

Figure 14 Photograph showing thin- to medium-bedded, dark-grey color hornblende gneiss in the south of Weigyi village. (N 24°45' 58" & E 97°03'38")

Figure 15 Photograph of medium to thick-bedded, dark-grey color greywacke. (N 24°39'47.3"&E 97°05'35.9").

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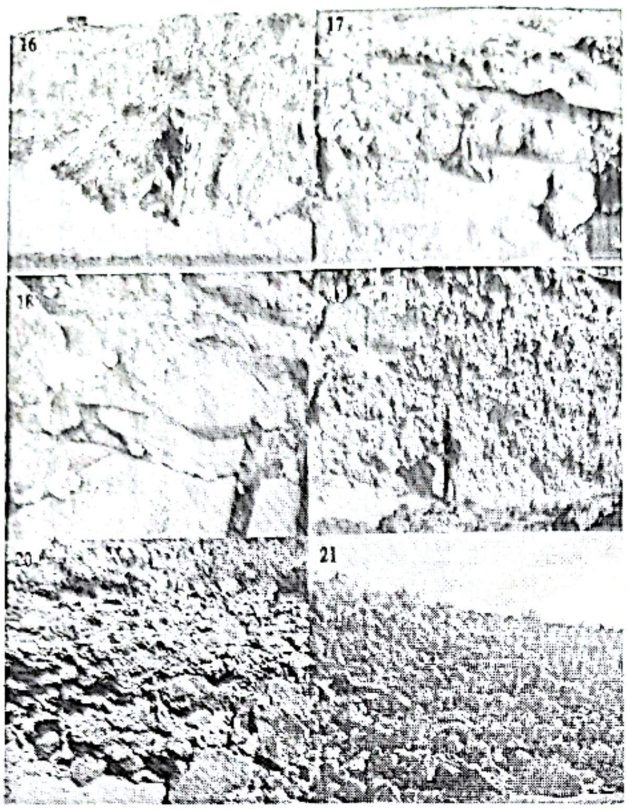

Figure 16 Photograph showing highly deformed thin-bedded, buff to red color chert. (N 24°40' 27.1"&E 97°05' 5.4")

Figure 17 Photograph showing pillow basalt alternate sequences with red chert. (N 24°46'50" & E 97°02'42")

Figure 18 Photograph showing medium to thick-bedded, dark-grey *Orbitolina* sp. bearing limestone with convolute structure. (N 24°40'03" & E 97°05'22.8")

Figure 19 Photograph showing exposure of melange zone. (N 24° 42'52.5" & E 97° 04' 17.7")

Figure 20 Photograph showing fanglomerate on the eastern bank of Ayeyarwady River. (N 24° 43' 38.8"&E 97° 03' 46.2)

Figure 21 Photograph showing recent gravel beds along the Ayeyarwady Riverbank. (N 24° 43' 38.8"&E 97° 03' 46.2

Acknowledgements

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Mineralization, Mineralogy and Paragenesis of the Precious and Base-Metals at Tatlet Area, Mohnyin Township, Kachin State

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Abstract

The research area is situated in the NW of the Lake Indawgyi, Mohnyin Township in Kachin State. It consists of two rock units, namely igneous - serpentinite, basalt and gabbro; and metamorphics - talc chlorite schist, epidote muscovite schist, actinolite schist, muscovite schist, graphite mica schist, garnet mica schist, hornblende biotite schist and micaceous quartzite. The purpose of the research area is to investigate the mineralization process, mineralogy, paragenesis and types of mineral deposit. In order to know above that, samples were performed with X-ray Analytical Microscope, the Atomic Absorption Spectrometer (AAS) and ore microscope. As a result, the mineralogy of the vein can be recognized into two paragenetic stages. The ore mineral assemblages consist mainly of pyrite, chalcopyrite, galena, sphalerite and minor arsenopyrite. Gold mainly occurs as primary in quartz veins, sulfides - quartz vein and in the ambient of rock alteration zone. The vein related alteration is characterized by silicification, sericitization and chloritization from inner to outer. Finally, we can conclude that the mineralization at Tetlet area might probably possess the characteristics of low-sulfidation epithermal style although they may be found in wide range of epithermal to mesothermal system.

Keywords: Mineralization, Epithermal, Mesothemal.

INTRODUCTION

Location, Arial Extent and Accessibility

The study area is situated close to the northwestern part of the Lake Indawgyi, located in Mohnyin Township in the Kachin State of the Northern Myanmar. The area is bounded by Latitude 25° 20′ N and 25° 24′ N and Longitude 96° 16′ E and 96° 22′ E in one inch to one-mile scale topographic map of 84-C/7. It is 5 miles (N-S) long and 6 miles (E-W) wide, covering approximately 30 square miles.

It is accessible through the recently developed Nyaungbin-Saingdaung pass from Hopin on the Mandalay-Myitkyina railroad and Belumyo-Namma pass from Mohnyin on the Mandalay-Myitkyina railroad only during dry season. The location map of the study area is shown in Fig.(1)

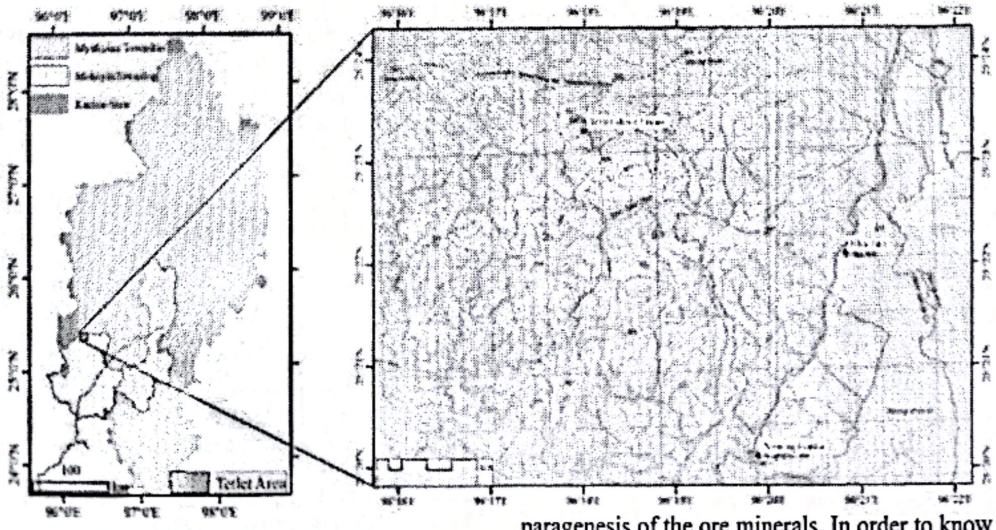
Purposes of Study

This research intends to focus the following:

1. to investigate the mineralization processes,
2. to interpret the ore mineralogy and paragenesis of the precious and base metals.
3. to describe the types of mineral deposits.

Methods of Study

The one-inch topographic map 92 C-7 is used as base map. The map is enlarged to a scale of 4 inches to a mile. GPS instrument and Brunton compass are used extensively in the field, for measuring specific locality, dip and strike of the mineralized veins. About 20 ore samples are polished for examining under ore microscopy. Detailed studies under ore microscopy are used for petrographic analysis and ore mineralogical study and the results are used to interpret the



paragenesis of the ore minerals. In order to know their paragenesis from the auriferous vein in Tetlet area (20 samples) was performed with X-ray Analytical Microscope at the Mandalay

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University Research Center, University of Mandalay, Mandalay and 4 vein samples were analyzed with Atomic Absorption Spectrometer (AAS) in Future Mining Company.

Rock Units

The area under investigation is located between the Taung Chaung Fault and Sagaing-Namyin Fault. This area is chiefly composed of igneous and metamorphic rocks. The geological ages of these rocks are regarded as most probably late Jurassic to early Cretaceous for the metamorphics and Cretaceous to Eocene for igneous rocks respectively. Based on the field observation and the possible rock sequence is (in descending order) shown in Table (1).

Lithologic Unit	Ages
Alluvium	Quaternary
Igneous Rocks	
Serpentinite	Cretaceous to
Basalt	Eocene
Gabbro	
Metamorphic Unit	
Talc chlorite schist	
Epidote muscovite schist	
Actinolite schist	Late Jurassic to Early
Muscovite schist	Cretaceous
Graphite mica schist	
Garnet mica schist	
Biotite schist	
Micaceous quartzite	

MINERALIZATION

Based on the field observation, gold mainly occurs as primary in quartz veins, sulfides (base-metal sulfides and pyrite) - quartz vein and in the ambient wall rock alteration zone, replacement and dissemination in serpentinites and in secondary enrichment gossans zone. Gold veins are found as laminated, stylolaminated and massive veins and veinlets. The mineralization is mainly in the forms of veins and stockworks although disseminated and replacement types are locally found as well. Precious metal is usually bulky and associated principally with Pb and is alomost invariably hosted in phyllitic schists. Many other gold workings are confined to narrow mineralized zones. The largest vein at Thway south of Tetlet is some 1m thick with Au and pyrite.

Distribution of Gold Mineralization

Gold mineralization in the research area is situated at Tetlet village and its surroundings. At the present investigation of the study area, gold deposits were found as both primary and placer deposits. The placer gold workings have been found in the Nankhan Chaung, the Sa-gyin Chaung, the Pi-daung chaung and the Taungsin Chaung. The primary gold deposits are being worked in the elevated hills near Tetlet village.

Gold bearing quartz veins are mainly hosted in the phyllitic schists and serpentinites.

Table (2) Generalized paragenetic sequence of the vein minerals (Width of lines corresponds to abundance)

Minerals	Stage 1	Stage 2
Pyrite		
Arsenopyrite		
Chalcopyrite		
Galena		
Sphalerite		
Electrum		
Tetrahedrite		
Bornite Pyrrhotite		
Covellite		
Chalcocite		

The most productive mineralizations (local gold worksite) in the research area are Thway, Phayargon, Yadanasein and Myint Oo working sites. Location map of the research area is shown in Fig.(2).

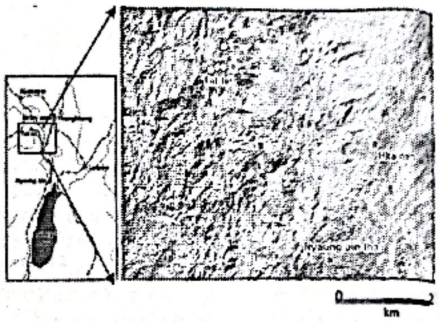

Fig. (2) Location of gold worksites in the study area.

Yadanasein gold work site

This working site (Loc. N 25° 23' 19.70". E 96° 17' 55.70") is situated just NE of Thway Worksite and has 1722 ft in elevation. The host rocks are phyllitic schists and the vein is striking nearly E-W. Associated minerals in the mineralized quartz veins are pyrite, chalcopyrite and secondary calcite flakes are found near the veins. The characteristic vein textures are laminated, stylolaminated and massive (Fig.3).

Thway gold worksite

Fig. (3) Laminated to massive quartz vein found at Yadanaseine gold work-site.

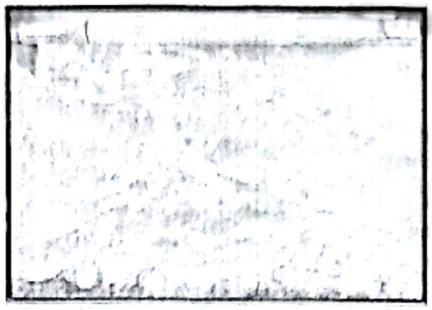

Fig. (4) Numerous mineralized slightly colloform quartz veins observed in phyllitic schist.

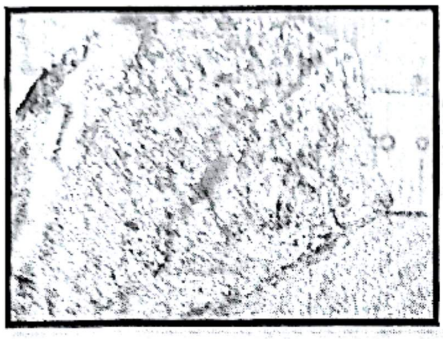

Fig. (5) Free gold also observed in quartz vein at Thway work-site.

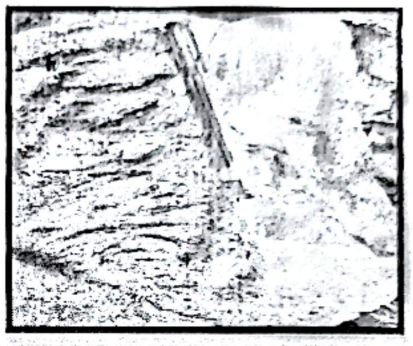

Fig. (6) Auriferous quartz vein in serpentinite.

Fig. (7) mineralized quartz vein in graphite schist.

Fig. (8) Some parts of quartz vein are distorted and pinched and swelled due to shearing effect at Myint Oo work-site.

This gold worksite (Loc. N 25° 23' 4.80"- E 96° 17' 55.7") is located just close SW of Tetlet village and has the elevation of 1980 ft. The mineralized quartz hosted in phyllitic schists and occur 310° in strike and dip 50° SW. The mineralized vein has 35 cm thick, Fig.(4) and visible gold occurs with pyrite, chalcopyrite and galena Fig (5). The vein textures of this gold work site are laminated layer and stylolaminated layer.

Phayargon gold worksite

This local gold site (Loc. N 25° 23' 4.80"- E 96° 18' 19.90") is located 1 km SE of Thway gold worksite and the elevation is 2022 ft. The host rock is mainly serpentinite (Fig.6) and the vein strikes 330° and dips 70° NE. Free gold is also observed and vuggy textures are common in quartz veins. The thickness of the vein is 30 cm. Graphite schist found in this area seems also to be favorable for gold mineralization (Fig.7).

Myint Oo worksite

This site (Loc. N 25° 25' 00"- E 96° 17' 55.5") is situated in the northern part of the study area and the elevation is 1890 ft. The host rock is phyllitic schists. Mineralized quartz veins are deformed (Fig.8) and contain free gold with pyrite, chalcopyrite and arsenopyrite. Pyrite occurs as disseminated in the host rock. Mineralized quartz veins are pinched and swelled. Chloirte alteration occurs in host rocks. The mineralized veins are striking 330° and dipping 70° SW.

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MINERALOGY AND PARAGENESIS

Wallrock alteration is an important association of hydrothermal ore deposit because the processes of ore deposition are the same processes that give rise alteration assemblages (Susak, 1994). In the study area, two alteration zones, such as sericitization and chloritization are found around the wallrock. Auriferous epithermal alteration is best preserved. Altered rocks (sepentinites) display some or all of chlorite alteration. Highest precious and base metal values are associated with vuggy silica alteration in this area. Wallrock alteration is characterized by silicification, sericitization and alteration was accompanied by moderate to high addition to Fe_2O_3, K_2O, MgO and additions of Au and Ag. Base metal Pb and Cu are also locally enriched in the alteration zones (Wang et al., 1996). In the field, the mineralized vein system is enclosed by the zones of alteration with variable intensity and thickness. The following are the general characteristics of these zones.

1. Wall-rock alteration can be characterized by hydrothermal alteration minerals such as quartz, adularia, sericite, calcite and chlorite.
2. The alteration patterns of the area are not yet well-defined, due in part to the lack of detailed alteration studies. In general, present deposits are characterized by the sericitic alteration that sometimes borders a silicified zone near the vein. Also near the vein, fine-grained potassium feldspar and/or chlorite are often disseminated in the wallrock.
3. Therefore, the vein related alteration is generally characterized by silicification, sericitization and chloritizaion from inner to outermost zones.
4. Once silicified, the rocks were more brittle, allowing the apparently late emplacement of the massive auriferous quartz – sulfide veins.
5. The alteration zone itself is frequently mineralized. In some places, disseminated auriferous pyrite and arsenopyrite mineralization occurs adjacent to ore veins and may extend up to 1m from the vein.
6. Vein system locally exhibits iron oxide stains in the field as well as under microscope.
7. Generally there are two phases of vein system mentioned earlier. The younger phase is marked by fine- quartz veinlets, cutting across the older phase of coarse-white quartz locally. It is found that coarse quartz contains very low value of gold relative to the fine quartz veins which sometimes carry a fair amount of gold.
8. Most of the alteration processes in the study area are sericitization, chloritization, silicification, pyritization, and some clay alteration.
9. There is no consistent relation between the size of ore body and the size of the alteration envelope in many places (See also Fig.9).

To determine the mineral paragenesis and origin of mineralization, the mineral association and textural relationship under the reflected microscope are identified. Under ore microscope, some ore minerals generally display euhedral form but others are irregular in shape. Besides, subhedral and long prismatic forms are not uncommon.

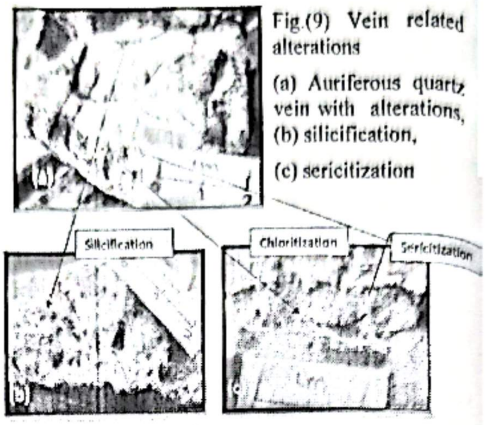

Fig.(9) Vein related alterations

(a) Auriferous quartz vein with alterations, (b) silicification,

(c) sericitization

Ore Mineralogy

Pyrite: Studies on the sequence of mineralization have shown that pyrite occurs in almost entire period of mineralization and is associated with other sulfides. It is pale yellow to yellowish white in color. Among the sulfides, pyrite is the most commonly observed mineral. This mineral is

Fig.(9) Vein related alterations

(a) Auriferous quartz vein with alterations, (b) silicification,

(c) sericitization

invariably the earliest sulfide mineral. It occurs as large euhedral grains (Fig.10) as well as finely crystalline aggregates almost throughout the mineralization processes. The occurrence of pyrite in the present mineralization suggests several generations. Coarse pyrite is commonly fractured and cemented by gangue quartz and some sulfides such as galena (See also Fig.10). In some places, pyrite occurs as relic crystals in quartz cavities (Fig.11). The early formed pyrite cubes occur as relic crystals in anhedral chalcopyrite and sphalerite. Particularly, the mineral was replaced along the fracture and grain boundaries by sphalerite and galena. Pyrite with gel structure can be seen as a result of transformation of marcasite to pyrite from isolated point (Oelsner, 1966). Pyrite is also found as small disseminated grains throughout the vein and as aggregates of small cubes.

Sphalerite: Sphalerite occurs as anhedral grains of various sizes within pyrite and chalcopyrite. Oriented small grains and rods of chalcopyrite (chalcopyrite diseases or exsolution texture) (Oelsner, 1966) are rarely found in sphalerite. Sometimes, sphalerite is rimmed by chalcopyrite. It is intergrowth with galena in some places. Sphalerite also occurs along the rings of pyrite and in fractures of pyrite (sees also Fig.10). Later sphalerite veins are injecting into quartz veins and chalcopyrite vein. Sometimes, they also crosscut

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the gold flakes and gold veinlets in the pyrite groundmass, indicating that it was late in paragenesis.

Galena: Whitish galena occurs as anhedral masses. It is found as fine- to medium- grains associated with sphalerite. The perfect cleavage is usually visible and characterizes triangular pits

Fig.(10) Subhedral pyrite (Py) commonly fractured and cemented by gangue quartz (Qtz) and along the fractures sphalerite veins are injecting. 40X

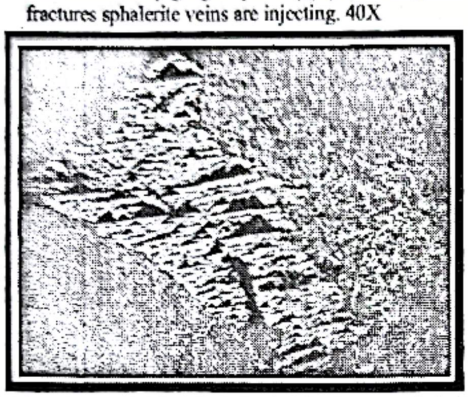

Fig. (12) Galena showing characteristic triangular pits. 40X

(Fig.12). Curved cleavage pits occur in galena pointing out the post depositional deformation. It commonly replaces pyrite along irregular cracks and grain boundaries. Galena sometimes encloses earlier-formed sphalerite. Some sphalerites are locked within the grain boundary of galena and electrum. In some places, anhedral sphalerite is replacing along the boundary of galena. Some galena grains are replacing the chalcopyrite (Fig.13) and the gold flake. Electrum is replacing galena and some galena grains adjacent to the electrum indicate that replacement is still going on (Fig.14). This fact indicates that galena is a little earlier than electrum in paragenesis. Locally it occurs with electrum in combination form encapsulated in pyrite.

Electrum: Gold occurs together with silver in the form of electrum. Electrum is essentially observed as disseminated specks within pyrite, chalcopyrite, galena (Fig.14) and sphalerite (Fig.15). With increasing Ag content, the color of electrum becomes whitish yellow. Sometimes electrum grains and veinlets are cut by sphalerite. Some of the electrums are rimmed by galena and vice versa (Fig.14). Electrum locally occurs together with galena within pyrite. Ellipsoidal grains of electrum are intimately associated with some sulfide ores such as pyrite, chalcopyrite, sphalerite and galena. Electrum in quartz gangue is occasionally observed. Some minute electrum grains are encapsulated in pyrite which renders the gold ore refractory. Bright yellow color of gold suggests that it has a relatively high fineness of gold. Polishing hardness of electrum is greater than galena but less than chalcopyrite.

Fig.(11) Relic pyrite (py) crystals within quartz vein. 20X

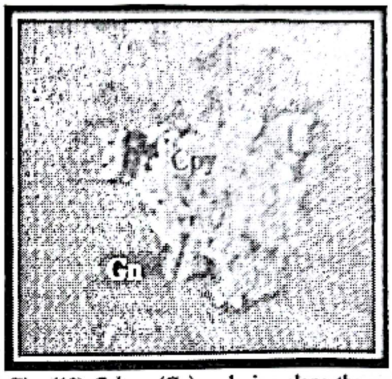

Fig. (13) Galena (Gn) replacing along the grain boundary of chalcopyrite (Cpy).

Chalcopyrite: The most common copper mineral is chalcopyrite. It occurs as subhedral irregular grains (Fig.16a). It is also observed in the fracture and grain boundaries of gangue quartz. It also fills in the fractures of the pyrite. As mentioned earlier, it was replaced by galena (Fig.16b). Locally chalcopyrite gives exsolution texture with bornite. Chalcopyrite occurs in close association with electrum. It corrodes pyrite and sphalerite.

Bornite: Bornite has pinkish to purplish color forming as irregular aggregates and as coating on or lamella intergrowth with chalcopyrite. It alters to covellite on grain boundaries and its core. It together with covellite is enclosed in sphalerite.

Covellite: Covellite occurs as indigo blue with violent tint to bluish color anhedral grains. Covellite together with chalcocite and bornite also occur in pyrite, chalcopyrite and sphalerite along the fractures and grain boundaries. Moreover, it also occurs along the boundary and core of the bornite.

Chalcocite: Chalcocite occurs as bluish white disseminated grains and veinlets within the pyrite. It also occurs along the grain boundaries of sphalerite and chalcopyrite.

Marcasite: It gives yellowish white with pinkish tint. It is found as anhedral to subhedral grain.

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Occasionally, small amount of marcasite disseminates in anhedral pyrite. This mineral is rarely found under ore microscope.

Hematite: It has white gray with bluish tint. Sometimes it occurs as bladed form (Fig.17). It can be observed in minor amount in association with chalcopyrite, pyrite and sphalerite.

Pyrrhotite: It gives creamy pinkish brown color and has the pleochroism of creamy brown to reddish brown. It is commonly found as anhedral granular masses.

Arsenopyrite: The mineral occurs as small white colored subhedral to euhedral grains marginal to gold. It is embedded in anhedral pyrite. It is characterized by white color, rhomb form and anisotropism.

Malachite-Azurite: These minerals occur together with the quartz and along the grain boundary of the chalcopyrite and pyrite (Fig.18). It is characterized by blue color and high relief under reflected light. It is formed by the interaction of sulfide fluid with the carbonate rocks. It is also important mineral in oxidized zone of ore deposit.

Interpretation of Gangue and Ore Mineralogy

Mineral paragenesis is determined by microscopic mineralogical and textural features of ore and gangue minerals using ore microscope and polarized microscope. The mineral assemblage and related paragenetic sequence of the vein systems of the study area is shown in Table (2). The mineralization is mainly characterized by Au –Ag bearing pyrite– chalcopyrite dominant sulfide assemblage along with gangue mineral assemblage consisting mainly of quartz, adularia, sericite and calcite.

Fig. (14) Galena (Gn) is replaced by electrum (El) and vice versa. 40X

Fig. (15) Electrum (El) occurs as speck within the galena (Gn) replaced the boundary of pyrite (Py) and along the fractures of pyrite substituted by sphalerite. 40X

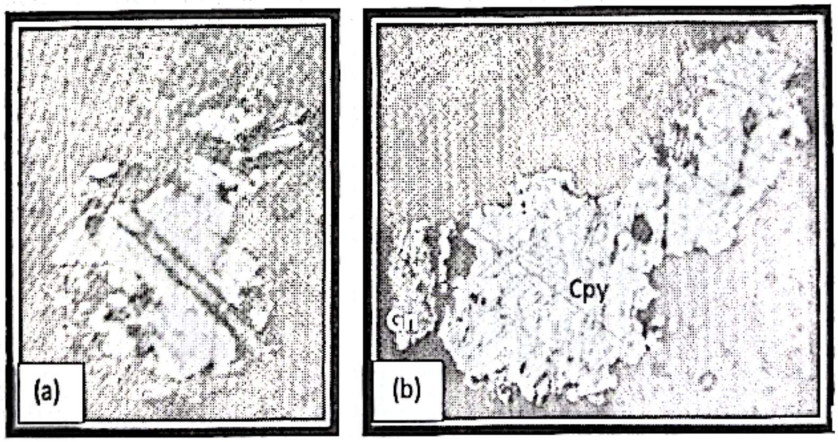

Fig. (16) (a) Subhedral chalcopyrite grain and (b) galena (Gn) replacing by chalcopyrite (Cpy).60X

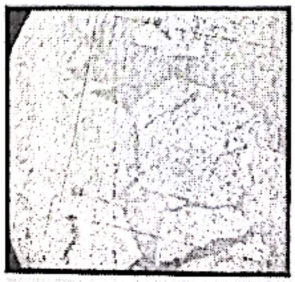

Fig (17) Hematite (Hem) with bladed nature. 40X

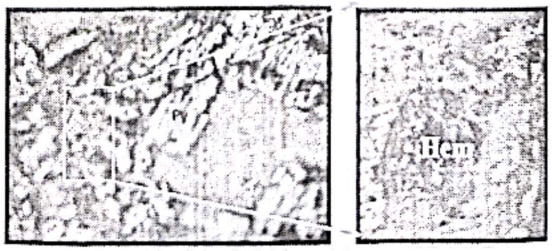

Fig (18) Malachite and azurite found along the grain boundary replacing the pyrite (Py). 40X

Precious metals and associated base metals of Tetlet area are considered to have been formed by deposition from the hydrothermal solution related to igneous intrusion. The presence of minor pyrrhotite and chalcopyrite diseases are some evidences for mesothermal mineralization in some places. Small amounts of marcasite and hematite occur in veins. These mineralogical characteristics reflect the moderate activity of oxygen, neutral pH condition and low sulfur content of hydrothermal fluids at the site of mineralization (Izawa, 1995), suggesting the study area to be a low sulfidation style epithermal deposit. The mineral occurs as typical and distinctive gangue phase of the so-called adularia–sericite type deposit of Heald *et al.*, (1987) and is not found in other category of epithermal deposit known as acid- sulfate (Kaolinite–alunite) or high sulfidation type (White and Hedenquist,, 1995). Sericite also known as fine-grained white mica, hydromica, hydromuscovite, hydrothermal illite etc., (e.g. Hedenquist and Browne, 1989) is also a common gangue mineral together with quartz, adularia and calcite.

SUMMARY AND CONCLUSION

The study area is situated close to the N of the Lake Indawgyi, located in Mohnyin Township in the Kachin State of the Northern Myanmar. The areal coverage of the study area is approximately 30 square miles. It is chiefly composed of serveral rock units, namely igneous-serpentinite, basalt and gabbro; and metamorphics – talc chlorite schist, chlorite schist, epidote muscovite schist, actinolite schist, muscovite schist, graphite mica schist, garnet mica schist, biotite schist and micaceous quartzite. Several local gold work-sites are located throughout the study area. Based on the field observation, gold mainly occurs as primary in quartz veins, and ambient wall was rock alteration zone, replacement and dissemination in serpentinites and in secondary enrichment gossans zone. Gold bearing quartz veins is mainly hosted in the phyllitic and serpentinites. The texture of the veins are mostly banded, stylolaminated, and even massive Some are fracture fillings and veinlets. The most productive gold worksites in the study area are Thway, Phayargon, yadanasein and MyintOo. Gold bearing quartz veins are formed mostly with pyrite, chalcopyrite, galena and minor arsenopyrite. In the study area, the gold bearing quartz veins are hosted in the metasedimentary rocks and serpentiniteswith varying attitudes. Stable isotope studies of ore stage minerals and physical and chemical characteristic of fluid responsible for gold mineralization in the study area were so far unknown. The vein related alteration is characterized by silicification, sericitization and chloritizaionfrom inner to outermost zones. Studies on the sequence of mineralization have shown that pyrite occurs in almost entire period of mineralization and is associated with other sulfides. The occurrence of pyrite in the present mineralization suggests several generations. Coarse pyrite is commonly fractured and cemented by gangue quartz and some sulfides such as galena. Sphalerite occurs as anhedral grains of various sizes within pyrite and chalcopyrite. The perfect cleavage of galena is usually visible and characterizes triangular pits. Galena sometimes encloses earlier-formed sphalerite. Some galena grains are replacing the chalcopyrite and the gold flake. Gold occurs together with silver in the form of electrum. Electrum is essentially observed as disseminated specks within pyrite, chalcopyrite, and galena and sphalerite. The most common copper mineral is chalcopyrite replaced by galena. Hematite is found as bladed form and malachite-azuriteoccur along the grain boundary the chalcopyrite and pyrite. The mineralogy of the vein can be recognized into two paragenetic stages. Adularia is the widespread mineral together with quartz and sericite. Because of boiling, gold and silver are more enriched in veins containing abundant adularia than virtually quartz rich veins. In low-sulfidation deposits, alunite does not occur as a hypogene mineral. Based on these facts, the mineralization at Tetlet area might probably possess the characteristics of low- sulfidation epithermal styles although they are found in wide range of epithermal to mesothermal. Due to security reason, it was too hard for us to go everywhere for collecting data as we planned before. Accordingly, the data we collected are not fully satisfiable. If we were able to go anywhere and to collect complete data, then the result of the study would become fully satisfiable. Hopefully, we will have some more chance to go everywhere we want in the research site and will be able to conduct a better research in the future.

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GEO 007

Facies Analysis of Metasedimentary Rocks Exposed in Katha-Naba Area, Sagaing Region

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Abstract

The research area locates between Katha and Naba townships, northern part of Sagaing region. Regionally, it also lies within the northern part of the Central Cenozoic Belt. Structurally, it is the southward structural continuation of high-pressure metamorphic belt of Jade Mine area. This area is composed of various kinds of schists trending with NNE-SSW direction and generally steeply inclined towards SE direction. Based on the hand specimens and petrographic analysis of thin sections, eight representative mineral assemblages are defined in metapelites. Depending on mineral paragenesis, the research area can be observed as greenschist facies to epidote amphibolite facies. Greenschist facies is well documented by the mineral assemblages of actinolite + chlorite + epidote + muscovite + albite + quartz. These facies is roughly covers the temperature range from low temperature (300°C-500°C). Greenschist-epidote amphibolite facies transition is well characterized by the mineral assemblages of almandine + biotite + muscovite + chlorite + quartz and staurolite + almandine + biotite + muscovite + quartz. The critical minerals with their respective phase diagram for each facies are graphically represented by means of ACF and AKF diagrams.

Keywords: Metapelites, Greenschist facies, Amphibolite facies, Mineral assemblages

Introduction

The study area is located between Katha and Naba townships, northern part of the Sagaing Region. It is bounded by vertical grid 790 to 930 and horizontal grids 180 to 300 in one in topographic map of 92D-3, 92D-4, 92D-7 and 92D-8. This area can be easily reached from Myitkyina by car or train throughout the year. The Naba-Katha railway and the Indaw-Katha car road run through the study area from west to east. The whole research area is a very rugged terrain especially with a deep valley in its central part. Location map of the study area is show in Fig (1).

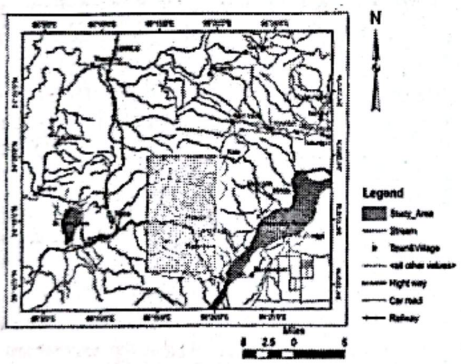

Fig (1) Location map of the research area

Regional Geologic Setting

The study area is located within the northern part of the Central Cenozoic Belt. Regionally, most part of northern Myanmar is mainly composed of basic and ultrabasic igneous rocks, volcanic rocks, sedimentary and metamorphic rocks. To the northern part of the study area, is well known Jade Mines area, consisting of phyllites, kyanite schist and garnet-mica schist intruded by sill-like bodies of serpentinite, peridotite and chlorite bearing dunite (Noetling 1893, Clegg, 1941). Further west beyond these, it is surrounded by Wuntho massif and Central Volcanic Line. Wuntho massif is constituted by submarine basalt and Hb-andesites that pass into dacite (Mitchell et al, 1978). The Sagaing fault, right lateral strike fault, passes through the western part of the study area. The southern part is covered by Pleistocene gravels, Irrawaddy foation, Male formation, Tagaung Taung ultrabasics, Mayathein Metamorphics, Katha Metamorphics, Ngapyawdaw Chaung formation and Tonnge basalt and alluvium Fig (2)Fig (2) Regional geologic setting map of the research area.

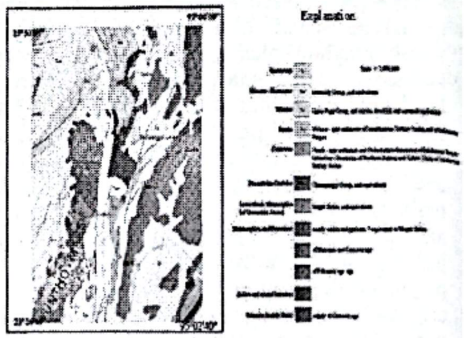

Fig (2) Regional geologic setting of the research area

Purposes of research

The principle objectives of the present research area are as follow:

1. To study the lithology of the rock units exposed in the study area
2. To describe the petrography of the rock units
3. To discuss the petrogenesis of the rock units
4. To interpret mineral assemblages and the metamorphic facies of metasedimentary rock units

Methodology

Both field and laboratory methods are used for present research. In the field, one-inch topographic maps 92 D/3, 92 D/4, 92 D/7 and 92 D/8 are used as base map. These maps index enlarged to a scale of two inches to one mile. GPS instrument and Bruton Compass are used extensively in the field, for measuring specific locality, foliation, joints, bearings, dip and strike, etc. Contact lines and fault traces between

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different rocks were plotted on the map by using the data mainly from the field observations and satellite images. But the various kinds of previous literatures written by many authors and the former geological map were studied. In the laboratory, the rock samples collected in the field were cut, polished and ground to prepare thin sections. Then, 60 thin sections of representative rock samples were studied under a petrologic microscope. Metamorphic mineral assemblages and metamorphic facies were determined on the basic of field occurrences and microscopic studies.

Stratigraphy

The research area is mainly composed of the rocks of the Katha Metamorphics, essentially low to medium grade rocks trending in NNE-SSW direction. They are talc-chlorite schist, chlorite schist, graphite schist, quartzite, biotite schist, micaceous quartzite, actinolite schist, garnet biotite schist, garnet graphite schist, garnet staurolite schist and quartz mica schist. The geological ages of these rocks are regarded as most probably late Jurassic to early Cretaceous in age. In some part of the area, serpentinite can be found. Based on the field observation, the possible rock sequence is (in descending order) shown in Table (1).

Table (1) Rock Sequences of Katha-Naba area

Rock Units		Ages
Sedimentary Units		
Alluvium		Recent
	Unconformity	
Gravel		Pleistocene
	Unconformity	
Irrawaddy Formation		Pliocene to Pleistocene
	Unconformity	
Metaigneous Rocks		
Serpentinite		? Tertiary
Metasedimentary rocks		
Talc-chlorite schist		Late Jurassic
Chlorite schist		
Graphite schist		
Garnet quartz mica schist		
Biotite schist		
Actinolite schist		to
Garnet-biotite schist		
Garnet-graphite schist		
Garnet-staurolite schist		Early Cretaceous

Distribution and Lithology of Rock Units

In metasedimentary units, garnet-biotite unit is found at the upper part of the Sabaipon Taung and along the Kywekawpyant Chaung. It shows light grey or green on fresh surface and buff color on the weathered surface. The grain size of garnet ranges from 0.7 mm to 2 mm in diameter.

Talc chlorite schist occupies at the northern part of the research area. On the fresh surface, it shows a light green color and weathered surface shows dark color. This unit occurs as massive characters and highly brecciated in some places. It is fine to medium grained consisting of talc, chlorite, muscovite and quartz. Quartz veins are intercalated in this outcrop. This quartz veins are parallel with foliation. Most of the rock units dip nearly SE direction Fig (3) (a).

Chlorite schist unit exposes at the eastern part of the Bomin Taung. It is associated with graphite schist. It is thinly foliated. This unit can be seen as whitish color on weathered surface and light green color on the fresh surface. It is mainly composed of fine-medium grained and consisted of chlorite and mica. It is soapy appearance, friable and soft. The general trend is nearly N_S and dip toward east Fig (3) (b).

Graphite schist exposes at the base of the Minbawkhin Taung and Bomin Taung and associates with garnet mica schist. It is easily marked by it lead grey color, soft, friable and fine-grained in texture. Minor drag folds crenulations can be observed in this unit. The general trend is nearly N-S and dipping towards east 30°-50°.Garnet-quartz mica schist occupies throughout the area especially in southern part. This unit is hard and compact. Numerous garnet grains are observed. Gold is also extracted from this unit by local people Fig (3) (c).

Biotite schist, well foliated unit, crops out along the Aungbin Chaung, Patit Chaung and Bolan Chaung Fig (3) (d). It can also be seen in the upper part of stream sections and on the crest of the Kakyaw Taung. Weathered color is light yellow to yellowish brown and grey color on the fresh surface. Thin bands of graphite are intercalated, and thickness of individual layers varies from 0.3 inches to 3 feet in some area. The general strike of this unit is N20°W with the dip of 62.

Actinolite schist are cropping out at the side of the stream tracks of north of research area. On the fresh surface, it shows buff color and light grey or green color on fresh surface. It characterizes medium-grained size. This is well foliated in nature and associated with graphite schists. Quartz veins which are ranging from 0.3 inches to 0.9 inches can be observed. It is highly brecciated, contorted quartz veins are also present Fig (3) (e).

Garnet-graphite schist essentially exposes along the stream sections at the eastern part of the research area. It is fine to medium grained, hard and compact. This rock has a notably porphyroblastic texture with very large (3 to 4mm) euhedral to subhedral garnet grains in fine matrix of muscovite and graphite. Graphite is irregular in shape and randomly scattered in some section. The small-scale folding of the original schistosity produces crenulation cleavage in which the platy minerals were aligned. Gold is extracted from quartz veins of this unit by local people. Fig (3) (f).

Garnet-biotite schist, friable and readily disintegrated unit, crops out at the upper part of the Sabaipon Taung and along the Kywekawpyant Chaung. This unit shows light grey or green in color and buff color on the weathered surface. It is associated with quartz mica schist andgarnet graphite schist. Abundance of muscovite with garnet porphyroblasts of this unit can be easily recognizable in the field. On the weathered surface, garnet changes its color to brownish or reddish brown indicating the Fe content or almandine.

Garnet-staurolite schist with strongly foliation can be found at the eastern part of Bomin Taung. The outcrops are trending in the direction of N63°W with the dip of 12° east. Good exposures

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of garnet quartzite crop out at the base on the southern part of Bomin Taung. It shows reddish brown color in the weathered surface and light grey color on the fresh surface Fig (3) (g).

Garnet-quartz mica schist occupies throughout the area especially in southern part. This unit is hard and compact. Numerous garnet grains are observed. Gold is also extracted from this unit by local people Fig (3) (h).

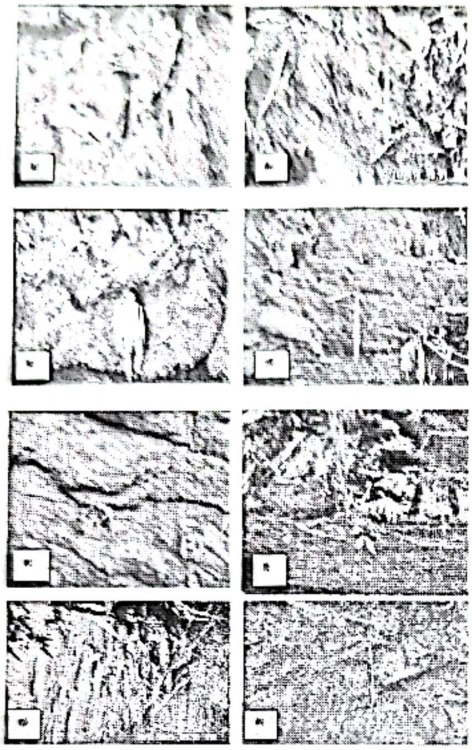

Fig (3) **(a)** Good outcrop of talc chlorite schist that exposed in the northern part of the area **(b)** Highly brecciated or thinly foliated nature of chlorite schist outcrop near the northern part of Pinmalutt village **(c)** An exposure of dark gray or lead gray color graphite schist showing well foliated in nature **(d)** Strong foliation of yellowish brown color biotite schist at the base of KantkusanTaung **(e)** Weathered yellowish brown colored garnet graphite schist showing well foliated nature with lens-shaped quartz veins and quartz stringers **(f)** Well foliated unit of actinolite –schist showing buff color on the weathered surface **(g)** Well foliated, soft, friable and buff color staurolite schist that exposed along the Petit Chaung **(h)** Medium-thick bedded nature of reddish brown colored garnet bearing quartzite outcrop.

Petrography

More than (60) sections were cut from various rock samples from the research area for the petrography studies. Modal compositions of some rocks were estimated with visual estimation. Detailed petrography descriptions for most important rock units are as follows;

Talc-chlorite schist

The rock essentially composes of talc (35%), chlorite (20%), muscovite (20%) , quartz (15%) and other accessory mineral(10%). Talc occurs as flaky crystals. Chlorite is often bent and crenulated. It shows pale green in color under XN and perfect basal cleavage. Minute aggregate layers of quartz grains are observed in some slice. Most of the grain occurs as elongated or equigranular grains. Micas especially muscovite, occurs as flaky form. It is fine grains and produce schistosity in some rocks Fig (4) (a).

Chlorite schist

Microscopically, the rock mainly composes of chlorite (35%), quartz (25%), muscovite (20%), albite (10%), epidote (5%) and others (5%). Chlorite is dominant mineral and gives bluish green in color. It forms as fibrous aggregates in some slice and align parallel with foliation. It forms as fibrous aggregates in some slice and align parallel with foliation. Quartz grains tend to be more or less elongated and often show granular aggregates form. These aggregates are parallel to chlorite and muscovite. Most of the grains are various in sizes and gives 0.02mm to 0.2mm in diameter. Epidote occurs as sub-elongated minerals. It aligns parallel with schistosity. Well-defined schistosity is formed by alternative arrangement of chlorite layers and aggregates of quartz layer and muscovite Fig (4) (b).

Graphite schist

It is mainly composed of graphite with minor feldspar (40%) quartz (30%), muscovite (20%) and chlorite (10%). Anhedral to subhedral quartz grains are lens-liked aggregates that are bounded by graphite and muscovite. It has 0.1 to 0.5mm in average grain size and aligned parallel to the schistosity. Boundaries between quartz grains are mostly sutured and the grains show undulatory extinction. Most of the graphite is conspicuous minerals in thin section. Graphite is primarily identified by its occurrences as trains or strings of dark grains. Micas, mainly muscovite, are long splendid form. Parallel alignment of muscovite flakes is marked by foliation. The grain size of muscovite is 0.1 to 0.4mm in diameter Fig (4) (c).

Biotite schist

Microscopically, biotite schist is mainly composed of biotite (45%), muscovite (25%), quartz (10%) and minor accessories of graphite and feldspar (10%). Biotite is aboundant and appears as subhedral to anhedral flaky or bladed form. It is yellowish to brownish yellow and shows pleochroism. It is sometimes altered to chlorite

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along the cleavage plane. Quartz occurs as anhedral grain showing lenticular and mosaics of small grain. It is parallel with foliation. Muscovite can be seen as flaky form. It is also occurred as parallelism along the foliation. The foliation is strongly crenulated and can clearly be seen in thin section. Graphite occurs as disseminated scales and tabular masses with dark colour or opaque. Most of the feldspar are turbid grains and also parallel with foliation Fig (4) (d).

Actinolite schist

Under microscope, this rock is mainly consists of actinolite (30%), plagioclase (20%), quartz (20%) epidote (15%) and minor chlorite (10%). Opaque mineral grains (5%) are also occurred. Actinolite takes the form of slender needle grains with irregular terminations. The plagioclase in this rock is albite. It occurs as a mosaic of shapeless grains and some grains show xenoblastic grains, or large idioblastic porphyroblasts enclosing parallel strings of actinolite needles. Some porphyroblasts show simple twin. Small grains of yellow, iron-rich epidote are observed. It occurs of the schistosity. Segregation of actinolite- epidote-chlorite lamellae, are alternating with white layers rich in albite the nematoblastic schistose texture.

Garnet-graphite schist

In thin section, this rock is essentially constituted graphite (30%), muscovite (25%), quartz (25%), feldspar (10%) and porphyroblast garnet (10%). This rock has a notably porphyroblastic texture with very large (3mm) euhedral to subhedral garnet grains in fine matrix of muscovite and graphite. Strings of graphite and fine-grained muscovite flakes are parallel and aligned. Most of the muscovite is concentrated with lesser amounts occurring as groundmass laths which are oriented parallel to the foliation. Quartz occurs as anhedral grain and it shows undulatory extinction Fig (4) (e).

Garnet biotite schist

Microscopically, the rock essentially consists of biotite, muscovite (40%), biotite (20%), garnet (15%), quartz (15%) and feldspar (10%) with minor accessory of iron ore minerals. Muscovite is found as lepidoblast and flaky form. It shows yellowish brown color in thin section. It also occurs as long prismatic crystals with preferred orientation around the garnet porphyoblasts. Biotite also occurs as flaky form and shows greenish brown to brown color. In some section, biotite gives short prismatic form. Garnet occurs as euhedural to subhedral form and the size range 0.5 to 3mm. Most of the garnet grains show partings or cracks. Anhedral grains of quartz are mostly equal in size. It also occurs as elongated grains along the foliation direction Fig (4) (f).

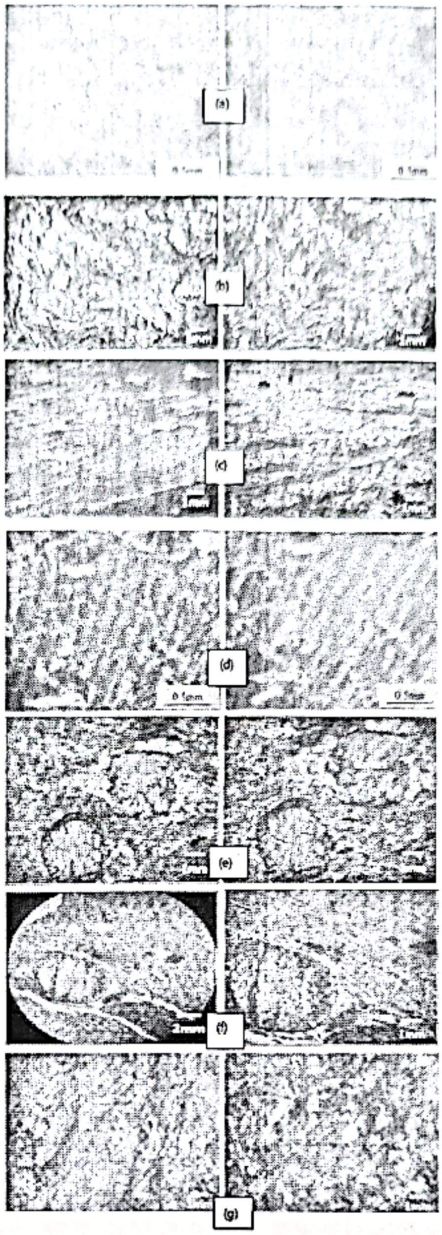

Figure (4) **(a)** Photograph showing schistose texture of chlorite that aligned parallel with foliation in talc-chlorite schist (PPL, XN) **(b)** Parallel arrangement of chlorite, muscovite flakes and graphite strings with some lenticular quartz in Chlorite schist (XN, PPL) **(c)** Photograph showing the irregular massed of graphite in graphite mica schist (PPL,XN) **(d)** Photomicrograph showing intensely crenulated to tightly folded schistocyte in Biotite schist (PPL, XN) **(e)** The foliation tends to wrap around the garnet porphyroblast (PPL, XN) **(f)** Photomicrography showing garnet porphyroblast with dominant schistosity of muscovite and graphite in Garnet graphite schist (PPL, XN) **(g)** A mosaic of polygonal quartz grains showing fractured having suture boundaries in quartz mica schist (PPL, XN)

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Garnet staurolite schist

This rock is mainly composed of garnet (10%), staurolite (25%), muscovite (25%), graphite (15%), quartz (10%), feldspar (10%) and other opaque minerals (5%). Staurolite minerals are pale straw color in thin section. Most of the staurolite is rhomb shaped and numerous quartz grains are occurred as inclusions. Large garnets are subhedral to euhedral grains and redddish brown to brown in color. Muscovite is parallel oriented and occurs as flaky form. Grain size may be 0.1 to 0.8mm in diameter. Dark gray color graphite strings are found as foliation. Anhedral to subhedral quartz grains are 0.1 to 0.5mm in diameter. Mostly graphite strings, muscovite, elongated or flattened fine-grained quartz grains and feldspar will mark the schistosity.

Quartz-mica schist

The rock comprises dominant quartz (75%), with fairly amount of garnet (10%) and muscovite (15%). Under the microscope, anhedral to subhedral quartz grains are mostly equigranular texture. It is ranging from 0.2 to 0.5mm in diameter. It has sutured boundaries and show wavy extinction. Muscovite shows moderately schistosity and ranges from 0.1 to 0.5mm in size. Reddish brown to brown colored almandine garnets are anhedral to subhedral in shape Fig (4) (g).

Petrogenesis

In the study area, the rock units composed are mainly of pelitic to psammatic schists and metabasites. The study is chiefly underlain by the rocks of the Katha Metamorphics. Petrogenesis of metasedimentary units is mainly based on the basis of lithology, mineralogy, mineral assemblages, mineral chemistry, texture, field relationships and correlation to the other areas. Besides, the equilibrium mineral assemblages comprised in the rocks as well as the textural arrangement of these minerals are investigated under the petrography microscope. The present area lies in the southward structural continuation of high-pressure metamorphism belt of Jade Mine Area. Based on the mineral assemblages, it can be traced that the metamorphic rocks of the study area fall in the greenschist facies to epidote-amphibolite facies of low to medium grade pressure orogenic metamorphism. Metamorphic grade increases from the east towards the west of the study area.

Metamorphic Mineral Assemblages and Metamorphic Facies

In the research area, thin sections of metamorphic rock units were used to know their mineral assemblages and their relationships. Metapelitic minerals are very close to or identical with the original minerals of the unmetamorphosed sediments. The principle minerals of metapelites are quartz, feldspar and biotite and they usually associated with white mica or chlorite. The most frequently observed minerals are garnet (usually an almandine in composition) and graphite. Talc is the major constituent minerals in talc chlorite schist. Some mineral has a large stability range and may occur in several metamorphic facies, whilst other assemblages have a more restricted stability range and may be diagnostic for one facies only. Besides, some rock types do not show diagnostic mineral assemblages at some particular metamorphic grades. In addition, changing fluid composition may affect the P-T stability of mineral assemblages. So, a more complete representation of metamorphic facies should involve relationships in P-T space. Metamorphic facies and grade identification were done based on the basis of occurrences of equilibrium mineral paragenesis and index minerals. Based on hand specimens and basic petrography analysis of thin sections, (8) representative mineral assemblages defined in metapelites are as follows;

(1) Quartz + Chlorite + Talc ± Muscovite

(2) Quartz + Muscovite + Albite +Chlorite

(3) Quartz + Muscovite + Chlorite ± albite ± epidote

(4) Quartz + Muscovite + graphite

(5) Quartz + Muscovite + biotite +graphite

(6) Garnet + Quartz + Muscovite

(7) Garnet + Chlorite + Muscovite +Biotite + Quartz

(8) Garnet + Staurolite + Biotite + Muscovite + Quartz

From the above mineral assemblages, muscovite is used as an indicator for pelitic protolith. Mineral Depending on the mineral parageneses, the research area may be delinated as greenschist facies to epidote amphibolites facies.

Greenschist facies

At P-T conditions of greenschist facies, it is characterized by the mineral assemblages, actinolite + chlorite + epidote + albite + quartz. The first three minerals give the rock type its characteristic green color. The chlorite, biotite and garnet in metapelites belong to these facies and more Al-rich metapelites may contain chloritoid. In the research area, greenschist facies is well characterized by the mineral assemblages of chlorite + muscovite + albite + quartz in quartz mica schist, chlorite, biotite, muscovite, quartz in metapelites. Greenschist facies roughly covers the temperature range from low temperature (300°C-500°C) at low to moderate pressure metamorphism.

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Table (2) Summary for metamorphic mineral assemblages and facies

Type of metamorphism	Protolith	Metamorphic conditions		Metamorphic equivalents	Characteristic mineral assemblages
Regional Metamorphism	Metapelite	Low grade	Greenshist facies	Chlorite schist	Quartz+muscovite+quartz +chlorite
				Talc-chlorite schist	Quartz+chlorite+talc+muscovite +albite
				Biotite schist	Quartz +biotite+muscovite+graphite
				Actinolite schist	Actinolite+epidote+albite+chlorite +quartz
		Medium grade	Epidote Amphibolite facies	Garnet-biotite schist	Garnet+chlorite+muscovite+biotite +quartz
				Garnet-staurolite schist	Garnet+staurolite+biotite+muscovite +quartz

Epidote-Amphibolite facies (Greenschist Amphibolite Facies transition)

In the greenschist facies albite+actinolite (together with chlorite and epidote) are stable, in the epidote-amphibolite transition facies, the coexisting, albite and oligoclase-andesine-actinolite and hornblende occur, in the amphibolites facies, hornblende-oligoclase-andesine are stable. In the study area, greenschist-amphibolite facies transition is well documented by the mineral assemblages of almandine + biotite + muscovite + chlorite + quartz and staurolite + almandine + biotite + muscovite + quartz in metapelitic rocks. The assemblages of hornblende + plagioclase + garnet + epidote is equivalent to epidote-amphibolite facies. Almandine, staurolite and hornblende minerals are diagnostic minerals in these facies.

Results, Discussion and Conclusion

The present study area and its environs is the northeastern part of Central Cenozoic Belt (Central Lowland) of Myanmar. The Sagaing fault, right lateral strike slip fault, passes through the western part of this area. The Katha-Gangaw Range and the Minwun Range are separated by the Meza Valley. The present study area is chiefly composed of the rocks of the Katha Metamorphics. Various units of metamorphic rocks essentially low to medium grade, the dominant rock types are pelitic to psammatic schists, metabasite and serpentinite.

Facies analysis of metasedimentary rocks was done on the basis of the occurrence of equilibrium minerals paragenesis and index mineral observed in thin sections. Based on hand specimens and basic petrography analysis; eight representative equilibrium mineral assemblages are mentioned. It can also be interpreted on the basis of lithology, mineral assemblages, field relationship and correlation to other area. Based on the observations of mineral assemblages, it can be evidenced that the metamorphic rocks of the study area fall in the greenschist facies and epidote-amphibolite facies. The metamorphic grade increases from east to west of the study area.

Based on field observation, mineralogy and textural evidences, it can be considered that there are two main types of metamorphisms that affecting this area: regional metamorphism and locally by dynamic (cataclastic) metamorphism.

It is close to the western margin of Sino-Burmalia Ranges (Kachin-Shan-Tenasserian Highlands or Eastern Highlands Bender, 1983), and also the Western Province (northern part of Myanmar Plate) of Mitchell et al., (2007). The Eastern Province is a part of Shan-Thai Block (Bunopos et al., 1983). Structurally the study area is bounded in the west by the Sagaing- Namyin Fault, a major plate boundary between the Western Myanmar and Asian Plates.

Until of recent years, the study area is connected with other areas to define the possible time of metamorphism, especially on the basis of lithologic similarity and lateral continuity. According to the structural and lithological features, the metamorphic rocks of the study area are similar to those of the Katha-Kumon range. Radiometric dating was performed on metamorphic rocks, using $^{39}Ar/^{40}Ar$ methods for muscovite and biotite, in Katha and Kumon Ranges, and the results indicate that the metamorphism took place in 37 to 32 Ma, Late Eocene to Early Oligocene (G. I. A. C, 1999) and (Myo Min, 2007). Based on the above described points, the time of metamorphism of the study area could be assigned tentatively to Late Eocene to Early Oligocene.

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Types and Origins of Iron Ore Deposits and Occurrences around Pyin Oo Lwin Mandalay Region, Myanmar

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Abstract

Iron ore deposits around Pyin Oo Lwin lies in the western margin of the Shan Plateau within Sibumasu Terrane. Rock units exposed in the area are Paleozoic rocks including Sitha Formation (Middle Ordovician), Kyaingtaung Formation (Late Ordovician), Nyaungbaw Formation (Silurian age), Zebingyi Formation (early to middle Devonian age) and Maymyo Formation (middle Devonian to Permian age). Iron ores are mainly limonite and hematite with minor amounts of pyrite and magnetite. The iron ore deposits mainly forms in Maymyo Formation. The iron ore deposits at Twinnge and Naungthakaw deposits represent a typical residual deposit above Maymyo Dolomite. The deposit at Kyadwinye contains limonite- hematite ore covering Maymyo dolomite and sandstone of Devonian age. This deposit is of bedded sedimentary origin followed by residual concentration. The occurrences of micro fossils (forams?) and ooids which are entirely or partially replaced by interlayered hematite indicate that the iron deposit is primarily of sedimentary origin probably formed at the end of Paleozoic time (Tin Aung Myint, 2002). Pisolitic and oolitic iron nodules (mainly hematite) occur in Wetwun and Thandaung. Brecciated limonitic ore (35.2 %Fe) (a.k.s boxitic iron ore) is found in Inya. The porous and soluble nature of Maymyo Formation is the favorable place for the formation of iron deposits on Shan Plateau. Besides, chemical weathering processes leached dolomite and calcite minerals from earlier formed iron deposit, causing the increasing of iron grade in the ore as well as removing of gangue minerals from the ore in order to form the ferric iron oxides as secondary residues. Jordan et al., (2017) dated the zircon U-Pb ages of 399 Ma, for a limestone in Maymyo Formation near Pyinoolwin which suggests that the age is consistent with fossil ages of the Middle Devonian Maymyo Formation. The relativity plots of the zircons suggest the provenance has a Gondwana affinity, as the peaks of the zircons confirm the affinity with the Sibumasu Terrane.

Keywords: iron ore deposits, Maymyo Formation, Gondwana affinity, Sibumasu Terrane

I. Introduction

Iron is one of the most abundant elements in the earth's crust and few rocks are iron-free (Pettijohn, 1974). Iron is a heavy, chemically active mineral, the native metallic element. The common iron minerals are iron oxide (hematite, limonite, etc.), iron carbonate (siderite), iron silicates (gluconite, etc.) and iron sulphides (pyrite, marcasite, etc.). In Myanmar, some more than fifty iron ore have been reported.

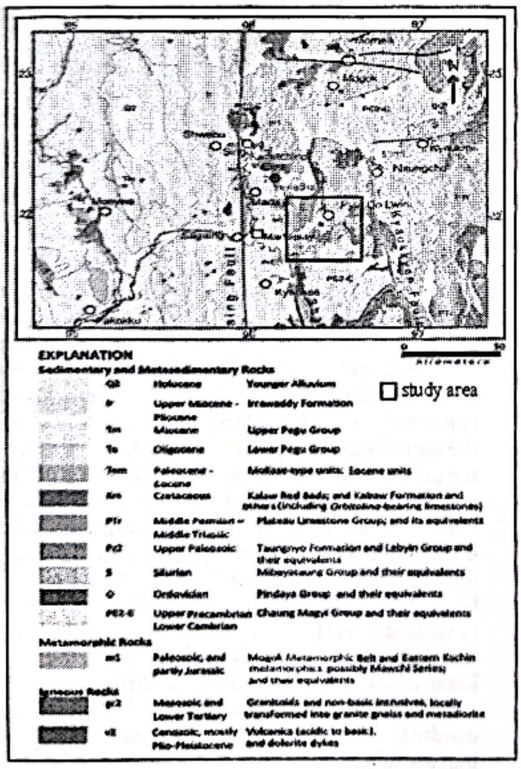


Fig.(2) Regional geological map of the study area and its environs.
(Source: Myanmar Geosciences, 2014)

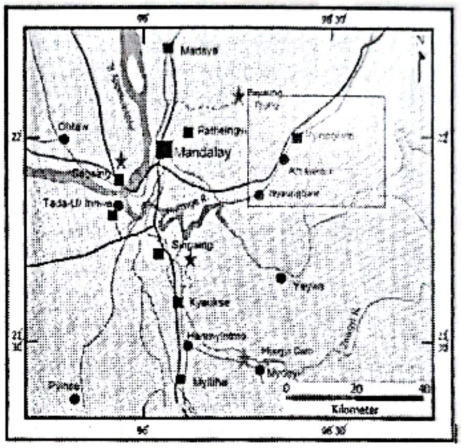
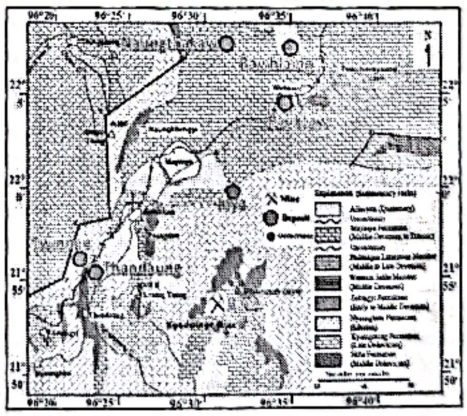


Fig. (1) Location map of the study area



1.1 Regional Geologic Setting

Iron ore deposits around Pyin Oo Lwin (Fig. 1) lies in the western margin of the Shan Plateau (Shan-Thai Block) within Sibumasu Terrane. The Shan- Thai Block lies to the east of the

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west Myanmar Terrane (aks Myanmar Plate) separated by the well-known Sagaing Fault of Win Shwe (1971). These two blocks are also separated by the "Shan Scarp Fault" or "Boundary Fault". The Shan Scarp fault runs along the western margin of the Shan Plateau and the structural features in the study area are related to this regional fault (Fig. 2). The basement of the plateau is Chaung Magyi Group of Proterozoic age (1800 Ma to 530 Ma). The Paleozoic sediments are exposed on it. Iron ore deposits lies mostly in the Maymyo Formation. The strata exposed in the Twinnge- Thandaung form a western limb of the Kyaingtaung anticline and Kyadwinye iron deposits and other occurrence around it have a south-west-dipping homocline which itself is the eastern limb of the Kyaingtaung anticline.

1.2 Method of Study

Detailed geological study of the area, classification of rock units and the occurrences of the iron deposits were carried out during the course of field study. Detailed geological data of the lithologic units and structural elements were measured and recorded for structural interpretation. Tape-and-compass method and bore hole data are employed to determine the thickness of iron ore deposits and the types of deposit in the study area. The representative ore and rock samples were taken from each borehole and test-pit. The collected ore samples were examined under ore microscope in order to know the mineral paragenesis and origin, and also analyzed by using PXRF for iron content. Photographs and sketches were taken for some significant features.

II Geology

In this area, the regional strike generally runs northeast-southwest, parallel to the regional topographic trend. The Paleozoic sediments are exposed repeatedly in the Zebingyi, Thondaung, Kyaing Taung, Aniskan, Baw and Wetwun villages. There are also remarkable a series of structural natures such as Zebingyi syncline, Kyaing Taung Anticline, Anisakan Syncline and another anticline located SE of Wetwun. The detailed geological map of the study area is shown in Fig. (3). Rock units are as follows.

Lithology	Geologic Age
Alluvium	Quaternary *Unconformity*
Maymyo Formation	Mid-Devonian to Permian
Zebingyi Formation	Early to Middle Devonian
Nyaungbaw Formation	Silurian
Kyaingtaung Formation	Late Ordovician
Sitha Formation	Middle Ordovician

III Iron Ore Deposits and Occurrences

It is found that iron ore deposits around Pyin Oo Lwin are primarily as bedded ores on Maymyo Formation and secondarily found as residual deposits in Terrarossa. There are several iron ore deposits such as Twinnge, Thandaung, Inya, Kwindwinye, Wetwun (Pauktaw), Bawhlaing and Naungthakaw. Among them, the biggest one is Kyadwinye deposit.

3.1 Iron Ore Deposit at Kyadwinye (21°53'39.64"N, 96°30'58.67"E)

It is located on the eastern limb of a major anticline (Kyaingtaung anticline) whose anticlinal crest is located about six miles to the west. Iron ore occurs entirely in Maymyo Formation. Kyadwinye deposits contain high iron content (50%-60% Fe). Moreover, numerous small-scale iron occurrences which are economically unfeasible are found throughout the area.

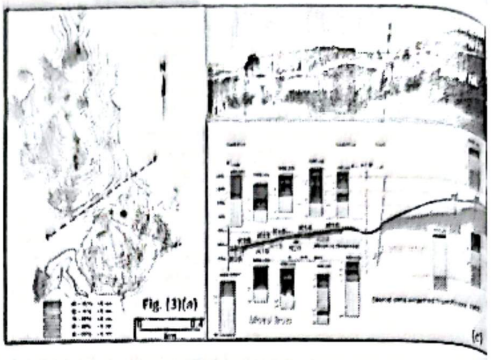

Fig. (3) Geology map of Pyinoolwin area including iron localities. ((Source: Aye Ko Aung & Kyaw Min, 2011; Khaing Khaing San, 2005; Khin Maung Shwe, 1973; Myint Oo, 1997; Win Win Kyi; 1990, Tin Aung Myint, 2002; 2013; & Zaw Min Thein, 1995) ***(Compiled by Tin Aung Myint, 2014)***

In Kyadwinye mine, the iron deposit occurs on the Main hill (Foot wall) (3498') and mine site in lower hill (Hanging Wall) separated by Kyadwinye fault. The area coverage is about 6725640 square feet (624811.9 sq.m.). Iron ore map (Fig. 4a), cross sections and bore hole profiles (Fig. 4b & c) are shown respectively. The thickness of iron deposit on the Main hill is only 12.8' (4m) thick. However, at the mine, the iron ore deposit is much thicker, reaching up to 70' (22m) in thickness. Field investigation shows that the mine is situated on the down thrown side of the fault. This normal fault is thought to be formed before the deposit because ore body in lower hill is much thicker than the Main hill and there is no evidence that this fault separates the ore body.

In Kyadwinye, the iron ore deposit comprises limonite and hematite with minor amount of pyrite and magnetite found in dolomite and sandstone of Maymyo Formation. The bore-hole data indicates gradual increase of limonite content with depth. This is because limonite contains hydroxide and the nearer the water table, the more limonite content increases. The surface of the ground shows scattered light brown ferruginous gravel and larger pieces of iron ores. Iron ore occurs in different forms: as boulders, nodular masses, gravels or floats Fig. (5 a-d). The sizes of the ore boulders decrease from south to north. The biggest one is reaching up to 15 cubic meters (530cubic feet). Iron ores are not cemented together nor very firmly embedded in the sandy loam which surrounds them; neither do they form a continuous layer. Some ore boulders show dendritic tubes filled with silt resembling worm burrow tubes Fig. (5b).

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The ore is trucked to the No.1 Iron and Steel Plant at Aniskan located about 16 km west of Pyinoolwin. The plant produces pig iron, steel billet, rounded bars and steel grinding balls (Soe Win, 1994). Although Krupp and BGD (1961-62) gave a reserve of 3 million tons, the estimated iron ore reserve is less than 2 million tons with average iron content of 58.5% (Tin Aung Myint & Mi Mi Ko, 2004).

3.2 Other Iron Ore occurrences around Pyin Oo Lwin

Baw (21°54'3.05"N, 96°32'20.50"E):

Around Baw, iron ore deposits unconformably overlie on the Maymyo Formation.

Fig. (4) (a) Iron ore and bore hole location map, (b) Panaromic view of the mine area and (c) cross section passing through the Bore holes of (Fig. a) with their Fe content. (Tin Aung Myint, 2002) (some data acquired from Krupp, 1961-1962)

Inya (22° 0'57.77"N, 96°32'53.19"E):

It is located 9 km SE of Pyin Oo Lwin. Brecciated limonitic ore occurs in dolomitic limestones. 4.5 million tons with an average Fe content of 35.2 %, Ti O_2 content of 1.5 %. The deposit although favorable for open cast mining, the ore is difficult to dress (intergrowth of hematite ore / laterite / bauxite). The Fe content is generally low and high TiO_2 content renders the ore difficult to smelt.

These deposits are embedded in ferruginous sandy soil layer and sandy loam layer. The localities of iron occurrences and their detailed descriptions are shown in Fig (6) & Table (1). There are altogether 9 occurrences that contain iron content of 21.33% to 61.38%. These iron ore deposits are Kyaukphyagyaw (G.058534), Thegon (G.065519), Pongon (East) (G.099554), Nattawtaung (G.107558), Sintheka Taung (G.112564), Nattawlay Taung (G.124575), Pawpyin (NE) (G.106570), Baw (S) (G.091514), and Kyadwinye(S) (G.069529), respectively. Among them, Kyaukphyagyaw deposit contains high iron content (60% Fe). Moreover, numerous small scale iron occurrences which are economically unfeasible are found throughout the area. Thus, it can be correctly interpreted that Kyaukphyagyaw will be another alternative mining site of iron ore when the Kyadwinye Mine is exhausted.

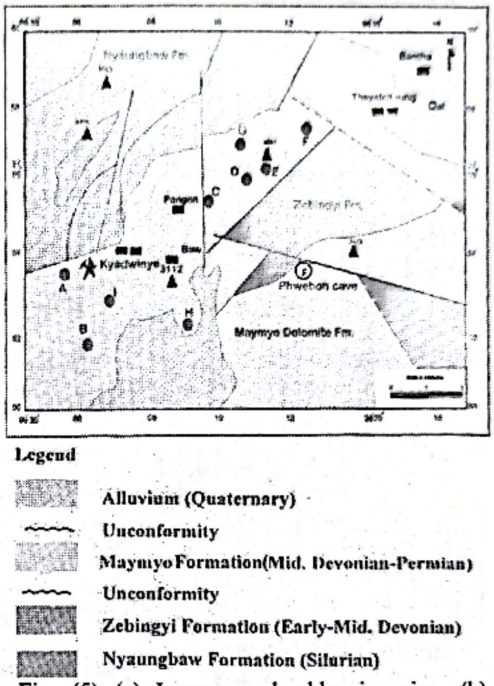

Fig. (5) (a) Large ore boulder in mine, (b) Dendritic patten like tubes filled with sandy silt in the area, (c) Various sizes of iron ores and (d) Iron gravels mixed with loam on Maymyo Formation.

Twinnge (21° 57'N, 96° 22' E):

J.C Brown (1916) described the iron ore deposit at Twinnge between Mandalay and Pyin Oo Lwin. Hematite and limonite in nodules of varying size which lie near the base of a red clay (terra rossa) capping dolomitic limestone. It is a typical residual deposit lying above the Maymyo Formation which has been exposed to continental weathering since the end of the Mesozoic. 1m thick iron ore horizon is developed, consisting of limonite and limonite/ hematite nodules and concretions. The estimated ore is about 275,000 tons. The iron content varies from 56.3% to 60.1% Fe.

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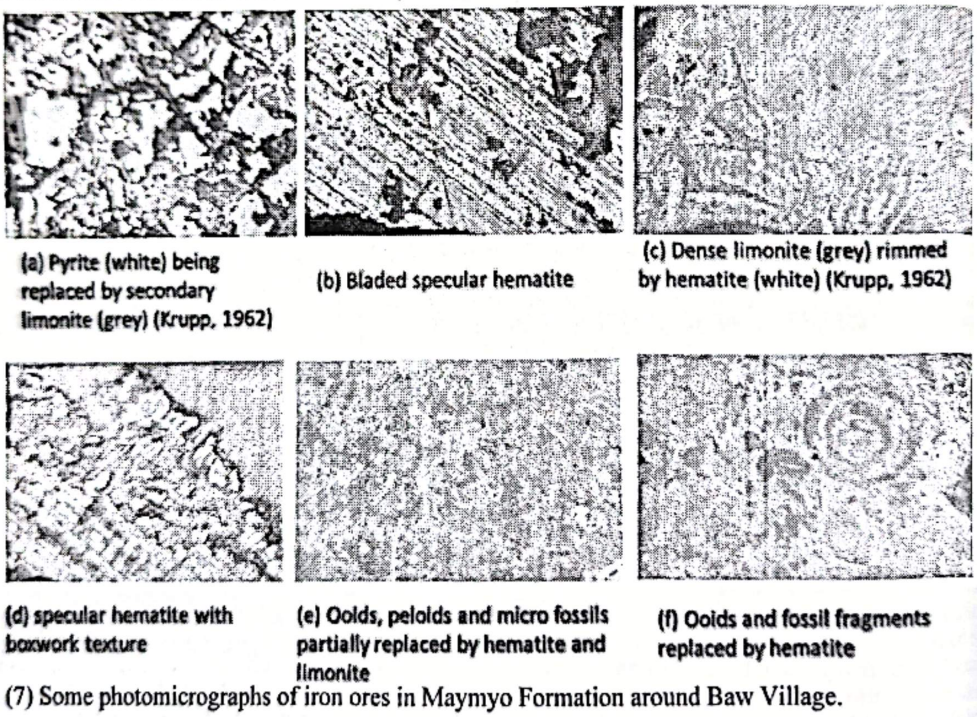
Table (1) Ore Reserve and chemical analyses of small iron ore occurrences around Baw (Source: DGSE, 2000 & Tin Aung Myint, 2002)

No	Code	Work Site	Area (Sq.m)	Thickness (m)	Mineral Percent			Sp.Gr.	Category	Ore Reserve	
					FeO%	SiO_2%	Al_2O_3%			Total	>5cm
1	A	Kyauk-hnaung-nyin (G 088534)	38100	0.9	61.38	1.27	8.66	4.18	P_3	11000	9900
2	B	Thagon (G 085519)	138112	1.2	39.03	26.51	12.72	3.12	P_3	40800	34300
3	C	Pongan (East) (G 099554)	51816	1.8	26.10	45.71	12.43	3.47	P_4	33800	26400
4	D	Nattawtaung (G 107558)	38576	2.7	32.33	37.08	11.03	3.66	P_4	22400	19600
5	E	Sinbokataung (G 112584)	32004	1.7	26.25	45.27	10.09	3.29	P_4	15800	12200
6	F	Nattawlaytaung (G 124575)	45750	1.5	29.15	39.80	13.57	3.86	P_4	24600	24000
7	G	Pwapyin (Northeast) (G 106570)	28956	2.3	24.49	46.78	5.63	3.82	P_4	24300	20400
8	H	Baw (South) (G 091514)	41148	1.2	21.33	46.81	11.88	3.40	P_4	15500	13700
9	I	Kyadwinye (South) (G 095529)	16764	1.0	27.28	31.71	18.81	3.25	P_4	5300	4600

Fig. (6) Geological map of the Baw area (Win Win Kyi, 1990 & Tin Aung Myint, 2002)

Pauktaw (22° 4'46.78"N, 96°35'13.07"E) :

It lies close to the Mandalay- Lashio railway line, some 4.5 miles SW of Wetwin station in the direction of Maymyo. It is a small excavation worked in 1920 and 1921 by the Burma Corporation. 1,700 tons of ore, with an average iron content of 56- 57 %, have been removed from this working. The analysis of pisolitic materials contains 25.2 % Fe, 19.0 % Al_2O_3, 6.2 % MgO, and 10 % SiO_2 (Soe Win, 1994)



(a) Pyrite (white) being replaced by secondary limonite (grey) (Krupp, 1962)

(b) Bladed specular hematite

(c) Dense limonite (grey) rimmed by hematite (white) (Krupp, 1962)

(d) specular hematite with boxwork texture

(e) Ooids, peloids and micro fossils partially replaced by hematite and limonite

(f) Ooids and fossil fragments replaced by hematite

Fig. (7) Some photomicrographs of iron ores in Maymyo Formation around Baw Village.

Bawhlaing (22° 8'34.34"N, 96°34'58.14"E):

It lies 2 miles NE of Pauktaw deposit. It is a shallow deposit lying on the top of a limestone knoll. A reserve of 40,000 tons was estimated in 1927. The ore contains 56.6 % Fe, 3.7 % Al_2O_3, and 2.0 % SiO_2.

Naungthakaw (22°8'47.03"N, 96°31'45.46"E):

It lies about 6 miles to the NW of Pauktaw. Workable hematite ore vary from thin bands of few inches to thick ones of several feet thick. The deposit is covering the area of about 8 sq. miles. It is of residual type in Plateau Limestone. The iron content is 56 % Fe. This was mined by the Burma Corporation Ltd, in pre- war years with an annual production between 35,000 and 40,000 tons.

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Thandaung (21°57'23.75"N, 96°22'50.99"E):

The deposit is located SW of Pyin Oo Lwin and can be approached from Sitha village by a cart road. Iron ore is in the form of angular fragments and debris. Pisolitic and oolitic iron nodules also occurred. The deposit was once worked by Burma Corporation Ltd (Soe Win, 1994).

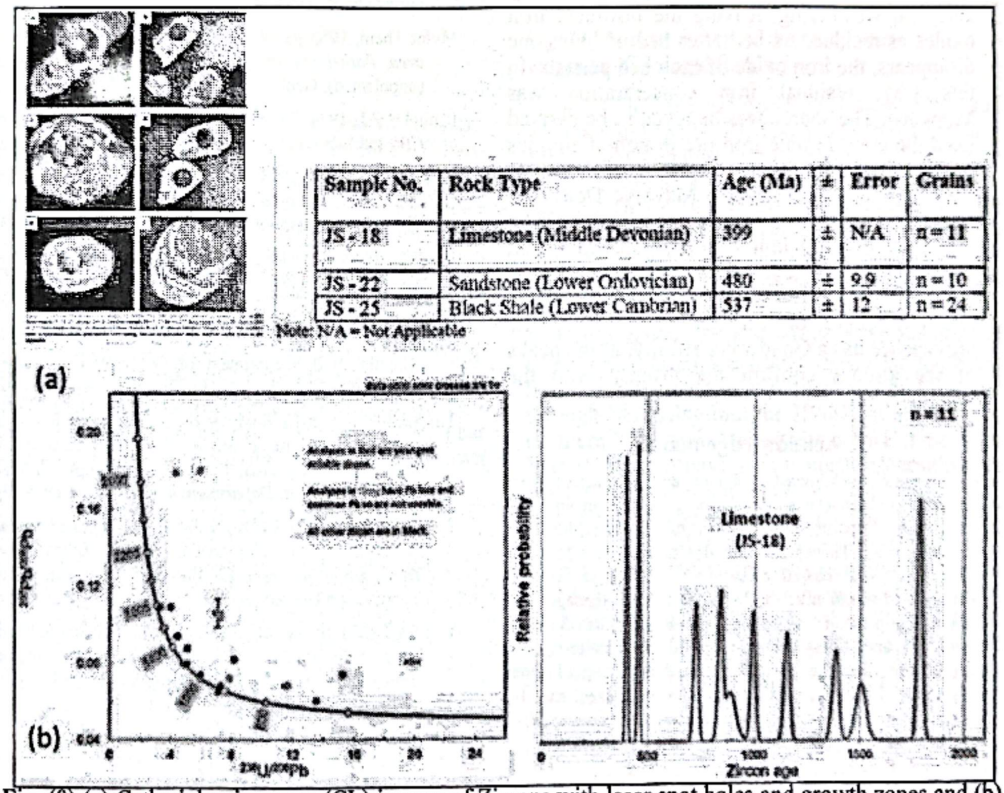
IV Discussion

4.1 Deposit Styles and Types

Field investigation shows that iron ore unconformable overlies on the Maymyo Formation and it is nearly parallel to the underlying beds. Peloids and some distorted ooliths occur in iron slide (see Fig. 7). Ooids and peloids are typically replaced by limonite and hematite. Some micro fossils (forams?) are also observed and partially replaced by hematite. It could be stated that iron ore deposits around Pyin Oo Lwin was primarily sedimentary origin. Although the ores are found as sub-parallel to the bedding, they form rarely as layers. Despite them, the ores occur mostly as boulders and nodular masses. This is because the chemical weathering processes leached siliceous and carbonated minerals from the bedded iron deposit, resulting in an up grading of the iron content. To sum up, Kwadwinye deposit is of bedded sedimentary origin followed by residual concentration. Pisolitic and oolitic iron nodules (mainly hematite) occur in Wetwun and Thandaung. Twinnge and Naungthakaw deposits represent a typical residual deposit above Maymyo Dolomite.

4.2 Geochronology

The Devonian is a period of Earth's history that went through radical change both physically and chemically. In this study, Laser Ablation Inductively Coupled Mass Spectrometry (LA-ICPMS) was used to determine detrital zircon ages within the black shales, sandy limestone and shaly limestone from the Lower Cambrian, Lower Ordovician and Middle Devonian and Middle to Upper Devonian in Myanmar together with scientists from Tasmania University, Australia. The zircon U-Pb ages for sample JS-18 which is a limestone, was aged at 399 Ma, which suggests that the age is consistent with fossil ages of the Middle Devonian Maymyo Formation. Sample JS – 22 is a sandstone from the Lower Ordovician Naungkhangyi group which was ages at 480.3 Ma ± 9.9 Ma. Sample JS-25 which is a black shale, is aged at 537 Ma ± 12 Ma (Jordan Sheppard et al., 2017) (Fig. 8).



Sample No.	Rock Type	Age (Ma)	±	Error	Grains
JS - 18	Limestone (Middle Devonian)	399	±	N/A	n = 11
JS - 22	Sandstone (Lower Ordovician)	480	±	9.9	n = 10
JS - 25	Black Shale (Lower Cambrian)	537	±	12	n = 24

Note: N/A = Not Applicable

Fig. (8) (a) Cathodoluminesence (CL) images of Zircons with laser spot holes and growth zones and (b) Concordia diagram and probability curves of ratios of 207Pb / 206Pb vs. 238U/ 206Pb for sample A) JS-18 silty limestone from Middle Devonian Maymyo Formation. (Source: Jordan et al., 2017)

This suggests the U-Pb zircon age of the rock to be from Lower Cambrian Ngwetaung Group. The relativity plots of the zircons suggest the provenance has a Gondwana affinity, as the peaks of the zircons confirm the affinity with the Sibumasu Terrane. This indicates both the source of the detrital zircons, and the source of the sediment.

V. Conclusions

Rock units exposed in the area are Paleozoic rocks including Sitha Formation (Middle Ordovician), Kyaingtaung Formation (Late Ordovician), Nyaungbaw Formation (Silurian age), Zebingyi Formation (early to middle Devonian age) and Maymyo Formation (middle Devonian to Permian age).

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Iron mineralization occurs mainly on dolomite and sandstone of Maymyo Formation. It is mainly composed of hematite and limonite with minor amounts of pyrite and magnetite. Iron ores occur in different forms as boulders, nodular masses, iron gravels and floats which are not cemented together or very firmly embedded in the sandy clay (loam) that surround them, neither do they form a continuous layer. The thickness of the iron deposit varies from 4 to 22 meters in mine site. Large ore boulders may reach about 529.7 cubic feet (15 cubic meters) in size. According to bore hole data, the size of the ore boulders decreases from south (lower hill) to north (Main hill) in Kyadwinye mine. The iron deposit around Pyin Oo Lwin is primarily of bedded sedimentary origin probably formed at the end of Paleozoic as the presence of micro fossils (forams?) and ooids which are entirely or partially replaced by interlayered hematite as the iron is essentially and completely precipitated as ferric oxide or may replace calcium carbonate shells or ooids. Moreover, readily soluble and porous natures of Maymyo Formation are the favorable site to concentrate the formerly formed bedded iron deposit. Therefore, the removal of soluble constituents and concentration of the insoluble ones must have been enormous. These conditions, limestone formation will be slowly dissolved by chemical weathering, leaving the insoluble iron oxides as residue. As bed after bed of limestone disappears, the iron oxide of each bed persists. In this way, residual iron concentration was happened. The source was believed to be derived from the considerable iron ore in non-aluminous dolomite and ferruginous sandstone of the lower stratigraphic horizons of the Maymyo Dolomite. The zircon U-Pb ages of 399 Ma, for a limestone in Maymyo Formation near Pyinoolwin which suggests that the age is consistent with fossil ages of the Middle Devonian Maymyo Formation. The relativity plots of the zircons suggest the provenance has a Gondwana affinity, as the peaks of the zircons confirm the affinity with the Sibumasu Terrane.

Acknowledgements

We acknowledge Rector and pro-rectors from University of Mandalay and Professor Dr Than Than Nu, Head of Geology Department, University of Mandalay for their encouragement. Thanks, are also due to admirable Saya Dr Than Zaw, who passed away many years ago but still remembered in our mind, U Myint Kyi, Mine manager and responsible personnel of the iron mines in the area for their hospitality and willing help during field trip. Finally, special thanks are extended to all responsible personnel from Myitkyina University, Myanmar who organized the 1st Myanmar International Science and Culture Conference 2019 and allowed our paper to be published in the proceeding.

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GEO 009

Stratigraphy and Petrography of Ordovician rocks from Sitha-Paungdaw area, Pyinoolwin Township

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Abstract

The study area is located in western marginal zone of the Eastern Highlands (Shan-Tanintharyi Massif) is situated about seven miles south of Pyin Oo Lwin. It occupies in one - inch topographic map 93 C/15. In the study area, can be differentiated into two lithostratigraphic units of formation in Ordovician age. They are Sitha and Kyaungtaung Formation. The Sitha Formation is mainly composed of medium - to thick-bedded, bluish grey limestone with irregular silt partings and patches. It is locally well jointed fissure filled silt partings and locally dolomitized. The fossils are common in some places, but less fossiliferous than the Kyaingtaung Formation. Petrographically, in this limestone is classified as pelsparite, ooidsprite and biomicrite. The lithologic type, sedimentary structures and faunal content indicate that may have been accumulated in a slightly agitated, warm, shallow neritic environment. The Kyaingtaung Formation is chiefly composed of thick-bedded, yellowish grey to reddish brown silty limestone with a few amounts of calcareous siltstone and marl. They are containing abundant brachiopods, crinoid stem and bryozoans. Petrographically, in this limestone are classified as silty biomicrite. The lithologic type, sedimentary structure and faunal content indicate that the Kyaingtaung Formation was a warm, shallow and slightly agitated environment.

Keywords: lithostratigraphic units, Ordovician, fossiliferous, environment

INTRODUCTION

Location and Size

The investigated area lies in western marginal zone of the Eastern Highlands (Shan-Tanintharyi Massif) is situated about seven miles south of Pyin Oo Lwin. The study area is located by north latitudes 21° 51′ to 21° 59′ and east longitudes 96° 22′ to 96° 27′to in one-inch topographic map 93 C/5. This area is bounded by vertical grids 530 to 640 and horizontal grids 900 to 990. It covers an area of approximately 35 square miles of rugged and mountainous terrain. This area is Mandalay - Pyin Oo Lwin motor car road and railway - road cut across the middle part of the area. It can be easily reached in all year round. The location map of the study area is shown in Fig. (1).

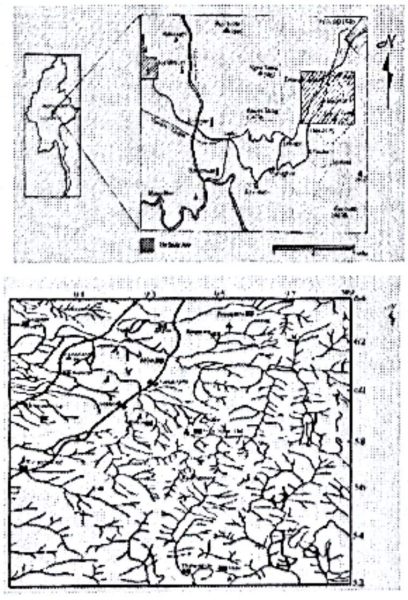


Fig. (1) Location map of the study area

Regional Geologic Setting

The regional geologic setting of the area is shown in Fig.(2). The Kachin-Shan-Tanintharyi Massif in which the present area (Sitha - Paungdaw area) situated is a distinct geotectonic domain (Maung Thein, 1973) forming the western part of the Eastern Highlands (Shan Massif) the Sino-Myanmar Ranges (Bander, 1983).

The Shan Massif lies to the east of the Central Lowlands. The Shan-Tanintharyi Massif is largely covered by the Shan State. To the west, it is separated from the central basin by the Shan Scarp Fault running from the Gulf of Mottama through Mandalay into the Kumon Ranges in the northern Myanmar. The eastern border of the Shan Massif is occupied by a northeast-southwests triking band of granitic and metamorphic rocks. The northern boundary of the Shan Massif probably coincides with a NNE striking belt of ultrabasic and basic intrusive extending from north of Mogok far into the northern most region of Myanmar. Towards south, the Shan Massif decreases in width and extends for a considerable part into the northwest Thailand, limited to the east gain by the intrusive granitic rocks. Large area of the Shan Massif is covered by thick carbonate rocks of Ordovician, Silurian, Devonian, Permian and Early Mesozoic age which were deposited in the Myanmar-Malaysian Geosyncline (Kobayashi, 1964).

The present area is mainly composed of Ordovician rocks (Sitha Formation and Kyaingtaung Formation), Silurian (Nyaungbaw Formation), Devonian (Zebingyi Formation) and Carboniferous to Early Triassic (Maymyo Dolomite). The rock units are repeatedly exposed due to a series of nearly north-south trending major anticlinal and synclinal structures, and associated longitudinal fault and cross faults. The contact

between the rock sequences are either graditional, conformable or tectonic.

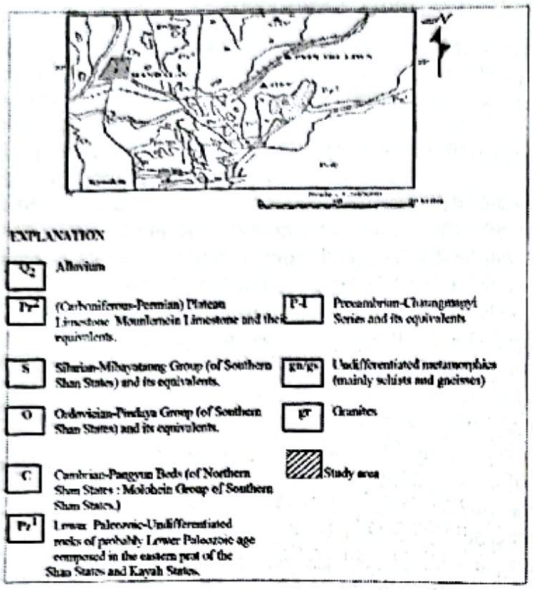


Fig. (2). Regional geologic setting of the area

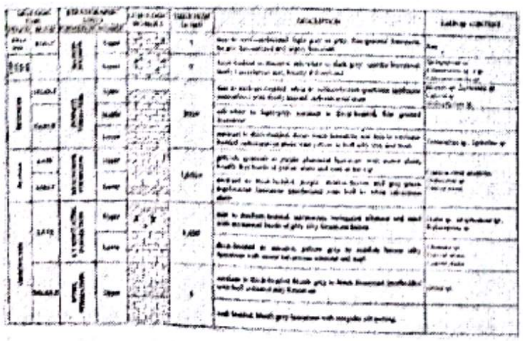
STRATIGRAPHY

Stratigraphic Succession

The investigated area lies in western marginal zone of the Eastern Highland. It consists of the Paleozoic units from Ordovician to Early Triassic limestone, silty limestone, argillaceous limestone, sandy limestone and dolomitic limestone. In the study area, the rocks can be differentiated into five lithostratigraphic units of formation rank on the basic of stratigraphic relationship and faunal content. The stratigraphic succession in ascending order (from order to younger) of the area is as follows: 5. Maymyo Dolomite 4. Zebingyi Formation 3. Nyaungbaw Formation 2. Kyaingtaung Formation 1. Sitha Formation.

The generalized composite stratigraphic column of the study area is shown in Table (1). The thickness of these beds varies from thinly bedded to massive. Ordovician to Devonian units are successively overlain by graditional contacts. This may be a major hiatus at the end of Devonian period with reference to terrigenous sedimentations of quartzose sandstone prior to Maymyo Dolomite precipitation. The geological map of the study area in Fig. (3).

Table (1). Stratigraphic column of the study area



Sitha Formation

General Statement

The name "Naungkangyi Series" was first established by La Touche (1913) and subdivided the Ordovician strata of the northern Shan State into Upper Naungkangyi Stage and the lower Naungkangyi Stage. I.G.C.P (1980) renamed La Touche's lower Naungkangyi Stage as the Tha-yauk-myaung Formation. The Tha-yauk-myaung Formation was designated a formal lithostratigraphic unit as Sitha Formation (M.A.S.U, 1983). It was named after the village of Sitha, situated at about 10 miles south of Pyin Oo Lwin. Sitha Formation is referred medium to thick bedded, bluish grey colour limestones with irregular silt parting.

Distribution and Lithology

The Sitha Formation is well exposed in the southern part of the area. Good bedded nature bluish grey limestone of this formation are exposed in the study area. It is well exposed near Sitha and Thabyegyin villages and also occurred on the left side of cart-tract from Nyanyintha to Thabyegyin. The Sitha Formation occurs as len-shaped outcrops between the Kyaingtaung Formation and occupying the core of the Nyanyintha anticline. This formation is composed mainly of medium - to thick - bedded, bluish grey limestone and it can be easily distinguished by the presence of irregular silt partings and patches. These limestones are locally well jointed fissure filled with silt particles. The well-bedded character is seen clearly in Fig. (4). The bedding character and colour much different from grey-green limestone of Nyaungbaw Formation.

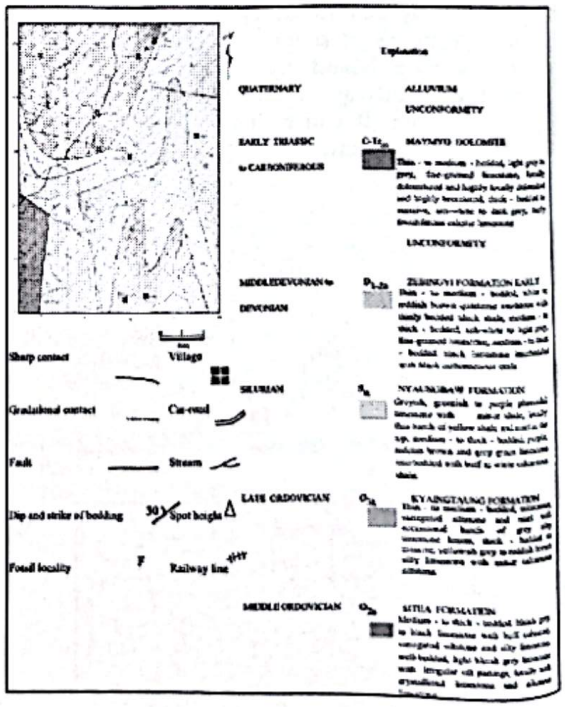


Fig. (3). Geological map of the study area

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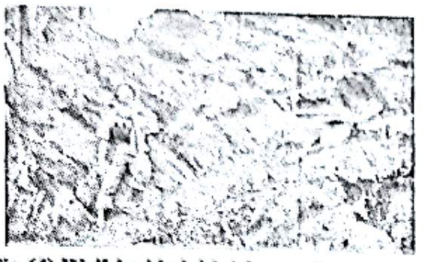

Fig.(4) Well-bedded, bluish grey limestone of Sitha Formation (grid : 957 537)

The lower part of Sitha Formation is composed of medium - to thick - bedded, bluish grey, fine grained limestone will irregular silt partings. Sometimes, the weathered surface shows small sinkholes, silt patches and tubes appear to be formerly worm-burrow tubes and hence the name "burrow limestone" is sometimes used. The occurrence of a fairly thick sub-unit of oolitic limestone is also present in the lower part of the Sitha Formation. The upper part is chiefly composed of well bedded, hard and compact, bluish grey to yellowish brown limestone with irregular silt partings and with calcite veinlets with subordinate buff-coloured siltstone and marl. The limestone are locally dolomitized.

Nature of Contact

The Sitha Formation is trending generally north-south and dipping eastward about 25°. This area unit is conformably overlain by the calcareous siltstone of Kyaingtaung Formation. In some places the faulted contact is recognizable at the eastern base of the Kyaingtaung range.

Fauna and Age

This important fossils are common in the Sitha Formation.

(i)Cephalopod: *Michelinoceras sp.* in Fig. (5).

(ii)Sponge: *Crinoid stems*

(iii)Bryozoan: *Diplotrypa sp.*

(iv)Brachiopods: *Orthis sp; Rafinesquina sp; Chonetes sp.*

(v)Trilobites : *Calymena*

According to lithologic characters, stratigraphic position and faunal assemblage, the age of this unit is most probably Middle Ordovician.

Correlation

The Sitha Formation of the study area can be correlated with the lower Naungkangyi stage of La Touche (1913). It can also be correlated with the Wunbye Formation of the Pindaya Group in southern Shan State (Myint Lwin Thein, 1973) and Tha-Yauk-Myaung Formation of I.G.C.P (1980).

Fig.(5) Cephalopod shell fragments in bluish grey limestone of Sitha Formation(grid:957 537)

Kyaingtaung Formation

General Statement

The name "Naungkangyi Series" was first used by La Touche (1913) to describe the Ordovician strata in the northern Shan State. I.G.C.P (1980) used the term "Kyaingtaung Formation" for the upper Naungkangyi Series of La Touche. Kyaingtaung Formation is mainly composed of buff to purple micaceous siltstone and fossiliferous marl with occasional bands of limestone lenses. The rocks of this unit are locally abundant bryozoans and brachiopods. This units is well exposed at the Kyaingtaung Range (4174 feet).

Distribution and Lithology

The Kyaingtaung Formation is widely exposed in the eastern and southwestern parts of the study area. The type section is observed at Kyaingtaung (4174 feet). It is best exposed along the crestal part of Kyaingtaung Range. It can be observed in the vicinity of Ingyi village. To the northwestern part of the area, this formation is fairly exposed.

On the basic of lithologic character, faunal content and stratigraphic relationship, this unit can be subdivided into the lower silty limestone and the upper buff-coloured marl and siltstone in Fig.(6). The lower part of the Kyaingtaung Formation is chiefly composed of thick - bedded, yellowish grey to reddish brown silty limestone with a few amount of calcareous siltstone and marl. They are containing abundant brachiopod and crinoid stems. The upper part of this formation is highly fossiliferous and is mainly composed of thin-to medium bedded buff, yellow, orange purple, white-coloured micaceous siltstone and marl with occasional bands of silty limestone lenses. The siltstone and marl of this formation are easily recognized by the presence of abundant brachiopods, crinoid stem and bryozoans. In many cases, buff siltstone and marl are sub-indurated to soft and the beds are mostly deformed.

Nature of Contact

The Kyaingtaung Formation is trending nearly north-south and dipping generally eastwest about 30°. This formation is well-exposed at the Kyaingtaung (4174 feet). The lower contact of Kyaingtaung Formation and Sitha Formation is graditional. The contact between the Kyaingtaung Formation and the overlying Nyaungbaw Formation is graditional. It is seen to occur in the Nyanyintha anticline.

Fauna and Age

Kyaingtaung Formation is richly fossiliferous. As the beds are folded and distorted, some forms are also distorted. The following important fossils are present in the Kyaingtaung Formation in Plate (1).

(i)Cephalopods: *Michilinoceras sp.*

(ii)Brachiopods: *Orthis sp; Hesperothis sp; Plectorthis sp; Saucrorthis sp; Dinorthis sp; Strophomena sp; Sowerbyella sp; Rafinesquina sp*

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(iii)Sponge: *Crinoid stem*

(iv)Bryozoans : *Diplotrypa sp.*

On the basic of faunal evidence, lithologic characters and its stratigraphic position, this unit is most probably Upper Ordovician.

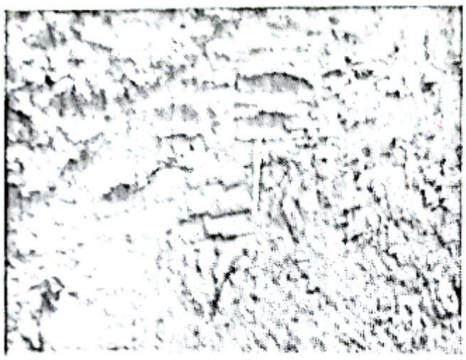
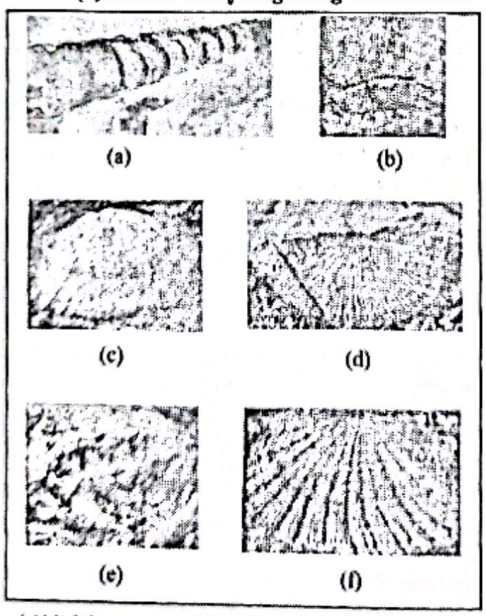


Fig. (6)Thin-bedded, buff colored siltstone of Kwangtung Formation (grid : 954 572)

Correlation

On the basis of the faunal content, lithologic similarity and stratigraphic relationship, the Kyaingtaung Formation of the study area can be correlated with the Upper Naungkangyi Stage of La Touche (1913). I.C Brown (1918) correlated the Naungkangyi Series with the Pu-Pjao Beds of Yunan. The Kyaingtaung Formation of I.G.C.P (1980) is correlated with the Nan- On Formation of Pindaya Group in southern Shan State (Myint Lwin Thein, 1973).

Plate (1) Fossils of Kyaingtaung Formation



(a)*Michilinoceras sp* (x2) (b) *Hesperothis sp* (x3)
(c)*Plectorthis sp* (x 2) (d) *Strophomena sp* (x 3)
(e)*Crinoid stems* (x 3) (f)*Saucrorthis* irravadica (x 2)

RESULTS AND DISCUSSION

(PETROGRAPHY)

In the present area, the samples were numbered and oriented up relative to the bedding plane for detailed petrographic analysis. These samples were cut into thin sections and studied under microscope. The type, grain size, percentage, textural relationship and salient diagenetic features were determined. The volumetric composition and grain size of the constituents were visually estimated with the aid of charts prepared by Terry and Chilinger (1955) and Folk (1968). Each sample was then classified according to the methods (Folk, 1962) and (Dunham, 1962).

Sitha Formation
Pelsparite/ Pelletal grainstone

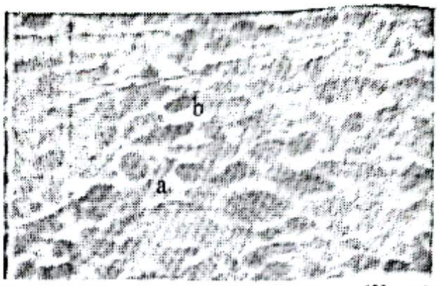


Fig. (7)Photomicrograph showing ellipsoidal pellets(a) and bioclast(b) of Sitha Formation. (x 40)

Megascopically, they are medium - thick - bedded, grey-to bluish grey colour, hard and compact limestone. It is exposed in good exposure on the study area.

Microscopically, it is mainly composed of macrospar 30%, peloid 60%, bioclast 7%, and other 3%. The cementing material between the peloids and bioclasts is sparry calcite. The cement shown here is made up of larger crystal, but with no preferred shape or orientation evident. The pelletal grains, probably faecal in origin, show a typical equal size, ellipsoidal shape and, in addition to the clay-sized carbonate mud which makes up the bulk of them in Fig.(7) .

The bioclast show a fully cemented rock, with two cement generations. The first cement, occurring as thin isopachous rim, is marine in origin of low intertidal to subtidal and pores are filling with blocky crystals. The peloid-rich rocks are characteristics of low-energy environment.

Ooidsparite / Ooid packstone-grainstone

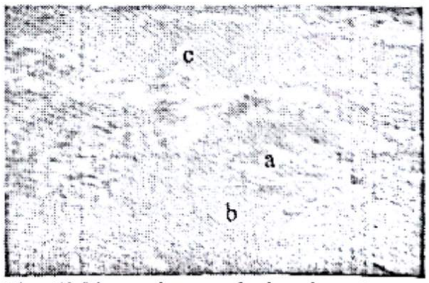


Fig. (8) Photomicrograph showing olomitized Ooids with radial layers(a), dolomite crystal(b) and bioclast(c) of Sitha Formation. (x 40)

Megascopically these limestones are medium - to thick - bedded grey to bluish grey, hard and compact. It is exposed in limit exposure on the study area. The oolitic texture can be easily observed with unaided eye.

Microscopically, it is mainly composed of macrospar 65%, ooid grains 30% and bioclasts 5%. The cementing material between the ooids and bioclasts is sparry calcite and they are partly dolomitized. The rounded spheroidal grains are

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identified as ooids on the basis of size, shape and sorting. Oolites are small spherical or sub-spherical accretionary bodies, 0.25 mm to 2 mm in diameter. The ooids have a poorly preserved concentric structure, rounded circular outline and directly related to the shape of their nucleus. Many oolites have apparently no nucleus at alldue to the prevasive of dolomitization. In this section, the internal structure of ooids may have been partly lost by dolomitization. The layer by layer replacement of dolomite crystals in the ooids produced the concentric laminae of dolomite. So, the texture of the envelope may be entirely concentric. Some oolites are tangentially contact with each other and rare in concavo-convex contact. Detailed study of each and every ooids indicated that dolomitization took place as a different patterns. There are three styles of dolomitization in ooidal grains in Fig.(8). The bioclasts are mostly brachiopod's shell, rarely trilobite fragments and echinoid plates.

Biomicrite / Bioclastic wackestone

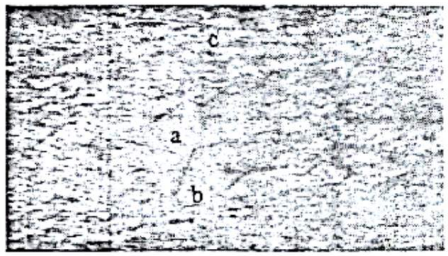

Fig.(9) Photomicrograph showing bryozoans(a), broken echinoderm plate(b), and detrital quartz grains (c) of Sitha Formation. (x 40)

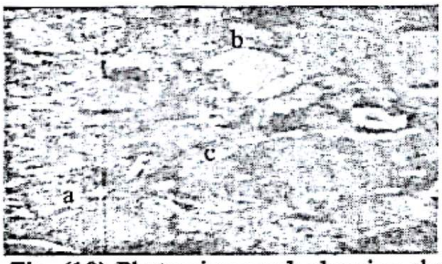

Fig. (10) Photomicrograph showing sharp-shape outline of crinoid ossicles(a), brachiopod shell(b) and bryozoans(c) of the Sitha Formation. (x 40)

Megascopically, the rock is thick - bedded, dark grey, fossiliferous limestone with irregular silt parting and patches. The weathered surface shows small sinkholes and burrow structure. Microscopically, the limestone is mainly composed of micrite 65%, bioclast 30%, sparite 3%, and detrital quartz-silt 2%. Bioclasts consist of echinoderms, bryozoans and brachiopod fragments in Fig. (9). Bioclasts are filled with both micrite and sparry calcite. The hard part of echinoderms have an unmistakable appearance. Each plate behaves optically as a single crystal of calcite due to syntaxial overgrowth or syntaxial rim cements in Fig. (10). But the spines of echinoids, joints of the stems of crinoids, etc., may be distinguished by their size and outlines. The quartz-site grains are sub-angular to rounded and scattered within the matrix. The presence of fossil fragments and abundance of micrite reflect slow deposition in a low energy environment. It probably indicates open sea shelf environment.

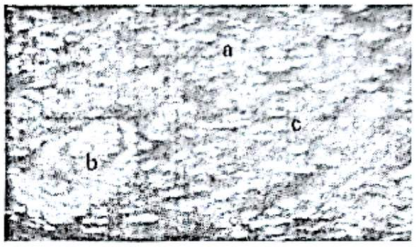

Fig.(11) Photomicrograph showing rounded quartz silt grains(a), bioclast(b), brachiopod shell(c) of fossiliferous Kyaingtaung Formation. (x 40)

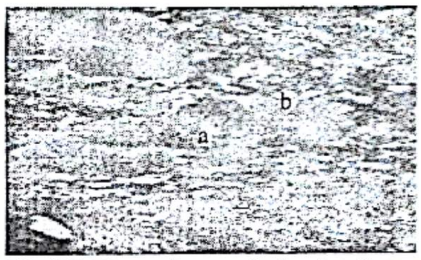

Fig.(12) Photomicrograph showing the thin shell bivalve (a), bryozoans (b) of the Kyaingtaung Formation. (x 40)

Kyaingtaung Formation
Silty Biomicrite / Silty mudstone

Megascopically, the rock is thin - to medium - bedded, buff, yellow, orange, purple, and white-coloured micaceous siltstone and marl with occassional bands of silty limestone lenses. Microscopically, it consist of micrite 58%, quartz-silt 35%, bioclast 5%, and other 2%. The fine-grained calcite matrix contains abundant silt-sized quartz. The quartz grain are angular to subangular ranges. It is also occurs in some bioclasts. The bioclasts mainly include brachiopods shell fragment, bryozoans and crinoids plate and molluscan fragments in Fig. (11). The grain must have been lithified at the time of reworking to allow the rounding of the echinoderm fragment. The sediment between the shells is muddy in Fig. (12). Bioclasts are filled with both micrite and sparite. The micrite matrix contains scattered fine sand and silt grains composed of megafossils such as brachiopod suggests a sedimentation in a basinal euxinic environment.

CONCLUSIONS

The Sitha - Paungdaw area, in the Pyin Oo Lwin Township, is situated in one inch topographic map 93 C/5. The study area is situated at the center of the Eastern Highlands. The ridges are trending nearly north-south and streams are running east-west. The rock can be differentiated into five lithostratigraphic units of formation rank on the basic of stratigraphic relationship and faunal content. The stratigraphic succession in ascending order (from older to younger) is as follows: 5. Maymyo Dolomite(Carboniferous to Early Triassic) 4. Zebingyi Formation(Devonian)

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3.Nyaungbaw Formation(Silurian) 2. Kyaingtaung Formation(Upper - Ordovician) 1. Sitha Formation(Middle - Ordovician).

The Sitha Formation is mainly composed of medium - to thick - bedded, bluish grey limestone with irregular silt partings and patchs. Petrographically, the limestone is composed of micrite 65%, bioclast 30%, sparite 3%, and detrital quartz silt 2%. Bioclasts are filled with both micrite and sparry calcite. Each plate behaves optically as a single crystal of calcite due to syntaxial overgrowth or syntaxial rim cements. The lithologic characters and faunal content suggest that the Sitha Formation was accumulated in a warm, shallow and slightly agitated environment. The Sitha Formation is assigned to Middle Ordovician and is correlated with the Lower Naungkangyi State of La Touche (1913), the Wunbye Formation of the Pindaya Group in southern Shan State (Myint Lwin Thein, 1973) and Tha-Yauk-Myaung Formation of I.G.C.P (1980). The Kyaingtaung Formation is chiefly composed of thick - bedded, yellowish grey to reddish brown silty limestone with a few amount of calcareous siltstone and marl. Petrographically, the silty biomicrite is consist of micrite 58%, quartz-silt 35% and other 2%. The quartz grains are angular to subangular. The bioclasts mainly include brachiopods shell fragment, bryozoans and crinoids plate. The Kyaingtaung Formation was a warm, shallow and slightly agitated environment. The Kyaingtaung Formation is assigned to Upper Ordovician. The Kyaingtaung Formation can be correlated with the Upper Naungkangyi Stage of La Touche (1913) and the Kyaingtaung Formation of I.G.C.P (1980) is correlated with the Nan - On Formation of Pindaya Group in southern Shan State (Myint Lwin Thein, 1973).

ACKNOWLEDGEMENTS

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GEO 010

Petrochemistry of Igneous Rocks Exposed at Wabochat Area, Singu Township, Mandalay Region

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ABSTRACT

Wabo Chat area is located in Singu Township, Mandalay Region, about 10 km NE of Let Pan Hla, covering about 50 km², in UTM map of 2296-02. The study area has high relief and located in the mountainous region. The study area consists mainly of granite, marble and gneiss. According to the XRF analyses the igneous rocks of the study area are mainly biotitemicrogranite (Taunggyun granite), leucogranite and pegmatite. In general, these rocks have SiO_2 (62.5-68.8%), Al_2O_3 (20.3-25.5%), CaO (0.181-1.980%), MgO (0.010-1.210%), Fe_2O_3 (0.169-1.740%), TiO_2 (0.010-0.365%) and Na_2O+K_2O (7.792-11.709%), which indicate acidic in composition and fall within calc-alkaline series, S-type and peraluminous nature.

Keywords: Wabochat area, Granite, Calc-alkaline, S-type

INTRODUCTION

The study area is located in Singu Township, about 10 km NE of Let Pan Hla, covering about 50 km², in UTM map of 2296-02. This area is accessible all the year round. The location map of the study area is shown in (Fig 1).

Regional Geologic Setting

The study area is situated within the north-south trending Mogok Metamorphic Belt (MMB) of Searle and Haq (1964). This belt lies between the Shan scarp to the east and Sagaing Fault to the west. The regional geological map of the study area is shown in (Fig 2). The study area is situated between the Shan Massif in the east and the Central Cenozoic Belt in the west. The Mogok Metamorphic Belt including the study area extends for over 1500 km along the western margin of the Shan-Thai Block of Mitchell (2005) and southeastern flank of Himalayas.

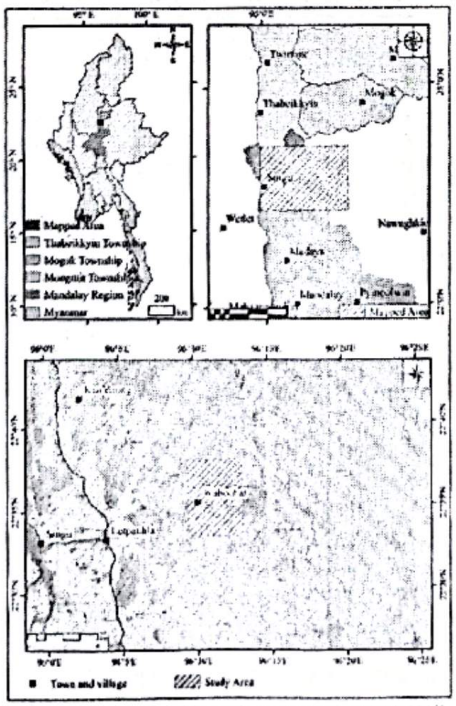

Figure (1) Location map of the study area (source: MIMU, 2010)

The MMB crops out in N-S direction from Kyaukse to Sabenago (east of Male village) through northeast Mogok to NW of Putao at the northernmost extremity of Myanmar. MMB is comprised steeply dipping, deformed, and medium to high grade metamorphic rocks such as marbles, calc-silicate rocks, gneisses and small amount of quartzite. They are intruded by leucogranite, biotite microgranite (Kabaing Granite) and pegmatite dykes.

Just to the west of the area is the Ayeyarwaddy River which flows north to south along the well-known Sagaing Fault, a north-south trending right lateral strike-slip fault. In the eastern part of the area, marble, gneiss, calc-silicate rocks and granite rocks are exposed.

In the west of the area, Nattaung in Singu Township exists and the rock types of that area are metasedimentary rocks and igneous rocks (Maung Maung Naing, 1987).

GENERAL GEOLOGY

The rock units shown in the rock succession are recognized and mapped in this study area. They composed mainly of metamorphic and igneous rocks formed at the differing geological episodes. The study area consists mainly of granite, marble and gneiss. In the northern and southern parts, calc-silicate rocks and marbles are well exposed. Some rock units have been intruded by dykes and veins of pegmatite and aplite, quartzofeldspathic and quartz veins. The geological map of the study area is shown in Figure (3) and some exposure of the igneous rock units are shown in Figures (4,5,6,7). The rock succession was adequately established according to lithology, mineral composition and field relationships and correlation with the other areas.

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The relative ages of the metamorphic rocks are designated by correlation with those of the Wapyutaung-Ondan area to the further north, the Chaunggyi-Zayatkwin area to the north and Letpanhla-Nattaung area to the west mapped by Ali Akbar Khan (1985), Myint Naing (1987), Maung Maung Naing (1989), and Me Me Aung (2012) respectively, depending upon lateral continuity of outcrops and their distinctive lithologic similarity.

Figure (2) Regional Geological Map of the study area and its surroundings (Source: Geological map of Myanmar, MGS, 2014

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Rock Succession of the Study Area

Igneous Rocks — Tertiary

- Taunggyun granite (biotite microgranite)
- Leucogranite
- Pegmatite

Metamorphic Rocks

- Quartzite

Unconformity

- Marble; Diopside and Phlogopite marble, diopside marble intercalated with diopside calc-silicate rocks — Upper Paleozoic to Mesozoic
- Calc-silicate rocks; diopside calc-silicate rock intercalated with diopside marble — Upper Paleozoic to Mesozoic

Unconformity

- Gneiss; biotite gneiss and minor amounts of garnet biotite gneiss — Lower to Upper Paleozoic

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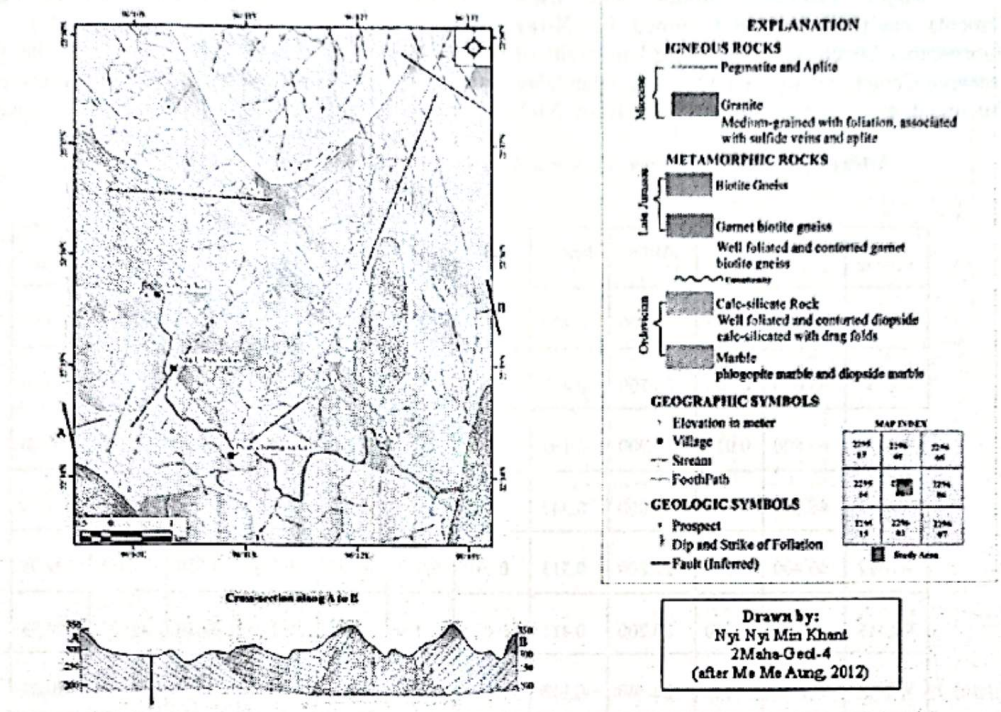

Figure (2.1) Geological map of the study area

Figure (3) Geological map of the study area

Figure (4) Photograph shows the contact between biotite microgranite (Upper) and garnet-biotite gneiss (Lower). Microgranite show highly jointed nature (Loc. N 22° 34′ 12″, E 96° 11′ 50″)

Figure (5) Photograph show the exposure of leucogranite which is highly jointed and light color on both weather and fresh surface(Loc. N 22° 33′ 59″, E 96° 13′ 41″)

Figure (6) Photograph showing pegmatite vein intruded in biotite gneiss. Quartz-rich vein intruding parallel with the layers of host garnet-biotite gneiss(Loc. N 22° 33′ 59″, E 96° 12′ 34″)

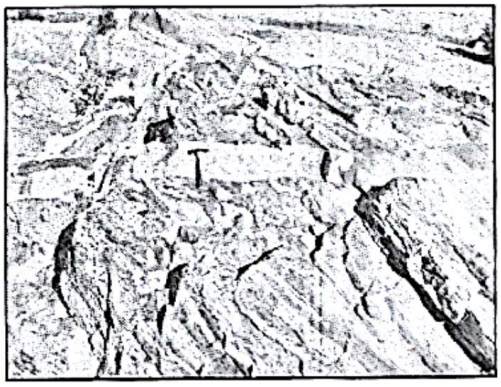

Figure (7) Photograph show east dipping biotite gneiss intruded by aplite vein (Loc. N 22° 34′ 02″, E 96° 13′ 27″)

PETROCHEMISTRY AND PETROGENESIS OF IGNEOUS ROCKS

General Statement

The major igneous units exposed in the Wabo Chat area are mainly biotite microgranite, leucogranite and pegmatite with minor syenite. More than twenty representative rock samples collected from the study area have been selected and analyzed for the petrologic studies. The collected samples were carefully selected for laboratory analyses such as petrologic and petrochemical analyses.

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Major elements, minor and trace elements analyses were determined by X-ray Fluorescence Spectrometer (XRF) at University of Research Center, Mandalay University, Mandalay. The major and trace element oxides from XRF analysis are shown in Table (1). For the present study mineralogy and major element oxides are used to describe, name and classify rocks. In most cases, the chemistry alone is the criterion for classification. The major element data, using the construction of variation diagrams, display the data as bivariate or trivariate plots. This type of diagram is used to show the interrelationship between elements in the data-set and it is from these relationships that geochemical processes may be inferred.

Table (1) Major- and minor- element analyses (in Wt.%) of the plutonic rocks from the study area

Sample	SiO_2	TiO_2	Al_2O_3	Fe_2O_3	MnO	MgO	CaO	Na_2O	K_2O	P_2O_5	Total
WB-4	65.700	0.047	22.800	0.309	0.013	0.177	0.539	6.020	4.250	0.042	99.90
WB-5	65.600	0.048	23.700	0.402	0.009	0.139	0.541	6.390	3.040	0.029	99.90
WB-12	65.800	0.010	22.900	0.169	0.010	0.010	0.539	6.800	3.750	0.010	100.00
WB-13	66.700	0.068	22.000	0.347	0.008	0.164	0.695	5.810	4.090	0.010	99.89
WB-17	66.400	0.051	21.800	0.313	0.010	0.332	0.756	6.740	3.520	0.026	99.95
WB-18	65.000	0.010	23.200	0.411	0.015	0.010	0.484	6.140	4.630	0.033	99.93
WB-19	65.700	0.010	22.700	0.113	0.010	0.010	1.710	7.920	1.770	0.028	99.97
Gnt-2	68.000	0.038	20.300	0.358	0.006	0.192	2.220	7.600	0.192	0.045	98.95
Gnt-3	68.000	0.050	21.000	0.490	0.018	0.010	0.788	5.390	4.080	0.021	99.85
Gnt-4	67.600	0.054	21.100	0.435	0.014	0.159	0.801	5.650	4.040	0.010	99.86
Gnt-5	68.400	0.041	20.700	0.231	0.008	0.177	1.980	7.700	0.681	0.021	99.94
Gnt-6	68.800	0.052	20.800	0.336	0.010	0.144	0.839	4.720	4.180	0.013	99.89

Chemical characteristics of igneous rocks

In this study, chemical classifications of the igneous rocks are based on major and minor oxides data obtained from the XRF analysis. Chemical data (major and minor oxides data) were used in the classification of igneous rocks and major oxides are also used in the identification of original tectonic setting of igneous rocks.

The igneous rocks of the study area are mainly biotite microgranite (Taunggyun granite), leucogranite and pegmatite. In general, these rocks have SiO_2 (62.5-68.8%), Al_2O_3 (20.3-25.5%), CaO (0.181-1.980%), MgO (0.010-1.210%), Fe_2O_3 (0.169-1.740%), TiO_2 (0.010-0.365%) and Na_2O+K_2O (7.792-11.709%). Based on the XRF analysis data, silica % show that the igneous rocks exposed in the study area are acidic in composition.

From the petrochemical view, the chemical designation in most common use is based on silica percentage. For the study area SiO_2 content ranges from 62 to 69 % in biotite microgranite and leucogranite and up to 70% in pegmatite. Wilsom (1989) uses TAS diagram, adopted from Cox et al. (1979), to give a preliminary classification of plutonic igneous rocks which is one of the most useful classification schemes. For the present study chemical data, i.e., the sum of the Na_2O+K_2O content (total alkalis, TA) and the SiO_2 content (S) are taken directly from a rock analysis as wt% oxides and plotted onto the classification diagram. This diagram (Fig 8), points out the bulk composition of igneous rocks is granite.

Major and minor oxide data are used to constructed variation diagram for igneous rocks, by plotting against SiO_2 in order to see variation among them (Fig 9). On the Harker' diagram, SiO_2 is positively correlated with K_2O and FeO whereas other major and minor oxides such as TiO_2, CaO, P_2O_5, Al_2O_3, Na_2O and MgO are negatively correlated with SiO_2.

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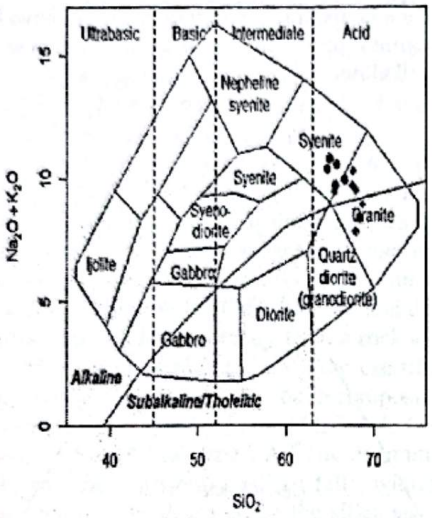

Figure (8) Chemical classification of plutonic rocks using total alkali versus silica, (TAS) diagram of Cox et al. (1979) adapted by Wilsom (1989) showing the field of plutonic rocks of the study area

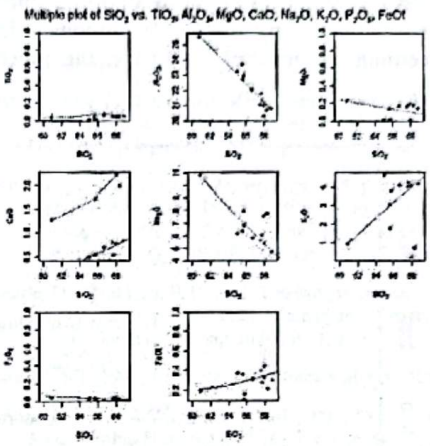

Figure (9) Harker variation diagram of intrusive igneous rocks from the Wabo Chat area (Curves in the diagram indicate the correlation trend).

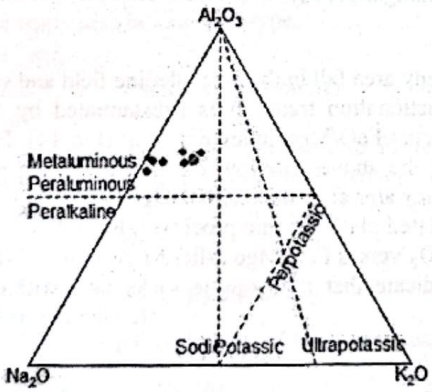

Figure (10) Aluminous saturation indices by using Al_2O_3-Na_2O-K_2O plot

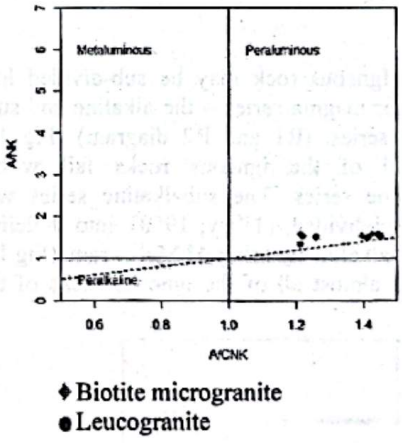

Figure (11) Aluminous saturation indices (Shand, 1943) of the graniticrocks from the study area. (Source: Winter, 2001)

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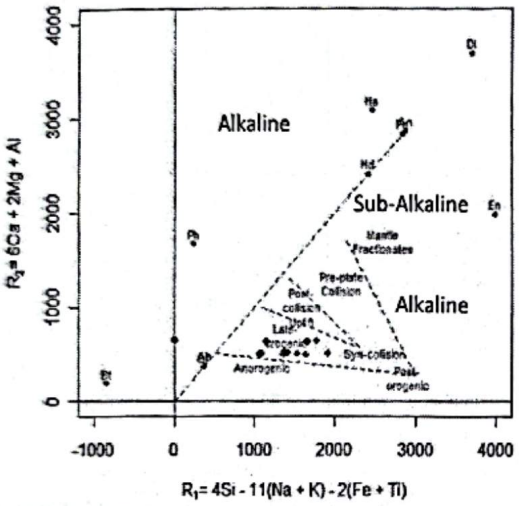
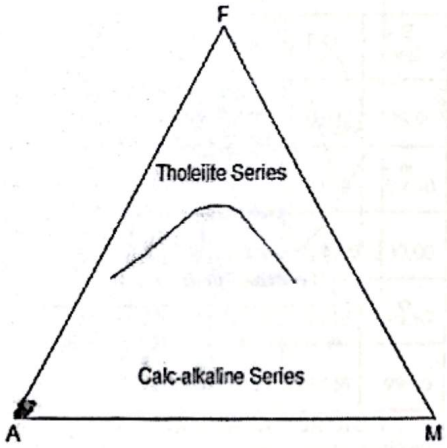
In the (Al_2O_3+Na_2O+K_2O) diagram (Fig 10), the igneous rocks of the study area fall in the field of peraluminous. It is substantiated by A/NK versus A/CNK diagram. (Fig 11) show all of the igneous rocks fall within the peraluminous field. Concerning the mineral chemistry, the igneous rocks of the study area have the mole percent alumina is greater than the sum of lime, soda and potash (Al_2O3> CaO+Na_2O+K_2O). Based on the silica and alkali content, igneous rocks have been classified into two major series: alkaline and subalkaline.



♦ Biotite microgranite
● Leucogranite

Figure (12) The subdivision of plutonic into alkaline and sub-alkaline magma using the parameters R1 and R2 (after De la Roche et al., 1980)

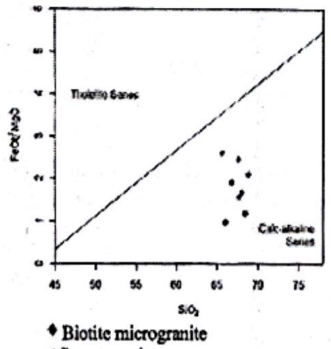


♦ Biotite microgranite
● Leucogranite

Figure (13) $Fe_2O_{3(T)}$ -(Na_2O+K_2O) –MgO, AFM diagram in terms of alkalis, total Fe and Mg for granitic rocks of the study area. The dividing line is based on the work of Irvine and Baragar (1970).

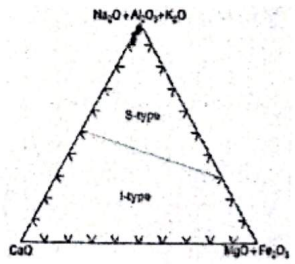
Igneous rock may be sub-divided into two major magma series – the alkaline and sub-alkaline series. (R1 and R2 diagram) (Fig 12) show all of the igneous rocks fall within subalkaline series. The subalkaline series was further subdivided, (Tilley, 1950), into tholeiitic and calc-alkaline by using AFM diagram. (Fig 13) indicates almost all of the igneous rocks of the study area fall in the calc-alkaline field and single fractionation trend. It is substantiated by SiO2 versus FeO/Mgo index diagram, (Fig 14). Based on the above criterion, the igneous rocks of the study area are genetically related to the subduction related plate tectonic processes. Bi-variate plot of SiO_2 versus FeO/Mgo (after Miyashiro 1974) also indicate that the granitic rocks falls within the calc-alkaline magma series.

For the type of granitoids, various plots are used to distinguished I-type and S-type. (Fig 15), ACF diagram, indicates that the majority of igneous rocks from the study area belong to S-type.



♦ Biotite microgranite
● Leucogranite

Figure (14) The subdivision of tholeiitic and calc-alkaline rocks by using SiO_2 versus FeO/Mgo (after Miyashiro 1974)



♦ Biotite microgranite
● Leucogranite

Figure (15) ACF diagram for the granitic rocks of the study area. Molar ratios: A- Al_2O_3+Na_2O+K_2O, C- CaO, F- Fe2O3+ MgO (after Hyndman, 1985)

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Conclusions

According to the XRF analyses the igneous rocks of the study area are mainly biotitemicrogranite (Taunggyun granite), leucogranite and pegmatite. In general, these rocks have SiO_2 (62.5-68.8%), Al_2O_3 (20.3-25.5%), CaO (0.181-1.980%), MgO (0.010-1.210%), Fe_2O_3 (0.169-1.740%), TiO_2 (0.010-0.365%) and Na_2O+K_2O (7.792-11.709%). Based on the XRF analysis data, silica % show that the igneous rocks exposed in the study area are acidic in composition. For the present study chemical data, the sum of the Na_2O+K_2O content (total alkalis, TA) and the SiO_2 content (S) are taken directly from a rock analysis as wt% oxides and plotted onto the classification diagram and points out the bulk composition of igneous rocks is granite. In the ($Al_2O_3+Na_2O+K_2O$) diagram and (A/NK versus A/CNK diagram show all of the igneous rocks fall within the peraluminous field. Based on the silica and alkali content, igneous rocks have been classified into two major series: alkaline and subalkaline. (R1 and R2 diagram show all of the igneous rocks fall within subalkaline series. The subalkaline series was further subdivided, (Tilley, 1950), into tholeiitic and calc-alkaline. By using AFM diagram and SiO2 versus FeO/Mgo index diagram granite and pegmatite belong to the calc-alkaline series. For the type of granitoids, various plots are used to distinguished I-type and S-type. ACF diagram indicates that the majority of igneous rocks from the study area belong to S-type.

Acknowledgements

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Diversity of Fish Fauna in Myit-Too-Myit-Sut In (Lake), Amarapura Township, Mandalay Region

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Abstract

Biodiversity is essential for balancing ecosystem and facing varied problems to environment. The study was carried out from December 2018 to August 2019 to evaluate the species composition, richness and diversity of fish fauna in Myit-Too-Myit-Sut In. Specimen collection was done bimonthly from In owner at the landing site of the In. Data was analyzed by Margalef's species richness index, Simpson's diversity index, Shannon-Wienre's index and Hill's evevness index. A total of 37 species belonging to 27 genera, 16 families and eight orders was recorded. The highest number of species and individuals were found in January. The percent species composition was the highest in order Cypriniformes (43.24%), followed by Perciformes (21.62%), Siluriformes (16.22%), Synbranchiformes (8.11%) and (2.70%) in each remaining orders, Osteoglossiformes, Clupeiformes, Beloniformes and Tetraodontiformes. The value of Margalef's richness index, d (3.6099) was the highest in January. The highest values of Simpson's index D (0.0804), Shannon-Wiener's index H' (2.7063), Hill diversity numbers N_1 (13.9740), N_2 (11.4373) were recorded during December. The highest evenness value E (0.8273) was found in August. The lowest species richness d (2.7462) was in August, Simpson's diversity index D (0.1027), Shannon-Wiener's index H' (2.4574), Hill diversity index N_1 (10.6747) and N_2 (8.7417) were recorded during June. The lowest evenness value E (0.7903) was found in April. It was found that the diversity of fish species was higher during cold season than during rainy season. The satisfactory value of diversity indices indicated the healthy ecosystem of study area. It may be concluded that the results based on the diversity of fish fauna is useful in designing and implementing conservation strategies in order to maintain the sustainability of fisheries in Myit-Too-Myit-Sut In.

Keywords: fish, species composition, diversity indices, sustainability

Introduction

Fishes influences the life of human in various ways. They act as a rich source of food, especially as a protein and lipid. Fish constitutes half of the total number of vertebrates in the world. They live in almost all conceivable aquatic habitats. A total of 21,723 living species of fish have been recorded out of 39,900 species of vertebrates, out of these 8,411 are freshwater species and 11,650 are marine (Saeed *et al*., 2013).

The fish diversity, community structure and species assemblages in the streams and rivers are interdependent on many abiotic and biotic factors. These factors determine the success or failure of fish species assemblages in the rivers or streams within the range of spatial distribution limits (Minns, 1989).

Today the fish diversity and associated habitats management is a great challenge and the ability to evaluate the effects of habitat change and other impacts on the fish population required extensive surveying of the fish population before and after the change occur (Lester *et al*., 1996; Dudgeon *et al*., 2006). In the recent year, several broad scale studies have identified modification and loss of aquatic habitat as primary factor threatening the conservation of freshwater fishes and communities (Allen and Flecker, 1993).

Fish is sensitive to changes in water chemistry due to different anthropogenic activities from their catchments. Fish responses to environmental disturbances, including hydro-morphological factors are different in time and space in comparison to simpler organisms, as they tend to be integrated over larger intervals. Fish has been identified as suitable for biological assessment due to its easy identification and economic value (Siligato & Bohmer, 2001).

Degradation and loss of fish habitats due to winter irrigation for rice cultivation, construction of embankments, siltation of water bodies by natural process and water pollution by industry, and agrochemicals, the natural inland fish stocks have declined significantly and fish biodiversity and poor fishers' livelihood have been affected seriously (Ali, 1997). Ibanez *et al*., (2007) pointed out that to ensure a sound management and sustainable exploitation of freshwater biodiversity it is vital to develop a deeper understanding of the factors and processes that determine aquatic diversity at different spatial scales.

Myit-Too-Myit-Sut In is situated in Amarapura Township, Mandalay Region. Myit-Too-Myit-Sut In consists of Myit-Sut In and Myit-Too In. During the dry season, these Ins are connected by a small stream, but during the rainy season when the two rivers, Ayeyarwady and Myitnge overflow their banks, the two Ins became one expense of water reaching a maximum area of about 15 km^2.It is situated only two miles distant from Taungthaman Lake. It is the fishing ground supplying abundant food resource for the livelihood of local people. Therefore this study site was chosen because it is known as richness of fish fauna and its nature is very different from other Ins in Amarapura Township. The present study was carried out to evaluate and assess the fish diversity in relation to species composition, richness and diversity status of the fish species recorded in Myat-Too-Myit- Sut In.

Materials and Methods

Study Area

Myit-Too-Myit-Sut In is situated Amarapura Township, Mandalay Region. It is located between 21° 50' 24" N to 21° 51' 10"N and 96° 00' 36" E to 96° 01' 25" E.

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Study Period

The present study was conducted from December 2018 to August 2019.

Specimen Collection and Preservation

Collection of specimens were made bimonthly from In owner at the landing site during the study period. The collected of specimens were examined and color photographs were taken soon after they were caught before the body color disappeared. Relevant morphometric and meristic data of fishes were noted and recorded. Small fish were preserved in five percent formalin and the large fishes in ten percent formalin. The fishes were collected with only seine net (5-10cm mesh size) and from which number of species, total number of individuals of each species were recorded for evaluation on diversity of fish species.

Identification and Classification

Identification of fish species was followed after Talwar and Jhingran (1991), Ferraris, (1998) and Jayaram (2013).

Data Analysis

Species richness, diversity and evenness of fish species were analyzed by Margalef (1958), Simpson (1949), Shannon-Wiener (1948), and Hill (1973), Ludwing (1988).

Species Richness (Margalef, 1958)

$$d = \frac{S - 1}{Ln(N)}$$

Where, d = Margalef's species richness index

S = Number of species

N = Total number of individuals

Simpson's Diversity Indice (1949)

$D = \sum_{i=1}^{S} \frac{n_i(n_i - 1)}{n(n - 1)}$ (Simpson, 1949)

Where, Σ = sum

D = Simpson's index of diversity

S = number of species

n_i = number of individuals in the ith species

n = total number of individuals of all species

Shannon-Wiener's Index (1948)

$$H' = -\sum_{i=1}^{S} \frac{n_i}{n} Ln \frac{n_i}{n}$$

(Shannon-Wiener, 1948)

Where, H' = index of species diversity

S = number of species

ni = number of individuals in the ith species in the sample

n = total number individuals of all species in the sample

For Hill's diversity number (1973)

Number 1: $N_1 = e^{H'}$

Where, H' = Shannon's index

N_1 = number of abundant species in the sample

Number 2: $N_2 = 1/D$

Where, D = Simpson's index

N_2 = number of very abundant species in the sample

Evenness

Hill's ratio (1973).

$$E = \frac{(1/D) - 1}{e^{H'} - 1} = \frac{N_2 - 1}{N_1 - 1} \text{(Hill, 1973)}$$

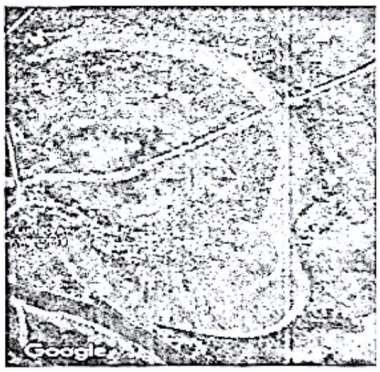

Fig 1. Location Map of the Study site (Source : Google Earth)

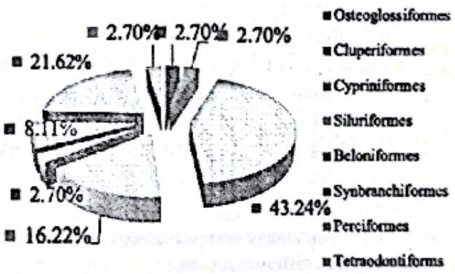

Fig 2. Percentage composition of fish species recorded in different orders

Results

A total of 37 species, confined to 27 genera and distributed among 16 families and eight orders was recorded from Myit-Too-Myit-Sut In during December, 2018 to August, 2019 (Table 1).

Species Composition, Richness and Diversity

Order Cypriniformes was represented with the highest number of species (43.24%), followed by Perciformes (21.62%), Siluriformes (16.22%), Synbranchiformes (8.11%) and (2.70%) in each of the remaining four orders, Osteoglossiformes, Clupeiformes, Beloniformes and Tetraodontiformes (Table 2, Fig. 2).

Table 1. List of fish species recorded in Myit-Tee-Myit-Sut In during December 2018 to August 2019

No	Order	Family	Scientific Name	Common Name	Local Name
1	Osteoglossiformes	Notopteridae	*Notopterus notopterus*	Grey featherback	Nga-phe
2	Clupeiformes	Clupeidae	*Corica soborna*	Ganges river spart	Nga-phan-thay
3	Cypriniformes	Cyprinidae	*Salmostoma sardinella*	Sardinella rozorbelly minnow	Yin-baung-zar
			Amblypharyngodon atkinsonii	Burmese carplet	Nga-byet
			Osteobrama belangeri	Manipur osteobrama	Nga-phan-ma
			Puntius chola	Chola barb	Nga-khon-ma-mee-ni
			Puntius sophore	Spot fineswamp barb	Nga-khon-ma-mee-kwet
			Barbonymus gonionotus	Silver barb	Thai-nga-khon-ma
			Systomus sarana	Olive barb	Nga-khon-ma-gyee
			Cyprinus carpio	Common carp	Shwe-wah-nga-gyin
			Cirrhinus mrigala	Mrigal	Nga-gyin-phyu
			Gibelion catla	Catala	Nga-thaing
			Labeo calbasu	Black rohu	Nga-net-pyar
			Labeo rohita	Rohu labeo	Nga-gyin-myat-san-ni
			Labeo microphalmus	Murree labeo	Nga-lu
			Labeo stoliczkae	Ray-finned fish	Nga-lee
		Cobitidae	*Lepidocephalichthys microgogon*	Loach	Nga-tha-le-doh
			Lepidocephalichthys thermalis	Burmese loach	Nga-tha-le-doh
4	Siluriformes	Bagridae	*Mystus cavasius*	Gangetic mystus	Nga-zin-yine-phyu
			Mystus leucophasis	Sittaung mystus	Nga-nauk-thwar
			Mystus pulcher	Pulcher mystus	Nga-zin-yine-ni
		Siluridae	*Ompok bimaculatus*	Indian buffer catfish	Nga-nu-than
			Wallago attu	Boal	Nga-butt
		Loricariidae	*Hypostomus plecostomus*	Suckermouth fish	Nga-soke-khwet
5	Beloniformes	Belonidae	*Xenentodon cancila*	Freshwater garfish	Nga-phaung-yoe
6	Synbranchiformes	Mastscembelidae	*Macrognathus aral*	One stripe spiny eel	Nga-mway-ni
			Macrognathus zebrinus	Zebra-spinyeel	Nga-mway-doh-kyan-sit
			Mastacembelus armatus	Zig-spinyeel	Nga-mway-nagar
7	Perciformes	Ambassidae	*Parambassis ranga*	Indian glass fish	Nga-zin-zat
		Anabantidae	*Anabas testudineus*	Climbing perch	Nga-byay-ma
		Osphronemidae	*Trichopodus pectoralis*	Thick lipped gourami	Nga-phyin-tha-let
		Cichlidae	*Oreochromis sp.*	Tilapia	Tilapia
		Gobiidae	*Glossogobius giuris*	Tank goby	Nylon-nga
		Channidae	*Channa orientalis*	Walking snakedhead	Nga-yant-gaung-to
			Channa punctatus	Spotted snakedhead	Nga-yant-panaw
			Channa striatus	Striped snakedhead	Nga-yant
8	Tetraodontiformes	Tetraodontidae	*Leiodon cutcutia*	Ocellated puffer fish	Nga-pu-din

The highest number of 34 species was recorded in January. The highest number of individuals (9335) was recorded in January. The lowest number of 20 species was recorded in August. The lowest number individuals (1011) were recorded in August (Fig. 3, 4).

Table 2. Percentage composition of fish species recorded in different orders

Order	Number of species	Composition (%)
Osteoglossiformes	1	2.7
Clupeiformes	1	2.7
Cypriniformes	16	43.24
Siluriformes	6	16.22
Beloniformes	1	2.7
Synbranchiformes	3	8.11
Perciformes	8	21.62
Tetraodontiforms	1	2.7
Total	37	99.99

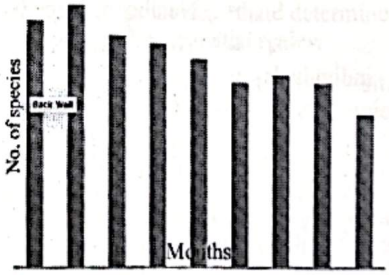

Fig 3 Monthly occurrence number of fish species during December 2018 to August 2019

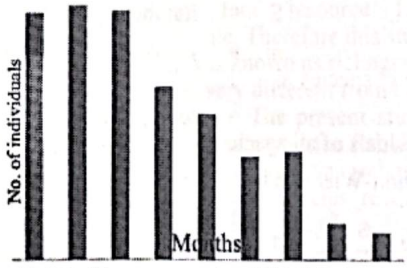

Fig 4. Monthly occurrence number of fish individuals during December 2018 to August 2019

According to monthly data, the highest number of species was found in January (34), followed by December (32), February (30), March (29), April (27), June (25), May and July (24 each) and August (20). A total number of individuals (49435) were recorded in the study period. The

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Table 3. Monthly number of individuals per species recorded during the study period

No	Scientific name	Total number of individuals									Total
		Dec 2018	Jan 2019	Feb 2019	Mar 2019	Apr 2019	May 2019	Jun 2019	Jul 2019	Aug 2019	
1	*Notopterus notopterus*	80	56	85	57	35	13	20	13	0	359
2	*Corica soborna*	0	15	32	0	17	0	0	0	0	64
3	*Salmostoma sardinella*	0	19	16	0	0	0	0	0	0	35
4	*Amblypharyngodon atkinsonii*	960	1060	1050	570	470	375	360	135	154	5134
5	*Osteobrama belangeri*	700	850	865	550	450	398	375	96	120	4404
6	*Puntius chola*	700	956	900	600	550	530	476	148	97	4957
7	*Puntius sophore*	942	1072	1000	631	580	475	450	165	100	5415
8	*Barbonymus gonionotus*	0	15	27	0	0	0	0	0	0	402
9	*Systomus sarana*	33	37	57	52	0	0	0	10	0	189
10	*Cyprinus carpio*	0	0	1	0	0	0	0	0	0	1
11	*Cirrhinus mrigala*	36	10	0	20	10	15	0	0	0	901
12	*Gibelion catla*	26	27	29	25	15	0	5	0	0	127
13	*Labeo calbasu*	25	15	0	0	0	0	0	0	0	40
14	*Labeo rohita*	32	10	17	16	15	0	0	0	0	90
15	*Labeo microphthalmus*	24	12	0	0	0	0	0	0	0	36
16	*Labeo stoliczkae*	10	25	0	35	36	37	0	15	17	175
17	*Lepidocephalichthys micropogon*	486	0	310	200	150	125	30	200	97	1598
18	*Lepidocephalichthys thermalis*	850	950	865	560	490	356	475	25	15	4586
19	*Mystus cavasius*	762	712	546	345	335	320	240	10	45	3315
20	*Mystus leucophasis*	0	0	1	0	0	0	0	0	0	1
21	*Mystus pulcher*	872	972	1075	872	790	175	500	175	100	5531
22	*Ompok bimaculatus*	27	15	0	17	0	0	10	0	0	609
23	*Wallago attu*	18	25	37	15	18	0	10	0	0	123
24	*Hypostomus plecostomus*	23	25	0	0	10	5	5	0	0	68
25	*Xenentodon cancila*	230	150	180	150	80	10	20	5	0	825
26	*Macrognathus aral*	28	20	35	37	20	5	26	25	10	206
27	*Macrognathus zebrinus*	25	25	15	10	15	25	15	5	15	150
28	*Mastacembelus armatus*	20	30	0	15	25	26	0	23	10	149
29	*Parambassis ranga*	986	1086	956	856	756	600	597	100	82	6019
30	*Anabas testudineus*	64	53	50	45	57	47	35	26	17	394
31	*Trichopodus pectoralis*	50	36	34	26	23	25	19	10	15	238
32	*Oreochromis sp.*	600	700	630	340	265	175	175	95	90	3070
33	*Glossogobius giuris*	350	250	230	250	120	50	100	50	10	1410
34	*Channa orientalis*	30	27	19	15	0	7	13	17	5	133
35	*Channa punctatus*	27	15	36	15	24	2	5	7	7	138
36	*Channa striatus*	36	30	22	20	12	5	10	2	5	142
37	*Leiodon cutcutia*	17	35	19	20	0	0	15	5	0	111
	Total	9069	9335	9139	6364	5368	3801	3986	1362	1011	49435

highest number of individual was observed in January (9335), Followed by February (9139), December (9069), March (6364), April (5368), June (3986), May (3801), July (1362) and August (1011) were found (Table 3).

During the study period, the highest value of Margalef's species richness index d (3.6099) was recorded in January. The highest values of Simpson's index D (0.0804), Shannon-Wiener's index H' (2.7063), Hill diversity numbers N_1 (13.9740), N_2 (11.4373) were recorded during December. The highest evenness value E (0.8273) was found in August. The lowest species richness d (2.7462) was in August, Simpson's diversity index D (0.1027), Shannon-Wiener's index H' (2.4574), Hill diversity index N_1 (10.6747) and N_2 (8.7417) were recorded during June. The lowest evenness value E (0.7903) was found in April. (Table 4).

Discussion

In the present study, 37 species of fishes confined to 27 genera, 16 families, and eight orders were identified and described. Among the eight orders, Cypriniformes comprising 43.24% (with 16 species) followed by Perciformes 21.62% (with eight species), Siluriformes 16.22% (with six species) Synbranchiformes 8.11% (with three species) and the remaining Osteoglossiformes, Clupeiformes, Beloniformes and Tetraodontiformes 2.70% (only one species each) respectively.

According to these data, Cypriniformes thus appeared as the most dominant order in Myit-Too-Myit-Sut In, followed by order Perciformes in order Siluriformes, and Synbranchiformes respectively. The lowest species composition was that of the order Osteoglossiformes, Cluperiformes, Beloniformes and Tetraodontiformes.

Some locale workers worked out on diversity of fish fauna in different areas. Among them, Pyone Pyone Hla (2009), Htay Htay Sein (2010) and Ni Ni Aye (2013) conducted on Lakes in Mandalay Reigon and reported that the fish of Cypriniformes, Perciformes and Siluriformes were abundant and dominant species in composition and these species are commercially important fishes. The present finding is in accordance with that of those researchers.

Mon Htwe Lwin (2011) and Nwe Ni Saw (2013) similarly reported a total number of (41) fish species from the lakes in different areas. In the present study, a total of 37 fish species belonging to 27 genera, 16 families and eight orders were recorded from the study area. Therefore, the present findings are less in number of species compared to the above-mentioned findings because it is different for the study area and

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duration. In the present study, the highest number of fish species (34) and the maximum number of individuals (9335) were found in January (cold season).

In the present study the lowest diversity indices were found in July, it may due to water level reached its maximum on an account of heavy rain in this time and some species may be dispersed

Table 4. Monthly diversity indices of species during December 2018 to August 2019

Diversity index	Dec 2018	Jan 2019	Feb 2019	Mar 2019	Apr 2019	May 2019	Jun 2019	Jul 2019	Aug 2019
Total no. of individuals	9069	9335	9139	6364	5368	3801	3986	1362	1011
Total no. of species	32	34	30	29	27	24	25	24	20
d	3.4019	3.6099	3.1797	3.1969	3.0274	2.7905	2.8949	3.1590	2.7462
D	0.0804	0.0921	0.0882	0.0879	0.0947	0.1022	0.1027	0.0858	0.0905
H'	2.7063	2.5785	2.6113	2.646	2.5725	2.4722	2.4574	2.6524	2.5758
N_1	13.974	12.1778	12.6176	13.0977	12.098	10.8484	10.6747	13.1878	12.1423
N_2	11.4373	9.8559	10.3339	10.3742	9.5611	8.7866	8.7417	10.6572	10.0457
E	0.8184	0.8093	0.819	0.7921	0.7903	0.8099	0.8189	0.8081	0.8273

The lowest number of species (20) and the minimum number of individuals (1011) were recorded in August (rainy season). The abundance of fish species varied between the rainy and cold seasons. Since the In is replenished from the water of Ayeyarwady and Myitnage upstream that carried along fresh stock of fish during the rainy season catachability in terms of both the number of species and individuals would normally be higher during the following cold season however, as most of the fishes were already harvested during following months (hot season) catchability decreased prior to the rainy season and the onset of the rainy season.

According to monthly data, the highest value of species richness (d) was found in January. The highest value of Simpson's index diversity (D), Shannon- Wiener's index (H') Hill number value N_1, N_2 were found, in December in the study period. The Shannon-Wiener's index H' value of present study ranged from 2.4574 to 2.7063. The results of present study is in accordance with (Hossain *et al.*, 2017) who reported that overall value ofH' remain always higher 2.0 which suggested that the biodiversity condition of the water bodies of Kusiara River is found to be satisfactory. So, also the water body of the Myit-Too-Myit-Sut In during the cold season following the rainy season. The lower value of diversity D (0.0804) and d (3.6099) higher were recorded in December and January than other months whereas the lowest diversity indices were found in June during the study period. Similar results were also reported by Galib *et al.* (2013) who recorded the value of diversity and richness indices of fish fauna that was higher in the winter months (November to February) than other months in Bangladesh. The value of D is reciprocal to d.

Nath and Deka (2012) indicated that the richest fish diversity is in winter. The lowest number of species was recorded in the month of June, this is due to heavy rain during this time which makes fishing very difficult as water level reached its maximum in Chandubi Tectonic Lake, India.

to other sites with the water current.

The present findings are in close conformity with Cho Sin Win (2016) who studied species diversity of fish fauna in Nat Min Chaung In. She recorded that the highest value of Simpson's index diversity D, Shannon-Wiener's index H' and Hill number value N_1, N_2 were found in November and the lowest diversity index were found in July.

The major causes for deviation in the biodiversity indices are seasonal, nutrients, bottom of the aquatic ecosystem supporting the coexistence of different species and seasonal fish migration and recruitment. Seasonality also affects the breeding behavior of fish (Ryer and Orth, 1987) (cited by Hossain *et al.*, 2017). In the present research the deviation of biodiversity indices were observed. This may be due to changes in seasonality and water quality during the study period.

Margalef's Index is dependent on sample size and may vary from actual diversity value to some extent (Nair *et al.*, 1989). This may occur due to changes in water depth, increasing fishing rate etc. Lower species diversity indicates the selective use of fishing gear (Keskin and Unsal, 1998). Increse harvesting, habitat modification, reduced water flow, growing human intervention on wetland are also considered as significant threats for dwindling species diversity (Chaklader *et al.*, 2014; Hossain *et al.*, 2015).

Namin and Spurng (2004) reported that Shannon-Wiener index (H') is the value slightly impacted; 2.00-2.99, moderately impacted and <2.00, severely impacted. Based on this scale, the present study of (H') is categorized as moderately impacted in study area because H' value is within the range 2.46-2.71.

During the study period, the monthly evenness index values appeared to be approximately the same, so that it indicated that the water body of Myit-Too-Myit-Sut In is eco-friendly for the fishes to thrive, since the E values close to one reflected the healthiness of the environment in which the species thrive.

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Hill (1973) proposed a unification of several diversity measures in a single statistic. While N_1 is the equivalent of Shannon diversity, N_2 is the reciprocal of Simpson's diversity. Naturally the values of N_2 are less than the values of N_1. According to the data recorded the value of N_2 representing very abundant species were found to be lesser than those of N_1 that measures the number of abundance species.

According to IUCN Redlist 2017, in the present study *Osteobrama belangeri, Ompok bimaculatus* and *Wallago attus* pecies were in the category of Near-threatened species, *Cyprinus carpio* species was in the category of Critically endangered species. Based on the results of present study, it was found that there was little variation of diversity indices values. Satisfactory values of diversity indices represent the healthy ecosystem of the study area.

Conclusion

The results have established that the diversity of fish species was higher during the winter season than during the rainy season. Keeping in view the importance of natural fish resources, it may be concluded that the information on diversity, different diversity indices will help in implementing future conservation strategies and maintaining the diversity of fish fauna in Myit-Too-Myit-Sut In.

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Innovative Assessment on Ecological Situations of Fisheries and Socioeconomic of Irrawaddy Delta, Myanmar

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Abstract

In Myanmar, Irrawaddy River conveys lots of benefits, fruitful natural resources, various livelihoods, traditional culture of local community along the riverine from the northern part of Myanmar (Kachin state) to southern Myanmar, Irrawaddy delta. Socioeconomic situation of Irrawaddy delta is mainly relying on fisheries as well as agriculture sector, in doing so, there was done public meetings as surveys and interviews on socioeconomic situations including ecological impacts on water bodies with innovative solutions with local community at 13 locations of different villages, where it was also observed on conserving fisheries resources, surveying paddy fields, checking water quality, analyzing main sources of water contaminants, and discussion with villagers at their villages towards environmental awareness regarding Sustainable Development Goals (SDGs). Ecological impacts are due to Illegal, Unreported, and Unregulated (IUU) *fishing*; electric fishing, using chemicals, using wrong net size, wrong seasonal catching especially for fisheries resources including aquatic life. Therefore, the socioeconomic situations of Irrawaddy delta according to survey of this research works; there are about 50 % is representing for fisheries sector, about 35 % is for agriculture sector, government sector is about 7 %, and others are 8 %. At Nga-Won River in Pathein city, Irrawaddy delta, where water quality analysis concerning physico- chemical indicator is for Biological Oxygen Demand (BOD), Dissolved Oxygen (DO), and heavy metals analysis by comparing with desirable as well as imperative rate regarding World Health Organization (W.H.O) standard. Stakeholder mapping with interdisciplinary approach is also done to be public awareness for community development regarding SDGs.

Keywords: local community, socioeconomic situation, fisheries resources, environmental awareness, Sustainable Development Goals (SDGs)

Introduction

Irrawaddy delta, Latitude: 16°16.1682 N and Longitude: 95°24.1184 E, is situated in the south of Myanmar, lots is streams and creeks are situated as complicated networks, where fisheries sector concerning freshwater as well as salt water and agriculture sector as mainly paddy production are vital importance for economic sector for local as well as international markets. In doing so, socio economic situations are chiefly relying on fisheries as well as agriculture, there were successfully done interviews at thirteen locations in the Pathein city area, capital of Irrawaddy delta, namely, "Tar – Kine" village, "Kun- An- Na- War" fisheries and lobster enterprise in "Mar Ta" village, "Ywar- Thit - Kone" village, "Tha-Lat-Khur" village, "Yuzana Group of Companies" for aquaculture, "Lin – Kwin – Gyi" village, "Lane – Kone" stream at "Lane – Kone" village, "Yae - Kyaw – Wa" village, "Sat – Ka – Lay" village, "Kan- Gyi-Taunt" township, "Chaung – Thar" Beach, Marine Science Research and Training Center (MSRTC), "Shwe Thaung Yan" Township, "Tine – Hmu" port, Pathein city, Irrawaddy delta, Myanmar.

Field survey was done along Nga-Won River (The biggest main branch of Irrawaddy River) because there are big complicated network of small streams and brooks in Irrawaddy Delta. Field surveying along Nga – Won River and its watershed areas were accomplished. Meeting & discussion with local people at their villages for socioeconomic status, classification fish in accordance with field fish guidebook.

Fu Caihong et al. (2015) mentioned understanding how external pressures impact ecosystem structure and functioning is essential for ecosystem-based approaches to fisheries management. We quantified the relative effects of fisheries exploitation and environmental conditions on ecological indicators derived from two different data sources, fisheries catch data (catch-based) and fisheries independent survey data (survey-based) for 12 marine ecosystems using a partial least squares path modeling approach (PLS-PM). We linked these ecological indicators to the total biomass of the ecosystem. Although the effects of exploitation and environmental conditions differed across the ecosystems, some general results can be drawn from the comparative approach. In this research works, it is focusing on ecological indicators such as conserving fisheries resources, surveying paddy fields, checking water quality, analyzing main sources of water contaminants, and discussion with villagers at their villages towards environmental awareness regarding Sustainable Development Goals (SDGs) as comparative approach as well as interdisciplinary approach.

IUCN-WESCANA Water Publication (2004) described freshwater ecosystems provide a multitude of goods and services including water supply, flow regulation, waste assimilation, and regulation of climate and atmospheric chemical composition. Additionally, freshwater is the basic ingredient in food, power, and raw material production, as well as recreation. Despite some difficulties in giving a proper value to water due to obvious complexities, the intrinsic value (or non-use services, such as cultural, aesthetic, or scientific values) is also very important. George Washington National Forest (2011) mentioned aquatic ecological integrity must include physical, chemical, and biological integrity. Furthermore, biological integrity is dependent on physical and chemical integrity. Key factors related to physical, chemical, and biological integrity have been identified that are important for maintaining aquatic ecological sustainability. IUCN-WESCANA Water Publication (2004) stated that many of the inland waters in North Africa undergo great seasonal variations in their main features, as well as variations in their surface area, according to the seasonal abundance or scarcity of water. In the present study, aquatic freshwater ecosystem

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plays a vital role; therefore, it is analyzed water resources as physico- chemical indicator for dissolved oxygen, pH and alkalinity, turbidity and suspended solids, organic matters, metals, organic contaminants, total phosphorus, pesticides, and other elements in water resources as well as Dissolved Oxygen (D.O), Biochemical Oxygen Demand (B.O.D), Chemical Oxygen Demand (C.O.D), pH value, salinity, T.D.S (Total Dissolved Solids); the result of water bodies in Irrawaddy River is chemically potable by comparing with the standardization of World Health Organization (WHO) with two values, desirable as well as imperative values.

According to Gareth J. Lloyd, et al, (2013), the integrated, efficient, equitable and sustainable management of water resources is of vital importance for securing ecosystem health and services to people, not least of which is food production. The challenges related to increasing water scarcity and ecosystem degradation, and the added complexities of climate change; highlight the need for countries to carefully manage their surface water and groundwater resources. Vincent Carignan and Marc – Andre Villard (2001) explained there are three main types of management approaches available to natural resources managers: coarse-filter, fine-filter, and ecosystem management. In the present study, integrated water resources are necessary to focus on because rice factories were built along the Nga-Won River, in doing so, their side products of the factories as well as household side products were easily throwing into this River, therefore, the pollutions of the River is increasing more.

Jill S. Baron., et al., (2003) stated fresh water is vital to human life and economic wellbeing, and societies draw heavily on rivers, lakes, wetlands, and underground aquifers to supply water for drinking, irrigating crops, and running industrial processes. The benefits of these extractive uses of fresh water have traditionally overshadowed the equally vital benefits of water that remains in stream to sustain healthy aquatic ecosystems. In this study, water resources are playing vital role for fisheries resources as well as human beings survival for lots of purposes including household use, drinking, industrial purposes in Irrawaddy delta, Myanmar. Within 5 years in this study area, these are decreasing trout species because of using poisonous chemicals as well as electric fishing. Indeed, this fish is very famous for export, above 20 kg is for export size that is economically importance for local community in this area. The area for catching this trout fish is from "Sat – Ka – Lay" village through "That – Kyal – Kyaung" village towards borderline of "Nga – Pu Taw" Township where beginning of sea water (salted water) is, these areas are habitat preference of this trout species as natural restricted zone. This area is also preferred upcoming sea water (salted water) that bring lots of trout; the most interesting point is all trout from the smallest size to biggest size fish is carrying eggs in females, regardless the age and size of female trout that they can carry eggs at all ages.

The freshwater trout is more delicious than sea trout because the previous one's meat it more sweet and compact than the second one. The body shape of freshwater trout is shorter than the sea trout. The color of the freshwater trout is little pale brown and the color of sea trout is bright white. The season for highest catching rate amount is cold season because the water bodies are very warm at that time. Nowadays, there is increasing water pollution as deteriorations as there are lots of plastic bags, household wastes are catching in the fishing net, therefore, these are extra works for all fishermen to remove these unwanted wastes in the fishing nets. At the upcoming water level days, this trout are staying at the bottom of the Nga – Won River, on the other hand, at the permanent water levels days, the trout are staying at the surface of water bodies of the River, there are two times changes of water levels per month, all fishermen can notice this point carefully for their economic fishing.

Hall and Grinnell (1919) were among the first to use the indicator concept by associating plant and animal species to particular 'life zones' (i.e. large geographic areas with similar structural and compositional characteristics). In this research work in Irrawaddy delta, there is gradually decreasing biodiversity richness as biota representing for fauna and flora as some species are uncommon, rare, threatened because of poor environmental awareness concerning ecological factors on natural resources. From "Htee" port (Pathein city) to the opposite bank of Nga – Won River; there is "Tar – Kine" village where groups of fishermen's households. Interviews were done for socio-economic survey as their incomes as well as outcomes. In this village, there are fishing by using "Tiger Net" (Kyar net) as well as making "Tiger Net" (Kyar net) as fishing gears. Meeting & discussion with local people at their villages for socioeconomic status, classification fish in accordance with field fish guide book. There are economic incomes by comparing past and present; in doing so, there were plenty of fish in the past by getting huge amount of various fishes. On the other hand, it is getting few amounts of fish nowadays. Economic importance fish are Trout (Nga- Tha-Laut), Ka-Ka-Tit, Nga-Pon-Nar, Cat fish (Nga-Sin- Yine), Carp (Nga-Gyin), Huge lobsters group. Regarding past situations for getting various fishes, the quantities are much more ten times than nowadays. In present, there are environmental deteriorations in the Nga – Won River such as battery shock typed electric fishing, using chemical to catch fisheries, lobsters and prawn.

Jill S. Baron., et al., (2003) noted freshwater ecosystems differ greatly from one another depending on type, location, and climate, but they nevertheless share important features. For one, lakes, wetlands, rivers, and their connected ground waters share a common need for water within a certain range of quantity and quality. In addition, because freshwater ecosystems are dynamic, all require a range of natural variation or disturbance to maintain viability or resilience. In the present study, water bodies of the streams, creeks are connected each other as network by flowing fluctuations as wax- as well as wane- days in the study area of Irrawaddy delta.

Vincent Carignan and Marc – Andre Villard (2001) described that we review critical issues that must be considered when selecting indicator species for a monitoring program that aims to maintain or restore ecological integrity.

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First, we examine the pros and cons of different management approaches on which a conservation program can be based and conclude that ecosystem management is most appropriate. We then identify potential indicators of ecological integrity at various levels of the ecosystem, with a particular emphasis on the species level. In the study area, ecological integrity of water resources and its relationship with survival of fisheries resources in aquatic ecosystem of Nga Won River, Irrawaddy delta.

IUCN-WESCANA Water Publication (2004) mentioned the most frequently used fishing techniques are gill nets and fixed traps, and fishermen often have primitive boats. Marketing is done in a fairly disorganized way, and the product, if not eaten by the fishermen themselves, is sold near the fishing areas. The fishing techniques used are often very simple. While know-how is well established for exploiting brackish or marine coastal lakes, and there are traditional fishing techniques, know-how about fishing the region's freshwaters remains relatively undeveloped. Often, fishing is merely an incidental activity practiced by farmers or other people. In the present study, fishermen are using mostly traditional fishing gears as well as various nets, for example, "Tar – Kine" village again where "Tiger Net" (Kyar net) as well as making "Tiger Net" (Kyar net) as fishing gears. All villagers are carefully watching the water level according to wax and wane, in doing so, there are two times of rising water level per month, one week for one time, therefore, total 14 days to catch fish per month. Hen fishermen use one "Tiger Net" it is essential to have three boats for this task and it is fixed at one place in Nga - Won River current.

According to Forslund, A., et al., (2009), Goal 7 of the MDGs commits nations to ensure "environmental sustainability" and includes three global targets and eight official global indicators. Specifically, it calls on nations "to integrate the principle of sustainable development into country policies and programmes and reverse the loss of environmental resources". The goods and services sustained by environmental flows play a central role in achieving the MDGs. Environmental flows offer an effective means for countries to mainstream the environment – especially freshwater ecosystems – into national development planning. In this research work, it is focusing on three tasks, fisheries resource conservation, water resource analysis, and socioeconomic development regarding Sustainable Development Goals (SDGs); in doing so, it was observed for current fisheries resources regarding SDGs goal 14, life below water; water resource analysis regarding SDGs goal 6, clean water and sanitation; as well as socioeconomic situations regarding SDGs goal 1, no poverty; goal 2, zero hunger; goal 3, good health and wellbeing. Finally, it is necessary to have stakeholder mapping including all stakeholders as researchers, academicians, policy makers, decision makers, and local community regarding SDGs goal 17, partnerships for the goal, with interdisciplinary approach.

Aims and Objectives

1. To observe current fisheries resources in the riverine ecosystem of with innovative solutions
2. To focus on the origin of impacts that are directly affected on fisheries resources and water resources,
3. To understand socioeconomic situation of local community regarding SDGs
4. To provide the acquired information to stakeholders and be enable a knowledge-based evaluation to environmentally sustainable socioeconomic development

Materials and Methods

Study area

Irrawaddy delta, Latitude: 16°16.1682 N and Longitude: 95°24.1184 E.

Research Design

1. Analyzing of physico-chemical indicators concerning water resources
2. Assessment on the impacts of water resources and fisheries resources
3. Making public awareness for natural resource conservation with stakeholder mapping

Laboratory procedure

(1) Concerning fisheries resources conservation; collection of fisheries resources from rivers & local markets, preservation fish with 95 % Ethanol, classification fish in accordance with field fish guide book and recorded

(2) Concerning socioeconomic situations; Meeting & discussion with local people at target villages (thirteen villages) for socioeconomic status,

(3) Concerning water resources; Taking water samples systematically in the plastic bottles at "Tine – Hmu" port, Pathein city, Irrawaddy delta in order to make water quality analysis at the laboratory of MCDC (Mandalay City Development Committee) within 24 hours for water quality analysis concerning physico-chemical indicator, BOD, DO, Heavy metals analysis. All possible analysis is systematically checking there. Observation on main possible sources of contaminants to river, checking pH of River.

(4)

Result

Therefore, in the study area, it was observed for socioeconomic situations by making observation on main possible sources of contaminants to river are side products from rice factory, Fisheries and Lobster factory, petrol shop, households' waste along Nga- Won River by meeting & discussion with local people at their villages for socioeconomic status. "Tar – Kine" village; Fishermen said that Maximum fish yield is in July, August, September, October annually; In past 2 decades ago, it was getting 100 % fish yield but nowadays it is getting 10% in water level rising days per month. The economic fish such as Trout (Nga- Tha-Laut), Ka-Ka-Tit, Nga-Pon-Nar, Catfish (Nga-Sin-Yine), Carp (Nga-Gyin), Huge lobsters' group are popular in this Irrawaddy delta. There were seen the fishing gears such as "Tiger net" and its related boats that are practically using in the Nga- Won River, main branch of Irrawaddy River in the Irrawaddy delta.

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Regarding socioeconomic surveys on fisheries resources in this study was accomplished at the "Kun- An- Na- War" fisheries and lobster enterprise in "Mar Ta" village, Pathein Township; there are main economic groups such as Pangasius fish group (Nga – Dan) fish, Ka-Ka- Tit fish, Gobies (Ka- Tha -Boe) fish, (Nga - Paut - Thin) fish, Trout (Nga- Tha- Laut) fish, and big prawn as well as huge lobsters. "Kun- An- Na- War" fisheries and lobster enterprise is one of the biggest groups in Pathein city area, Irrawaddy delta, that enterprise distribute fisheries products as well as dry fisheries products to whole Myanmar as well as export to abroad. There are two kinds of trout, namely, marine and freshwater; in this, freshwater trout is tastier and more expensive than marine forms. The catching season for trout is December, January, February, and March per year. When sea water (salted water) is rising into freshwater; it is more opportunities to get various fishes, prawn, and lobsters. If there is not coming sea water (salted water) into freshwater bodies, there will be less opportunity to get various fish, prawn, and lobsters that experience were known by meeting & discussion with local people at their villages for socioeconomic situation. Fishermen said that when soft shell prawn as pioneers is coming in the Nga – Won River, it will be surely followed huge prawn and lobsters in this River.

At "Yae - Kyaw – Wa" village where meeting with farmers and fishermen for their socio-economic situations; they cultivated rice "Ayer – Min" rice as well as "Paw – San – Yin" rice as two times per year (raining season and summer season). They said that there was getting few fishes in their area, the main fish species in this area is one kind of cat fish, *Mytius* species (Nga - Zin – Yine) fish, George prawn, Gobies fish, small prawn, Ka – Ka – Tit fish, eel as well as lobsters. They usually use "Floating Net" (Phaut – Kat – Pike – Ba – Win) net to catch prawn as well as fish. They earn paddy farms as well as fisheries at the same time; they are very expert in catching eel in Irrawaddy delta. Fresh tasty lunch was warmly offered by local fisherman at their home, "Tar – Kine" village, Pathein area, Irrawaddy delta. "Sat – Ka – Lay" village where is very famous for catching freshwater trout, *Hilsa* species, very tasty fish, therefore, this fish is critically regarded as economic importance fish by meeting and discussion with fishermen at their home, they are practically making the fishing net especially for trout. Similarity with other fish species, nowadays, this trout species is also rarer than previous time by comparing catching rate in the past and present. Fishermen for catching trout fish is silent in the raining season for 3 months; after end of raining season, their fishing works are starting again for catching trout species. The fishing net just for trout fish is very unique; they can make this net themselves practically at their home. Their catching time for one net is about 8 hours for one time.

Concerning fisheries culture enterprise in this study; "Yuzana Group of Companies" for aquaculture, Pathein city, Irrawaddy delta; meeting with Director of "Yuzana Group of Companies" and effective discussion about distribution of aquaculture products in Myanmar as well as export to abroad especially EU (European Union), their main target species is one kind of cat fish (Pangasius species) (Nga – Dan) fish. They are introduced with Vietnam aquaculture advanced technology regarding "Indoor hatchery" breeding of this target species commercially from egg stage to mature stage to market size. Feeding for fingerling of fish is imported from EU countries. The Manager explained in detail about this target fish from egg stage to mature commercial size. Breeding of fish male and female, squeezing eggs and mixing with sperms of male fish in jar, then, transferred to culture tanks for 20 hours for hatching (variation may be 2 hours). After 3 days from egg stage, the minute fingerlings fishes will be transferred to prepared earth fish ponds with the standard of Vietnam standard, there are 20 lakhs fingerlings in one acre square meter (4000 square feet fish pond), and there will be 2 weeks in this prepared earth pond by regulating water level. Transferring time for fingerling fish is early morning as well as evening, avoid direct sunlight at the daytime. Feeding for fish 1inches (1 gram) size is "Aller aqua" (made in Denmark) as protein ratio in it is 60 %. Feeding for fish 2 inches size (2 grams) is "Green feed" (made in Vietnam) by checking with FCR (Feed Conversion Ratio). Survival rate from fingering 1-gram size to strong 20-gram size fish is 70 % to 80 % within 50 days. Survival rate from 20-gram size fish to 1000-gram size fish is 80 % to 90 % within 6 months. Actually, survival rate less than 1 gram is 10 % to20 % but this indoor hatchery technique is 30 % survival. Nowadays, "Yuzana Group of Companies" for aquaculture's main target species are cat fish species especially Pangasius (Family Silunidae) as (Nga – Dan) fish, carp species (Family Cyprinidae), freshwater fish (Nga – Mote), marine (salted Lobster) as Tiger lobster and Banamie lobster are main target species for export. The order from abroad is highest demand; therefore, they try to catch demand with their supply by balancing demand versus supply rate. Their standardized freeze big Factory is officially based at "Pan – Ta – Naw" Township, Irrawaddy delta under the authority of "Yuzana Group of Companies" for aquaculture.

Regarding socioeconomic surveys on agriculture sector in this study was accomplished at "Ywar- Thit - Kone" village, Pathein Township, Irrawaddy delta, in this village, there are 100 households with about 500 populations, in this regards, 37 households are farmers; meeting with leader of farmers and discussion at their hut about paddy and rice yield regarding socioeconomic situation. There are main kinds of paddy; (1) "Sin – Thu – Kha" rice that is needed 135 days to harvest, (2) "Paw – San – Yin" rice that is need also 135 days to harvest, and (3) "Pa – Khun – Shwe – War" rice that is needed 110 to 115 days to harvest . The cultivated grains for cold season are peanut and sesame. Fortunately, there is opportunity to meet with Agriculture Deputy Director and Officer in this field, in doing so, there is fruitful knowledge. Agriculture Deputy Director and Officer explained about paddy production for whole Irrawaddy delta is acres 37 lakhs for raining season paddy cultivation as well as acres 13 lakhs for summer season paddy cultivation. There are five kinds of soil types in Irrawaddy delta. There is various pea cultivation in summer, such as pea nut, "Mat" pea,

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"Pae Tie Sein" pea, "Bo – Cate" pea, the various pea from Irrawaddy delta is highest qualified. There is climate change; the paddy fields are faster than the target dates to be earlier ripened in advance as getting warmer. There are five kinds of paddies in Irrawaddy delta, namely,(1) "Paw - San – Bae – Kyar" rice, (2) "Paw – San – Yin" rice, (3) "Sin – Thu - Kha" rice, (4) "Aye – Yar – Min" rice, and (5) "Pa – Khan – Shwe – War" rice. There are four kinds of rice seeds; namely, (1) Breeder seed, (2) Foundation seed, (3) Registered seed, and (4) Certified seed. In this field, it is just for certified seed production zone for distribution of seed to farmers for their cultivation effectively to get maximum sustainable yield (MSY) for rice fields. Indeed, there are lots of challenges to produce certified rice seed; it is trying hard to overcome the difficulties and challenges, nowadays. Farmers hope that to produce quality rice in Irrawaddy delta because this delta is main production zone for quality rice for the whole Myanmar as well as export to abroad. Survey at "Tha-Lat-Khur" village, Pathein Township, Irrawaddy delta, in this village, there are 49 farmers. In Myanmar, there are total of rice production is about 1200 enterprises, in doing so, there are 11 enterprises are highly qualified.

It was also observed about paddy fields at "Kan- Gyi-Taunt" township, Pathein, Irrawaddy delta; Agriculture officer explained about Irrawaddy delta's rice production is one fourth production of the whole Myanmar concerning varieties trial system concerning rice production. They mentioned about research works regarding certified as well as qualified rice seeds, pest control methods, soil types and preparation methods, controlling pH level of soil types, controlling various fertilizers, using calcium for preparation of various soil types, the ratio of hydrogen in the soil, regarding soil conservation, encouragement to use natural fertilizers such as stools of cow, potassium ratio, calcium oxide ratio, magnesium ratio, soil microbes and their role in paddy fields, weather and climate change, rules and regulations of the certification of certified rice seed after checking the paddy fields by their Agriculture Department. The maximum yield of "Sin – Thu – Kha" rice is 90 to 100 Tin (Myanmar standard) per acre of paddy field.

Concerning other farming of Da-Ni leaves in this study area, "Lin – Kwin – Gyi" village, Pathein Township, Irrawaddy delta; meeting with farmer and fishermen & discussion at their villages for socioeconomic situations; especially for "Da – Ni" leaves for using roofs and wall of the home. There are two times or three times per year to get "Da – Ni" leaves annually by making with hand for covering roof as well as wall of the home traditionally in these areas. This is also economic importance because there are lots of "Da- Ni" forest in these regions that is also prevent for erosion. This is ever green "Da – Ni" forest is vital importance for sustainable ecosystem especially habitat preference of all aquatic life. Therefore, for all these reasons, conservation of "Da – Ni" forest is essential task for socioeconomic importance as well as environmental conservation in Irrawaddy delta area. The electricity supply in these areas is solar light because their homes are based in water bodies. Their main economic incomes are selling "Da – Ni" leaves as well as catching fish by using "Tiger net". The farmer and fishermen do prefer upcoming sea water into freshwater because it will be brought various fishes and lobsters with salted water into freshwater bodies.

Regarding ecotourism service in this study area, "Chaung – Thar" Beach, very famous Beach in Myanmar, it is situated in Irrawaddy delta, for survey to sea and the product from sea such as various fresh fishes, lobsters, squids, clams, snails, oysters as well as dry products of these. It was also found ornamental / decorated clams as well as fresh coconuts are very famous there. Eco – tourism service as well as hotel zone are also economic importance for local community's survival there.

Regarding research purposes, there is "Marine Science Research and Training Center (MSRTC), "Shwe Thaung Yan" campus, "Shwe Thaung Yan" Township, Irrawaddy delta it is under the authority of Pathein University, Ministry of Education, Myanmar. They explained about their campus and its role in Irrawaddy delta. Then survey to the sea beside this area concerning mangroves and its role in the ecosystem that is vital importance for habitat of aquatic life as well as prevention of erosion.

Discussion and Conclusion

Fu Caihong et al. (2015) stated that the analyses also showed that the effects of environmental conditions on the ecological indicators were predominantly significant, and tended to be negative, suggesting that in the recent period, indicators accounted for changes in environmental conditions and the changes were more likely to be adverse. Total biomass was associated with fisheries exploitation and environmental conditions; however its association with the ecological indicators was weak across the ecosystems. Knowledge of the relative influence of exploitation and environmental pressures on the dynamics within exploited ecosystems will help us to move towards ecosystem-based approaches to fisheries management. This research work is totally agree with this concept because the impacts of environmental deterioration are gradually hitting the aquatic ecosystem where fisheries resources and water resources are completely involved that are directly related with socioeconomic situation of local community in the study area s of Irrawaddy delta, Pathein city area.

IUCN-WESCANA Water Publication (2004) showed dialogue among policy makers plays a vital role in building trust and confidence among riparian states. In this study, it is focused on the links of stakeholders with interdisciplinary approach especially for local community development.

Vincent Carignan and Marc – Andre Villard (2001) mentioned we conclude that, although the use of indicator species remains contentious, it can be useful if

(1) many species representing various taxa and life histories are included in the monitoring program,

(2) their selection is primarily based on a sound quantitative database from the focal region, and

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(3) caution is applied when interpreting their population trends to distinguish actual signals from variations that may be unrelated to the deterioration of ecological integrity. Finally, we present and discuss different methods that have been used to select indicator species. In this study, it is very important to be effective monitoring aquatic biodiversity richness with innovative solutions especially for target species as well we key species of sustainable aquatic ecosystem.

IUCN-WESCANA Water Publication (2004) mentioned Major Issues: Globally, freshwater ecosystems are experiencing a significant loss of their biodiversity due to continuous human interventions. In the quest to meet growing demands - warranting development of freshwater resources - many countries have neglected the consideration of biodiversity as an important factor. Gareth J. Lloyd, *et., al,* 2013 stated that however, the flexibility of the approach means that it is interpreted and applied in ways that prioritize and address immediate challenges created by demographic, economic and social drivers, often at the expense of environmental sustainability – and hence also of long-term food security. In the present study, there are still some challenges to conserve fisheries as well as water resource in natural ecosystem.

Jill S. Baron., et al., (2003) described Fresh water is vital to human life and economic well-being, and societies extract vast quantities of water from rivers, lakes, wetlands, and underground aquifers to supply the requirements of cities, farms, and industries. Our need for fresh water has long caused us to overlook equally vital benefits of water that remains in stream to sustain healthy aquatic ecosystems. These ecosystem benefits are costly and often impossible to replace when aquatic systems are degraded. For this reason, deliberations about water allocation should always include provisions for maintaining the integrity of freshwater ecosystems. In this study, there were focusing on fisheries resources, water bodies, and socioeconomic situations of local community as these three sectors are closely related as the resources are costly that is very difficult to replace if one is missing in the ecosystem, therefore, it is encouraging to be monitoring freshwater ecosystem towards sustainable state.

Jill S. Baron., et al., (2003) concluded Freshwater ecosystems have been described as "biological assets (that are) both disproportionately rich and disproportionately imperiled." They need not be so threatened. By recognizing the need for naturally varying flows of water and sediment, and reduced pollution loads, we can maintain or restore freshwater ecosystems to a sustainable state that will continue to provide the amenities and services society has come to expect while helping native aquatic species to flourish. IUCN-WESCANA Water Publication (2004) concluded that Biodiversity and environmental protection require the establishment of interdisciplinary, inter sectorial, and inter-institutional projects - both large and small - that develop strategies in a holistic way, building primarily on the needs of the catchment inhabitants. This comprises finding enough space for natural ecosystems, species, and people, and restoring basic processes so that water moves through ecosystems with the appropriate flow regime, temperature, and chemical composition. In this study, it can be concluded that it is necessary to monitor the causes of impacts on water bodies as well as fisheries resources and need to observe the impacts with innovative solutions how to reduce and the best way to mitigate the threatened environmental impacts. For conservation of fisheries resources and water bodies in order to be socioeconomic development of local community, in doing so, the role of stakeholders is very importance with interdisciplinary approaches to solve challenges with critical solutions for local community development regarding SDGs.

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Appendix

Figure1. Google map of Irrawaddy delta

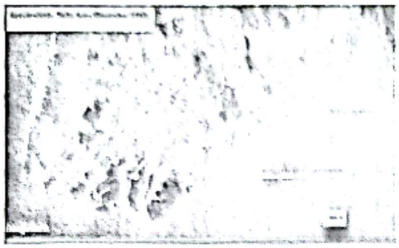

Figure2. Google map of Irrawaddy delta

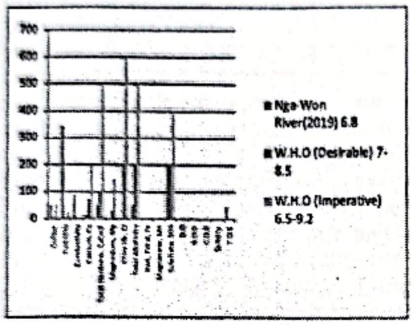

Figure3. Physico-Chemical Parameters of Water Quality of Nga-Won River, Pathein city, Irrawaddy delta, Myanmar (2019)

Figure4. Sustainable Development Goals (SDGs) (2015-2030)

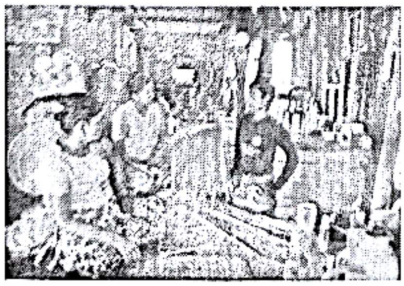

Figure5. Discussion with local community at the Tar-Kine village, Irrawaddy delta, Myanmar

Figure6. Observation on Da – Ni leaves for socio economic incomes

Figure7. Observation on fisheries culture at Yu-Za-Na fisheries enterprise, Irrawaddy delta

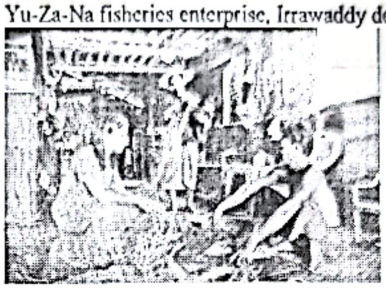

Figure8. Observation on Tiger net, fishing gears, Irrawaddy delta, Myanmar

Figure9.Observation on fisheries at "Kun-An-Na-War" fisheries enterprise, Irrawaddy delta

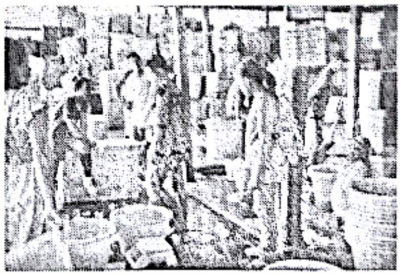

Figure10.Observation on fisheries at "Kun-An-Na-War" fisheries enterprise, Irrawaddy delta

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Figure11. Discussion with fisherman family about fishing gears and socioeconomic incomes

Figure12. Observation on paddy fields in Irrawaddy delta, Myanmar

Figure13. Discussion with experienced expert of agriculture sector, Irrawaddy delta

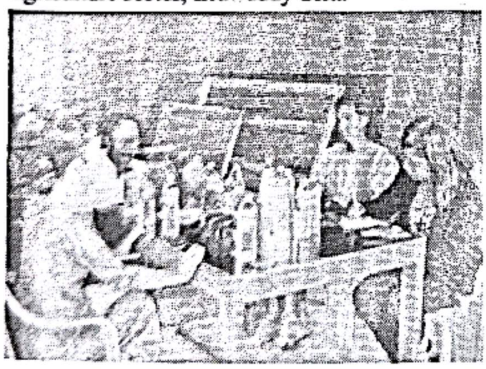

Figure14. Discussion with experienced experts of agriculture sector and farmer, Irrawaddy delta

Table1. Physico-Chemical Parameters of Water Quality of Nga-Won River, Pathein city, Irrawaddy delta, Myanmar (2019)

Parameters	2019	W.H.O standard	
Physical Examination		Desirable	Imperative
pH	6.8 mol/l	7 - 8.5 mol/l	6.5 - 9.2 mol/l
Colour	>50	5	50
Turbidity	343 NTU	5 NTU	25 NTU
Conductivity	89.5 timhe/e m		
Chemical Analysis			
Calcium	11 mg/l	75 mg/l	200 mg/l
Hardness Total	48 ppm	100 ppm	500 ppm
Magnesium	5 mg/l	30 mg/l	150 mg/l
Chloride	5 mg/l	200 mg/l	600 mg/l
Total Alkalinity	48 mEq/l	200 mEq/l	500 mEq/l
Iron Total	>0.2 mg/l	0.1 mg/l	1.0 mg/l
Manganese	0.03 mg/l	0.05 mg/l	0.5 mg/l
Sulphate	<200 mg/l	200 mg/l	400 mg/l
D.O	5.59 mg/l		
B.O.D	8 mg/l		
C.O.D	-mg/l		
Salinity	0.1		
T.D.S	47.2mg/l		

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ZOL 004

Demography of The Children in Some Areas of Myo-Thit Ward, Meiktila, Mandalay Region

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Abstract

The study of Demography of children from three wards of Myothit was conducted for three years from 2015 to 2017. During study period, yearly total number of children birth rate and death rate were collected from Urban Health Center (UHC), General Hospital, Meiktila and interview survey was conducted in three wards. The data of health history of children was collected randomly by interview survey to the 100 mothers coming to Maternal and Children Welfare Association (MCWA) for vaccination to the children. From this interview survey, Children age, sex ratio, birth rate, death rate, Birth weight, children position, pregnant duration, mothers' age, mothers' education and occupation were collected. The birth rates of children were found to increase in three years. The number of death was three males and one female in 2015 and one male and one female in 2017. The number of death was not recorded from three wards in 2016. Total numbers of female children were larger than the total numbers of males. The most number of children were found within the birth weight 3.0 to 3.2 Kg. The numbers of young mothers were more than old mothers.

Keywords: Demography, children, sex ratio, birth rate, death rate

Introduction

Demography is the science of population dynamics. It encompasses the study of the size, structure and distribution of the populations, and how populations change over time due to birth, death and migration and aging. A population may be defined as a group of organism of the same species occupying a particular space at particular time (Krebs, 2001).

Four population parameters are natality, mortality, immigration and emigration. Natality is the reproductive output of a population and mortality is the death of organism in a population. Natality rate may be expressed as the number of organism produce per female per unit time, is synonymous with the realized fertility rate (Krebs, 2001). Three major variables distinguished individuals in many populations, sex, age and size. Age is a significant variable in human population and age effects are common to many species. Age-sex structure is the composition of population as determined by the number or population of male and females in each category. Information of age-sex composition is essential for the description and analysis of many other types of demographic data (Krebs, 2001). The sex ratio is the ratio of males and females in the population. The sex ratio of a population clearly affects the potential reproductive rate (Preston, 2001).

In describing a population phenomenon like mortality rates are often calculated for specific age groups of the population to gain a more sophisticated picture of how the population is changing over time. This is especially important for gauging the efficacy of health interventions that are targeted at specific segments of the population such as among children under one year old may require a very different intervention than would very high death rates among adults over 70 years of ages (Preston, 2001).

Access to medical care and proper nutrient are essential to the normal growth and development of infants (0 to 12 months) and toddlers (12 or 36 months). Infant's mortality is one of the most significant indications of the levels of social development within each country. Consequently, mortalitytends to be lower in developed countries and higher in less developed countries. The highest population growth rates remained high during this time and later increased after the end of the war(Hichen, 2012).

Myanmar has a low fertility rate (2.15 in 2016), especially as compared to other southeast Asia countries of similar economic standing, like Cambodia (2.56) and Laos (2.76), representing a significant decline from 2.23 in 2011to 2.15 in 2016. The fertility rate is much pronouncedly lower in urban areas. This is attributed to extreme delays in marriage (almost unparallel in the region, with the exception of developed countries), the prevalence of illegal abortions, and the high proportion of single, unmarried women of reproductive age (with 25.9% of women aged 30-34 and 33.1% of men and women aged 25-34 single). These patterns stem from several cultural and economic dynamics. The first is economic hardship, which results in the delay of marriage and family (Reuter, 2013).

There are fifteen wards in Aung-san Area, Meiktila. Among them, MyothitNo (1), (2) and (3) wards have high population densities. Populations who live in these wards were both the high socioeconomic persons and low socioeconomic person. As a starting point of the demography field, the demography of the children at three wards of Myothit ward is designated with the following objectives:

- to assess birth rate, death rate and sex ratio of the children under five years age in study area

-to compare the birth weight and their age of children

-to examine the children's position and level of education, occupation and age classes of mothers

Material and methods

Study sites

The present study was conducted in Myothit Ward, Meiktila which is located in the central plain area of Myanmar and stands at elevation of 750 feet above sea level. It was located between longitude (20° 51' 53") N and latitude (95° 49' 20") E.

Study period

The present study lasted from October 2015 to October 2017.

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Study design

The study area was divided into three parts designated as study sites I, II and III in the research. In Myothit Ward, No. 1 ward is defined as study site I, No. 2 ward as study site II and No. 3 wards as site III (Fig.1).

Data collection

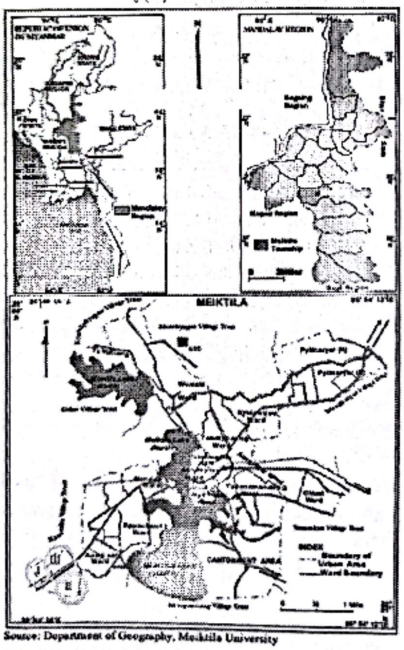
Most of the data for number, birth rate, death rate, sex ratio of the children from 2015 to 2017 were taken from Urban Health Center (UHC), General Hospital, Meiktila. Interview survey was conducted by visiting the homes of the children who stayed in three wards of Myothit from January 2017 to December 2017 to get the parameters of children and mother background history. In study period, the data of health history of children was collected randomly by interview survey to the 100 mothers coming to Maternal and Children Welfare Association (MCWA) for vaccination of Polio, BCG (Bacille, Calmette, Guerin), DPT (Diphtheria, Pertussis, Tetanus), TT

$$\text{Crude birth rate} = \frac{\text{Number of live births in a year}}{\text{Total midyear population}} \times 1000$$

$$\text{CBR} = \frac{B}{P} \times 1000$$

$$\text{Crude death rate} = \frac{\text{Number of deaths in a year}}{\text{Total midyear population}} \times 1000$$

$$\text{CDR} = \frac{D}{P} \times 1000$$



Source: Department of Geography, Meiktila University

Fig.1 Locations of three study sites in Meiktila Township, Mandalay Region

(Measles), Hepatitis (B) to the children.

Data analysis

The recorded data were recorded, tabulated and shown in histograms and pie charts. Birth rate (Fertility rate) was assessed as total children born by a particular ward in a year. Death rate (Mortality rate was assessed as total children death by a particular ward in a year and sex ratio was the ratio of boys and girls.

Result

Birth rate and death rate of newborn and children from Myothit Ward, Meiktila

A total of children born from three wards of Myothit Ward during the study period 2015, 2016 and 2017 were 392, 433, and 439 respectively.

Birth rate and death rate of children from No. 1, Myothit Ward, Meiktila

In ward No. 1, total number of children was 159 individuals in 2015, 174 individuals in 2016, and 178 individuals in 2017. Total numbers of children in this ward were found to increase during this study. With the respect to sex ratio, the female children were higher than male in two years, 1 male: 1.1 female (in 2015), 1 male: 1.1 female (in 2016)and 1 male: 1 female (in 2017). The numbers of death were two individual males in2015 and one female in 2017. Severe birth

Table1 Number of birth and death of children from No. 1, Myothit Ward, Meiktila in 2015

Sr No	Age class (Years)	No of children	Sex		No. of children death		No. of children live	Cause of death
			Male	Female	Male	Female		
1	0-1	32	15	17	2	-	30	e/ co
2	1-2	24	14	10	-	-	24	Nil
3	2-3	43	20	23	-	-	43	Nil
4	3-4	35	15	20	-	-	35	Nil
5	4-5	27	12	15	-	-	27	Nil
	Total	161	76	85	2	-	159	

asphyxia, neonatal jaundice and low birth weight were cause of death in babies. The crude birth rate were 9.38 (2015), 19.53 (2016) and 17.44 (2017) and the crude death rate were 0.63 (2015), 0(2016) and 0.48(2017) (Table 1, 2, 3, 10 &11and Fig.2,6,7,8).

Birth rate and death rate of children from No. 2, Myothit Ward, Meiktila

In ward No 2, total numbers of children were 79 individuals in 2015, 99 individuals in 2016, and 90 individuals in 2017. In respect to sex ratio, the number of male was smaller than female within three years, 1 male: 1.1.3 female (in 2015), 1 male: 1.1 female (in 2016) and 1 male: 1.5 female (in 2017). The number of death was one male in 2015 and One female in 2017. The number of death was not recorded from No 2 ward in 2016. The babies died by meningoencephalitic and severe birth asphyxia. The crude birth rates were 8.99(2015), 14.51(2016) and 7.61(2017) and the crude death rates were 0.5 (2015), 0(2016) and 0.76 (2017) (Table 4, 5, 6,10 &11 and Fig.3, 6,7 & 8).

Birth rate and death rate of children from No. 3, Myothit Ward, Meiktila

In ward No 3, the total numbers of children were 155 individuals in 2015, 160 individuals in 2016 and 172 individuals in 2017. In respect sex ratio, 1 male: 1.1 female (2015), 1 male: 1.2 female (in 2016) and 1male:1.2 female (in 2017).The number of death was 1 male and 1 female by neonatal jaundice in 2015. The death of children was not recorded in 2016 and 2017. The crude birth rates were 10.15 (2015), 18.23(2016) and 17.12 (2017) and the crude death rates were

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0.41 (2015), and 0 in 2016 and 2017 respectively. (Table 7, 8, 9,10 & 11 and Fig.4, 6, 7 & 8).

Relationship between number of children and parameters of babies and their mothers

One hundred children randomly collected with different age classes (within one to five years old), were recorded. A lowest age class was (0.5-5.5 months) and a maximum age class was (50.5 - 60.0 months). The highest number of children (40) was recorded in the lowest age classes. The second highest number of children(28) was found in class 2.The lowest children numbers were found in the age class 8 and 9.Children numbers fluctuated in all age classes (Table 12, Fig. 9).

The children born in Myothit Ward during study period had different weight. Lowest birth weight had few numbers of children (3) and gradually increased in higher birth weight classes. Most numbers of children (16)were found in (3.0 to 3.2 Kg) birth weight class. Maximum birth weight was 3.8 Kg (Table 13, Fig. 10).

The relation of pregnancy period with child position (hierarchy) and number of children are showed in Table 14. Pregnancy duration of nine months and ten months were assumed to be normal born. Minimum pregnancy time was 8 months and maximum pregnancy time was 9 months.

Education standard, occupation and age classes of mothers

Among the 100 mothers who were randomly collected, most were non-graduated (73) and remaining 27 mothers were graduated. Educated mothers were found fewer than those of uneducated mothers in all age classes. In present research, government servants (18 %), merchants (13%) and housewives (49%) were recorded (Table 16).

Table 2 Number of birth and death of children from No. 1, Myothit Ward, Meiktila in 2016

Sr No	Age class (Years)	No of children	Sex		No. of children death		No. of children live	Cause of death
			Male	Female	Male	Female		
1	0 – 1	42	19	23	-	-	42	Nil
2	1 – 2	32	15	17	-	-	32	Nil
3	2 – 3	26	14	12	-	-	26	Nil
4	3 – 4	39	20	19	-	-	39	Nil
5	4 – 5	35	15	20	-	-	35	Nil
	Total	174	83	91	-	-	174	

Table3 Number of birth and death of children from N.o 1, Myothit Ward, Meiktila in 2017

Sr No	Age class (Years)	No of children	Sex		No. of children death		No. of children live	Cause of death
			Male	Female	Male	Female		
1	0 – 1	37	22	15	-	1	36	***
2	1 – 2	43	20	23	-	-	88	Nil
3	2 – 3	32	15	17	-	-	26	Nil
4	3 – 4	27	14	13	-	-	58	Nil
5	4 – 5	40	19	21	-	-	35	5
	Total	179	90	89	-	1	178	

* = severe birth asphyxia** = neonatal jaundice*** = low birth weight

Table 4. Number of birth and death of children from No. 2, Myothit Ward, Meiktila in 2015

Sr No	Age class (Years)	No of children	Sex		No. of children death		No. of children live	Cause of death
			Male	Female	Male	Female		
1	0 – 1	19	9	10	1	-	18	*
2	1 – 2	22	9	13	-	-	22	Nil
3	2 – 3	17	7	10	-	-	17	Nil
4	3 – 4	12	5	7	-	-	12	Nil
5	4 – 5	9	5	4	-	-	9	Nil
	Total	79	35	44	1	-	78	

Table 5. Number of birth and death of children from No. 2, Myothit Ward, Meiktila in 2016

Sr No	Age class (Years)	No of children	Sex		No. of children death		No. of children live	Cause of death
			Male	Female	Male	Female		
1	0 – 1	19	10	9	-	-	19	Nil
2	1 – 2	19	9	10	-	-	19	Nil
3	2 – 3	22	9	13	-	-	22	Nil
4	3 – 4	22	10	12	-	-	22	Nil
5	4 – 5	17	7	10	-	-	17	Nil
	Total	99	45	54	-	-	99	

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Table 6. Number of birth and death of children from No. 2, Myothit Ward, Meiktila in 2017

Sr No	Age class (Years)	No of children	Sex		No. of children death		No. of children live	Cause of death
			Male	Female	Male	Female		
1	0 – 1	10	3	7	-	-	10	Nil
2	1 – 2	19	10	9	-	-	19	Nil
3	2 – 3	20	9	11	-	1	19	****
4	3 – 4	22	10	12	-	-	22	Nil
4	4 – 5	19	7	12	-	-	19	Nil
	Total	90	39	51	-	1	89	

* = severe birth asphyxia **** = Meningoencephalitic

Table 7 Number of birth and death of children from No. 3, Myothit Ward, Meiktila in 2015

Sr No	Age class (Years)	No of children	Sex		No. of children death		No. of children live	Cause of death
			Male	Female	Male	Female		
1	0 – 1	27	13	14	1	1	25	**
2	1 – 2	38	16	22	-	-	38	Nil
3	2 – 3	34	18	16	-	-	34	Nil
4	3 – 4	30	12	18	-	-	30	Nil
5	4 – 5	28	16	12	-	-	28	Nil
	Total	157	75	82	1	1	155	

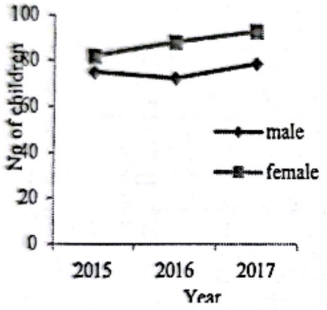

Fig.4 Birth number of children from No 3 Myothit Ward, Meiktila

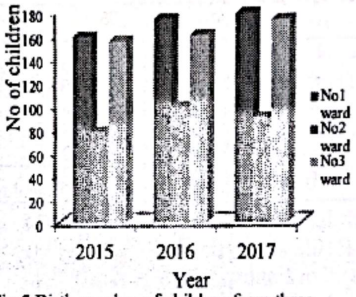

Fig.5 Birth number of children from three wards, Myothit, Meiktila in 2015-2017

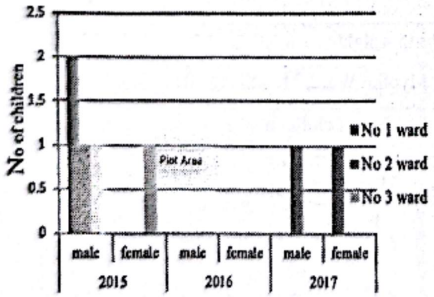

Fig.6 Death number of children from three wards, Myothit, Meiktila in 2015 – 2017

Table 10 The crude birth and death rate of children from three study sites

Year	Myothit Ward (1)		Myothit Ward (2)		Myothit Ward (3)	
	Birth rate	Death rate	Birth rate	Death rate	Birth Rate	Death rate
2015	9.38	0.63	8.99	0.5	10.15	0.41
2016	19.53	0	14.51	0	18.23	0
2017	17.44	0.48	7.61	0.76	17.12	0

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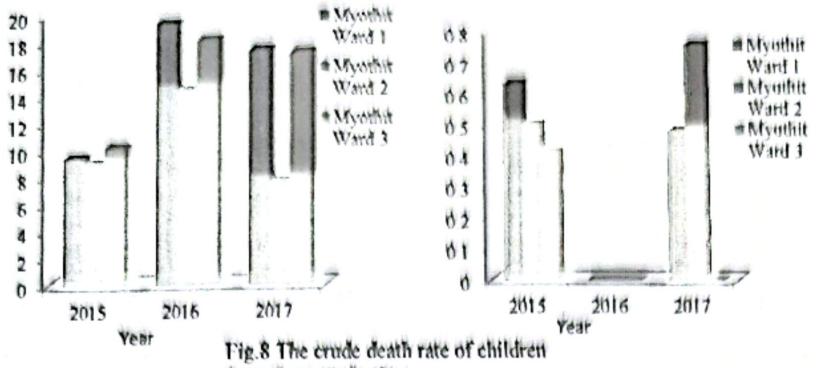

Fig.8 The crude death rate of children from three study sites

Table 11 Sex ratio of children from three study sites in study period

Year	Myothit Ward (1)	Myothit Ward (2)	Myothit Ward (3)
2015	1 male: 1.3 female	1 male: 1.3 female	1 male: 1.1 female
2016	1 male: 1.1 female	1 male: 1.1 female	1 male: 1.2 female
2017	1 male: 1.5 male	1 male: 1.5 female	1 male: 1.2 female

Table 12.Number of children with different age classes from three wards of Myothit, Meiktila in 2017

Class No.	Age classes of children (month)	No of children			Percentage of Children
		Male	Female	Total	
1	0.5 -5.5	21	19	40	40%
2	5.5 -10.5	15	13	28	28%
3	10.5 -15.5	4	1	5	5%
4	15.5 -20.5	3	7	10	10%
5	20.5 -25.5	2	2	4	4%
6	25.5 -30.5	0	3	3	3%
7	30.5 -35.5	0	3	3	3%
8	35.5 -40.5	1	0	1	1%
9	40.5 -45.5	0	1	1	1%
10	45.5 - 50.5	1	2	3	3%
11	50.5 -60.0	0	2	2	2%
	Total	47	53	100	100%

Table 13. Number of children with different classes of birth weights from three wards of Myothit, Meiktila in 2017

Sr No.	Birth weight of children (Kg)	No of children			Percentage of children
		male	female	Total	
1	Below - 2.0	1	2	3	3%
2	2.0 -2.2	3	2	5	5%
3	2.2 -2.4	2	7	9	9%
4	2.4 -2.6	8	3	11	11%
5	2.6 -2.8	6	4	10	10%
6	2.8 -3.0	5	8	13	13%
7	3.0 -3.2	6	10	16	16%
8	3.2 -3.4	4	7	11	11%
9	4.3 -3.6	6	2	8	8%
10	3.6 -3.8	6	8	14	14%
	Total	47	53	100	100%

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Table 14. Relationship between pregnant duration and children's position of 100 children from three wards of Myothit, Meiktila in 2017

Sr No.	Pregnant duration (months/ days)	Children position (hierarchy)					Total No of children
		1st child	2nd child	3rd child	4th child	5th child	
1	7/0	2	0	1	0	0	3
2	8/0	1	0	1	0	0	2
3	9/0	25	10	3	0	0	38
4	9/5	7	4	1	0	0	12
5	9/10	2	2	0	0	0	4
6	9/20	0	0	0	0	0	0
7	10/0	16	12	3	1	3	35
8	10/5	2	3	0	0	1	6
	Total	55	31	9	1	4	100

Table 15. Relationship between mother's age classes and children position in three wards of Myothit, Meiktila in 2017

Sr No.	Age classes of mothers (year)	No of mothers	Children position (hierarchy)					Total children
			First child	Second child	Third child	Fourth child	Fifth child	
1	Under 18	1	1	0	0	0	0	1
2	18-23	9	9	0	0	0	0	9
3	24 -29	44	31	13	0	0	0	44
4	30 -35	31	7	15	6	1	2	31
5	36 -41	15	7	3	3	0	2	15
6	42 -Above	0	0	0	0	0	0	0
	Total	100	55	31	9	1	4	100

Table 16 Relationship education standard, occupation and age classes of mothers in three wards of Myothit, Meiktila in 2017

Sr No	Age classes of mother	No of mother	Education of mothers		Occupation of mothers		
			GR	Non-GR	GS	MR	HW
1	Under 18	1	0	1	0	0	1
2	18 - 23	9	2	6	1	6	2
3	24 - 29	44	13	31	10	13	21
4	30 - 35	31	9	23	5	8	15
5	36 - 41	15	3	12	2	3	10
6	42 above	0	0	0	0	0	0
	Total	100	27	73	18	33	49

GR= graduate, Non-GR= non-graduate, GS= government servant, MR=merchants, HW= housewives

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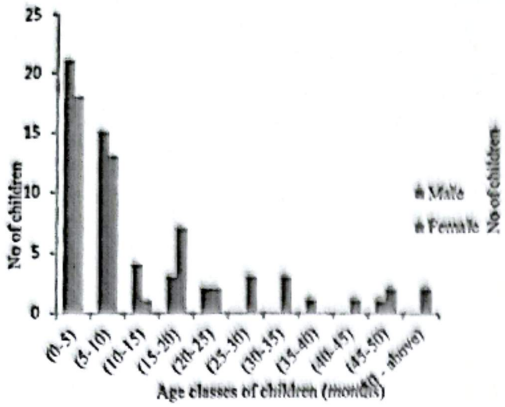

Fig.9 Number of children with different age classes from three wards of Myothit, Meiktila in 2017

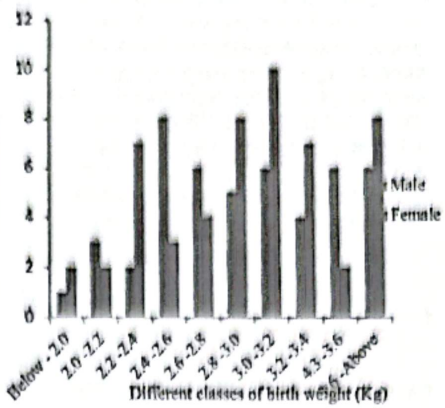

Fig.10 Number of children with different classes of birth weight from three wards of Myothit, Meiktila in 2017

Discussion

Demographic analysis can be applied to whole societies or to groups defined by criteria such as education, nationality, religion, and ethnicity. It encompasses the study of the size, structure, and distribution of these populations, and spatial and/ or temporal changes in respond to birth migrations, aging and death (Hitchens, 2012).

In the present research, a total of childrenborn from three wards of Myothit Yard during the study period 2015, 2016 and 2017 were 392, 433, and 439 respectively.The birth rates of children were found to increase in three years. The crude birth rates of Myanmar were 17.79 (2016) and 17.88 (2017). In the present research, although the crude birth rates of Ward No. 1 and No. 3 were not significantly different, the birth rate of Ward No.2 was significantly lower than the birth crude rates of Myanmar. Because Population of Ward 2 was the smallest among three study sites.

Myanmar's infant mortality rate is 48 per 1,000 live births while the motility rate for children under five is 62 per 1,000 live births, both of which are the highest in Southeast Asia(The UNICEF report, 2013). But in recent research, death rates of children were 0.63, and 0.48 in Ward No.1, 0.5 and 0.76 in Ward No.2 and 0.41 in Ward No.3. There were no death rates of children in all study sites in 2016. So this research was concluded that the health of children from study area was good condition.

An important structural aspect of populations is the relative numbers of males and females who compose it. Due to the higher female fetal mortality, the sex ratio at birth worldwide is commonly thought to be 107 boys to 100 girls, although this value is subject to debate in the scientific community. The sex ratio for the entire world population is 101 males to 100 females (Matthew, 2005).It does not consistency in this research.

In recent research, in No 1 ward, Myothit with the respect to sex ratio, the female children were slightly higher than male in two years, 1 male: 1.1 female (in 2015), 1 male: 1.1 female (in 2016). But in 2017, the sex ratio was 1 male: 1 female.

Infant mortality is higher in boys than girls in most parts of the world. Recent studies have found that four boys and two girls died within three years from three study sites. There were probably numerous prenatal environmental factors affect on the baby mortality.

In present research, pregnancy duration of 9 months was found inthe most mothers (38) and pregnancy duration of 10 monthswas observed in the second most mothers (35). A few earlier and late born was found in this study.

Full time pregnancy is calculated as being 40 weeks, which is 10 months. However, mother's gestational weeks are only 38 weeks. Some pregnancies last for 9 months and because that is when the baby is usually full time, but many women don't deliver about 40 weeks or more. The new definition is babies born at 39 to 40 weeks of pregnancy have the best chance of healthy start in life (Davis, *et al.*, 1972).

According to standard of WHO, the normal weight of a baby who reaches full term between 37 and 40 weeks is 2.7 - 4 Kg (6-7 lbs), with an average weight less than 3.5 Kg (7.7 lbs). A baby who weighs less than 2.5 Kg (5.5lbs) is considered to have a low birth weight. In recent research, the most number of babies (16) were 3.0-3.2 Kg. The babies with low birth weight were three individuals. So the babies born in Myothit Wards had adequate full birth weights.

The average age of first- time mothers is increasing because more women are waiting until their 30s and 40s to start having kids and fewer women are having their first kids in their teens and 20s. The CDC (Centers for Disease Control and Prevention) report says, in 1970, only 1.7 out of 1,000 women were having their first child between the ages of 35-39 years (Pearl, 1972).In the present research, the most mothers (56) were found as first-time mothers, among them, majority were in the (24-36) years old.

Among 100 mothers, most were uneducated (73 mothers) and remaining 37 mothers were educated. There were 49 housewives, 18 government servants and 33 merchants in present research. Educated mothers were found fewer in numbers than those of uneducated mothers in all age classes. It is not for good for the future of the country.

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According to present research, the death rates of children from three wards of Myothit were very rare to compare with the birth rate of children from there. Most children were normal born .The most numbers of children were found within the birth weight 3.0 to 3.2 Kg. These birth weights were constant with the standard birth weights of WHO. Although Myothit Ward was not the downtown area of Myeiktila, the health condition of children who lived there were in optimal condition.

Conclusion

In the present research, a total of children born from three wards of Myothit Yard during the study period 2015, 2016 and 2017 were 392, 433, and 439 respectively. The birth rates of children were found to increase in three years. The number of death was three males and one female in 2015 and one male and one female in 2017. The number of death was not recorded from three wards in 2016.Total numbers of girls were larger than the total numbers of boys. Most children are normal born and few were early and late born. The most mothers (56) were found as first-time mothers, among them, majority were in the (24-36) years old. Among 100 mothers, most were uneducated (73 mothers) and remaining 37 mothers were educated.

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Firstly, my obligation goes to Dr Tin Maung Tun, Rector of West Yangon University and Dr Aung Win, Rector of Myitkyina for permission to do this work. I am greatly indebted to Dr Soe myint Aye, and Dr Aye Aye Ko Prorector of Myitkyina University for encouragement to publish this research paper.I ' like tothank to Professor Dr Thida Oo, Head of Department of Zoology, West Yangon University for her encouragement.

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ZOL 006

Assessment of Ayeyarwady River Fishery on a Segment between Madaya and Singu

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Abstract

The Ayeyarwady River is Myanmar's most important commercial waterway and it is a home to support a rich diversity of animals including fish species. Rapid Assessment of Ayeyarwady River Fishery on a segment between Madaya and Singu was conducted in Aprial, 2014 to January 2015. Department of Fisheries Mandalay Region coordinates and organize meeting with fisher group (Madaya to Singu Segment). Participatory Methods were used to collect data and fisherman preference in the management of the fishery. Twelve fishing locations were visited by the project team interviewing 111 fishers. The results obtained show that the fishery was overfished and the present methods of fishing unsustainable. The point that we would like to make is participatory approach to fishery management certainly have many benefits, both for the fishers and for the researchers, administrating. Possibility exists to manage the fishery so that the stock will recover.

Keywords: Rapid Assessment, Participatory, overfished, unsustainable.

Introduction

Inland fisheries of Myanmar are closely tied to the monsoon regime. This is especially so in the central dry zone where monsoon dictates almost every aspect of the livelihood of the people. Due to the regular reversal of the Monsoon; six months wet the South West Monsoon and six months dry the North East Monsoon the characteristic of the fisheries is unlike the fisheries of the lower regions of the Ayeyawady, it is highly seasonal fixed or stationary in nature and are closely tied to flood plains or river channels collectively known as Eing[1]. These Eing are auctioned to the highest bidder by Department of Fisheries, the proceeds going to the State/Divisional Government. These auctions were usually done at the onset of South West Monsoon during the month of June. The successful bidder then waits for the flood water to enter the channel or the flood plain hopefully bringing in migratory fish on which the whole fishery depends. Towards the end of the South West Monsoon the operator will erect bamboo fences at the mouth of main outlets from the flood plain or river channels to prevent fish from returning to the river. Using a variety of fixed and mobile gears entrapped fish are systematically harvested.

The production of river fishery depends mainly on annual flooding of the plains and wetlands along the four major river systems; the Ayeyawady, Chindwin, Thanlwin and Sittaung. In tropical river systems production catching of fish and other aquatic animals depends largely on the extent duration and timing of flooding and access to productive floodplain habitats (Welcome 1985). Flooding releases nutrients from inundated so that there is an explosive growth of phytoplankton and zooplankton. A simple food chain develops rapidly after flooding and provides the food for much of early growth of fish fry which themselves serve as food for many predatory fish. In the Ayeyawady and Chindwin river systems, monsoon rains cause a large annual flooding, the most discharge from July to October. The ecology of fish and other aquatic animals is adjusted to this flood. This flood is viewed as a hazard in many ecological theories however Junk *et.al* (1989) postulated the flood pulses concept, where he put forward a view that annual flood pulse is biologically productive and the most important event in a river ecosystem. An interaction between water and land is created by the flood what is known as the moving littoral or aquatic-terrestrial transition zone. This zone is inundated only during floods.

River channels Myit Suit Eing form the significant fishery in the study area. Out of the 15 planned, 12 realized sites surveyed. As 3 sites were dropped for security reason. Out of the 12 serveyed 9 were river channel Eing and 3 were flood plain Eing. Leaving aside for a moment the questionable practice of granting fishing rights in river channels, a brief nature of the fishery is presented at this juncture.

Inland waters of Myanmar are made up of riverine systems and supports productive capture fisheries. These river systems create an area of approximately 8100,000ha of seasonal flood plains and 13000,000 ha of permanents water bodies, on which there is no likely productivity of theoretical annual production data. (FAO & NACA, 2003)

This word is taken form Yule, Henry (1858). A narrative of the mission sent by the governor-general of India to the court of Ava in 1855, with notices of the country, government, and people London: Smith, Elder & Co. Plate-22, Map showing relative position Tsagain and Ava from a survey by Major Grant Allan, Assistant quarter master general and special deputy commissioner on the frontier of Pegu in which Taung ah mah Eing (Taungthaman Eing) was mention. Rather than using the customary usage of the word "Inn" which already has meaning of its own the word "Eing" a transliteration of a Burmese word အင်း to English Eing is preferred and used throughout this report.

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although Dof data showed an increased yield from 158.93-thousand-ton n 2001-2002 to 1012.97 in 2012-2013 it clearly shows the need for proper assessment of the inland fishery sector. Information is key to responsible and effective fisheries management, within small-scale fisheries, the necessary data are often absent due to a lack of human and financial. The objectives of this study are;

- to address this issue by undertaking assessment of a river fishery, with the involvement of local fishers and
- to understand the context of the fishery.

Materials and Methods

Study Area

Research Area is located between Singu and Mandalay including Madaya Township. Total of 12 fishing sites were covered during the investigation. These are shown in Figure.1. Study area lies between Mandalay to Singu North latitude 24° 34' 5" and East Longitude 96° 26' 3. The river channel is straight slow flowing because of the present of numerous sand bank forming river channels. These channels located by the bank are classified as river Eing by the Department of Fishery. Very little is known of the physical, chemical and hydrology parameters of river water.

Study Period

The study was carried out from Aprial, 2014 to January 2015. Inception meeting was held at Yadanabon University on 23th July 2014.

Methodology

Assessment was conducted on fisher communities from a minimum of 12 villages on the Ayeyawady River, between Singu and Mandaya.

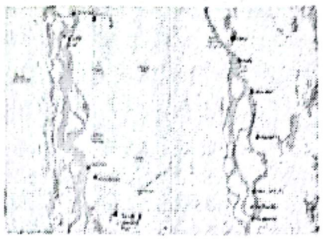
The study used participatory methods with fishermen answering structured questionnaires. Voluntaries from fishing households were invited from each village regardless of gender. Engaging stakeholders in research and decision-making on European marine issues is endorsed at high levels because agreement of stakeholders is believed to be essential for any management plan to succeed. The principal desired outcome of stakeholder participation in research is to improve the scientific data and knowledge required for management and governance. (Mackisson.S, *et al.*, 2010)

Data analysis and inference

A total of 12 fishing sites comprising nine river channels and three flood plain Eings were visited to collect the following data;

1. Interview data (Appendix 1)
2. Species data (Appendix 2)

A total of 111 fishers were interviewed and they can be classified as full time 57 fishers, part time 54 fishers and occasional workers 16. A team of researchers and DOF (Singu and Mandalay) visited river eings and collect data on species composition, catch and livelihood (Plate 1, Plate 2).



River Eing

Floodplain Eing

Figure.1. Map of Ayeyawady River (between Singu and Madaya) showing the location of 12 surveyed fishing sites.

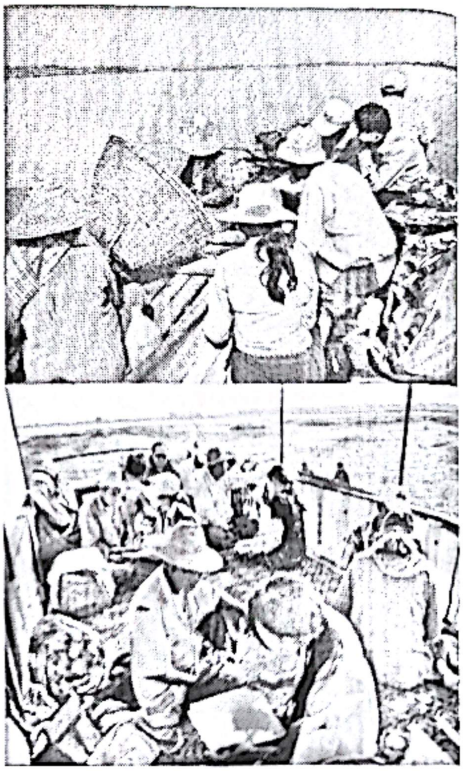


Plate 1. Interview with fishermen at Madaya

Plate 2. Interview with fishermen at Singu

Results

Plate 1. Interview with fishermen at Madaya

Field work was conducted in Madaya Township during 25th -27th of October 2014 and in Singu Township during 11th -14th of November 2014. Our research team assisted by DoF Mandalay visited flood plain Eing and river channel (Myit suit Eing) (Plate 3a and 3b). The list of villages is given in (Table 1). The fishermen were caegorised as permanent of full-time, temporary or part-time and occasional. The mean catch per day per fishermen and catch per fishermen per year where available, species composition and livelihood data were collected. Villages visited and the number of fishers interviewed is summarized in (Table 2 and 3). The fishermen community residences were visited and individuals interviewed to obtain information on the fishermen's socio-economic status. During the fish species were collected fro the landing sites and some from the markets. During the surveys altogether 52 fish species belonging to 36 genera, 20 families and 9 orders

Plate 2. Interview with fishermen at Singu

were recorded (Table 4). Among the 52 species Siluriformes was most dominant constituting 34% followed by Cypriniformes constituting 31%, Perciformes constituting 17%, Synbranchiformes constituting 6%, Clupeiformes constituting 4% and Osteoglossiformes, Mugiliformes, Beloniformes and Tetraodontiformes constituting 2% each of the total fish species (Fig.2).

Observation gather during the survey indicate that the fish stock in the study area is very much reduced in terms of species diversity as well as species abundances. Most fisheries are small-scale, with landings made at many dispersed sites where records are not kept. Most of the species are small size, lower economic value and includes many juveniles form of higher value fishes. A small number of high values, large fishes were picked and iced to be sent to Mandalay leading the bulk of the small fish which are mainly processes into salted fish or fish paste (Plate 4). The sustainability of such a harvest is clearly questionable and there is a urgent need for proper management of these areas influencing the livelihoods of their users.

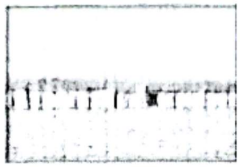


Plate 3a. River Eing

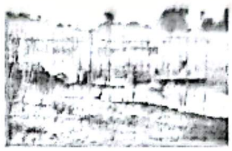


Plate 3b. Flood Plain Eing

Fishing and harvesting from aquaculture is practised by male household members but women also often play an important role. Women tend to used small-scale gear, whereas men dominate other types of fishing, particularly where hard manual labour is involved, such as in the large-scale

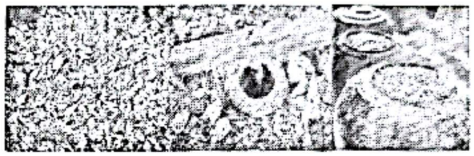


Plate 4. Bulk of the small fish and small fish stored in large glazed pots for fermentation

Plate 5.Bamboo fence (Yin and Sel)

Plate 6. Basket trap targeted for *Salmophasia* spp. (Woman involved in fishing)

Plate 7. Dragnet rigged for electric fishing

Plate 8. Barrier fence of a flood plain fishery

Plate 9. Dophin working group fishers at Hin-thar-ma Village

fishereies. In this study, fishers use a variety of gears of all sizes, many of which were developed to suit local conditions. The largest gears, such as bamboo fence (Yin/Sel) are rather non-selective and target fish which are migrating in large numbers (Plate 5). Most smaller traditional gears are specialised for fishing particular habitats in a particular way to catch a few target species. Women fishing specific traditional gear targeted for a specific small pelagic species (Plate 6).

In this study recorded that about 7% of fisher and fish plant worker were women and 93% were men according to interview data (Fig 3).

Almost all fishermen interviewed said that the catch is much lowered than previous years. They

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blamed it on a legal electric fishing operated by outside peoples (Plate 7). They claimed that electric fishing deplete spawners injure or kill juveniles leading to gradually decline in local fish stock. During the survey we do not encountered any electric fishing operation although we spend four days and two nights on the river. The presence of DoF people who accompanied us or the big vinyl poster advertising our study which hang from the site of the boat warned the fishers to stay away. On the other hand all the river channel fishery or Myit Suit Eing employed bamboo fence (Yinn) to close off the channel trapping any migrating fishes. The gaps between the bamboos strip are very narrow less than 1cm preventing small fishes from escaped. The mesh size of the nests used are (1cm) also very small leading to the complete harvest of any fish left in the river channel behind the bamboo fences. This practice has been going on for the past decades leading to the depletion of fish stock (Plate 8).

The study area covers part of the Ayeyarwady protected zone and among the interviewing were 9 fishers engaged in cooperate fishing with Dolphin (Plate 9). They also stated that catch has decline and the Dolphins are moving to other area since they do not get enough fish in the area. All these observations indicated that the river fishery in the study area is in need of proper management. Because of the work done by the Dolphin working group, fishers in the area are aware of management choice and preferences and the general idea of participatory management. However most of them are reluctant to give accurate catch data because they feared tax or fees might be charged on them. Nevertheless consistent value of catch obtained from all nine river channel fisheries along as some level of confidence in the data vary in mind be uncertainties associated with interview data. Out of three flood plains fishery studied the Ku-lel Eing operated as a culture-based capture fishery and Nga-pyae-ma Eing and Tha-min-chan-pauk-wei Eing are a fishery / agriculture operation.

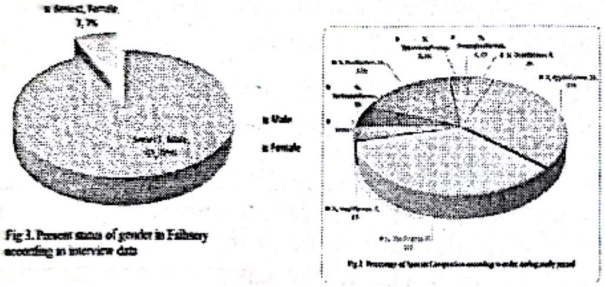

Fig 3. Present status of gender in Fishery according to interview data

Table 1.Villages List

No.	Village Name	Type of Eing	Code
1	Thi Ia (Kyi Tapalin Wea)	Myit-suit Eing (river channel)	Singu
2	Khu Lel (Khu Lel Eing)	Flood plain Eing (flood plain)	190153
3	Shwe Hlay (Sa Kyin Hmaw Wea Eing)	Myit-suit Eing (river channel)	190164
4	Chaung Wa (Kyet-lei-sit Eing)	Myit-suit Eing (river channel)	190168
5	Thar Yar Wa Di (Wetkoke Eing)	Myit-suit Eing (river channel)	190190
6	Hin Thar Hpo (Myit-poe-phaung-daunk Eing)	Myit-suit Eing (river channel)	190197
7	Hin Thar Ma (Myaung-myit-thaung-poe-u-daunk Eing)	Myit-suit Eing (river channel)	190202
8	Mway Sun (Cheo-dmusk Eing)	Myit-suit Eing (river channel)	189923
9	Mway Ta Laing (Nga-pyay-ma Eing)	Flood plain Eing (flood plain)	189914
10	Sein Pan Kone (Palin-phaung-daunk Eing)	Myit-suit Eing (river channel)	190028
11	Hlaing Kyune (Hlaing-kyune-sin-chi-tyine Eing)	Myit-suit Eing (river channel)	190089
12	Tha Min Chan (Pauk Wea) (Abt-gyan-kyi-pin Eing)	Flood plain Eing (flood plain)	190134

Table 2. Summary of Stakeholder's meetings conducted in Madaya Township.

No.	Village Name	Eine Name	No. of Fishers	Gender				Fishing gear
				Male	Female	Parmanent	Partime	
1	Sein Pan Kone	Palin Phaung Daung + Village	11+7	11+7	-	4+6	7+1	Beach seine net (Worm pu Pike)/Seine (Swe Pike)/ driftnet (Hmyaw Pike)
2	Mway Sun	Kyi Oo Daung	8	6	2	6	2	Set gill net(Tana Pike)/ Bamboo fence (Yin Tar)/ driftnet (Hmyaw Pike)/ fishe trap (Hmyune)/ Basket trap
3	Mway Ta Line	Nga Pyay Ma	18	14	4	10	7 1(byer)	Cast net (kun)/Set gill net(Tana Pike)/ Bamboo fence with filter trap (Sel)
4	Sin Kyun	Hlaing Kyun Sin Chi	7	7	-	5	2	Fishing with Dolphin/Cast net (kun)/Set gill net(Tana Pike)/driftnet (Hmyaw Pike)
5	Tha Min Chan Pauk Wae	Ar Jan Kyi Pin	7	7	-	5	2	Cast net (kun)/Set gill net(Tana Pike)/Bamboo fence (Yin Tar)/driftnet (Hmyaw Pike)/ Handline
		Total	58	52	6	36	22	

Table 3. Summary of Stakeholder's meetings conducted in Singu Township.

No.	Village Name	Eing Name	No. of Fishers	Gender				Fishing gear
				Male	Female	Parmanent	Partime	
1	Thi Ia	Kyee-tapalin-wea	7	7	-	3	4	Set gill net(Tana Pike)/ driftnet (Hmyaw Pike)/ fish trap (Hmyune)
2	Khu Lel	Khu Lel	11	11	-	4	7	Set gill net(Tana Pike)/ Long line (Myar tana)/ fish trap (Hmyune)/Dusk park / Cast net (kun)/ Bamboo fence (Yin Tar)
3	Shwe Hlay	Lin-pan-kya	5	5	-	4	1	Set gill net(Tana Pike)/ Cast net (kun)/Bamboo fence (Yin Tar)/ driftnet (Hmyaw Pike)/ fish trap (Hmyune)
4	Chaung Wa	Kyet-lei-sit	8	6	2	5	3	driftnet (Hmyaw Pike)/ Cast net (kun)/Set gill net (Tana Pike)/ Bush park
5	Thar Yar Wa Di	Wetkoke	12	12	-	-	12	driftnet (Hmyaw Pike)/ Cast net (kun)/Set gill net (Tana Pike)/ Bamboo fence (Yin Tar)/ Long line (Myar tana)
6	Hin Thar Hpo	Myit-poe-phaung-daunk	3	3	-	-	3	driftnet (Hmyaw Pike)/ Set gill net(Tana Pike)/fish trap (Hmyune)
7	Hin Thar Ma	Myaung-myit-thaung-poe-u-daunk	7	7	-	5	2	Fishing with Dolphin/Cast net (kun)/driftnet (Hmyaw Pike)
		Total	53	51	2	21	32	

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Table 4. List of freshwater fish species form Ayeyarwady River between Madaya and Singu Township.

No	Order	Family	Species	Common Name	Local Name
1	Osteroglossiformes	Notopteridae	*Notopterus notopterus*	Grey feather back	Nga-phe
2	Clupeiformes	Clupeidae	*Hilsa ilisha*	Hilsa	Nga-tha-lauk
3			*Gudusia variegata*	Burmese River Shad	Nga-la-bi
4	Cypriniformes	Cyprinidae	*Salmophasia sardinella*	Sardinella razorbelly minnow	Yin-baung-zat
5			*Raiamas guttatus*	Burmese trout	Nga-la-wat
6			*Amblypharyngodon microsoma*	Burmese carplet	Nga-pyet
7			*Osteobrama belangeri*	Manipur Osteobrama	Nga-phant-ma
8			*Osteobrama cotio*	Cunma osteobrma	Nga-lay-daung
9			*Osteobrama feae*	Burmese Osteobrama	Nga-lin-ban
10			*Puntius chola*	Swamp barb, chola barb	Nga-khone- ma- myi- ni
11			*Puntius gonionotus*	Silver barb	Thai-nga- khone- ma
12			*Puntius sarana*	Olive barb	Nga-khone-ma-toke
13			*Cirrhinus mrigala*	Mrigal	Nga- gyin -phyu
14			*Catla catla*	Catla	Nga-thaing-kaung-pwa
15			*Labeo angra*	Carplet	Nga- lu
16			*Labeo calabasu*	Carp	Nga-net-pyar
17			*Labeo rohita*	Rohu	Nga-gyin-myet-san-ni
18			*Labeo stoliczkae*	Minor Carp	Nga-le/ Nga-thainn
19		Cobitidae	*Lepidocephalichthys berdmorei*	Burmese loach	Nga-tha-le-toe
20	Siluriformes	Bagridae	*Sperata acicularis*	Giant River-Catfish	Nga-kyaunn
21			*Mystus bleekeri*	Day's mystus	Nga-zin-yainn-kyet-chay
22			*Mystus cavasius*	Genetic mystus	Nga-zin-yainn-phyu
23			*Mystus leucophasis*	Sittang mystus	Nga-naut-thwar
24			*Mystus pulcher*	Striped dwarf catfish	Nga-zin-yainn
25			*Hemibagrus menoda*	Menoda catfish	Nga-ngaik/ Nga-aik
26			*Hemibagrus microphthalmus*	Irrawaddy mystus	Nga-ywaye
27		Siluridae	*Ompok bimaculatus*	Indian butter catfish	Nga-nu-than
28			*Ompok pabo*	pabo catfish	Nga-nu-than
29			*Wallago attu*	Boal	Nga-butt
30		Schilbidae	*Clupisoma macrophthalmus*	Burmes taakree	Nga-myuin-kyet-taung
31			*Clupisoma prateri*	Brumese garua	Nga-myuin-oak-phar
32			*Eutropiichthys vacha*	Batchwa vacha	Nga-myuin-kun-mar
33			*Neotropius antherinoides*	Indian potasi	Nga-za-kar
34		Sisoridae	*Gagata cenia*	Indian gagata	Nga-than-chate
35			*Bagarius bagarius*	Gangetic goonch	Nga-maung-ma
36		Clariidae	*Claris batrachus*	Walking Catfish	Nga-khu
37		Ariidae	*Arius acutirostris*	Salweeen catfish	Nga-yaung
38	Mugiliformes	Mugilidae	*Rhinomugil corsula*	Corsula mullet	Nga-zin-lone
39	Beloniformes	Belonidae	*Xenentodon cancila*	freshwater garfish	Nga-phaung-yoe
40	Synbranchiformes	Mastacembelidae	*Macrognathus aral*	One-stripe-spiny-Eel	Nga -mway -ni
41			*Macrognathus zebrinus*	Spiny-eel	Nga -mway -htoe-kyan-sit
42			*Mastacembelus armatus*	Tire-track-spiny-eel	Nga -mway -na-gar
43	Perciformes	Ambassidae	*Parambassis ranga*	Glass fish	Nga-Zin-Sat
44		Cichlidae	*Oreochromis sp.*	Nile Tilapia	Te Larr Pee Yarr
45		Gobiidae	*Glossogobius giuris*	Tank-goby	Naing-lon-nga
46		Anabantidae	*Anabas testudineus*	Climbiong Perch	Nga-pyay-ma
47		Belontiidae	*Colisa labiosus*	Thick-lipped-gourami	Nga-phyinn-tha-let
48			*Trichogaster pectoralis*	Snakeskin gourami	Be Larr/ Go yar me laye
49		Channidae	*Channa marulius*	Great Snakehead	Nga-Yant-Dainn
50			*Channa punctatus*	Spotted-snake-head	Nga-Yant -pa-naw
51			*Channa striata*	Snakehead Murrel	Nga-Yant -auk
52	Tetraodontiformes	Tetraodontidae	*Tetraodon cutcutia*	Green Puffer	Nga-Pue-Tinn

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Discussion

A fishery is a result of the interaction between fish species and fishermen with the environment. In freshwater inland fishery where multiple gears were in use to harvest a high diversity of species. Traditional management of such a fishery is not easily managed therefore a new approach of participatory management was put forward, where there is a clean sharing of responsibilities.

Fishermen and fishing communicate often possess a high level of knowledge regarding fish populations and ecology of the local (costal) area (FAO, 1997). They also have considerable understanding about social cultural and institutional arrangements resource allocation and conflict management. Although the history of fisheries management in Myanmar is relatively new, it is centrally administered by the government, using management approaches that have no scope for getting closer to the voice of resource users. Participatory approach is a mean of active engagement and can be seen as an alternative cultured approach. It means individuals and organizations work together, with stakeholders being involved in all stage of planning and delivery.

The present study is attempts at participatory research, where the community is actively engaged in the consultation to cooperation to collaboration depending on the nature of the issue and the willingness of the stakeholder to contribute effectively. We are fortunate with the selection of the study area, the community is familiar with participatory appraisal Methodologies, thanks to the research teams involved with Ayeyawady Dolphin Program.

One unexpected major issue uncovered by the study was illegal electric fishing activity taking place in the study area. Every fisher interviewed related their own experience with these "electric fishers" as robbery, how they were forced to stay on shore while these fish dacoits take away what is to be their rightful catch. When asked "from where do they come from?" The Northern village point to the South, while the Southern village point to the North. However, one fisherman said there are electric fishers in almost every village.

The role of gender in this study, woman play an importnt role in inland fishereis and in marketing. Women tend to used small-scale gear, fish near their house and process fish for the household, whereas men dominate other types of fishing, particularly where hard manual labour is involved, such as in the large-scale fishereies. In this study recorded that about 7% of fisher and fish plant worker were women and 93% were men. In a stuy of other provinces, kaing and Ouch (2003) found that about 20% of fishers were female, over half of aquaculturists were female, and 85% of fish traders were women.Women dominate marketing of fishery products throughout the country. Deap (1998) found that up to 90-95% of sellers in rural fish markets were women, and Khay and Hortle (2004) reported that Phnom Penh's 29 main fish markets support over 2,000 fish sellers, of which 90% are women, Small markets are the primary supplier of the fish to cities or towns, providing significant employment opportunities for women in an environment wher they can manage their own businesses.

Regarding the river channel fishery, it is noted that they constitute a complex network of leaseholders, fishers and casual workers. The diverse natures of river channels are reflected in the multi species and habitats, which resulted in the use of different types of gears. The major type of gear employed in the river channels of the study area is barrier type of gear, usually bamboo, which will cut off and concentrates fish coming off the flood plain as the water level fall. The barrier gears are very efficient by catch fish highly concentrated in the channels. Access to such "site" is usually in high demand as indicated by highly competitive auctioning of such sites of Eing conducted by the DoF.

Owners of these Eing tried to prevent other fishers to fish rear their barrier, although have no legal right beyond the barrier. They set up "no fishery areas" around the mouth of the river channels, thus hunting the destruction of catch among the community barrier gear is also labor intensive and investment is high. The high operation cost plus the high competitive auction. Sometimes lying the lease form the winner of the auction. Place heavy economic burden on the operator of the river Eing.

The recover as much as he could, the operator sublease the area he has stock out in the river to small scale fishery. As the river receded further the operator will use cast nets, push nets and finally where possible pumping and dewatering to catch much fish as he could, marketable fish will be send off while all remainder will be made into fish paste. The same practice was encountered at all river channel fisheries. As states before river channels are shelter for spawning and refuge for fingerlings waiting for the next flood so that they can disperse over the flood plains to grow or spawn. That the practices of legally allowing fishers to completely deplete these river channels is not sustainable.

Under the old freshwater fishery law the normal term of lease for an Eing fishery was three years, the operator has the sole responsibility to maintain the water ways, fish refuges, and for the maintenance of fish stock for the next season. If the performance of the lease owner is up to the standards set by DoF he will be awarded another term of lease without competition, and so on up to a maximum of 9 years continuously. In this way the Eing fisheries of the Ayeyawady were managed from colonial days by experienced Eing Thagyis (lease holder) who were the repositories of local knowledge handed down through generations. All this ended three decades ago.

Under the new constitution freshwater fisheries came under the State/Regional Governments and a destructive practice appeared among the Eing Thagyis, known as Eing Kaw Pet: at the end of the fishing season when the river has receded leaving pools of water, these are pumped dry and fish big and small are harvested. Because of an increase in the tender floor price and the new rule granting only one year lease, many Eing are now dependent on ngapi fish paste for survival. A happy note here is that DoF has managed to revert to the old 3 year lease.

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However the damage was already done, of the three flood plain Eing in the study area one has become a capture culture fishery and the other two agro based fishery where during the post monsoon months it is cultivation and in the wet season an Eing.There is very limited data on the biomass or species composition of river fisheries, however interviews with local fisherman bearing in mind the uncertainties indicate that the stock and composition of river fish has declined.

The point that we would like to make is participatory approach to fishery management certainly have many benefits, both for the fishers and for the researchers, administrating. However we would like to comment that prescribed or mandated participation is rarely effective.

Conclusion

The results of this study showed that the present state of the stock is within limits of uncertainties represented by low biomass and is probably overfished. This assumption was supported by interviewed data, where fishers agreed that the biomass of fish is lower than 5 years ago and that some species has disappeared. Fishers also agreed that there is need for proper management of freshwater fishery. Therefore, it is assumed that even though resources in the study areas is overfish. It has not reached the maximum sustainable level.

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ZOL 007

Feeding Habit and Pattern of Urban Rhesus Macaques and Around Human-Settled Landscape: Case Study in Central Dry Zone, Myanmar

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Abstract

In Myanmar rhesus macaques *(Macaca mulatta)* is found in forested habitats and urban areas. We learned in Central Dry Zone (Myanmar) . Direct counted method was applied for this study. Each site was followed and monitored in study phases of the day i.e morning phase (6:00 AM – 11:00AM), afternoon phase (11:00AM -3:00PM) and evening phase (3:00PM- 6:00PM). In study site, Site I the Macaque fed on a total of 41 plants species were countered under family Moraceae and Fabaceae (10%) comprises and Site II the Macaque fed on 50 plants species, and mostly to feed the tree species of Combretaceae (12%) and Moraceae (10%) and Site III the Macaque fed on 32 plants species, and preferred to fed Mimosaceae (18.75%). This study showed that Macaque adopted different foraging strategies based on the availability of resources in their habitat. Information on their feeding pattern will help in developing management guideline for the primates in urban environments. The role of primates within ecosystem is vital importance to link all living things through food chains as well as food webs, in doing so, their habitats and niches are necessary to conserve for sustainable population.

Keywords: Primates Conservation, Feeding habit, Rhesus Macaque, Central Dry Zone Myanmar

Introduction

The Union of Myanmar is situated in the north west of the Indochina peninsula, and is the largest country in mainland South East Asia. Alic *et al.*, 2012 studied conserving a species depends on an under-standing of its habitats requirements. Ohdachi *et al.*, 2010 stated that rhesus macaque is widely distributed in Afghanistan, India, the southern part of China, and the northern part of the Indochinese Pen. The role of primates within ecosystem is vital importance to link all living things through food chains as well as food webs, in doing so, their habitats and niches are necessary to conserve for sustainable population. Pragatheesh, 2011 stated that rhesus macaque is a diurnal species occurring in a variety of habitats occupying both terrestrial and arboreal niches. They inhabit the Rajasthan, agricultural plains of the Genetic basin the tropical forests of southeastern Asia, the temperate pine forests of the Himalaya ,and the ragged mountains of north central China (Southwick *et al.*, 1994) . Rhesus macaques are the most adaptable of all non-human primates and have learned to live amidst human habitations. In India, 80 to 90% of Rhesus Macaques live in close association with human populations and are therefore highly dependent on people for food (Southwich *et al.*,1965,1976 cited by Pragatheesh, 2011). Rhesus macaques (*Macaca mulatta*) is the most common non-human primate in the forested and Urban area of Asia (Hasan *et al.*, 2013). Flexibility in diet patterns plays a pivotal role in the survival of non-human primate species in urban and peri-urban ecosystems through resource sharing and competition and has evolutionary implications in the long-term. Primates are known to adopt several foraging strategies (Fleagle& Gilbert 2006).

In some cases, macaques depend on humans for being fed (Strum 1994) the feeding patterns of primates that live in tourist sites and temples are often influenced by provisioning of food by humans. Urban macaques have also acquired behavioral adaptations in food-acquisition technique (Mangalam& Singh 2013). Urban habitats, in contrast to natural ones, have a more direct influence on primate behaviors associated with competitive resource utilizations and foraging techniques. Several anthropogenic barriers and disturbances interfere with the feeding ecology of primate in urban environments.

The negative interactions between humans and macaques due to food provisioning and other anthropogenic drivers possess major challenges for the survival and persistence of the species. The need for translocation of Rhesus Macaques and the consequences were due to it proliferation in urban areas of India was suggested studied earlier (Malik & Johnson 1991, 1994; Southwick *et al.* 1998) .

Dry Zone Region, the study some hills are a natural lime-stone, steep and also found with forested area. Temples and pagodas also constructed on the hill, is one of the habitats of rhesus monkey. Present study was focusing on food and feeding habits of Rhesus monkey in study site.

Objectives

- to examine of plant species in the study area
- to assess food and feeding habits of the rhesus macaque
- to learn environment impacts and primate conservation at study area

Methodology

Study area

The present study was studied at the Mandalay region and Mague region.

Study site

The present study was conducted at the Yedaguntaung, Patheingyi Township. It is situated in the Central Dry Zone at 21° 57.955 – 21° 57.938 N and 96° 12 .809 - 96° 12.671 E. The highest peak of Yedaguntaung has an elevation of 212 m above the sea level and the base of hill has 108m (Site I). The present study was conducted at the Popa Taungkalat Kyaukpadaung Township. It is situated in the Central Dry Zone at 20° 54' 41.305" N and 95° 12' 24.1 8" E. The highest peak of has an elevation of 1518 m (4981 feet's) above the sea level (Site II). Shinmataung Yesagyo Township 21° 34' 29" N 95° 06' 11" E. The highest peak of Shinmataung has an elevation of 496.8 m above the sea level. (fig.1)

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Study period

The present study is conducted during the period from January to June 2019 (Site I), from October 2017 to January 2018(Site II) and July to October (2019) (Site III)

Identification

Plant species were identified and verify by Botany Department, Mandalay University and based on Kress *et al.*, 2003.

Collection of Data

The food and feeding habits of Rhesus macaques in the study area was estimated by using direct contact method (Barwer, 1972 cited in Chopra, G and Kumar, A., 2012). Each site was followed and monitored in study phases of the day i.e morning phase (6:00 AM – 11:00AM), afternoon phase (11:00AM -3:00PM) and evening phase (3:00PM-6:00PM). The feeding sites of rhesus monkey were marked and subsequently scanned to identify the feeding objects (plant parts i.e bark, gum, leaves, inflorescences etc, or animals, if any). We complied a lists of the all plants species (leaves, shoots, fruits, flower) (Islam and Feeroz., 1992)(Ahsan., 1994 Cited in Muzaffar *et al.*, 2007).

Data analysis

Data were analyzed using Microsoft Excel program and were presented as table and graphs.

Systematic positions

Phylum	-	Chordata
Class	-	Mammalia
Order	-	Primates
Family	-	Cercopithecidae
Genus	-	*Macaca*
Species	-	*M.mulatta* (Zimmermann, 1780)
Common name	-	rhesus macaque, rhesus monkey

Food plants, plant families, parts eaten and feeding and each plant species are showed in Table (1,2,3) . In study Site (I), Population size of rhesus were found to total of range, 200-300 individuals. The rhesus food at Yedaguntaung consisted of natural food and food offered by the visitors as well as indigenous people.

Results

Natural foods

In the study site I, the rhesus fed on a total of four plant species. Among them 30 were tree species six were small tree, one was shrub, one was grass and one was bamboo. (Table 1)

In the study sites were eating of leaves observed the highest number (41) plant of species, (8) plant flower, (14) plant fruit and (2) plant bark .The leaves composed the highest proportion (51%) of the natural food, flower (16.3%), fruit (28.6%) and bark (4%) (Fig -2). In the study site I area, a total of 41 plants species were countered under family Moraceae comprises those were. *Ficus religiosa* (Bawdi-nyaung) *Ficus hispida* (Kadat) *Artocarpus heterophyllus* (Peinne) *Ficus glomerata* (Tha phan). The rhesus preferred to feed family Moaceae. In the study site II- Popa Taungkalat, the population size were found to rang in 500-900 individuals during the study period. The rhesus fed on a total of 50 plant species were countered under 27 families, composing 34 trees, four small tree species (Table-2).

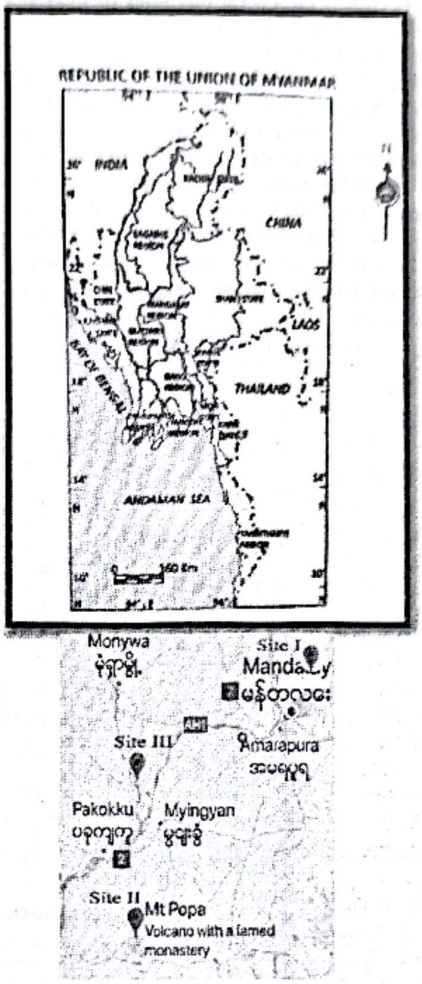


Fig.1 Map showing the study sites

(Source from Google Earth 2019)

In the study sites were eating of leaves the highest number (44) plant species fruit (21) species, and flower seven plant species. The leaf composed of the highest proportion (61.1%) of the natural food, flower (9.7%) and fruit (29.1%) respectively (Fig- 3). Site II area, A total of 50 plants were observed under family Combretaceae (12%) and Moraceae (10%). Their liked food to eat under family Combretaceae.

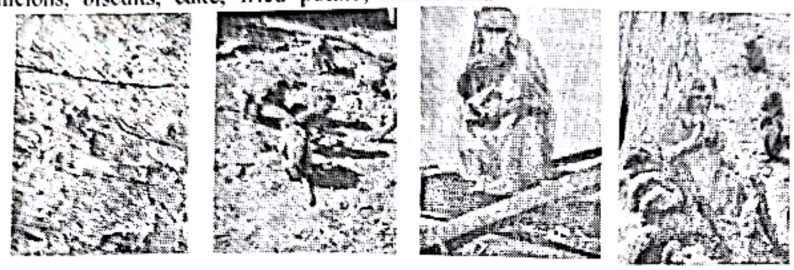
In the study site III – Shinma Taung, the population size were found to rang in 200-150 individuals during the study period. The rhesus fed on a total of 32 plant species were countered under 21 families, composing 27 trees, five small tree species (Table-3). Their liked food to eat under family Mimosaceae (18.75%) (Fig- 4)

Composition of plant species

Site I, a total of 42 plant species , site II a total of 50 plant species and site III a total of 32 plant species were collected identified. The hole plant species recorded and were distributed among

family with 42 species and family with 50 species plant site I preferred to feed family Moraceae (10%) and Fabaceae (10%), site II preferred to feed family Combretaceae (12%) and Moraceae (10%) and site III, liked food to eat under family Mimosaceae (18.75%) on the natural plant resources.

Provisioned foods. In Site I, the rhesus macaques are dependent on 14 various kind of provisioned food from villager and pilgrims. Provisioned foods include banana, guava, peanut, chick-pea, maize, mango, juices and sunflower seed. During the study period provisioned foods were most abundant are found. In Site II, monkeys were also dependent on 16 kinds of provisioned foods offered by pilgrims and local people. In this area were very attractive to monkeys because of the abundance of provisioned food offered by people. Provisioned food offered to monkeys consisted groundnut, rice, chick-pea, bananas, juices, sunflower seeds, water melons, biscuits, cake, fried potato, maize and popcorns. In Site III, the rhesus macaques are dependent on 12 various kind of provisioned food from villager and pilgrims.



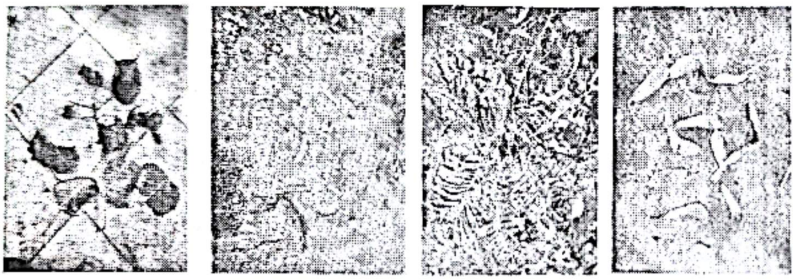


Table 1 Vegetative parts of different species of plants used by Macaca mulatta as food in Yedaguntaung (Hill) during January to June (2019)

No.	Tree species	Local name	Family	Plant parts
1.	*Azadirachta indica*	Tama	Meliaceae	L,F
2.	*Chukrasia tabularis*	Yin ma	Meliaceae	L,B
3.	*Delonix regia*	Sein ban	Cocalpiniaceae	L,F,Fl,B
4.	*Tamarindus indica*	Magyi	Cocalpiniaceae	L, F, Fl
5.	*Ficus religiosa*	Bawdi-nyaung	Moraceae	L, F
6.	*Ficus hispida*	Ka dat	Moraceae	-
7.	*Artocarpus heterophyllus*	Peinne	Moraceae	L
8.	*Ficus glomerata*	Tha phan	Moraceae	L, F
9.	*Mangifera indica*	Thayet	Anacardiaceae	L, F, Fl
10.	*Cocos nucifera*	Ohn	Arecaceae	F
11.	*Mimusops elengi*	Khayay	Sapotaceae	L, Fl
12.	*Senna siamea*	Mezali	Fabaceae	-
13.	*Butea monosperma*	Pauk	Fabaceae	-
14.	*Pterocarpus indicus*	Padauk	Fabaceae	L
15.	*Dalbergia glomeriflora*	Thit pagan	Fabaceae	L, F, Fl
16.	*Limonia acidissima*	Thi	Rutaceae	-
17.	*Aegle marmelos*	Okshit	Rutaceae	L, F
18.	*Leucaena leacocephala*	Aweyut/Bawzagaing	Mimosaceae	L, F
19.	*Acacia catechu*	Sha	Mimosaceae	-
20.	*Zizyphus jujube*	Zi	Rhamnaceae	F
21.	*Terminalia oliveri*	Than	Combretaceae	L, Fl
22.	*Terminalia catappa*	Banda	Combretaceae	F
23.	*Tectona hamiltoniana*	Dabat	Verbenaceae	L, Fl
24.	*Tectona grandis*	Kyun	Verbenaceae	-
25.	*Sterculia versicolor*	Shaw phyu	Sterculiaceae	-
26.	*Phyllanthus pomiferus*	Zibyu	Euphorbiaceae	-
27.	*Croto oblongifolius*	Thetyingyi	Euphorbiaceae	L
28.	*Diospyros embryopteris*	Te	Ebenaceae	-
29.	*Schrebera swietenioides*	Taw-gwe	Oleaceae	L,F
30.	*Cordia dichotoma* Small Tree	Thanut	Boraginaceae	-
1.	*Balanites aegyptiaca*	Thitpalwe	Balanitaceae	L, F
2.	*Hesperethusa cremulata*	Thanakha	Rutaceae	L
3.	*Bauhinia accuminata*	Swe-daw	Caesalpiniaceae	-
4.	*Annona squamosal*	Awzar	Annonaceae	L
5.	*Arenga nana*	Yone	Arecaceae	L, Fl
6.	*Jatropha curcas* Shrub	Kyet-su-gyi	Euphorbiaceae	-
1.	*Boscia variabilis* Climber	Thamon	Capparaceae	L
1.	*Cissampelos pareira*	Rat-na baung	Menispermaceae	L
2.	*Wattakaka volubilis* Grass	Gwedauk	Asclepiadaceae	-
1.	*Cynodon dactylon* Bamboo	Mye-sar myet	Rhamnaceae	L
1.	*Dendrocalamus strictus*	Male bamboo	Poaceae	L

Leaves, F = Fruit, Fl = Flower, B = Bark

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Table 2.Vegetative parts of different species of plants used by Macaca mulatta in Popa Taungkalat during October (2017) to January (2018)

No.	Family	No.	Scientific name	Local name	Type	Plant part
1.	Anacardiaceae	1.	Mangifera indica	Thayet	Tree	L, F
2.	Annonaceae	2.	Annona squamosal	Awzar	Small tree	L, F
3.	Apocynaceae	3.	Calotropisgigantea	Mayogyi	Shrub	L
		4.	Carissa spinarum	Kanset	Shrub	L
4.	Asclepiadaceae	5.	Wattakaka volubilis	Gwedauk	Climber	L
5.	Asteraceae	6.	Leucomerisdecora	Wet hmwe sote	Small tree	L, Fl
6.	Bignoniaceae	7.	Oroxylum indium	Kyawn sha	Tree	L, F, Fl
7.	Burseraceae	8.	Protimserratum	Tha di	Tree	L
8.	Coealpiniaceae	9.	Delonix regia	Sein ban	Tree	L, F, Fl
		10.	Tamarindus indica	Magyi	Tree	L, F
9.	Combretaceae	11.	Terminalia alata	Htauk kyunt	Tree	L
		12.	Terminalia bellirica	Thit seint	Tree	F
		13.	Terminalia catappa	Banda	Tree	L, F
		14.	Terminalia chebula	Phan gar	Tree	F
		15.	Terminalia oliveri	Than	Tree	L
		16.	Anogeissus acuminate	Youm	Tree	L, Fl
10.	Dipterocarpaceae	17.	Dipterocarpus tuberculatus	In	Tree	L
		18.	Shorea obtuse	Thit yar	Tree	L
11.	Ebenaceae	19.	Diospyros embryopteris	Te	Tree	F
12.	Euphorbiaceae	20.	Croto oblolgifolius	Thityingyi	Tree	L
		21.	Holpteleaintegrifolia	Phyut seint	Tree	L
		22.	Phyllanthus pomiferus	Zibyu	Tree	L, F
13.	Fabaceae	23.	Senna siamea	Mezali	Tree	L, F,Fl
		24.	Xyliaxylocarpa	Pyinkado	Tree	L
14.	Gramineae	25.	Dendrocalamus strictus	Hmyyi-wa	Bamboo	L
		26.	Eleusineindica	Sin-go-myet	Grass	L,F
15.	Juglandaceae	27.	Engelhardtiaspicata	Thitswelae	Tree	-
16.	Lamiaceae	28.	Colebrookenappositifoliasm	Chin-Htaung-la	Shrub	L
17.	Lythraceae	29.	Lagerstroemia speciosa	Pyin ma	Tree	L
18.	Meliaceae	30.	Azadirachta indica	Tama	Tree	-
		31.	Chukrasia tabularis	Yin ma	Tree	L, Fl
19.	Menispermaceae	32.	Cissampelos pareira	Rat-na baung	Climber	L
20.	Mimosaceae	33.	Acacia megaladena	Subok	Small tree	L
		34.	Albizzialebbek	Kokko	Tree	L, F
21.	Moraceae	35.	Artocarpus heterophyllus	Peinne	Tree	L, F
		36.	Ficus glomerata	Tha phan	Tree	F
		37.	Ficus hispida	Kadat	Tree	L
		38.	Ficus infectoric	Nyaung chin	Tree	L, F
		39.	Ficus spp.	Nyaung	Tree	L, F
22.	Myrataceae	40.	Eugenia spp.	Tha byby	Tree	L, F
23.	Papilionaceae	41.	Acaciapennata	Suyit	Climber	L
24.	Rhamnaceae	42.	Zizphus jujube	Zi	Tree	L, F
		43.	Cynodon dactylon	Mye – sar myet	Grass	L
25.	Rutaceae	44.	Aegle mamelos	Ohm shit	Tree	L, F
		45.	Murrayapaniculata	Yu san a	Shrub	L, Fl
		46.	Pisdiumacidummart	Malaka	Small tree	L, F
27.	Unbelliferae	47.	Harrisaniaperforata	Myin khwa	Shrub	L
28.	Verbenaceae	48.	Lantana aculeate	Seinna gut	Shrub	L, Fl
		49.	Tectona grandis	Kyun	Tree	L
		50.	Tectona hamitoniana	Dahat	Tree	L

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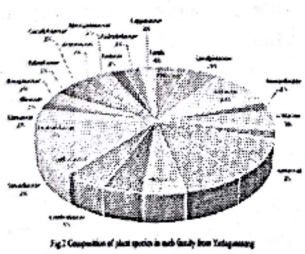
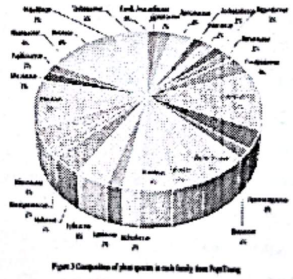
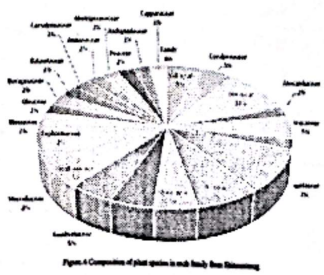
Table 3 Occurrence of plant species in the study site at Shinmataung area 2019

No.	Family	No.	Scientific name	Local name	Type
1.	Anacridaceae	1.	*Mangifera indica*	Thatyet	Tree
		2.	*Spondias dulcis*	Gwe-cho	Tree
2.	Annonaceae	3.	*Annona squamosa*	Awzar	Small tree
3.	Apocynaceae	4.	*Plumeria rubra*	Toyok-saga	Small tree
		5.	*Carissa spinarum*	Taw-khan pin	Small tree
4.	Arecaceae	6.	*Borassus flabelifer*	Htan	Tree
5.	Bombacaceae	7.	*Bombox ceiba*	Letpan	Tree
6	Boraginaceae	8.	*Cordia dichotoma*	Thanut	Tree
7.	Caesalpiniaceae	9.	*Tamarindus indica*	Magyi	Tree
		10.	*Delonix regia*	Sein ban	Tree
8.	Combretaceae	11.	*Terminalia oliveri*	Than	Tree
		12.	*Terminalia bellerica*	Thit-seint	Tree
9.	Cupressaceae	13.	*Cupressus arizonica*	Kyaukpan	Tree
10.	Dipterocarpaceae	14.	*Dipoterocarpus tuberculatus*	In	Tree
11.	Ebenaceae	15.	*Diospyros burmanica*	Te	Tree
12.	Euphorbiaceae	16.	*Phyllanthus pomiferus*	Zibyu	Tree
13.	Hypericaceae	17.	*Calophyllum inophyllum*	Pon-nyet	Tree
14.	Meliaceae	18.	*Chukrasia tabularis*	Yinma	Tree
		19.	*Azaclirachata indica*	Tama	Tree
15.	Mimosaceae	20.	*Leucaena leucocephala*	Bawzagaing/ Aweyar	Tree
		21.	*Acacia catechu*	Sha	Tree
		22.	*Acacia leucophloea*	Tanaung	Tree
		23.	*Acacia megaladena*	Subok	Small tree
		24.	*Archidendron cylpearia*	Taw-mezali	Tree
		25.	*Albizia lebbek*	Koko	Tree
16.	Moraceae	26.	*Ficus ap.*	Nyaung	Tree
17.	Myrtaceae	27.	*Psidium acidum*	Malaka	Tree
18.	Rhamnaceae	28.	*Zizyphus jujube*	Zi	Tree
19.	Rutaceae	29.	*Hesperethusa cermulata*	Thanakha	Small tree
20.	Sapotaceae	30.	*Mimusops elengi*	Khayay	Tree
21.	Verbanaceae	31.	*Tectona hamiltoniana*	Dahat	Tree
		32.	*Tectona grandis*	Kyun	Tree







Discussion

Rhesus macaques found in forested area and urban. Wenyuan *et al.* (1993) stated that rhesus monkeys are found in elevation between 240 and 1962 m asl (above sea level) in the deciduous forest. Aye Mi San (2007) also reported that long-tailed macaques inhabited at elevation of 122 m asl in evergreen lowland forest. In the study area, they inhabited an elevation site A and site B 657m dry forest. She stated that long-tailed Macaques at Bayin Nyi Naung Mountain are failovers and among 23 plant species five of tree plant are the most important for macaques especially *Ficus glomerata* (Thapan) which offers not only annually availabl fruits, but also leaves and buds. Nwe Nwe Win (2013) recorded that Rhesus macaques in Pho Win Taung are primarily frugivores in feeding habit. These monkeys are found to utilize at the least 30 food plant species of 45 plant species in the study area. Naw Phaw Phaw Say (2005) also reported that favorite fruits of macaques are *Ficus hispida* (Ka dat) *Grewia microcos* (Myaya) and *Ficus glomerata* (Tha phan) in Hlawga wildlife park.

Present study site I observed to feed in family Moraceae, *Ficus hispida* (Kadat), *Ficus religiosa* (Bawdi-nyaung), *Ficus glomerata* (Tha phan) and *Artocarpus heterophyllus* (Peinne). Site II recorted to feed in family Combretaceae and Moraceae, *Ficus religiosa* (Tha phan), *Ficus hispida* (Ka dat), *Ficus infectoric* (Nyaung chin), *Ficus* spp. (Nyaung) and *Artocarpus heterophyllus* (Peinne). Site III learned to feed in family Mimosaceae, *Leucaena leucocephala* (Aweyar), *Acacia catechu* (Sha), *Acacia leucophloea* (Tanaung), *Acacia megaladena* (Subok), *Archidendron cylpearia* (Taw-me-zali), *Albizia lebbek*(kokko) .At the result, same species and different site observed to fed different habitat. By reducing forest size and quality, habitat destruction leads to the reduction of food sources for forest-dwelling primates and, in some case, threatens them with local extinction (Lee&Hauser 1998; Muoria *et al.* 2003).The increasing population of Rhesus Macaques living in proximity to human habitations has become a major issue in India. Rapid urbanization, deforestation, and habitat fragmentation altered the natural living spaces of animals and their natural behavior in the wild. Most primate species were severely affected by threats 7in anthropogenic landscapes (Sinha & Vijayakrishnan 2017).

The dietary habits of Rhesus Macaques were totally different in a human-dominated forest land. Previous studies showed that the species thrived in eight diverse habitats (temple, urban, village, village-cum-pond, pond, roadside, canal side, and forest) having varying degrees of human interaction in India (Seth *et al.* 1986) cited in Ganguly *et al.*, 2018. The feeding practice seemed to increase the urban threats, diseases, and anthropogenic stress in the Rhesus Macaque population.

In our study, the species was observed to spend maximum time on the ground instead of on the trees and their dependency on supplementary, provisioned, and anthropogenic food sources did not indicate conservation success. Understanding the feeding ecology in this sanctuary would help in planning the management of macaques in other urban areas.

Conclusion

Mitra, (2000) stated in the absent of natural predators and very high birth rate the population of rhesus monkey is multiplying every year. This had leads to increase in commensal monkey population and so the man-monkey conflicts. Basically the problem of monkey nuisance lies attempts to fetch food and space in human habitats. Monkey problem is directly related with the people's life, health and property, and has a great social relevance, it is very important to undertake this problem as a subject matter for further investigation. In addition commensal rhesus macaques show a high degree of behavioral flexibility in response to habitat and resource variability, and knowledge of these differences is important for the conservation and management of highly commensal primate.

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ZOL 008

Distribution of The ABO Groups and Allelic Frequencies of Blood Donors in West Yangon University

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Abstract

Each year, a large number of individuals students in West Yangon University are deferred from donating blood. In this study period was 2018-2019 and collected total of 520 blood donors representing 161 males and 359 females contacted from West Yangon University were assessed and calculated the allelic frequencies of *I*^{A}, *I*^{B} *and 'i'*. Percentage of blood groups A was 24.62%, three of blood groups B, AB and O were 31.35%, 8.65% and 35.38% respectively. Four types of blood donation methods were Whole blood Donation (Every 56 days for a total of 6 donations a year), Double Red cell Donation (Every 112 days for a total of 3 donation a year), Platelet Donation (Every 7 days and can gives up to 24 time a year) and Plasma Donation (Every 28 days and can give up to 12 times a year). In this study used Double Red cell Donation and population genetics calculated by Hardy-Weinberg law.

Keywords: *I*^{A}, *I*^{B}, *'i'*, ABO, Allelic, Double Red cell Donation, Hardy-Weinberg

Introduction

Blood groups were discovered in 1991 by an Austrian scientist named Karl Landsteiner. Before that, doctors thought all blood was the same, so many people were dying from blood transfusions. Now experts know that if you mix blood can clump, which may be fatal. That's because the person receiving the transfusion has antibodies that will actually fight the cells of the donor blood, causing a toxic reaction. In order for a blood transfusion to be safe and effective, it's important for the donor and the recipient to have blood types that go together Wikipedia, (1977). People with blood group A can safely get group A blood, and people with blood group B can receive group B blood. It's best when a donor and recipient are an exact match and their blood goes through a process called cross-matching. But the donor doesn't always need to have the exact same type of blood as the person receiving it. Their types just have to be compatible. Type O negative red blood cells are considered the safest to give to anyone in a life-threatening emergency or when there's a limited supply O negative blood cells don't have antibodies to A, B or Rh antigens Bhasin, (1996). People with O negative blood were once called " universal" red cell donors because it was through they could donate blood to anyone with any blood type. But now experts know there can even be risks with this type of blood. While everyone's blood is made up of the same basic parts, there's actually a lot of variety in the kinds of blood that exist. There are eight different blood types, and the type you have is determined by genes you inherit from your parents. Most people have about 4-6 liters of blood is made up of different kinds of cells that float in fluid called plasma. Your red blood cells deliver oxygen to the various tissues in your body and remove carbon dioxide. Your white blood cells destroy invaders and fight infection. Your plasma is a fluid made up of proteins and salts. What makes your blood different from someone else's is your unique combination of protein molecules, called antigens and antibodies. Antigens live on the surface of your red blood cells and Antibodies are in your plasma. The combination of antigens and antibodies in your blood is the basis of your blood type, Blood Type Test, WebMd.com. (2008). There are four major blood groups and eight different blood types. Doctors call this the ABO Blood Group System. The groups are based on whether or not you have two specific antigens A and B. Group A has A antigen and B antibody. Group B has the B antigen and the A antibody. Group AB has A and B antigens but neither A nor B antibodies. Group O doesn't Have A or B antigens but has both A and B antibodies. There's also a third kind of antigen called the Rh factor. You either have this antigen (meaning your blood type is "Rh^{+} or positive"), or you don't(meaning your blood type is "Rh^{-} or negative"). So from the four blood groups, there are eight blood types; A positive or A negative, B positive or B negative, AB positive or AB negative and O positive or O negative. Blood groups are inherited from both parents. The ABO blood types are controlled by a single gene with three types of alleles inferred from classical genetics *I*^{A}, *I*^{B} and *i*. The I designation stands for is agglutinogen another term for antigen (Wikipedia, 2016). The present study was conducted with the following objectives:

- to collect the ABO blood groups of blood donor students in West Yangon University
- to calculate the phenotypic and genotypic frequency of *I*^{A}, *I*^{B} and *i*
- to record the pure blood groups A,B,O and AB in blood donor students, West Yangon University

Materials and Methods

Study area and study site

The study area was West Yangon University in Htan –tapin Township, Yangon Division Figure 1. The study site was situated between 16° 56′ 48.62′ N and 96° 00′ 48.13′ in Htantapin Township, Yangon Region. This result was carried out at National Blood Center at Yangon Division.

Study period

The study period was lasted from February 2018 to July 2019.

Methods

Collection of blood sample

Blood samples were collected from study site in blood bag (kit within 24 hours). The blood sample were transported to blood bank, at National Blood Center.

Materials

Apparatus, equipments, chemicals and reagents used in this work listed blood lancets and lancing device, plastic bottle kit, blood container kit, test tubes, small beaker haemoglobin test,

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blood shaker , spirit pad or Alcohol pad and fork set.

Questionary assay

Step 1.To donor fill in form
Step 2. To donor registration in computer
Step 3. Pre-donation information
Step 4. Donor interview and pre-donation counseling
Step 5. Donor health and risk assessment
Step 6. Acceptance for blood donation
Step 7. Examine medical checking by doctor
Step 8. Haemoglobin testing
Step 9. Carry the blood bag
Step 10. Picking up blood to donor
Step 11. Support to nutrients

Blood donor person was eighteen age above and male has body weight 110Lbs above and female has 100Lbs above body weight.

Blood and Blood components

1. Red Cell Components
   1.1 Whole Blood
   1.2 Red Cell Suspended In Optimal Additive Solutions
   1.3 Red Cell Packs for Paedistric Use
   1.4 Leukocyte-poor red cells
   1.5 Washed Red Cells
   1.6 Frozen-thawed Deglycerolized Red Cells
2. Platelet Concentrates
   2.1 Random Donor Platelet
   2.2 Single Donor Platelet
3. Granulocytes
4. CMV sero-negative Blood Component
5. Irradiated Blood Component
6. Fresh Frozen Plasma
7. Cryoprecipitate
8. factor Concentrate
9. DD avp

Gene frequency calculation

The gene frequencies of ABO blood groups were calculated by Bernstein's Formula (1925).

$$p = 1 - \sqrt{B^- / +O^-}$$
$$q = 1 - \sqrt{A^- + O^-}$$
$$r = \sqrt{O^-}$$

p = frequency of allelic I^A
q = Frequency of allelic I^B
r = Frequency of allelic i

Hardy-weinberg-equilibrium for 3 allele (1908)

The five conditions for nonevolving populations are rarely met in nature:

- No mutayions
- Random mating
- No natural selection
- Extremely large population size
- No gene flow

$$p^2 + 2pq + q^2 = 1$$

- Phenotype A → Genotypic frequency = $p^2 + 2pr = A$
- Phenotype B →Genotypic frequency = $q2 + 2qr = B$
- Phenotype AB →Genotypic frequency= $2pq$
- Phenotype O →Genotypic frequency= $r^2 = O$

Allele frequency of Rh blood group were estimated as ;

D = 1-d (Rh$^+$ = D, Rh$^-$ =d) alleles where $d = \sqrt{d^-}$

Results

Total collected blood samples were 520 RVCs blood donor students in West Yangon University. Out of which males 165 and females 355 were collected blood samples. Among the males were First year students 38, Second years students 44, Third years and first year honours students 35, Fourth and second years honours students 32, Thied years honours and Qualifying students five, Master 1and 2 students two, and Other (Teacher and Graduated) three. Females were collected First year students79,Second years students 86, Third years and first year honours students72, Fourth years and second years honours students76, Third honours and Qualifying students 18, Master 1 and 2 students 12, and Others (Teachers and Graduated) 18 (Table 1)and (Figure 2). Blood groups were recorded A type 128 students, B type was 163 students, O type was 184 students and O type was 45 students (Table 2) and (Figure 3). Frequency of ABO blood groups were 0.246%, in A, 0.314 %in B, 0.354% in O and 0.087% in AB (Table 3). Blood donor groups separated from age of 18-19, 20-21, 22-23 and 24 above were 247,215, 37 and 21 respectively (Table 3).

Phenotypic frequency of ABO blood groups

Among the total of 520 blood donor students of phenotypic frequency of A, B, O and AB were 128,163,184, and 45 individuals, in order of O>B>A>AB. Serially first year to others blood groups compared A, B, O, AB were (O = B>A>AB), (O>B>A>AB), (B>O>A>AB) (O>A>B>AB), (O =A>B>AB), (B>O>A), O>B =AB>A respectively (Table 3 and Figure 4).

Times of blood donation

Among the total of blood donation times were out of three times and above the ABO groups in table 4. **Genotypic frequency of ABO blood groups**

Genotypic frequency of blood groups I^A, I^B and i were found in Table3 and Figure 5.

Table 1. Blood groups of RCVs donors from WYU, Htantabin Township Redcross Association in 2019

Blood group	1st	2nd	3rd +H1	4th +H2	H3+Q	MSc 1+2	Others	Total frequency
A	22	33	23	36	8	3	3	0.246
B	40	37	40	31	5	6	4	0.314
O	40	44	39	38	8	5	10	0.354
AB	16	16	5	3	2	-	4	0.087
Total	117	130	107	108	23	14	21	1.00

Others = Graduate and teachers

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Table 2. Collected of blood groups from Htantabin Township RVCs Red-cross Association in gender

Blood groups	No. of males	%	No. of female	%	Total	%
Group A	36	28.13	92	71.88	128	24.62
Group B	48	29.45	115	70.55	163	31.35
Group O	60	32.61	129	70.11	184	35.38
Group AB	15	33.33	30	66.67	45	8.65
Total	159	100	361	100	520	100

RCVs = Red-cross Volunteer Association Students

Figure 3. Collected blood group percentage of gender

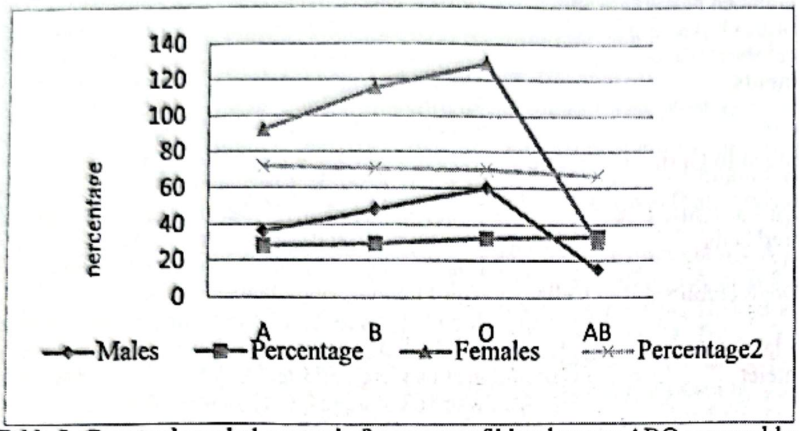

Table 3. Genotypic and phenotypic frequency of blood group ABO among blood donor members according to age

Age frequency	Genotypic frequency							Phenotypic frequency					Total
	A		B		O	AB	Total	A	B	O	AB	Total	
	I^AI^A	I^Ai	I^BI^B	I^Bi	ii	I^AI^B							
18-19	0.036	0.22	0.063	0.29	0.34	0.10	1.00	0.223	0.312	0.340	0.126	1.00	247
20-21	0.05	0.22	0.05	0.26	0.36	0.08	1.00	0.274	0.330	0.037	0.037	1.00	215
22-23	0.04	0.24	0.04	0.24	0.36	0.08	1.00	0.297	0.297	0.054	0.054	1.00	37
24-above	0.01	0.15	0.04	0.28	0.48	0.04	1.00	0.143	0.190	0.190	0.190	1.00	21
Total													520

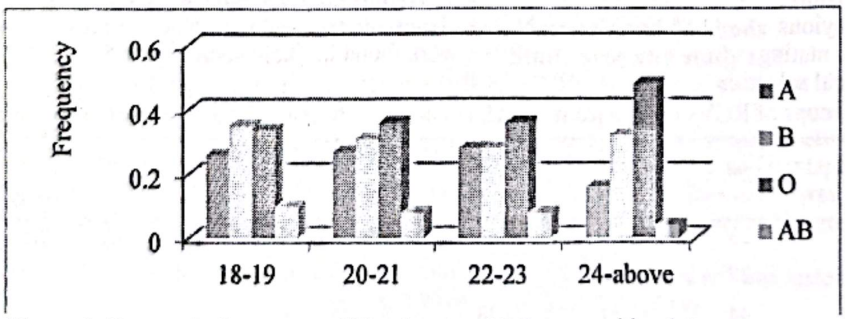

Figure 4. Genotypic frequency of blood group ABO among blood donor members according to age

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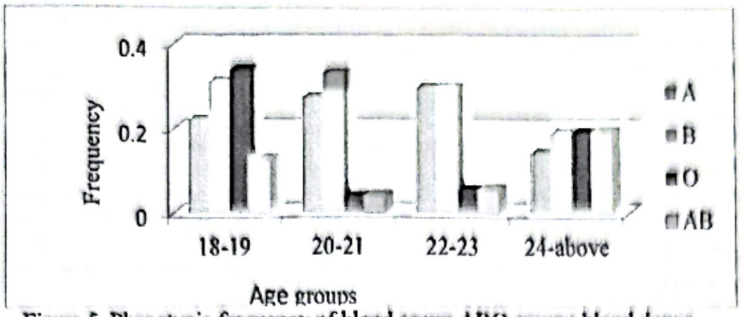

Figure 5. Phenotypic frequency of blood group ABO among blood donor members according to age

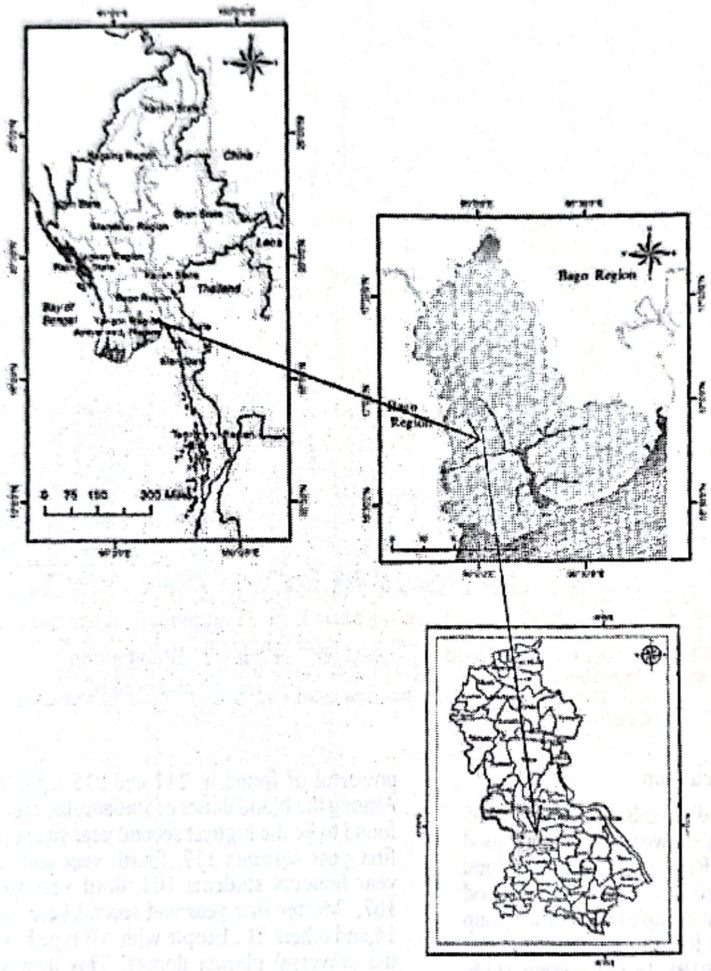

Figure 1. Map of study area of West Yangon University, Htantapin Township

(Source Department of Geography West Yangon University)

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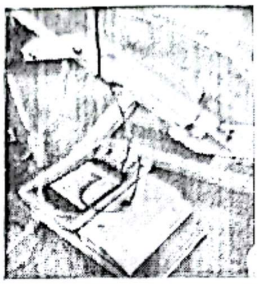
Table 4. Total count of blood donor above three times of RCVs Donors in Htantapin Township (WYU)

Sr. No	Blood groups	3 times		4 times		5 times		6 times		7 times		8 times		9 times		10 times	
		M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F
1	A	5	6	3	5	-	2	-	2	-	1	-	-	1	-	-	1
2	B	3	9	2	4	-	1	-	1	-	1	-	1	-	-	-	-
3	O	7	11	5	4	1	2	-	-	-	-	-	-	-	-	-	-
4	AB	2	3	-	-	-	1	-	-	-	-	-	-	-	-	-	-

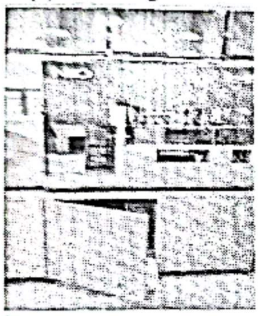
M = male, F = female

(a) Blood bag and test

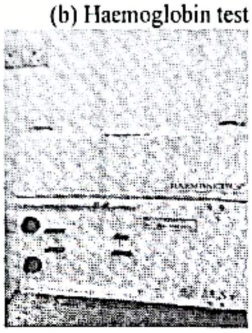
(b) Haemoglobin test



(c) Shaker



(e) Platelet blood donor blood container



(f) Blood bag container

Figure 2. Blood group testing and used of

Discussion

A total of 520 individuals belonging to165 males and 355 females were collected blood ABO types in Youth Red-cross volunteer blood donor Association in 2019. Percentage of blood in the world the highest group of blood was group O^+ 40 percent and the lowest group was AB one percent Pharm. Dr.(2019). In the present study the distribution of ABO blood groups among the highest was group O 35.38%, second highest was group B 31.35%, third group was A, 24.62% and the last group was AB, 8.65% . In order to O>B>A>AB in the student population (blood donor). Regarded to distribution of allele frequencies among the students, allele *i* was observed to the highest frequency 0.48 and the lowest in I^A 0.01. Parakask, (2013) reported that blood group B is very common in population of Asia descent, but rare in population of Wastern European decent. In the present study the ABO blood group phenotype frequencies of other blood groups most common in group B found in females 119 individuals.

Now the present study the young active students blood donor were age 18 to 21 and more powerful of found in 247 and 215 respectively. Among the blood donor of students the individual found to be the highest second year students 130, first year students 117, fourth year and second year honours students 108, third year students 107, Master first year and second year students 14,and others 21 . People with AB type blood are the universal plasma donors. This means their plasma can be transfused into any patient, regardless of the recipients' blood type Harrison (2007). In the present study found out AB type blood are rarely other than the O type. Moreover, type O is also the universal donor because this type O^-blood lack of antigen A<Band D, so they can give blood to any blood type but they can accept only O^- blood transfusion Chandra (2012). In the present study universal donor type O is more than other types. Donation methods are four kinds whole blood donation, Double red cell Donation, Platelet Donation and Plasma Donation. People with the following blood types should consider donating Double Red Blood Cells, O^-,O^+, A^-, A^+, B^-, every 112 days for a total of 3 donations a year. In the present study was used Double Red Cells method so collected Ten time, Nine time, Eight time, Seven time of

students age were under 24. Red blood cells(RBC) the most frequently used component, have a shelf life of 35-42 days at refrigerated temperatures Lockwood (2003) and Transfusion handbook (2008). People with the following blood types should consider donating Platelets are A^+, B^+, AB^-, AB^+, and O^+. You can donate platelets every 7 days and can give up to 24 times a year. If you have donated whole blood, you must wait at least 7 days before you can donate platelets In routine circumstances, the best days to donate platelets are Friday, Saturday, Sunday and Monday to meet hospital needs. In times of critical need, the best day to donate platelets is today Daniel (1975). Donation frequency were Whole Blood donors may donate every 56 days, Plasma donors may donate a maximum of 24 times per year. Other specialized donations are subject to other rules. At civil hospital Blood Bank Usually internal of Three Months is recommended. In Myanmar, National Blood band is recommended interval of Three Months. Prior to blood donation transfusion following tests are required for knowledge shearing PS for Malarial parasite, VDRL for Syphilis, ELISA for HIV, Hepatitis B virus and Hepatitis C virus Wikipedia (2010). In the present study collected of blood donor students individuals were pure blood selection tested return list recorded.

Conclusion

Collected blood sample were 520 in RCVs donor in West Yangon University, 2018-2019. Out of 165 were males and 355 were females, the highest blood group was O and the lowest was AB in students individuals. Allelic frequency (*i*) was higher than other types of blood and gender percentage were females than the males. Phenotypic frequency O>B>A>AB were found in study. Genotypic frequency I^A, I^B, *i* were blood group A, B and O etc. This study collected and gather of pure blood needed for every day every time donation of blood whose can help and care for fulfillment of blood transfusion needed patients.

Acknowledgements

We would like to express deep sense of gratitude to Rector Dr.Aung Win, Myitkyina University, Dr. Tin Maung Tun, West Yangon University and Prorectors Dr. Soe Myint Aye, Dr.Aye Aye Ko, Myitkyina University for their kind provision of the research facilities. We also wish to express our profound gratitude to Dr. Thida Oo, Professor and Head of Zoology Department, West Yangon University for their encouragement.

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ZOL 010

Seasonal Occurrence of Aquatic Birds Species in Moeyungyi Wetland Wildlife Sanctuary, Bago Region, Myanmar

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Abstract

Moeyungyi Wetland Wildlife Sanctuary was chosen as the study area which is located in Pyinbongyi Village in Bago Region. It is the first Ramsar site of Myanmar which is 112 kilometers away from the north of Yangon. The Moeyungyi wetland area is a freshwater lake and parts of biological and ecological role to the resident and migratory bird species. The study period lasted from June, 2017 to May, 2019. Fifty nine aquatic bird species of 43genera under 16 families belonging to seven orders were recorded during the study period. Aquatic birds were divided into migratory birds and residential birds in the Moeyungyi Wetland Wildlife Sanctuary. Out of 59 aquatic bird species, 33 migratory species of birds (56%) and 26residential species of birds (44%) were recorded. The population diversity index was calculated using by Shannon- Weiner and Simpson's diversity index. The most abundant bird species were recorded from November to February when the most migratory bird species are present with February providing the most ideal conditions. The Moeyungyi Wetland is a vital shelter for not only resident for their livelihood but also migratory water birds for their habitats. Large assemblies of migratory and resident water birds can be seen around the Moeyungyi Wetland area

Keywords: Moeyungyi Wetland Wildlife Sanctuary, migratory birds, residential birds, species diversity

Introduction

Aquatic birds are large and varied group of birds. It inhabits or depends on water bodies or wetland areas. Aquatic environments provide critical habitat to a wide variety of bird species. Some aquatic birds divide their time between aquatic and terrestrial environments, while others spend most of their lives in water, returning to land only to breed. Aquatic birds are good indicators of the health of the habitats they occupy, and conservation efforts on their behalf have benefited ecosystems as well as other species. Recreational bird watching is an important part of the ecotourism industry (Wikipedia, 2019).

Many species of aquatic bird migrate. Many water birds undertake annual long distance migrations. Some bird species undertake shorter migrations, travelling only as far as is required to avoid bad weather or obtain food. Several years may pass between visits to an area by a particular species. The most common migratory pattern involves flying north in the spring to breed in the temperate and returning in the autumn to wintering grounds in warmer regions to the south. Non-migratory birds are said to be resident (Wikipedia, 2019).

Wetlands are important natural resources in Myanmar. They are natural heritages of the country and play a vital role in the economy of Myanmar. The wetlands of Myanmar are mangroves, swamp forests, lakes and marshes.

The Moeyungyi is a well-known place wetland as well as important bird areas in Myanmar. The key representative takes in Myanmar need to be preserved to maintain the biological diversity of wetland ecosystem. The Moeyungyi Wetland area is a permanent freshwater lake and plays hydrological, biological and ecological role to the resident and migratory water birds.

Therefore, this research was aimed to study the seasonal abundance of aquatic birds in Moeyungyi Wetland area as the focus on following objectives;

- to record the aquatic bird species and estimate relative abundance from the study area
- to calculate the species richness, diversity index and evenness for recording the aquatic birds during the study period
- to obtain the information on an annual basis of migratory and residentiary bird species in the study area

Materials and Methods

Study area

Moeyungyi Wetland is situated in Bago Region. The Wetland has been notified as a wildlife sanctuary since 1988. Moeyungyi is a vital shelter for both resident and migratory waterbirds. The Moeyungyi Wetland covers almost 104 square kilometers and designated as a first Ramsar site in Myanmar since 2004. It is situated between 17° 30′to 17° 36′ North latitudes and 95° 33′ to 96° 39′East longitudes, near Pyinpongyi village. The area is located 10 meters above sea level. The average minimum temperature of study area is 22.62°C and the average maximum temperature is 33.01°C. The average humidity is 78.3% and the rainfall from 0mm to 1125mm (Wikipedia, 2019) (Fig. 1).

Study period

The study period lasted from June 2017 to May 2019. The study period was divided into hot season (March to June), wet season (July to October) and cool seasons (November to February).

Specimen collection

Point count method was used to obtain bird population (Bibby *et.al.*, 1992). The study area was divided into ten sampling points. Survey was undertaken early in the morning from 6:30 am to 10:30 am and in the evening from 4:00pm to 6:00pm. At each point, visual and hearing observations were recorded for ten minutes around 50m radius. Field survey was regularly performed by month with the help of binocular.

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Identification

The recorded birds were identified by Smythies (1953) and Robson (2000).

Data analysis

Richness Index

Margalef's index was used as a simple measure of species richness (Margalef, 1958).

$d = (S-1)/\ln N$

where, d = Margalef's index

S = total number of species

N = total number of individuals

Ln = natural Logarithm

The lower the index, the greater the richness

Shannon-Weiner Diversity index (H')

The diversity index was calculated by using the Shannon-Weiner Diversity index (1949).

$H' = -\Sigma PiLnPi$ where, H' = Shannon-Weiner Diversity index

$Pi = \frac{ni}{N}$

Pi = the proportion of total abundance represented by ln species

Σ = Sum

Ln = natural logarithm

ni = number of individuals of each species

N = Total number of individuals of all species

The value of Shannon-Weiner Diversity index usually falls between 1.5 and 3.5, only rarely it surpasses 4.5. A value near 4.6 would indicate that the numbers of individuals are evenly distributed between all the species (Bibi *et. al.*, 2013).

Simpson's Diversity index (D)

Simpson's Diversity index is a measure of diversity which takes into account both richness and evenness of species (Simpson, 1949).

$$D = \Sigma \frac{n_i(n_i-1)}{N_i(N_i-1)} \quad \text{(or)} \quad D = \Sigma Pi^2$$

Where, D = Simpson's Diversity index

n_i= total number of individuals of a particular species

N = total number of individuals of all species

The value of D ranges between 0 and 1. With this index, 0 represents infinite diversity and 1, no diversity. That is, the bigger the value of D, the lower diversity.

Evennness

Evenness is a measure of how different the abundances of the species in a community are from each other (Pielou, 1966).

J' (or) E = H'/Ln S

H' = Shannon-Weiner Diversity index

Ln = natural logarithm

S = total number of species

Ranges from zero to one, with zero signifying no evenness and one, a complete evenness.

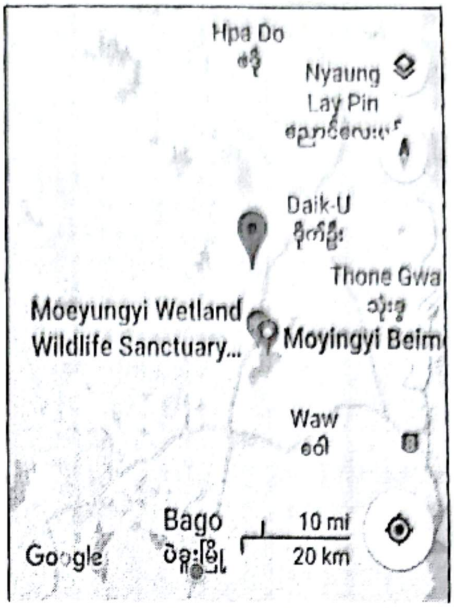

Fig.1 Map of the study area
(Source: Google Earth)

Results

Species composition of recorded aquatic bird species during the study period

A total of 59 aquatic bird species of 43genera under 16 families belonging to seven orders were recorded during the study period. In 2017-18, 53 species and 37 genera while 58 species and 42 genera in 2018-19 were recorded. Of these seven orders, Charadriiformes was the highest composition of bird species (37% each) followed by Pelecaniformes (19%) and Suliformes and Gruiformes (13%). The order Podicipediformes, Anseriformes and Ciconiiformes were the least (6% each) Fig. (2). Among recorded bird species, 56% of migratory bird species and 44% of residential bird species were examined in Figure 3.

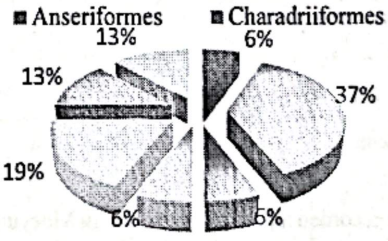

Fig.2 Percentage of aquatic bird species composition by orders from the study area

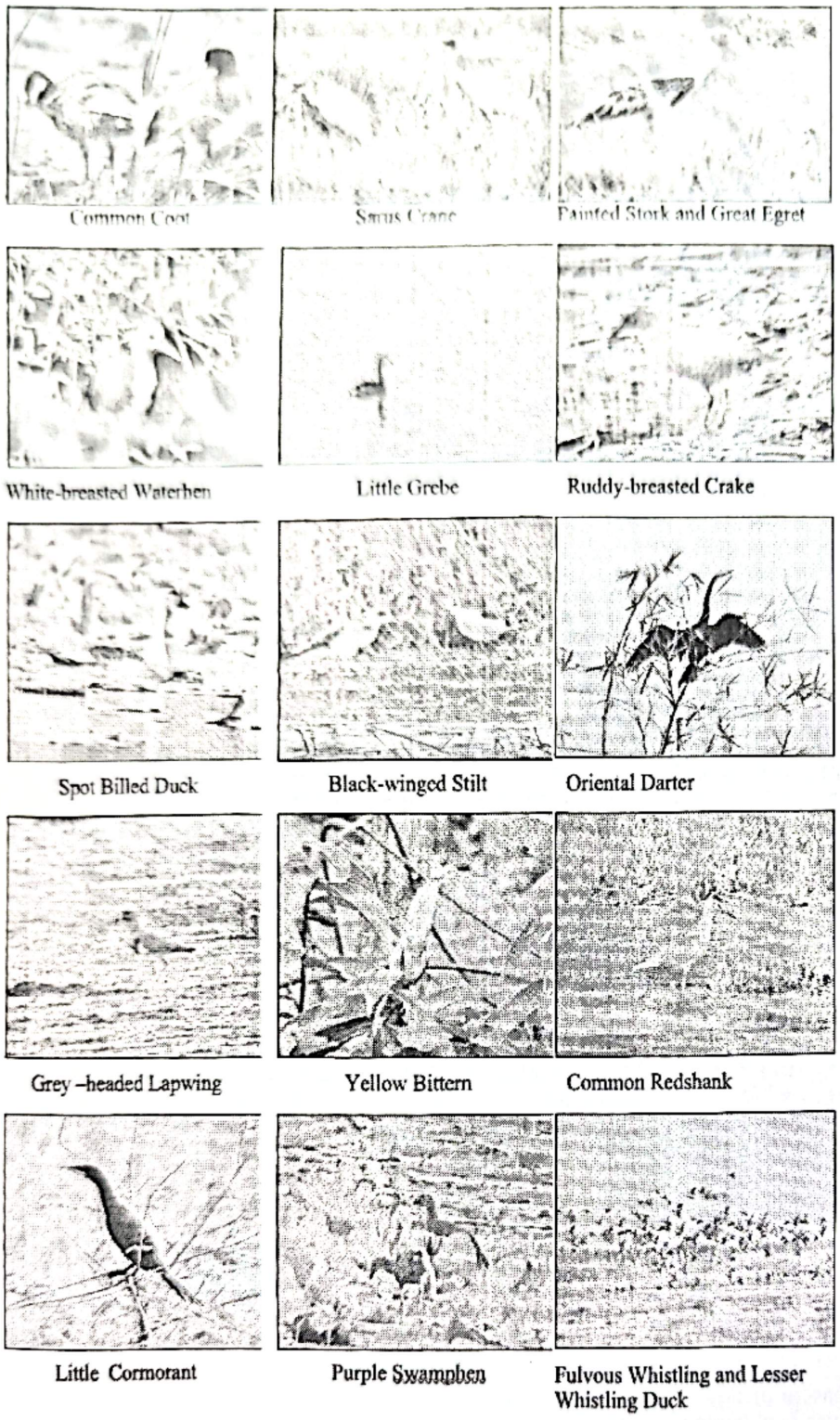

Plate.1 Some recorded aquatic bird species in Moeyungyi Wetland Wildlife Sanctuary

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Table.1 Systematic position of recorded aquatic bird species during the study period (According to Smythies (1953) and Robson(2000)

No.	Order	Family	Genus	Species	Common Name	Myanmar Name
1	Anseriformes	Anatidae	*Anas* Linnaeus, 1758	*A. querquedula*(Linnaeus, 1758)	Garganey	Don
2				*A. acuta* Linnaeus, 1758	Northern Pintail	BaeYit
3				*A. poecilorhyncha* Forster, 1781	Spot-billed Duck	Taw Wan Bei
4			*Sarkidiornis* Eyton, 1838	*S. sylvicola* (von Ihering, H. and von Ihering, R., 1907)	Comb Duck	Bae Goungkyar
5			*Dendrocygna* Swainson, 1837	*D.bicolor*(Vieillot, 1816)	Fulvous Whistling Duck	SitsaliGyi
6				*D. javanica* (Horsfield, 1821)	Lesser Whistling Duck	Sitsali
7			*Chenonetta* Brandt, 1836	*C. jubata*(Latham, 1801)	Maned Duck	Nil
8			*Nettapus* Brandt,1836	*N. coromandelianus*Gmelin, 1789	Cotton Pygmy Goose	Karakat
9			*Tadorna*Boie, 1822	*T. ferruginea* (Pallas, 1764)	Ruddy Shelduck	Hintha
10	Charadriiformes	Recurvirostridae	*Himantopus* Brisson, 1760	*H. himantopus* (Linnaeus, 1758)	Black- winged Stilt	Doung Lan Chayhtout
11				*H. leucocephalus* Gould, 1837	White- headed Stilt	Doung Lan Chayhtout
12		Jacanidae	*Hydrophasianus* Wagler, 1832	*H. chirugus* (Scopoli, 1786)	Pheasant-tailed Jacana	Kyar Phat Nin
13			*Metopidius* Wagler, 1832	*M. indicus* (Latham, 1790)	Bronze-winged Jacana	Kyar Phat Nin
14		Scolopacidae	*Gallinago* Brisson, 1760	*G. gallinago* (Linnaeus, 1758)	Common Snipe	Snipe
15			*Tringa* Linnaeus, 1758	*T. ochropus* Linnaeus, 1758	Green Sandpiper	Yay Nyaunt
16				*T. glareola* (Linnaeus, 1758)	Wood Sandpiper	Yay Nyaunt
17				*T. stagnatilis* (Bechstein, 1803)	Marsh Sandpiper	Yay Nyaunt
18			*Actitis* Illiger, 1811	*A. hypoleucos*(Linnaeus, 1758)	Common Sandpiper	Yay Nyaunt
19			*Calidris* Merrem,1804	*C. subminuta*Middendorff, 1853	Long-toed Stint	Chay Ni Kalay
20				*C.temminckii*(Leister, 1812)	Temminck's Stint	Nil
21			*Limosa* Brisson, 1760	*L. limosa*(Linnaeus, 1758)	Black Tailed Godwit	Nil
22			*Tringa* Linnaeus, 1758	*T. tetanus* (Linnaeus, 1758)	Common Redshank	Nil
23		Charadriidae	*Vanellus* Brisson, 1760	*V. indicus* (Boddaert, 1783)	Red-wattle Lapwing	Tit TiTu
24				*V. cinereus* (Blyth, 1842)	Grey Headed Lapwing	Tit TiTu
25			*Pluvialis* Brisson, 1760	*P. fulva* (Gmelin, 1789)	Pacific Golden Plover	TalineKhaung
26			*Charadrius* Linnaeus, 1758	*C. dubius* Scopoli, 1786	Little Ringed Plover	TalineKhaung
27		Glareolidae	*Glareola* Brisson, 1760	*G. maldivarum* Forster, 1796	Oriental Pratincole	Thoung Tin Hgnet
28		Laridae	*Childonias* Rafinesque, 1822	*C. hybrida* (Pallas, 1811)	Whiskered Tern	MyitTway
29				*C. leucopterus* (Temminck, 1815)	White-winged Tern	MyitTway
30			*Sterna* Linnaeus, 1758	*S. hirundo* Linnaeus, 1758	Common Tern	MyitTway
31				*S. albifrons* (Pallas, 1764)	Little Tern	MyitTway

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continued

No.	Order	Family	Genus	Species	Common Name	Myanmar Name
32	Podicipediformes	Podicipedidae	*Tachybaptus* Reichenbach, 1853	*T. ruficollis* (Pallas, 1764)	Little Grebe	Ta SeiHmok
33	Ciconiiformes	Ciconiidae	*Mycteria* Linnaeus, 1758	*M.leucocephala* (Pennant, 1769)	Painted Stork	HgnetKyar
34			*Anastomus* Bonnaterre, 1791	*A. oscitans* (Boddaert, 1783)	Asian Openbill	Khayu Toke
35	Pelecaniformes	Threskiornithidae	*Threskiornis* Gray, 1842	*T. melanocephalus* (Latham, 1790)	Black-headed Ibis	KhayuSokeKhaung Mae
36			*Plegadis* Kaup. 1829	*P. falcinellus* Linnaeus, 1766	Glossy Ibis	KhayuSoke
37		Ardeidae	*Ixobrychus* Billberg, 1828	*I. sinensis* (Gmelin, 1789)	Yellow Bittern	SattByaing
38				*I. cinnamomeus* (Gmelin, 1789)	Cinnamon Bittern	SattByaing
39				*I. flavicollis* (Latham, 1790)	Black Bittern	SattByaing
40			*Nycticorax* Forster, 1819	*N. nycticorax* (Linnaeus, 1758)	Black-crowned Night Heron	Lin Wat
41			*Ardeola* Boie, 1822	*A. bacchus* (Bonaparte, 1855)	Chinese Pond Heron	Byaing Auk
42				*A. grayii* (Sykes, 1832)	Indian Pond Heron	Byaing Auk
43			*Ardea* Linnaeus, 1758	*A. cinerea* Linnaeus, 1758	Grey Heron	Nga Hit Mwe
44				*A. purpurea* (Linnaeus, 1758)	Purple Heron	Nga Hit
45				*A. alba* Linnaeus, 1758	Great Egret	Byaing Ngan
46				*A. intermedia* Wagler, 1827	Intermediate Egret	ThayawatiByaing
47			*Bubulcus* Bonaparte, 1855	*B. ibis* (Linnaeus, 1758)	Cattle Egret	KywwKyaungByaing
48		Pelecanidae	*Egretta* Forster, 1817	*E. garzetta* (Linnaeus, 1766)	Little Egret	WaythaliByaing
49			*Pelecanus* Linnaeus, 1758	*P. philippensis*Gmelin, 1789	Spot-billed Pelican	Wanpo
50	Suliformes	Phalacrocoracidae	*Microcarbo* Bonaparte, 1856	*M. niger* (Vieillot, 1817)	Little Cormorant	Aw Yaw
51		Anhnigidae	*Anhinga* Brisson, 1760	*A. melanogaster*(Pennant, 1769)	Oriental Darter	Au Pan
52	Gruiformes	Rallidae	*Gallinula* Brisson, 1760	*G. chloropus* (Linnaeus, 1758)	Common Moorhen	Yae Kyat
53			*Porphyrio* Brisson, 1760	*P. porphyrio* (Linnaeus, 1758)	Purple Swamphen	Mei Nyo
54			*Gallicrex* Blyth, 1852	*G. cinerea* (Gmelin, 1789)	Watercock	Boung Toke
55			*Fulica* Linnaeus, 1758	*F. atra* Linnaeus, 1758	Common Coot	Yae Kyat Don
56			*Amauronis* Reichenbach, 1853	*A. phoenicurus* Pennant, 1769	White-breasted waterhen	Yay Kyat Yin Phyu
57			*Porzana* Vieillot, 1816	*P. fusca*(Linnaeus, 1766)	Ruddy- breasted Crake	Yay Ngone
58		Gruidae	*Antigone* Reichenbach, 1853	*A. antigone* (Linnaeus, 1758)	Sarus Crane	KyoKyar
59			*Chroicocephalus* Eyton, 1836	*C. brunnicephalus* (Jerdon, 1840)	Brown-headed Gull	Zin Yaw

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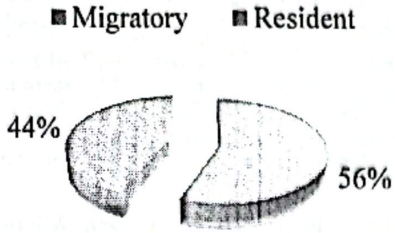

Fig. 3 Percentage of migratory and resident aquatic bird species

Seasonal and monthly occurrence of recorded birds during the study period

The maximum species were found in February and the minimum species were in June, July and August during the study period (Fig.4).The bird population was higher in 2017-18 than 2018-19 while the number of bird species was lower in 2017-18 (Fig.5).Bird populations were related to seasons that the physical parameters such as rainfall, temperature and humidity (Figs.7 and 8).The highest number of aquatic bird species and population was recorded in cool season, followed by hot season and the least in wet season (Fig.6).

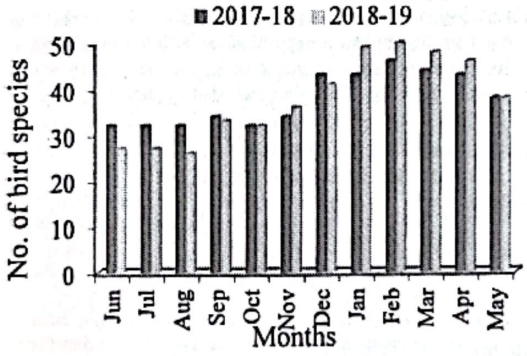

Fig.4 Monthly recorded bird species during the study period

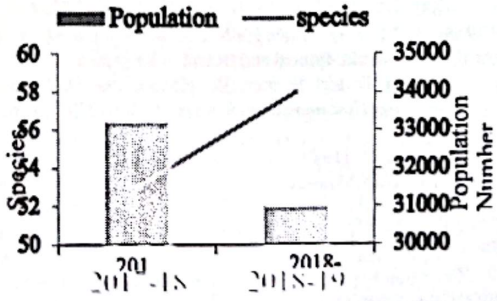

Fig.5 Recorded bird species and population throughout the study period

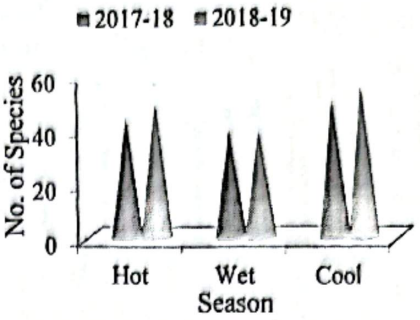

Fig.6 Seasonal recorded bird species throughout the study period

Different diversity index of recorded bird species

Different diversity index of recorded bird species were calculated as per standard method. The highest value of Shannon-Weiner diversity index (H′) was observed in cool season as 2.54, 2.64 followed by hot season as 2.47, 2.57 and the lowest was wet season as 2.05 in 2017-18 and 2018-19 respectively. The maximum value of Simpson's Dominance index (D) was recorded in cool season as 0.11,0.10 followed by hot season as 0.12, 0.11 and 0.27, 0.26 in wet season in 2017-18 and 2018-19 respectively. Species richness index (d) was found to be the highest in cool season as 13.13, 14.29 followed by hot season as 13.83, 14.65 and 14.30, 15.67 in wet season in 2017-18 and 2018-19 respectively. The maximum value of evenness (J′) revealed in cool season as 0.64, 0.65 and followed by hot season as 0.62, 0.63 and 0.52, 0.51in wet season in 2017-18 and 2018-19 respectively.

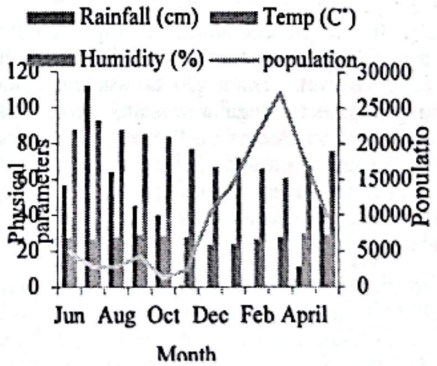

Fig. 7 Relationship between physical parameters and aquatic bird population in 2017-18

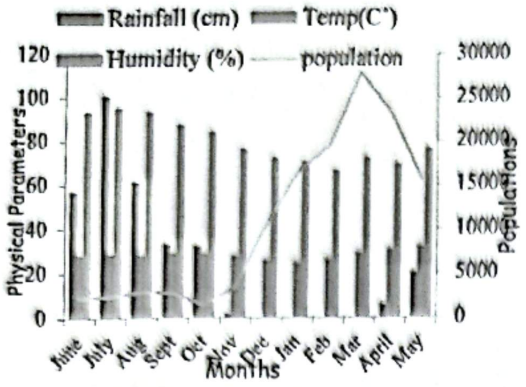

Fig. 8 Relationship between physical parameters and aquatic bird population in 2018-19

Conservation status

As far as conservation status (IUCN, 2018) is concerned the recorded species are categorized into Least concerned (LC) 54 species (91%), four species; *M. Leucocephala* (Painted Stork), *T. melanocephalus* (Black-headed Ibis), *P. philippensis* (Spot-billed Pelican) and *A. melanogaster* (Oriental Darter) are Near threatened (NT) (7%), *A. antigone* (Sarus Crane) (2%) as an Endangered species.

Discussion

In the present study, 59 aquatic bird species of 43genera under 16 families belonging to seven orders were recorded during the study period. Among them 53 species in 2017-18 and 58 species in 2018-19 were recorded. Out of recorded species *Fulica atra* (Common Coot) was not found in 2018-19. Due to the findings, *Chenonetta jubata* (Maned Duck), *Calidris subminuta*(Long-toed Stint), *Limosa limosa* (Black-tailed Godwit), *Amauronis phoenicurus* (White-breasted Waterhen) and *Porzana fusca*(Ruddy-breasted Crake)were only recorded in 2018-19.

In the present work, the highest number of aquatic birds was found in cool season while the least in wet season. It is assumed that bird migration is the regular seasonal movement, often north and south along a flyway between breeding and wintering grounds. Migratory birds are suitable habitat and even wintering sites for Moeyungyi Wetland Wildlife Sanctuary.

According to data, the highest number of bird species was recorded in February and population in March throughout the study period while the lowest bird species in the month of June, July, August and population in October. Migratory water birds annually visit the Moeyungyi lake from early November to the end of February (Wikipedia, 2019). It may be suggested that the favourable weather condition for nesting, breeding and better chance for availability of food source during these months.

With the respect of statistical analysis, the value of species richness index (d) was the greatest and the value of near complete evenness was in cool season, followed by hot season and wet season respectively. Therefore, the results confirmed that species richness were better in cool season. Similarly, the highest value of Shannon- Weiner Diversity index (H') and Simpson's Diversity index (D) was recorded in cool season followed by hot and wet seasons.

According to monthly recorded data, the results confirms that species richness (d), Diversity index (H' and D) and evenness (J') were more better in February than the rest throughout the study period.

In Moeyungyi Wetland Wildlife Sanctuary, 56% of migratory aquatic birds and 44% of residential birds were recorded during the study period. Therefore, migratory birds are coming to the wetland in winter annually. The survey programme observers and experts to collect exactly the numbers and species migrating to the wetland each year.

Conclusion

Wetland areas are important to Myanmar and are essential for agriculture in the country and cooperation is needed to conserve the wetland areas effectively to reduce climate change and environmental disasters which are being faced all over the world improve the economic lives of the people. Therefore, the conserving wetlands are very important.

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Biology of *Clavigralla gibbosa* (Spinola, 1837) and *Riptortus serripes* (Febricus, 1775) On Pigeonpea, *Cajanus cajan* L. in Htanaung Win Village, Monywa Township

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Abstract

Biology of *Clavigralla gibbosa* (tur pod bug) and *Riptortus serripes* (large brown bean bug) was carried out from July 2018 to 2019 October at Htanaung Win village, Monywa Township. In this study, life cycles of some insect pests: *Clavigralla gibbosa* and *Riptortus serripes* were observed in the laboratory conditions at 25±1 HC. The mating pairs of these insect pest species were collected from the pigeonpea fields and reared in the plastic boxes. The pigeonpea pods were supplied for the adults and nymphal instars of these pest species. The life cycles of *Clavigralla gibbosa* and *Riptortus serripes* were found the different stages: eggs, first to fifth nymphal stages and then adults. The incubation period of the two bugs was 8.55 days and 6.45 days, respectively. The total nymphal duration of these bugs was 31.2 days and 21.35 days respectively. The whole complete life cycle of *Clavigralla gibbosa* lasted about 35-45 days and *Riptortus serripes* took about 25-31 days.

Keywords: *Clavigralla gibbosa*, *Riptortus serripes*, Pigeonpea, Biology

Introduction

Insects are divided into groups according to the way they change during their development. These changes are called metamorphosis. Pests of field crops undergo either simple or complete metamorphosis (Gullan and Cranston, 2010).

Cajanus cajan commonly known as pigeonpea. It is an important legume crop belonging to the Fabaceae family. It is an erect and short-lived perennial shrub commonly grown as an annual. It is cultivated an almost 4 million hectares worldwide. It is the most extensively cultivated legume in India, Myanmar, Nepal, East Africa, some parts of South and Central America and the Caribbean. It is mainly cultivated for its seeds which is consumed worldwide because they are nutritious, have high protein content (21%) with high protein digestibility (68%) and high dietary fibers (Jaganathan and Liu, 2014).

Pigeonpea is locally known as pe-sin-ngon and is also widely cultivated in Myanmar. The young pest nymphs or larvae attack on the leaves, the flower buds, flowers and pods of pigeonpea. The larvae of insect pests bore the pods and feed on developing seeds, resulting in the direct yield loss. Gram pod borer (*Helicoverpa armigera*), plume moth (*Exelastis atomosa*), spotted pod borer (*Maruca vitrata*), tur pod bug (*Clavigralla gibbosa*), large brown bean bug (*Riptortus serripes*) and blister beetle (*Mylabris spp.*) are one of the most important constraints for low productivity of pigeonpea (Chitralekha *etal*., 2017). Chitralekha (2014) studied bionomics and behaviour of tur pod bug (*Clavigralla gibbosa* Spinola) on pigeonpea. Rana and Patel (2011) described biology of pigeonpea pod bug, *Clavigralla gibbosa* (Spinola) in India. Chitralekha *et al*. (2017) studied on biology of Tur Pods Bug, *Clavigralla gibbosa* Spinola on Pigeonpea Variety Manak, Haryana, India. Sucking pests feed by inserting their mouth parts into leaves, buds, pods or stems and sucking out the sap. The nymphs and adults of sucking insects suck sap from leaves, flowers and tender stem, but pods are most preferred. Damaged seeds are dark, shrivel and do not germinate. The use of low quality seeds germination will be poor, but also germinating seeds will be prone to pest attack (Jaganathan and Liu, 2014). By considering this, it is of importance to understand the life-history of some pest species.

Materials and Methods

Htanaung Win Village is located in Monywa Township, Sagaing Region (Figure 1). The study area was conducted in (0.5049) hectare pigeonpea field in the study area (Figure 2). An investigation of both insects was started from July 2018 to October 2019. The field trips were conducted at the study area in the evenings. The insects were identified following Pol, Belfied and Martin (2010), Crowson (2012) and Ranga Rao and Shanower (1999). The classification suggested by Borror, Triplehorn and Johson (1992) was used in the present study. The host plant was checked according to Kress, Defilipps, Earr and Yin Yin Kyi (2003). Ten pairs of adults of *Clavigralla gibbosa* and *Riptortus serripes* were collected from the study area and caged separately in pairs in plastic boxes (18×13×6.5cm). Fresh twigs with pods of pigeonpea were provided daily to the caged pairs of these bugs. The boxes were cleaned with water. The observation on number of eggs per female, incubation period, number of nymphal instars, nymphal period and life cycles of adults were recorded.

Figure 1 Location map of study area

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Results

The results on the biology of *Clavigralla gibbosa* and *Riptortus serripes* studied under laboratory condition from July 2018 to October 2019 have been summarized in Table 1, 2, 3, 4, 5 and 6.

In this study, the life cycles of the two pigeonpea bug pest species were studied and these insect pests were bred in the plastic boxes. From the study, five nymphal stages of *Clavigralla gibbosa* and *Riptortus serripes* were observed in their life cycles (Figure 3 and 4).

Life cycle of *Clavigralla gibbosa* on pigeonpea plant

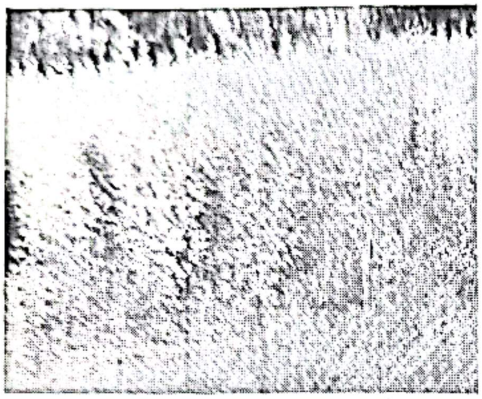

Figure 2 Sesame field of study area

Mating pairs

Adults mate in the evening and night. The mating duration lasted about 2 or 3 days (Figure 3 A).

Egg laying

After mating, about 6 to 10 days, the female laid a mass of eggs on the upper surface of the leaves, pods and around the stalk of the pigeonpea plants. Each female laid about 30-70 eggs (Figure 3 B).

Eggs

The freshly laid eggs glued to the surface of pods or leaves were creamy white in colour. After a few hours, eggs colour changed to light brown and ultimately brownish in colour. Eggs were more or less oval. The size of the egg is 0.5 -1 mm in length with the average of 0.78 ± 0.16 (Table 1). Incubation period was eight to nine days.

First instar nymph

The newly emerged nymph was delicate and creamy yellowish in colour. A "Y" shaped ecdysial line was prominent on the vertex. Abdomen was wedge shape and light yellowish in colour. Scoli were present on the 2nd, 3rd, 4th, 5th, 6th, and 7th abdominal segments. Two round shaped scent glands were present on the dorsal side of abdomen. The body length of this nymphal stage varied from 1.3 mm to 1.8 mm with the average of 1.55 ± 0.25 (Table 1). This nymphal stage lasted for four to six days (Figure 3 C).

Second instar nymph

The second instar nymphs resembled the first instar nymphs except in a pair of black robust spines on the either side of prothorax which become obvious in this instar. These spines were referred to thoracic spines. The body length varied from 2.6 -2.8 mm with the average of 2.70 ± 0.10 (Table 1). This nymphal stage lasted for four to six days (Figure 3 D).

Third instar nymph

The third instar nymphs were yellowish to reddish brown in colour with pinkish patches on dorsal surface of body. The thoracic spines become quite prominent in this instar. The size of scoli and scent gland increases. The body length varied from 3.9-4.2 mm with the average of 4.05 ± 0.15 (Table 1). These nymphal stages lasted for five to seven days (Figure 3 E).

Fourth instar nymph

The wing pads become prominent and grew up to the second abdominal segment. A "Y" shaped ecdysial line become clearer in this stage. The size of scoli becomes large in the instar. The body length of these nymphal stages was varied from 5.6-6.1 mm with average of 5.85 ± 0.25mm (Table 1). The nymphal stage lasted for five to seven days (Figure 3 F).

Fifth instar nymph

Fifth instar nymphs were as big as adults. Wing pads become prolong up to fourth abdominal segments. Last segment of leg (tarsus) become brownish. The distal potion of femur of hind legs was much swollen and bears two stout spines. The body length varied from 7.3-9.5 mm with the average of 8.40 ± 1.10 (Table 1). This nymphal stage lasted for nine to ten days (Figure 3 G).

Adult

The newly emerged adults were yellow to light salmon coloured but after 2-3 hours changed to brown. The distal portion of femur of hind legs was much swollen and bears two stout big spines in addition to some other spines. Five pair of spiracles were present dorsolaterally. The fore wings almost covered the entire abdominal length. The hind wings were dirty white and menbranous with yellowish brown costal margin. Scoli reduced completely in this stage. The body length varied from 13-15 mm with the average of 14.14 ± 0.77 (Table 1). The female was bigger than male (Figure 3 H).

All stages of the whole life cycle of *Clavigralla gibbosa* were lasted about 35-45 days under the temperature 25 HC to 35 HC (Table 1). Longevity of adult is about 16-24 days. The survival, mortality and larval development depend on the temperature (Table 3).

Life cycle of *Riptortus serripes* on pigeonpea plant

Mating pairs

Adults mate in the evening and night. The mating duration lasted about one or two days (Figure 4 A).

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Egg laying

After mating, about five to six days, the female laid the eggs on the upper surface of the leaves, pods and around the stalk of the pigeonpea plants. Individual female laid in clusters in the batches of 5 to 30 eggs per days. The eggs are laid singly about 15-120 eggs (Figure 4 B).

Eggs

The freshly laid eggs glued to the surface of pods or stems. Eggs were more or less ovoid in shape with a flat top and rounded base. The size of the egg is 1-1.5 mm in length with the average of 1.12 ± 0.16. They take about six to seven days to hatch (Figure 4 B).

First instar nymph

The newly emerged nymph was red brown colour. They look like the large ant. However they lack the very narrow 'waist' typical of ants. The head was more or less oval in shape and had two bulging compound eyes and long segmented antennae. The straight ecdysial line was prominent on the thorax. The body length of this nymphal stage varied from 4 mm to 5 mm with the average of 4.41 ± 0.27 (Table 2). This nymphal stage lasted for two to three days (Figure 4 C).

Second instar nymph

The second instar nymph resembled the first instar nymphs except in a pair of rounded secent glands on the surface of abdomen. The abdomen remains red-brown color. The white ecdysial line is prominent on mid-dorsally along the thorax. The body length varied from 6-7 mm with the average of 6.55 ± 0.28 (Table 2). This nymphal stage lasted for two to three days (Figure 4 D).

Third instar nymph

No other striking change except the appearance of a pair of wing pads on the thoracic region. The body color changed entirely the black color. Pro-thorax, Meso-thorax and Meta-thorax were distinct in this stage. The body length of these nymphal stages was varied from 8-9mm with average of 8.45 ± 0.34 (Table 2). The nymphal stage lasted for three to four days (Figure 4 E).

Fourth instar nymph

The newly moulted fourth instar nymphs were quite similar to the preceding instars except the wing pads become prominent and grew up to the first abdominal segment. The ecdysial line and secent glands reduced in this stage. The body color changed from the black to the brown. The body length of these nymphal stages was varied from 10-13 mm with average of 11.27 ± 0.99 mm (Table 2). The nymphal stage lasted for four to five days (Figure 4 F).

Fifth instar nymph

Fifth instar nymphs were as big as adults. The body colors were brown and dark brown patterns. Wing pads become prolong up to third abdominal segments. Instead of the crest on the pronotum the thoraxic spines became distinct in this stage. The scent glands disappear and the legs were more stouter. The distal potion of femur of hind legs was much swollen and bears two stout spines. The body length varied from 14-17 mm with the average of 15.50 ± 1.00 (Table 2). This nymphal stage lasted for eight to nine days (Figure 4 G).

Adult

The newly emerged adults were red-brown coloured but after 2-3 hours changed to brown. The bug has a shoulder spine on each side. The distal portion of femur of hind legs was much swollen and bears two stout big spines. The body length varied from 18-20 mm with the average of 18.63 ± 0.67 (Table 2), (Figure 4 H).

The life cycle lasted about 25-31 days under the temperature 25 to 35 HC (Table 2). Longevity of adult is about 10-18 days. The survival, mortality and larval development depend on the temperature (Table 4).

In this study, the comparison of the life cycles of *Clavigralla gibbosa* and *Riptortus serripes* bug species were observed that the differences in the duration of their life cycles and the size of eggs and nymphal stages between two species (Table 5 and 6).

Table 1 Length on the eggs, nymphs and adults stages of *Clavigralla gibbosa* (n = 10)

No	Stages	*Clavigralla gibbosa*		Temp HC
		Range (mm)	Mean ± SD	
1	Egg	0.50 - 1.00	0.78 ± 0.16	25-35
2	1st instar	1.30 - 1.80	1.55 ± 0.25	25-35
3	2nd instar	2.60 - 2.80	2.70 ± 0.10	25-35
4	3rd instar	3.90 - 4.20	4.05 ± 0.15	25-35
5	4th instar	5.60 - 6.10	5.85 ± 0.25	25-35
6	5th instar	7.30 - 9.50	8.40 ± 1.10	25-35
7	Adult	13.00 - 15.00	14.14 ± 0.77	25-35

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Table 2 Length on the eggs, nymphs and adults stages of *Riptortus serripes* (n = 10)

No	Stages	*Riptortus serripes*		Temp HC
		Range (mm)	Mean ± SD	
1	Egg	1 - 1.50	1.12 ± 0.16	25-35
2	1st instar	4 - 5.00	4.41 ± 0.27	25-35
3	2nd instar	6 - 7.00	6.55 ± 0.28	25-35
4	3rd instar	8 - 9.00	8.45 ± 0.34	25-35
5	4th instar	10 -13.00	11.27 ± 0.99	25-35
6	5th instar	14 -17.00	15.50 ± 1.00	25-35
7	Adult	18 -20.00	18.63 ± 0.67	25-35

Table 3 The survival and mortality of *Clavigralla gibbosa*

Stages	No	Survival	Mortality
1st instar	10	8	2
2nd instar	8	7	1
3rd instar	7	7	-
4th instar	7	7	-
5th instar	7	7	-
Adult	7	7	-

Survival = 70%, Mortality = 30%

Table 4 The survival and mortality of *Riptortus serripes*

Stages	No	Survival	Mortality
1st instar	10	8	2
2nd instar	8	6	2
3rd instar	6	5	1
4th instar	5	5	-
5th instar	5	5	-
Adult	5	5	-

Survival = 50%,Mortality = 50%

Table 5 Length on the eggs, nymphs and adults stages of *Clavigralla gibbosa* and *Riptortus serripes* (n = 10)

No	Stages	*Clavigralla gibbosa*		*Riptortus serripes*		Temp
		Range (mm)	Mean ± SD	Range	Mean ± SD	HC
1	Egg	0.50 - 1.00	0.78 ± 0.16	1 - 1.50	1.12 ± 0.16	25-35
2	1st instar	1.30 - 1.80	1.55 ± 0.25	4 - 5.00	4.41 ± 0.27	25-35
3	2nd instar	2.60 - 2.80	2.70 ± 0.10	6 - 7.00	6.55 ± 0.28	25-35
4	3rd instar	3.90 - 4.20	4.05 ± 0.15	8 - 9.00	8.45 ± 0.34	25-35
5	4th instar	5.60 - 6.10	5.85 ± 0.25	10 -13.00	11.27 ± 0.99	25-35
6	5th instar	7.30 - 9.50	8.40 ± 1.10	14 -17.00	15.50 ± 1.00	25-35
8	Adult	13.00 - 15.00	14.14 ± 0.77	18 -20.00	18.63 ± 0.67	25-35

Table 6 Duration of life cycle of *Clavigralla gibbosa* and *Riptortus serripes* (n = 10)

Stages	*Clavigralla gibbosa*	*Riptortus serripes*
Eggs	8 - 9 days	6 - 7 days
Mean	8.55 ± 0.44 days	6.45 ± 0.44 days
Larvae period	27 - 36 days	19 - 24 days
Mean	31.2 ± 3.01days	21.35 ± 1.75 days
Whole life cycle	35 - 45 days	25 - 31 days
Mean	40.1 ± 3.31 days	29.05 ± 1.96 days

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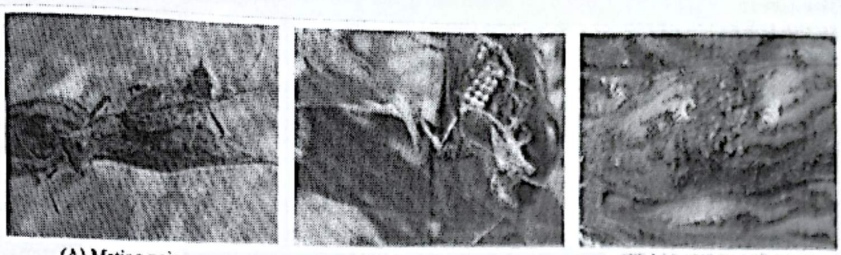
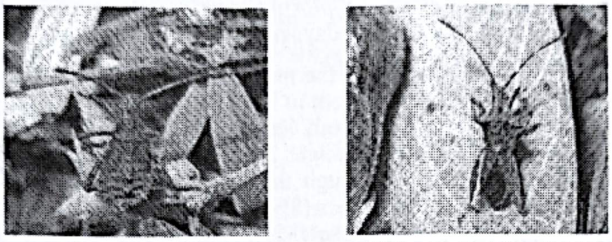


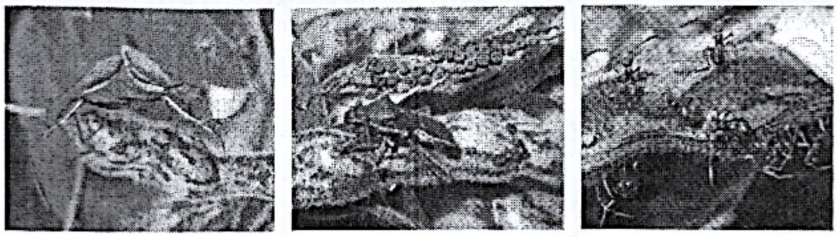
(A) Mating pair (B) Egg laying (C) 1st instar nymph

(D) 2nd instar nymph (E) 3rd instar nymph (F) 4th instar nymph

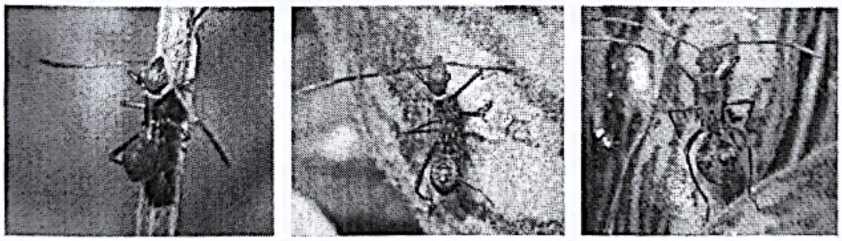


(G) 5th instar nymph (H) *Clavigralla gibbosa* (adult)

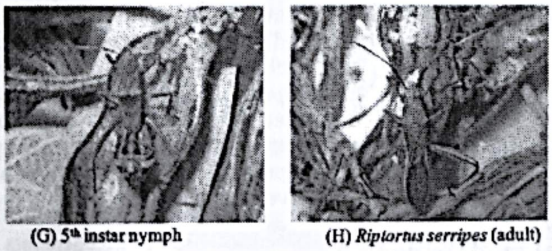
Figure 3 Life cycle of *Clavigralla gibbosa* on pigeonpea plant



(A) Mating pair (B) Eggs on pod and stem (C) 1st instar nymph



(D) 2nd instar nymph (E) 3rd instar nymph ((F) 4th instar nymph



(G) 5th instar nymph (H) *Riptortus serripes* (adult)

Figure 4 Life cycle of *Riptortus serripes* on pigeonpea plant

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Discussion

In the present study the life cycle of *Clavigralla gibbosa* and *Riptortus serripes* were studied in flowering and pod stages. The results of the present study, the life cycle of *Clavigralla gibbosa* and *Riptortus serripes* lasted about 35-45 days and 25-31 days respectively under the temperature 25 to 35 HC.

Spiny brown bug, *C. gibbosa* is pod sucking feeders. From the results of their life cycle, 1st, 2nd, 3rd, 4th and 5th nymphal instar and adults prefer feeding on the pods of the plants. The bug laid eggs to the surface of pods or leaves. After few hours colour changed from creamy white to light brown and then brownish in colour. Similar results were given by Rana and Patel (2001) and Chitralekha (2014) who reported that colour of eggs and changed to dark brown before hatching on pigeonpea, after 24 hours.

Chitralekha (2014) reported that the newly hatched nymph has wedge shaped abdomen with light yellow colour. The second instar nymphs have a pair of black stout spines on either side of the prothorax. The third instar nymph has a pair of developing wing pads. The fourth instar nymph has the more prominent the wing pads. The fifth instar nymph resembled to 4th instar except the wing pads prolong up to the 4th abdominal segment.

Chitralekha (2014) described that *Clavigralla gibbosa* life cycle lasted about 26 to 35 days at the temperature of 28-35 HC. The development of these pests varied depending on the temperature. In the present study, the duration of the life cycle of this species observed 35-45 days at the temperature 25 HC to 35 HC under laboratory condition. The survival rate of *Clavigralla gibbosa* is 70%.

In this study, the results were observed the newly hatched nymphs were pale yellowish in colour. The second instar was more or less similar to first instar except black stout spine on each side of prothorax. The third instar nymphs were yellowish to reddish brown in colour with numerous setae. The fourth instar nymphs resembled the third instar nymphs in colour and shape. The fifth instar nymphs have patches appeared on abdominal areas which were very light to dark in colour.

Chin *et al.* (2014) described that *Riptortus serripes* laid the eggs on the pods and the stems. The grown up nymphs were brown color. Larval period is about 15 to 25 days. The nymphal stages passed through five instars. The development of these stages varied depending on the temperature condition. Adults are usually brown coloured. The duration of life cycle lasted for about 5 weeks at the temperature 25-35 HC.

The nymphs of brown bean bug were pods feeders. In this study, five nymphal instar observed in their life cycle. All nymphal stages feed on pods. The female laid eggs on the pods and stems. The first instars feed on seeding stage of pods. The second instars feed on the pods and red-brown color. The third instars were black in body colour. Fourth and fifth instars were brown in body colour. Their life cycle lasted for 25-31 days at the temperature 25-35 HC under laboratory condition. The survival rate of *Riptortus serripes* is 50%. The results of the present study were observed similar to the above mentions.

Chin *et al.* (2014) reported that the newly hatched nymph has ant shaped with pale red colour. The second instar nymphs have a pair of scent glands on the abdomen. The third instar nymph has a pair of wing pads. The fourth instar nymph has the more prominent the wing pads. The fifth instar nymph resembled to 4th instar except the wing pads prolong up to the third abdominal segment. In this study, the results were observed the newly hatched nymphs were pale reddish in colour. The second instar was more or less similar to first instar except black on head and thorax. The third instar nymphs were blackish colour and like the large black ant with numerous setae on the thorax, abdomen and legs. The fourth instar nymphs were brown in colour and scent glands reduced. The fifth instar nymphs have more developed wing pads and stout spines on the thorax. Therefore the present results were similar to the above observation.

Chitralekha (2014) and Chin *et al.* (2014) were described that the life cycle of *Clavigralla gibbosa* and *Riptortus serripes* lasted about 32-45 days and 25-31days respectively.

In the present study, the two bug species were different in the size and duration of the life cycles. The body length of *Riptortus serripes* (18-20 mm) was longer than *Clavigralla gibbosa* (13-15 mm). Although the duration of life cycle of *Riptortus serripes* (25-31 days) was shorter than *Clavigralla gibbosa* (35-45 days). The results of the present study were observed similar to the above mentions.

In this study, the nymphs of bugs feed and pierce pods of pigeonpea. A large number of pests attack pigeonpea from seeding stages to maturity and cause economic loss. The pest damage to the major plant parts were severely affected the productivity of food legumes. Thus, the life cycles of some insects were studied. Since nymphs of all stages attacked the pigeonpea and vegetables crops, these recorded insect pests species were important species.

Conclusion

From the above results it can be concluded that, occurrence of sucking insect pest starts during seedling stage and gradually increases during the pods maturity stage. Local pigeonpea cultivators should be able to recognize important bug pests on pigeonpea plants. Some cultivators could not differentiate the damage caused by the various bug pest groups. Therefore, important to educate pigeonpea cultivators in the region on the identification of insect pests, and the damage they cause. The results of this study will be provided the information on the studied species to distinguish the kind of bug species on the pigeonpea plants and life cycle of these bug pests (*Clavigralla gibbosa* and *Riptortus serripes*) will also give additional information on the cultivators in deciding the judicious use of insecticides on the pigeonpea pests, and to provide useful information on seeking of the effective management.

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all the departmental facilities during the preparation of this paper.

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ZOL 012

Distribution and Population Abundance of Limestone Wren-babbler *Napothera crispifronscrispifrons* in Hpa-an Environs of Kayin State

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Abstract

The Limestone Wren-babbler *Napothera crispifronscrispifrons*is a species of Pellorneidae family. It is a key species of limestone habitat. Hpa-an Township is the capital of Kayin State which is situated at the bank of Thanlwinriver. It possesses the diverse habitats including fascination limestone habitat which rare in lower Myanmar. The study period starts from June, 2018 to May, 2019. The point count method with limited distance (200 m) by Bibby*et al*., 1992 was used. Census data were recorded at three days in a month, and one day in two selected sites. A total of six study sites namely Ya-the-pyan cave, Kawgooncave, Hpa-an Golden Valley, Htaung Wi cave, Yethar mountain and Kawkathaungcave were selected in this study. A total of 173 individuals of Limestone Wren-babbler were recorded. Among them, total 56 individuals were observed as White-throated Morph in Study sites 5 and 6. In this study period, highest population n=27 individuals was recorded in October, 2018 and least n=6 individuals in May, 2019.

Keywords: Limestone Wren-babbler, distribution, population abundance

Introduction

Most wren-babblers are ground loving species, elusive and difficult to observe in the forest understory and best found by their vocalization. These are quite small, chubby, long-legged birds with various patterns of spots (Gelang*et al*., 2009).

They are rather diverse in size and coloration, but are characterized by soft fluffy plumage. They are the birds of tropical areas, with the greatest variety in Southeast Asia and the Indian subcontinent. The entire family was previously included in the Timaliidae (Delacour, 1946).

There are three subspecies of Limestone Wren-babbler: *Napothera crispifronsannamensis* (Delacour&Jabouille, 1928) in Vietnam, *Napothera crispfronscalcicola* Deignan, 1939 in Thailand and *Napothera crispifronscrispifrons* (Blyth, 1855) in Myanmar and Thailand (BirdLife International and Nature Serve, 2011).

The Limestone Wren-babbler (*Napothera crispifronscrispifrons*) is a species of bird in the Pellorneidae family. It can found China, Laos, Myanmar, Thailand, and Vietnam. its natural habitats is subtropical or tropical moist lowland forests (Collar and Robson, 2007)

It is a key species of limestone habitat. In Southeast Asia, karsts cover an area of around 400,000 km^2 and their geological ages ranging from the Cambrian to the Quaternary (Day and Urich, 2000).

The high species diversity on karsts arises from a multitude of ecological niches afforded by complex terrains (e.g., fissured cliffs and extensive caves) and variable climatic conditions (Clement *et al*., 2016).

High species endemism can also occur on karst. Information of most bird species in Asian tropical areas, especially in limestone forests is still poor known.

Its natural habitats are subtropical or tropical moist lowland forests. It is a key species of limestone habitat. Wren-babblers :Timaliidae, Pellorneidae, Pnoepygidae and Elachuridae. Ground babblers are a family, Pellorneidae (Wikipedia, 2017).

Diverse in size and coloration, but are characterized by soft fluffy plumage and have distinctive songs. Birds of tropical areas, with the greatest variety in Southeast Asia and the Indian subcontinent. The entire family was previously included in the Timaliidae (Delacour, 1946).

Information of most bird species in Asian tropical areas, especially in limestone forests is still poor known. Current study will fill the gap of this situation.

- To investigate distribution of Limestone Wren-babbler
- To assess the population abundance of Limestone Wren-babbler

Materials and Methods

Study period

This study starts from June, 2018 to ends in May, 2019.

Materials

Observations of birds were used binocular (8×42) and telescope.Bird identification is used standardized field guide book by Smythies, 1953, and Robson, 2013.Video recordings and pictures with HS 10 - Fuji Camera will be taken for further confirmation.

Study design

Point count method (Bibby*et al*., 1992) and Line transect method (Bibby*et al*., 1992) were used for distribution, population and habitat features. During field survey, six points from each site were randomly selected.

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Study sites

Total six study sites were categorized:

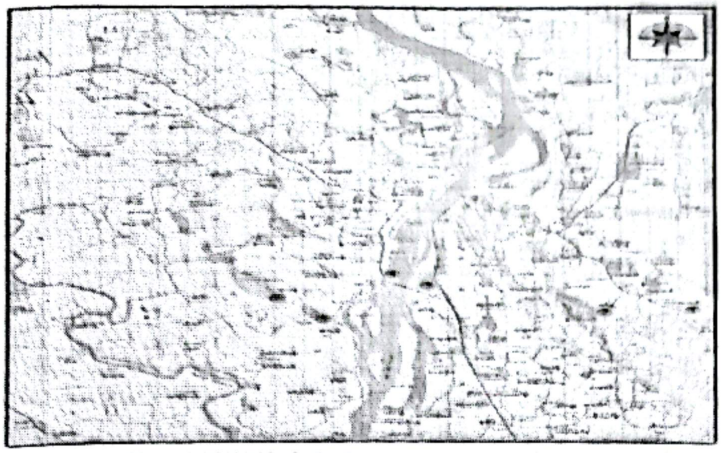
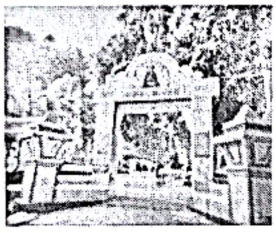
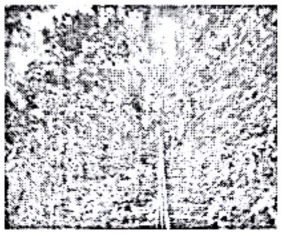


Fig. Topographic map of the study area
(Source: Office of Land Record,Hpa-an Township , Kayin State, 2017)

Sites	Places	Location	Habitat features
Site I	Kawkathaung Cave	16° 49' 41.30" N 97° 42' 24.21" E	Large trees, small trees, shrubs, herbs, bushes, temporary wetland and permanent wetland, one monastery and rich in Karst area
Site II	Yethar Mountain	16°50'51.68"N 97°38'16.01"E	Large trees, small trees, shrubs, herbs, bushes, paddy field, one monastery , rich in Karst area and human habitation
Site III	Htaung Wi Cave	16° 50' 30.57" N 97° 37' 16.69" E	Large trees, small trees, shrubs, herbs, bushes, paddy field, monasteries , hotels, human habitation and rich in Karst area
Site IV	Hpa-an Golden Valley	16°50'56.44"N 97°36'23.81"E	Large trees, small trees, shrubs, herbs, bushes, paddy field, human habitation, temporary wetland and rich in Karst area
Site V	Kawgon Cave	16° 49' 21.16" N 97° 35' 7.91" E	Large trees, small trees, shrubs, herbs, bushes, paddy field and permanent wetland, one monastery and rich in Karst area
Site VI	Ya-the-pyan Cave	16° 50' 6.44" N 97° 34' 13.53" E	Large trees, small trees, shrubs, herbs, bushes, permanent wetland, and rich in Karst area

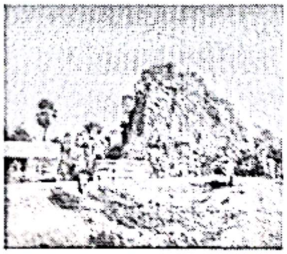


A. Site I

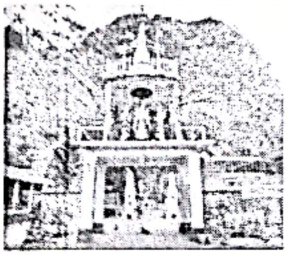


B. Site II

C. Site III



D. Site IV



E. Site V

F. Site VI

Plate 1 Study sites

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Results

Systematic position of Limestone Wren-babbler

Kingdom- Animalia
Phylum- Chordata
Class - Aves
Order - Passeriformes
Family-Pellorneidae
Genus - *Napothera*
Species- *Napothera crispifronscrispifrons*(Blyth, 1855)

Distribution of *Napothera crispifronscrispifrons*

Monthly distribution of studied species in study sites were shown in this table. Among them, 15 individuals in October, 2018 was highest distribution in study site I compared with at least single count in March, April and May, 2019.

Population abundance of Limestone Wren-babbler

A total of 173 individuals were recorded in this study. Among them, total 56 individuals were observed as White-throated Morph in Study sites V and VI. Among 6 study sites, studied birds were observed only in three sites. In site I with81 individuals, site V with57 individuals and site VI with 35 individuals were recorded respectively. Study sites II, III, IV were totally no recorded yet. In this study period, highest population was recorded in October, 2018. In study site I, this species was utilized with elevation started from 21m to 40 m in rainy season. In cool season, it was used from 21 to 80 m.

In study site V, this species was utilized the elevation started from 41m to 60 m in rainy season. In cool season, it was used from 41 to 80 m. In study site VI, this species was utilized the elevation started from 41 m in rainy season. In cool season, it was used from 41 m to 80 m.

Table 1 Monthly distribution of Limestone Wren-babbler in different study sites

	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Total
Site I	2	3	11	9	15	10	9	6	5	4	4	3	81
Site II	-	-	-	-	-	-	-	-	-	-	-	-	-
Site III	-	-	-	-	-	-	-	-	-	-	-	-	-
Site IV	-	-	-	-	-	-	-	-	-	-	-	-	-
Site V	2	3	6	9	7	6	6	6	4	3	3	2	57
Site VI	2	2	4	6	5	4	5	2	2	1	1	1	35

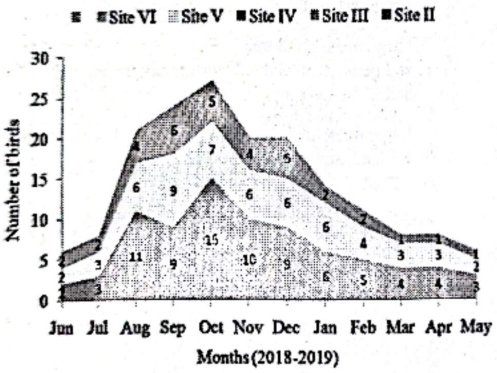

Fig. 1 Monthly distribution of Limestone Wren-babbler in different study sites

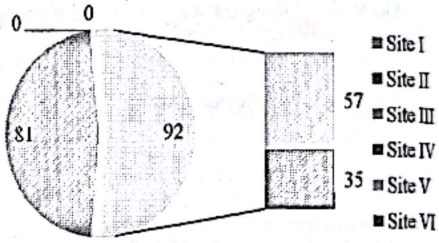

Fig. 2 Occurrence of studied species in different study sites

Table 2 Population abundance of Limestone Wren-babbler in study area

	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Total
Total	6	8	21	24	27	20	20	14	11	8	8	6	173

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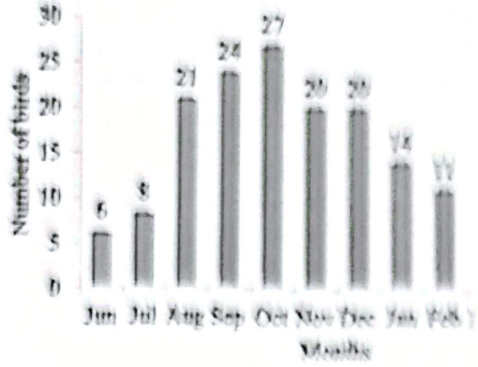
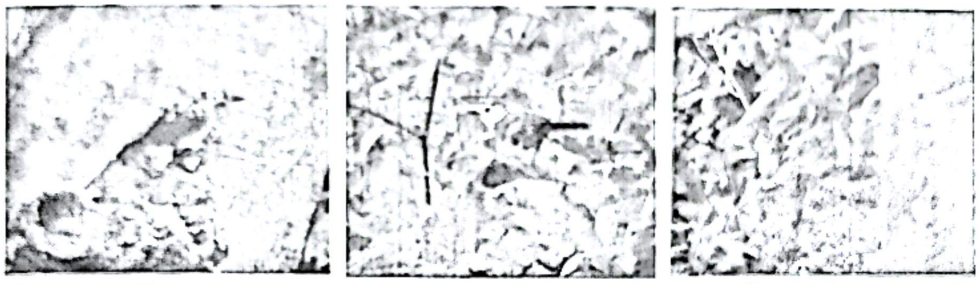


Fig 3Monthly population of studied species in different

A. Recorded Limestone Wren-babbler



*Napothera crispifronscrispifrons*with White-throated Morph in study site 5 and 6 (West bank of Thanlwin)

Plate 2 Limestone Wren-babbler in different study sites

Discussion

In this study, the peak count of Limestone Wren-babbler was recorded in site I and followed by site V and site VI. According to habitat features of study sites, study site I is rich in diverse habitats and less in human impacts and also in study sites V and VI.

In this study, the peak count of Limestone Wrenbabbler was recorded in site I and followed by site V and site VI. According to habitat features of study sites, study site I is rich in diverse habitats and less in human impacts and also in study sites V and VI.The elevational patterns of species richness for all bird groups were hump-shaped, which is consistent with most previous elevational diversity studies of birds in the Hengduanmountains and the adjacent Himalayas (Wu *et al*., 2013b; 2014;He *et al*., 2019). Hump-shaped patterns, therefore, appear to be the dominant pattern in this region.

According to the stratification, mid elevation was observed as the highest population of studied species.It may be coincided with the habitat features, behavior and habits of Limestone Wren-babbler because this species are ground dwelling species and prefer shrubs and bushes.

Dense forests are common at moderate elevations dominated by low growing shrubs, perennial herbs, mosses, ferns and lichens rich in Malaysia Rainforest (http://www.wwwf.org.my/forest). The highest population of Limestone Wren-babbler was recorded in October, 2018. It may be due to feeding habits of Limestone Wren-babbler were related to seasonally abundance of insect fauna and coincided with their breeding period.

Seasonal variation in abundance of Tropical insects is common phenomenon (Wolda, 1988 and Pinheiro*et al*., 2002). Several groups of insects are

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known to decline in number during the wet-mid season. Sometimes exhibiting and abundance that season is lower than that observed during the dry season (Robinson and Robinson, 1970 and Pinheiro*et al*., 2002).

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ZOL 013

Population Status and Habitat Preference of Sarus Crane *Grusantigone* (Linnaeus, 1758) in Indawgyi Wetland Environs, Kachin State

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Abstract

Sarus Crane *Grusantigone* (Linnaeus, 1758) is listed as "vulnerable" in the IUCN Red List of Threatened Species. Population status and habitat preference of Sarus Crane were studied in Indawgyi Wetland environs from June 2017 to May 2018. Line transect method was used to estimate the population status of Sarus Crane. The habitats of Sarus Cranes were classified three types of habitats as farmland, wetland and grassland. A total number of 149 Sarus Cranes including 120 adults, 26 juveniles and 3 chicks were recorded during the study period. It has been found that 2.22% of individuals of sarus crane were single, 55.56% in pairs, 24.44% in pair with young and 17.78% in groups The average flock size was 5.6 individuals. Out of 149 Sarus Cranes, 52.35% (78 individuals) in farmland, 31.54% (47 individuals) in wetland and 16% (24 individuals) in grassland were found. Although Sarus Cranes were found to be more distributed in farmland, analysis of habitat preference showed that Sarus Cranes prefer the habitats not only farmland but also wetland and grassland. The major significant threats to the survival of Sarus Cranes in this area were destruction of wetlands and grasslands due to agricultural expansion, people hunting for meat and uses of pesticides and fertilizers in agriculture. It is concluded that Sarus Cranes selected their habitats for foraging and breeding in the environs where not only plenty of their prefer food but also safety habitats.
Keywords: Sarus Crane, population status, habitat preference, Indawgyi wetland environs

INTRODUCTION

Sarus Crane is one of the world's tallest flying non-migratory birds having height of up to 1.8m (5.9 ft). Sarus crane is very large with grey wings and body, a bare red on head and part of the neck and omnivorous bird (Archibald *et al*., 2003). Sarus Crane has been listed as "Vulnerable" in the IUCN Red List of Threatened Species due to their habitat destruction. It is one of the 15 known species of cranes in the world and is the only resident breeding crane found in India and south-east Asia. It has been estimated to have a worldwide population of 8,000 -10,000 (Mein and Archibald, 1996).

Sarus Crane is a symbol of a healthy wetland ecosystem. Sarus Crane is an omnivorous bird and maintains the food chain and food webs furnish strength to wetland ecosystem (Gosai*et al*., 2016). Sarus Cranes utilize a wide variety of habitats, depending on food availability, cropping pattern and other seasonal factors (Mulherjee*et al*., 2001). Cranes are wetland dependent birds so their population status and habitat preference are closely related to the food availability and total area of wetland feeding habitat available. Habitat selection by birds is strongly influenced by security and food availability (Aryal*et al*., 2009).

Indawgyi Lake was also designated as a "Wetlands of International Importance" in 2016, needed to an effort to conserve the area which supports the livelihood of local people and is also home to a great diversity of waterbirds, fish and reptiles. In northern Myanmar, Indawgyi wetland serves as the largest among the wetlands supporting as the favourable habitats for Sarus Crane and other water birds.According to International Crane Foundation (2017) reported Sarus Cranes were observed in Bahmaw at Kachin State, Shan State, Rakhine State and the Ayeyarwady Delta in Myanmar.

Some population of Sarus Crane are found in Indawgyi Wetland environs. The current range of Sarus Crane includes northern, northwestern, and southern Myanmar. Any ecological studies of Sarus Crane have not been conducted in the study area, in spite of a few surveys on Sarus Crane was carried out in Indawgyi Wetland environs. Therefore, the present study aimed to assess the population status and habitat preference of Sarus Crane in Indawgyi Wetland environs with the following;

- to ascertain the present status of Sarus Crane in Indawgyi Wetland environs
- to assess habitat utilization of Sarus Crane in the study area
- to identify current threat faced to Sarus Crane in the study area

Material and Methods

Study area

Indawgyi wetland environs is located in Kachin State,northern part of Myanmar (Fig. 1). It lies between 25° 00′ 36.32" to 25° 17′ 41.35" N and 96° 12 ′ 59.63" to 96° 22 ′ 7.03"E. A total of study area was 63810.96 ha (30.01km x 20.6 km) including 30.22 % (39063. 465 ha) are farmland, 5.05% (6526.857 ha) are wetland and 1.54% (1991.945 ha) are grassland.

Site I: Panla, Chaungwa, Manahkaw, Ywathit, and Lonsant

Site II: Natmawkkhan, Hepu, Hepa, Sawingon, Nanmon, Shweleton, and Leponlay

Site III: Minenaung, Mamonkai, Loneton, Hepan, and Konmana

Study Period

Population status and habitat preference of Sarus Crane were studied in Indawgyi Wetland environ from June 2017 to May 2018.

Survey Methods

Line transect method was used to count the Sarus Crane population. A total number of 20 transects (1-5 km long each) that covered 22 villages around Indawgyi Lake. Out of 20 transects, 10 transects in farmland, 8 transects in wetland and 2 transects in grassland.

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Site IV: Nampede, Loimon, Nammilaung, Naungbin, and Naladan

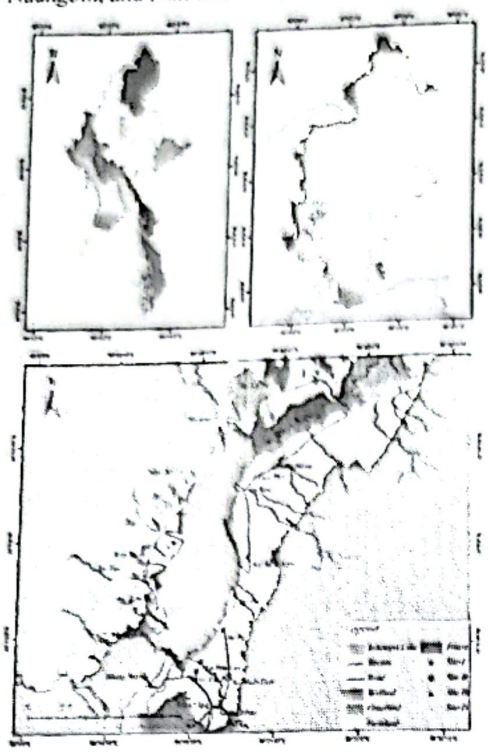

Fig. 1 Location map of Indawgyi Wetland environs

The sex, number of birds, presence or absence of juveniles, habitat type, and potential threats to Sarus Cranes were also noted. Interviewed surveys conducted with a wide variety of people such farmers, villagers, boatmen, fisherman and other local residents who well known about the crane. The habitat preference was analyzed by using habitat preference rating index (HPI).Identification of Species was confirmed as Sarus Crane according to Robson (2015).

Data Analysis

Data collected from the field were saved in Excel files and analyzed by SPSS.

Results

Population

During the present survey, 149Sarus Crane were sighted in 22 villages.Out of 22 villages, Sarus Cranes were recorded only in seven villages. Four village areas of abundance of Sarus Cranes have emerged in Indawgyi Wetland environs. Among 20 transects, Sarus Crane were observed along 8transects. The population was observed to be more concentrated in the western and northern part around common flood plains of the Indawgyi Lake. Among 20 transects, Sarus Crane were observed along eight transects.The population density for the whole area (0.31/km^2) was recorded.

Altogether 149 individuals were sighted from the study area during the study period.Among study sites,Sarus Crane were encountered in three villages in Site-I, only one village in Site-II, three villages in Site-III were found Sarus Crane. However not a single specimen was found in Site-IV.During the present survey, 22 villages were surveyed and Sarus Crane were encountered in seven villages. Four village areas appeared as abundance in Sarus Cranes in Indawgyi Wetland environs (Table 1).

Social Structure

Out of 149 individuals of Sarus Crane, 120 adults, 26 juveniles and 3 chicks were observed. Among the four social structures, 49.06% of Sarus Cranes were classified as pairs, 26.42% as pairs with young (family), 1.89% as single and 17.78% as flocks respectively. The average flock size was 5.6 individuals (Fig.2).

Habitat Preference

A total number of 149 Sarus Cranes were recorded during the study period, 52.35% (78 individuals) in farmland, 31.54% (47 individuals) in wetland and 16% (24 individuals) in grassland were found during field survey. According to questionnaire survey, altogether 220 of local people reported the habitat preference of Sarus Crane, 50.88%, 32.46% and 16.67% of reports mentioned farmland, grassland and wetland, respectively. Mostly of Sarus Cranes were found in farmland and a few number was found in wetland.

Foraging, nesting, and roosting in three kinds of habitats such as wetlands, grassland and farmland were used. . Survey data of the present study showed that Sarus Cranes were assumed to be mostly preferred the farmland than wetland and grassland, since Sarus Cranes were mostly found in the farmland. According to habitat preference index (HPI), their habitat preference found in more grassland than that of farmland and wetland (Table.1).

According to the survey result, the major threats faced to the survival of Sarus Cranes in the study area were agricultural expansion, loss and degradation of wetlands and grassland, agricultural use of pesticides and fertilizers, people hunting and human population growth have all contributed to the decline of Sarus Crane. Our results suggest that sarus cranes inhabit agricultural land, because of the suitability of the habitat. Sarus cranes prefer agricultural land for feeding and wetlands for roosting and grasslands for nesting and protecting their security.

Discussion

A total number of 149 individuals of Sarus Crane, 120 adults, 26 juveniles and 3 chicks were observed. The population of Sarus Crane were recorded to be more concentrated in north eastern (Site I) and south western (Site III) parts of the Indawgyi Wetland environs. These Sites support a fairly good population of Sarus Crane because these areas have extensive wetlands, floating vegetation areas, and seasonally flooded grasslands and flooded paddy fields. So, these zones have fairly healthy and breeding sites and was experienced with lesser disturbance than other sites.

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During the present study social structure of Sarus Crane revealed that mostly were found in pairs, some are in single, other are found as flock and also found parents with chick during survey period, which is considered as a healthy sign of a growing population as these population habits indicate the presence of potential breeders (pairs), breeding populations (families), mixture of potential breeders and breeding populations (groups), and non-breeding but potential breeders (solo cranes).

Table 1. Number of Sarus Cranes sighted in each villages during the study period

Villages	Adults	Juveniles	Chicks
Chaungwa	23	6	2
Manaklaw	14	5	-
Ywathit	8	-	-
Leponlay	2	-	-
Minenaung	4	-	-
Loneton	49	12	1
Hepan	20	3	-
Total	120	26	3

Table 2. Habitat preference Index of Sarus Crane in the study area during the study period

Habitat Type	Number of Sarus Crane (n=149)	X %	Y %	HPI ^ (X/Y)
Farmland	78	52.35	50	1.05
Wetland	47	31.54	40	0.89
Grassland	24	16.11	10	1.61

X % = Percentage of birds observed in each habitat types

Y % = Percentage of transect traversed in each habitat type

HPI = Habitat preference rating index

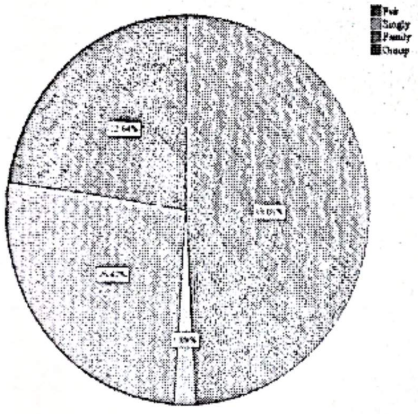

Fig 2. Social structure of Sarus cranes

A total number of 149 Sarus Cranes including, 78 individuals in farmland, 47 in wetland and 24 individuals in grassland were recorded in the study area during the study period. Although Sarus Cranes were found to be more distributed in farmland, analysis of habitat preference showed that Sarus Cranes prefer the habitats not only farmland but also wetland and grassland. Also farmland can provide good foraging conditions. But no grassland and wetland have in this area, they may be frequently disturbed by human and wildlife.

The major significant threats to the survival of Sarus Cranes in this area were destruction of wetlands and grasslands due to agricultural expansion, people hunting for meat and uses of pesticides and fertilizers in agriculture. According to the field survey result, Sarus Cranes selected their habitats for foraging and breeding in the environs where not only plenty of their prefer food but also safety habitats.

Conclusion

It would be concluded that population status of Sarus Crane in this area had been declined. But, social composition of Sarus Crane is considered as a healthy sign of growing population. So Sarus Crane must be conserved in this area and also awareness programme.

Acknowledgements

First and foremost I would like to express my profound gratitude to the organizers of MISCC 2019 for giving me the chance to participate in the Symposium. I am very grateful to DrNyuntSoe, Principal, MohnyinDegree College, for hisencouragement. I would like to express my special thanks to Professor DrMyintMyint Than, Head of Zoology Department, Mohnyin Degree College, for their encouragement and permission to present this paper.Our special thanks are due to U Maung Win and staffs of Nature and Wildlife Conservation Division in Indawgyi Wildlife Sanctuary for their organizing the activity and supports during the survey in various ways.

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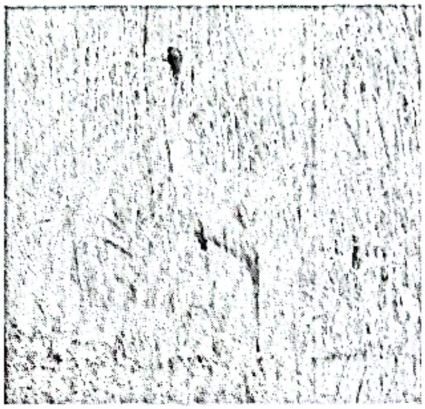
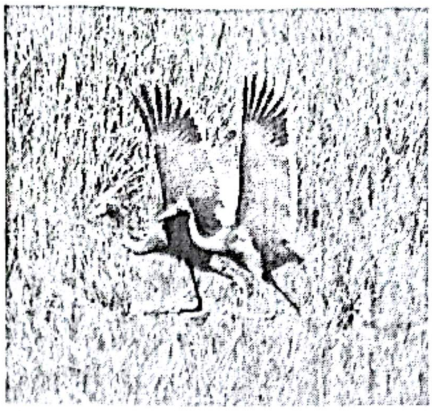


Single



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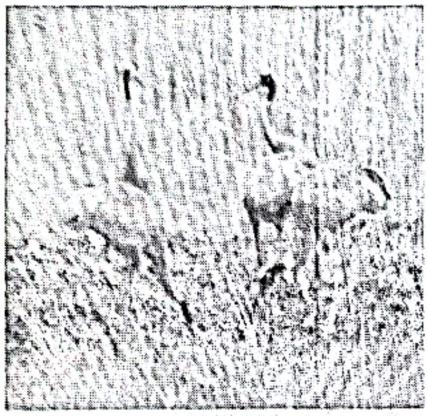
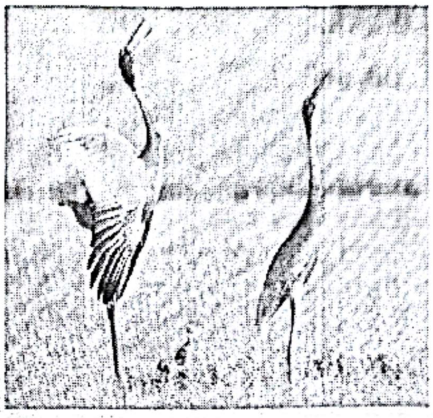


Group



Family

Plate.1 Social Structure of Sarus Crane

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ZOL 014

Occurrence and Abundance of Some Fish Species in HePu Village East Shore of Indawgyi Lake, Mohnyin Township, Kachin State

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Abstract

Investigation of species occurrence and index of abundance of some fish species in Hepu Village at eastern shore of Indawgyilake, Mohnyin Township, Kachin State, from December 2018 to August 2019 was conducted A total of 41 species, belonging to 28 genera and 19 families of nine order were collected Fish species were collected monthly throughout the study period It was indicated that the species composition of order Cypriniformes was highest with species (36.59%), followed by Pereciformes (26.83%), Siluriformes (21.95%), Clupeiformes (2.44%), Osteoglossiformes (2.44%), Tetraodontiformes (2.44%), Cyprinodontiformes (2.44%), Indostomiformes (2.44%) and Synbranchiformes (2.44%) respectively. The highest number of 40 species in February (2019) and lowest in July and August 33 species (2019) in each were recorded. The highest catch number was observed in December, followed by March, June, May, January, August, April, July and February. Base on the index of abundance; rare species (20), present species (4), permanent species (15) and dominant species (2) were recorded. Hepu Village at eastern shore of Indawgyi Lake was found to be within the suitable limit for survival, growth and culture for fishes throughout the year The finding of the present study would not only thus provide informative data on the availability of fish species resources in study area but also promote in planning future for maintaining the conservation of the ecosystem.

Keywords: Fish species, Indawgyi Lake

Introduction

Fish live in a wide variety of habitat from mountain torrents to depths of several kilometers in the ocean (Talwar and Jhingram, 1991). Most species of the world, 21,723 species are fish funa of these species, 8411 are fresh water and 11,650 are marine species. (Jayram, 1991).

Myanmar fishery industries have three main categories of fishing activities, namely marine fisheries, inland fisheries and aquaculture. In Myanmar, the fisheries sector is the fourth largest source of foreign exchange earnings after timber, mineral and rice. Myanmar has extensive fresh water resources, it has many natural lakes and there are 260 resources. The quality of Freshwater resources and habitat for inland fishes still good (Win Oo, 2015).

Fish is a very important of the diet of the people of Myanmar, with such a party high importance of the inland fisheries sector in the food security(Miao et al., 2010).They are also indicators of water quality and ecosystem health Myanmar is rich in natural resources from its abiotic and biotic environment. Human livelihoods, especially in developing countries mainly depend on aquatic resources. An estimate of 120 million people throughout the world depend on fish for all part of the income of their livelihood (Pereira, 2000).

Myanmar is endowed with rivers, lakes, and wetlands which can effectively provide fish resources fish exhibit enormous diversity fishes constituted almost half of the total number of vertebrates in the world. Freshwater fisheries and aquaculture are then considered as the important section in the nation's economy. Therefore, various study conducted on taxonomic view, seasonal abundance, population density, feeding habits and reproductive status of fish fauna including freshwater and marine fishes from Myanmar water.

Composition of the fish community can be a good indicator of fish habitat quality, as fish population in degraded habitats is usually dominated by one or a few very tolerant species. Fish are dependent upon both physical characters of their environment and other forms of aquatic life. Much baseline information on species diversity and abundance is needed before these measurements can be used to asses status of a fish community (Morrow and Fischenich, 2000).

Prediction of fish abundance requires information on a greater variety of habitat parameters which are associated with food and cover for fish. Fish species are also an important indicator of ecological health. The abundance and health of fish will show the health of water bodies (Hashemi et al., 2015).

Indawgyi lake is largest freshwater lake in Myanmar. It is located at the Mohnyin Township of Kachin State in the northeast Myanmar. It is also lies inside the Indawgyi Wildlife Sanctuary. The main water sources of the lake are inflow of main ten streams from surrounding mountain ranges and outflow in northeast through Indaw stream to join Moe Goung creek and then flow to the Ayeyarwady River. The lake has 12,000 hectares of open water, along with marsh, floating vegetation, and submerged macrophytes (UNESCO, 2015).

The fishermen caught the fish from this lake is the whole year. Local fishermen often use small, simple gears made from local available materials, such as bamboo and nylon rope. The gears come in various sizes and shapes according to species and fishing ground.

The present study was conducted at Hepu Village in the following objective;

- to record the occurrence of fish species
- to observe index abundance of fish species
- to compare monthly fluctuations of fish fauna during the study period

$$\text{Index of abundance} = \frac{\text{Total number of individuals of a species}}{\text{Total number of individuals of all species in a study site}} \times 100\%$$

(Lauzanne, 1983; cited by Olele et al., 2008)

MATERIALS AND METHODS

Study site

Hepu village was selected as study area and it situated between 25°05′09° North latitude

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and 96°23'16" East longitude at eastern shore of Indawgyi, Mohnyin Township, Kachin State.

Study period

The study period was lasted from December 2018 to August 2019.

Specimen collection

Fish species were collected with the help of local fishermen. Specimen collections were carried out monthly, categorized, counted, took photographs. Some specimens were preserved in 10% formalin for further analysis.

Identification of fish species

Specimens were identified based on Day (1978), Jayaram (1981), Talwar&Jhingran (1991).

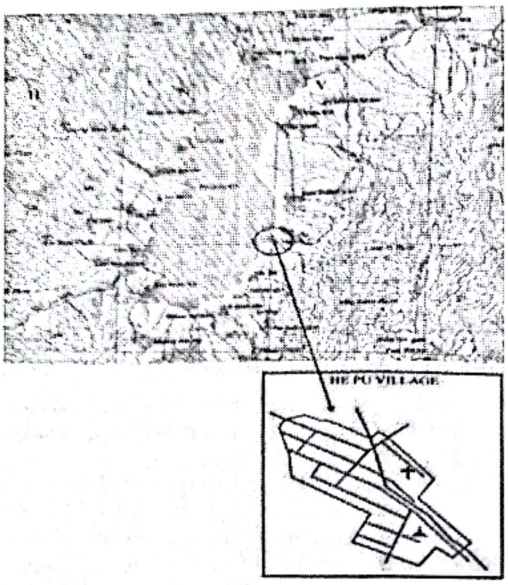

Fig. 1 Location of Indawgyi Map

Data analysis

Index of abundance or Ponderal index (PI) was used to analyze the fish sampled by number and expressed in percentage. A "dominant" fish species was that accounting for 10% or more both by number. Fish species with a Ponderal index of 1-9% was regarded as a "permanent" occupant of the lake. Contributions between 0.5-0.9 percent were the value ascribed to a "present" member, while a value below 0.5% was recorded as a "rare" member of the lake.

Results

Systematic position of the recorded fish species

A total of 41 species belonging to 28 genera, 19 families and 9 orders were recorded. (Table .1)

Species composition of fish

The total of 41 species of 28 genera under 19 families belonging to nine orders were recorded. The recorded nine orders were Osteoglossiformes, Clupriformes, Cypriniformes, Siluriformes, Cyprinodontiformes, Indostomiformes, Synbranchiformes, Perciformes and Tetraodontiformes. During the study peroid, the percentage species composition of eight species was found to be highest in the order Cypriniformes (36.59%), followed by (26.83%) in Perciformes, (21.95%) in Siluriformes, (2.44%) in Osteoglossiformes, (2.44%) in Tetraodontiformes, (2.44%) in Cyprinodontiformes, (2.44%) in Indostomiformes and (2.44%) in Sybranchiformes. (Table 4.2 and Fig 4.1)

The total of 41 species with 48733 individuals were recorded from Indawgyi Lake. The highest species number was recorded in January year 2019 with 40 species each, followed by December and September (37 species) in each, March and April (36 species). The lowest species numbers were recorded in May and June representing 34 species, 35 species and 33 species in July and August respectively.

Based on the individual number, the highest individual was recorded in December (6783 individuals), followed by March with 6055 individual and Jun with 5987 individuals. During the months of January , February , April , May , July and August total number of individuals were remarkably low to individual number of 5481, 4185, 4770, 5702, 4541 and 5229 respectively (Table 4.3 and Fig 4.1)

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Table 1.List of collected fish species from Hepu Village.

No	Order	Family	Scientific Name	Common Name
1	Osteoglossiformes	Notopteridae	1. *Notopterus notopterus*	Grey featherback
2	Clupeiformes	Clupeidae	2. *Gudusiavariegata*	Burmese River Shad
3	Cypriniformes	Cyprinidae	3. *Cirrhinusmrigala*	Mrigal
			4. *Labeocalbasu*	Black rohu
			5. *Labeonandina*	Nandi labeo
			6. *Labeorohita*	Rohu
			7. *Labeogonius*	Kutlalabeo
			8. *Osteobramabelangeri*	Manipur Osteobrama
			9. *Osteobramafeae*	Burmese Osteobrama
			10. *Amblypharyngodonatkinsonii*	
			11. *Puntioschola*	Swamp barb
			12. *Puntiusgonionotus*	Thai silver carp
			13. *Puntiuspuntio*	Puntio barb
			14. *Poropuntiusmyitkyinae*	Indawgyi barb
			16. *Esomusahli*	Burmese barb
			17. *Lepidocephalusguntea*	Guntea loach
			19. *Mystusbleekri*	Day's mystus
4	Siluriformes	Baridae	20. *Mystuscavasius*	Gangeticmystus
			21. *Mystusmicropthalmus*	Ayeyarwaddymystus
		Siluridae	22. *Ompokbimaculatus*	Indian butter-catfish
			23. *Ompokpabo*	Pabo catfish
			24. *Wallagoattu*	Boal
		Claridae	25. *Clariasbatrachus*	Magur
		Heteropneustidae	26. *Heteropneustesfossilis*	Stinging catfish freshwater
5	Cyprinodontiformes	Belonidae	27. *Xenantodoncancila*	Freshwater garfish
6	Indostomiformes	Indostomidae	28. *Indostomusparadoxus*	Indostomid
7	Synbranchiformes	Synbranchidae	29. *Monopteruscuchia*	Cuchia, Gangeticmudeei
	Perciformes	Ambassidae	30.*Pseudambasis baculis*	Himalayan glassy perchiet
			31. *Pseudambasisranga*	Indian glassy fish
		Nandinae	32. *Badisbadis*	Badis
		Cichlidae	33. *Oreochromisnilotica*	Nile tilapia
		Anabantidae	34. *Anabas testudineus*	Climbing perch
		Belonitidae	35. *Colisafasciatus*	Stripled Gourami
		Channidae	36. *Channamarulius*	Guiant snakehead
			37. *Channapuntatus*	Spotted snakehead
			38. *Channastriatus*	Stripped or banded
		Mastacembelidae	39. *Macrognathus oral*	One stripe spiny-eel
			40. *Mastacembelusarmatus*	Tire track spiny eel
9	Tetraodontiformes	Tetraodontidae	41. *Tetraodoncutcutia*	Ocellated Puffer fish

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Table. 2 Monthly collected fish species of index of abundance at study site

Scientific name	Dec	Jan	Feb	March	April	May	Jun	July	Aug	Total	% by number	Ponderal Index
Notopterus notopterus	200	120	100	150	100	90	70	45	150	1025	2.10	***
Gudusia variegata	600	500	350	800	300	200	350	100	150	3150	6.46	***
Cirrhinus mrigala	150	20	15	10	-	-	3	7	-	70	0.14	*
Labeo calbasu	10	15	10	20	15	20	13	35	30	170	0.35	*
Labeo nandina	20	18	12	20	15	25	10	20	15	155	0.31	*
Labeo rohita	20	24	20	12	20	24	15	25	20	180	0.37	*
Labeo gonius	-	-	-	-	-	-	6	-	-	6	0.01	*
Osteobrama belangeri	80	60	30	60	120	200	230	300	150	1230	2.52	***
Osteobrama feae	8	5	7	-	-	-	-	-	-	20	0.04	*
Osteobrama cunma	400	300	200	500	150	200	300	400	200	2650	5.44	***
Amblypharyngodon atkinsonii	500	300	350	500	800	1000	1500	900	1200	7050	14.47	****
Puntius ghoimonta	1000	800	800	1200	1000	1500	900	600	700	8500	17.44	****
Puntius chola	700	600	550	530	550	450	300	200	150	4030	8.27	***
Puntius puntio	800	500	300	450	150	200	100	100	80	2680	5.50	***
Parapuntius mylikyinae	30	35	20	50	100	200	350	200	300	1285	2.64	***
Esomus ahli	-	10	-	-	-	-	-	-	-	10	0.02	*
Lepidocephalus guntea	-	5	-	-	-	-	-	-	-	5	0.01	*
Aorichthys seenghala	40	68	72	80	40	45	50	40	45	480	0.99	*
Mystus bleekeri	10	10	15	20	10	8	4	7	-	84	0.17	*
Mystus cavasius	50	40	60	64	20	35	40	50	35	394	0.81	**
Mystus microphthalmus	-	3	-	-	-	-	-	-	-	3	0.01	*
Ompok bimaculatus	20	25	15	30	25	20	15	15	10	175	0.36	*
Ompok pabo	5	7	10	8	5	10	12	9	4	70	0.14	*
Wallago attu	20	15	8	16	12	10	15	10	15	121	0.25	*
Clarias batrachus	20	15	8	20	15	20	10	15	10	133	0.27	*
Heteropneustes fossilis	15	20	10	25	20	15	20	10	15	150	0.31	*
Xenentodon cancila	60	50	35	40	75	80	50	45	45	480	0.99	**
Indostomus paradoxus	10	20	15	28	5	10	7	-	-	95	0.20	*
Monopterus cuchia	15	6	8	7	5	4	-	-	3	48	0.10	*
Pseudambasis baculis	100	150	100	150	100	200	150	200	100	1250	2.56	***
seudambasis ranga	200	500	200	300	400	600	800	500	400	3900	8.00	***
ıdis badis	70	60	40	50	35	-	-	-	-	255	0.52	**
rsochromis nilotica	80	60	50	45	50	40	50	60	80	515	1.06	***
nabas testudineus	80	85	70	90	80	65	50	35	20	575	1.18	***
'olisa fasciatus	700	500	150	300	200	150	200	100	600	2900	5.95	***
'hanna marulius	20	35	15	20	15	20	10	5	5	142	0.29	*
'hanna punctatus	35	40	20	30	10	15	10	13	7	180	0.37	*
'hanna striatus	100	75	50	50	68	46	30	15	10	444	0.91	**
facrognathus oral	50	60	40	80	60	50	70	45	60	515	1.06	***
fastacembelus armatus	400	200	280	300	150	100	200	400	600	2630	5.40	***
'etraodon cutcutia	300	130	150	200	50	50	45	35	20	980	2.01	***
otal individual	6783	5481	4185	6055	4770	5702	5987	4541	5229	48733	100%	
otal Species	37	40	37	36	36	34	35	33	33	41		

* = Rare individual ≤ 0.5%

** = Present individual ≥ 0.5% – 0.9%

*** = Permanent individual ≥ 1.0% – 9.0%

**** = Dominant individual ≥ 10.0%

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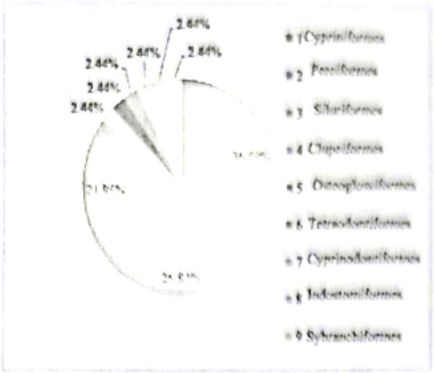


Fig. 2. Composition of fish species in different order at Hepu Village

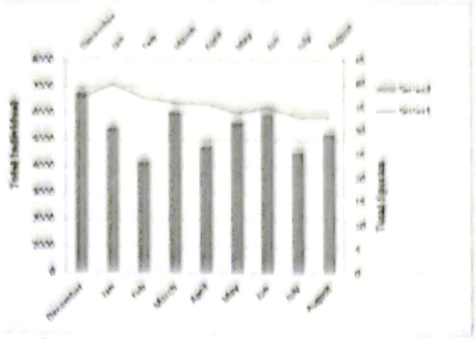
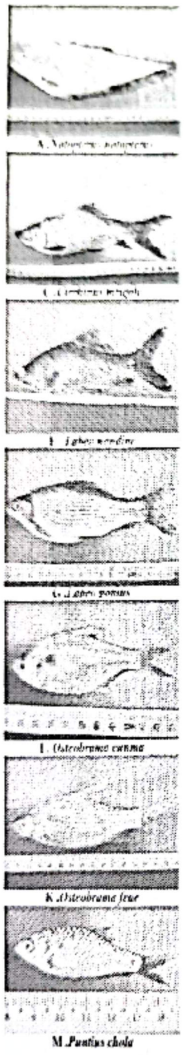


Fig 3. Monthly occurrence of species and individuals in Hepu Village



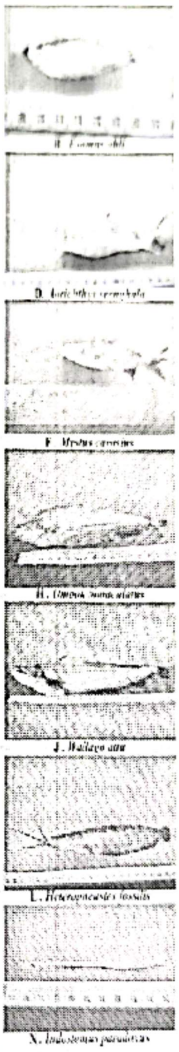


Plate1. Order collected fish species

Plate 2. Order collected fish species

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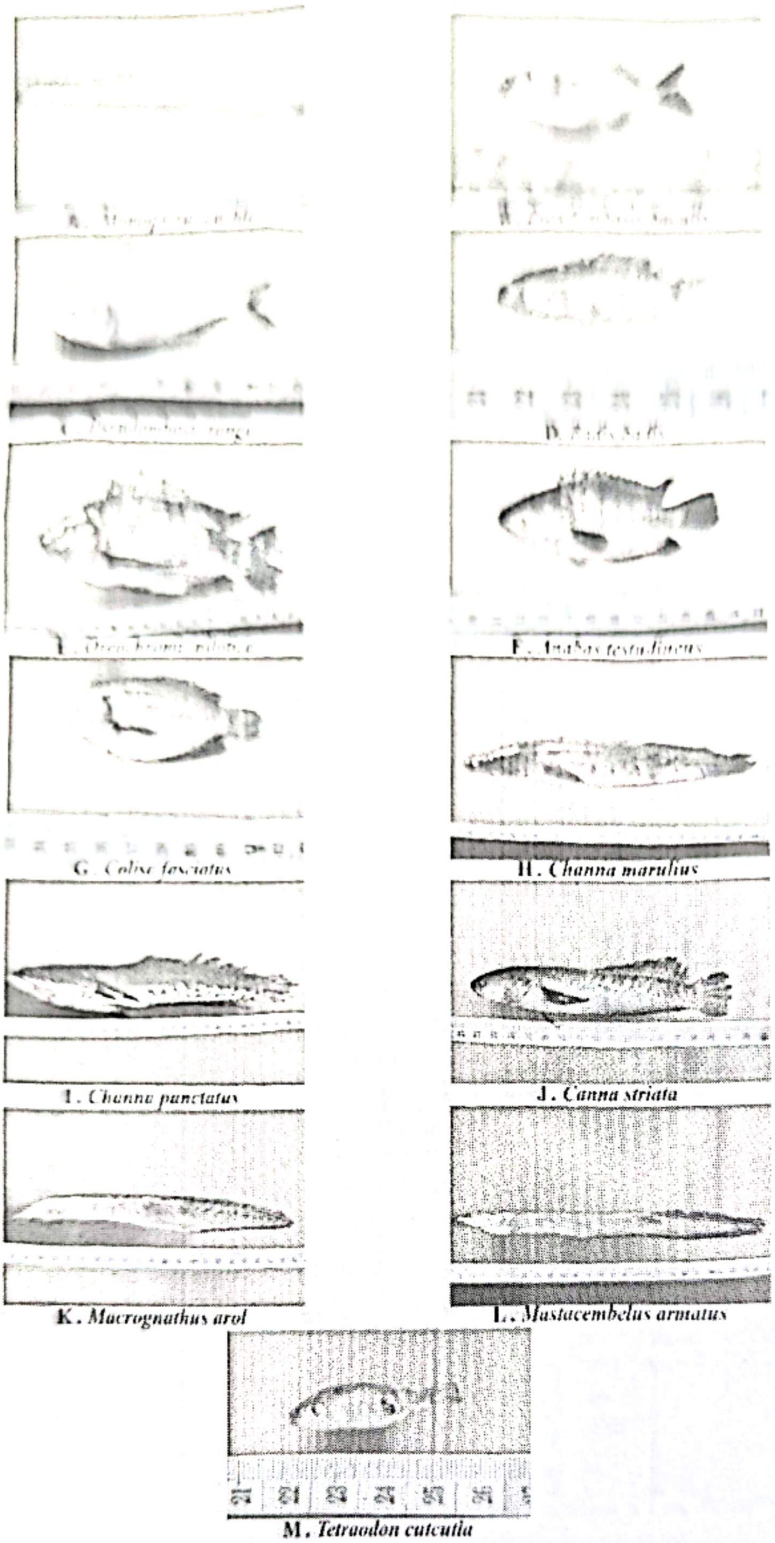

Plate 3. Order collected fish species

Discussion

During the study, a total of 41 species under 28 genera and 19 families belong to 9 orders were recorded from December 2018 to August 2019. The species composition of recorded 41 species was found to be the highest under the order Cypriniformes 15 species 36.59% and Perciformes 26.83%, Siluriformes, 21.95%, Synbranchiformes, Osteoglossiformes, Clupeiformes, Cyprinodontiformes, Indostomiformes, Tetraodontiformes, 1 species 2.44% were lowest composition in Hepu Village during the study period.

The highest species composition was recorded in order Cypriniformes (39.53%), while the lowest species composition in Osteoglossiformes, Cyprinodontiformes, Clupeiformes and Tetradontiformes 2.33% each (Sanda Maung 2012).The highest species composition was recorded in Cypriniformes 89.43%, the lowest in Synbranchiformes 0.01% (Ni Ni Aye, 2013). Therefore the finding of the present study deal with previous workers due to the components of species in order Cypriniformes.

In the present study monthly occurrence of species number was highest recorded in February 40 species and the lowest species in July and August 33 species each in 2019.

Yan Myo Naing (2013), reported that the highest number were recorded in May 39 species and lowest in August 13 species from Tinn-Gate In, Moegaung Township, Kachin State. From among these species, 20 species were found to be among those collected from Hepu Village. Among them, 20 species were recorded in Hepu village.

Monthly occurrence of fish species was recorded in the study area. A total of 48733 individuals were collected during the study period. The monthly total catch ranged from the minimum 4185 individuals in February to a maximum of 6783 specimens in December and the total number of species was 41 species.

Therefore 2 dominant species, *Amblypharyngodon atkinsonii,Puntius gonionotus* could be supplied as daily staple food for local native people and they could get high nutritive values from the fish. On the other hand, 20 species showed as rare species

As a whole, based on the species composition and abundance of fish species. During the study period in Indawgyi Lake may be considered still productive and supplying protein demand and livelihood for local people. Local people's knowledge and awareness is also needed to protect fauna in Indawgyi Lake. Therefore, such as natural valuable lake conducted for the conservation of fish fauna in Kachin State.

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ZOL 015

Lead and Antibiotic Resistant Bacteria Isolated from Soil of a Battery Factory Site

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Abstract

Lead is a hazardous heavy metal highly toxic to organisms including humans. This study analyzed soil from a battery manufacturing factory site for the occurrence of soil bacterial strains resistant to lead-contaminating the environs. Three isolates including *Bacillus subtilis*, *Serretia liquefaciens* and *Escherichria coli* were isolated and characterized. All three isolates had different growth at up to 2.0mM $Pb(NO_3)_2$ incorporated nutrient agar at 37°C overnight. Hence, all isolates had no growth on 3.0mM of the lead nitrate compound. The three isolates showed different antibiotic susceptibility patterns could be useful for detection of lead pollution in industrial sites by microbiological approach.

Keywords: Industrial soil, bacteria, lead, antibiotics, resistance.

Introduction

Human activities such as mining, use of chemical fertilizers and pesticides in agriculture , automobile mechanic activities ,car battery manufacturing plants and the use of vehicles for transportation release high amounts of pollutants including heavy metals into the biosphere (Adewole and Uchegbu, 2010).

Heavy metals containing industrial effluent cause health hazards to plants, animals, aquatic life and human increasing pressure on the flora and fauna (Robin *et al.*, 2012)Although some heavy metals are essential trace elements, most are toxic at high concentrations to all organisms (Alam *et al.*,2002).

Lead is a major pollutant found greatly toxic to human, animals, plants and environments. Lead has been widely used in batteries production, wire and cable insulation and jacking, radiation shields, stiffener in candle wicks and paint factories for many years(Zhang *et al.*,2015).Lead pollution can cause severe effects in soil and water ecosystems such as losses in biodiversity, changes in microbial community and reduced growth and reproductive rates in plants and animals (Krishbayya and Bedi, 1986; Myra *et al.*,2012)

In human, severe effects were caused by lead pollution to the children more than the adults and in 2016, 540,000 people were died due to lead contamination (WHO,2016)

Antibiotic resistance is acquired by a change in the genetic make-up of a bacterium, which can occur by either a genetic mutation or by transfer of antibiotic resistance genes between bacteria in the environment(Williams *et al.*,2002).

Heavy metal and antibiotic resistance have been shown to have a strong correlation in nature, and their interrelation is an important subjectsof study. Therefore, there is a need to isolate and characterize metal/ antibiotic resistance in the microorganisms as indicator that exist and interact in a contaminated environment.

Therefore, the objectives of this study are (1) to assess the microbial status of soil from battery factory site(2) to determine level of total bacteria count of soils from battery factory site (3) to isolate, identify and characterize some heavy metal resistant soil bacteria occurring in soils from industrial site and (4) to conduct soil analysis for heavy metals of the industrial site and (5)to test antibiotic sensitivity profile of bacterial isolates.

Material and Methods

Study area and study sites: The soil samples were collected from battery factory site in Hlaingtharyar Industrial Zone, Yangon Region.

Study period: Study was conducted from October 2018 to March,2019.

Study design: Soil sample (500g, 15cm depth)from battery factory site; Soil sample analysis and Isolation and identification of soil bacteria. The whole work consisted analysis of industrial soil for heavy metals with the measurement of pH and bacteriological study of the industrial soil for heavy metal (lead) resistant bacteria. Isolates strains were differentiated by antibiotic susceptibility test pattern

Materials

-Standard microbiological reagents, equipment and apparatuses

-Nutrient agar and broth , Plate Count agar, EMB agar, Muller hington agar(Himedia)

-Lead (ii)nitrate($PbNO_3$)$_2$

-Syringe filter PES 0.22µm,(30mm 50/pk)

-Antibiotic sensitivity discs(Clairo ® Mono, Arkray Healthcare Pvt ltd).

Bacteriological analysis

Methods

Soil sample transportation and storage

Each collected soil sample (0.5kg)was packaged in a black coloured polyethylene bag to avoid heat, light and drying. The soil samples were brought to Microbiology Laboratory, Department of Zoology, West Yangon University. Soil samples were analyzed immediately or stored in refrigerator at 4°C for 1-3 days.

Isolation and Culture of Soil Bacteria

Collected soil sample (5g) was mixed with 90 ml of 0.85% (w/v) salt solution and

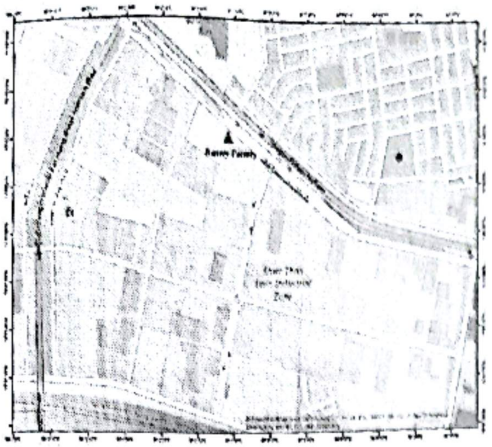

Fig.1 Map of Hlaingtharyar Township showing location of the battery factory; 16°52'5"N and 96°2'35"E (Source: Department of Geography, West Yangon University)

Soil analysis for metals

Energy Dispersive X-ray Fluorescence(EDXRF) analysis of soil samples were done at Chemistry Department, Monywa University.

Morphological and Biochemical Identification

Colony morphology: Bacterial characters

Bacterial colony characters including color, shape, margin, surface, elevation and size (diameter) were observed and recorded. Colony and cell appearance were recorded according to Bisen and Verma(2001)

Biochemical characterization of bacterial isolates

Bacterial isolates were grown on nutrient agar medium (HiMedia).The shape and colours of the cells were examined under the microscope after gram staining. Isolates were subjected to biochemical analysis for the activities of Catalase, Starch hydrolysis, Indole production, Methyl-red test, Vorges proskauertest, Citrate utilization, Urease,H_2S production, TSI and SIM tests.The tests result were used to identify the isolates according to Bergey's Manual of Systematic Bacteriology(1984,8thedition) and Manual for the Identification of Medical Bacteria (Cowan and steel,1981)

Screening for lead tolerant bacteria among the isolated strains in nutrient broth and agar

Results

EDXRF analysis showed that compounds of ten heavy-metals elements were found to contaminate the studied factory soils (Table 1).Industrial soil samples bacterial isolates were analyzed for heavy metals tolerance as well as isolation, identification and total viable cell count . Three species of soil bacteria, namely *Bacillus subtilis,Escherichia coli, Serratia liquefaciens* were isolated and identified. Total viable bacteria count (CFU/ml) in collected soil samples was 2.72 x 10^9 in battery factory site(Table 2,3 and 4).

incubated at 30° C in a shaker incubator, at 120rpm for 2 hour(Gandhi *et al*.;2015).Ten- fold serial dilutions of suspension will be made $10^{-1}$to 10^{-10}level.25µl of the dilutions was spread-plated on Nutrient agar by glass spreader and incubated at 37° C for 24 hours. Colonies with different morphology will be subcultured. Incubation at 37°C, overnight. The colonies that appeared on the agar plates were counted and the characteristics of the isolated colonies were noted down. Only the petri dishes with colony number between 30 and 300 were used to calculate the colony forming unit (CFU/ml).

Pure colony of each isolate was grown overnight in nutrient broth and inoculated on nutrient agar plates incorporated with different concentrations of heavy metal lead solution with distilled water. The lead(II)nitrate compound solution in distilled water, was sterilized by the Syringe Filter 0.22µm before incorporation into agar media. Cultures were incubated at 37°Cfor 24 hours and cell growth observed. After incubation, any kind of growth on the agar plate were subcultured on the same nutrient agar with lead for purity of strain.

Determination of lead tolerance level

The tolerance of the bacterial isolates to lead was determined by Minimum Inhibitory Concentration(MIC).Each 25µl of the dilutions was spread-plated by a glass spreader on Nutrient agar plates containing series of increasing concentrations of $Pb(NO_3)_2$(1.0mM,2.0mM,3.0mM) etc., until the tested isolate had no growth.The MIC value was determined after 48 hours of incubation at 37°C after Rajbanshi(2008).

Antibiotics susceptibility test

The antibiotic tests were done by standard agar disc diffusion method on Muller Hington agar. One hundred micro liters (µl)of fresh pure bacterial cultures were spread on Muller Hington agar, and discs of six antibiotic viz., Penicillin, Chloramphenicol, Erythromycin, Gentamycin, Ciprofloxacin and Cotrimazole were placed on the bacterial lawn grown on the plate.The plates were incubated at 37 °C for 24 hr. Inhibition zone diameter were measured in mm,and the tested isolate strains were classified as resistant (R),Intermediate (I) and Susceptible (S) according to the criteria recommended by National Committee for Clinical Laboratory Standards,(now CLSI).

All three identified isolates were tolerant to 0.2mM $Pb(NO_3)_2$ but ceased to grow at 0.3mM lead concentration(Table 5,Plate-1).

Antibiotic susceptibility tests revealed that the identified isolates had different antibiotic sensitivity patterns (Table 6, Fig-2and 3,Plate-2)to the six antibiotics tested.

Table1.List of metals defected by EDXRF in battery

Sr N0.	Metal Compound		Result
	Formula	Nomenclature	
1.	Al2O3	Aluminium oxide	16.929%
2.	Fe2O3	Iron(III)oxide	4.042%
3.	TiO2	Titanium dioxide	0.552%
4.	PbO	Lead(II)oxide	0.122%
5.	ZnO	Zinc oxide	0.090%
6.	MnO	Manganese oxide	0.062%
7.	Cr2O3	Chromium oxide	0.039%
8.	CuO	Copper oxide	0.027%
9.	Ag2O	Silver oxide	0.013%
10.	NiO	Nickel oxide	0.007%

Table 2.Total viable cell counts(CFU/ml) of lead tolerant isolates

Dilution factor of the sample	Heavy metal (Pb) incorporated media	Control plate (without heavy metal Pb)	Percentage of heavy metal(Pb) resistant bacteria
10^{-4}	0.84×10^{7}	27.20×10^{7}	3.08%
10^{-6}	0.44×10^{9}	18.00×10^{9}	2.44%

Table3.Colony morphology of identified bacteria isolated from battery factory soil

Bacteria species	**Colony morphology**
Bacillus subtilis	Colony large,margin is undulate or lobate, dry circular form,flat elevation
Serretia liquefaciens	Mucoid, umbonate elevation, entire margin, red and white colonies
Escherichia coli	Medium sized colonies, regular margin, convex elevation

Table 4.Biochemical characteristics of identified isolates from battery factory soil

Sr No.	Isolate	Catalase	MR	VP	Indole	Simmon citrate	Urease	TSI				Starch hydrolysis
								butt	slant	gas	H_2S	
1	*Bacillus subtilis*	+	+	+	_	+	+	K	A	_	_	+
2	*Serratia liquefaciens*	+	_	+	_	+	+	A	K	_	_	+
3	*Escherichia coli*	+	+	-	+	-	-	A	A	+	+	_

A=acid(yellow), K=alkaline(red)

Table 5. Results of lead (II)nitrate resistance tests on bacteria isolates

Bacteria isolates	Highest Concentration of heavy metal at which bacterial isolates were able to grow (mM)		
	1.0mM	2.0mM	3.0mM
Bacillus subtilis	+	+	-
Serratia liquefaciens	+	+	-
Escherichia coli	+	+	-

+ growth, - no growth

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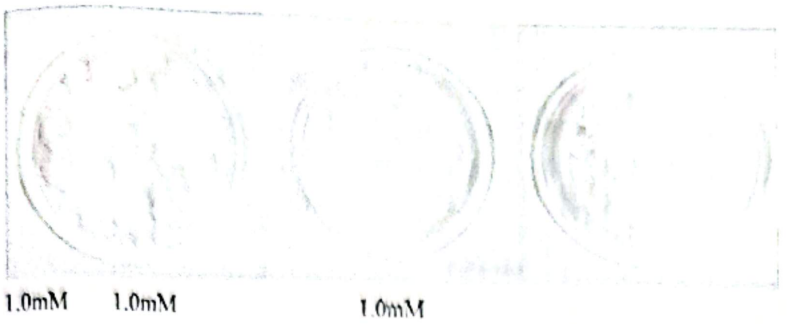
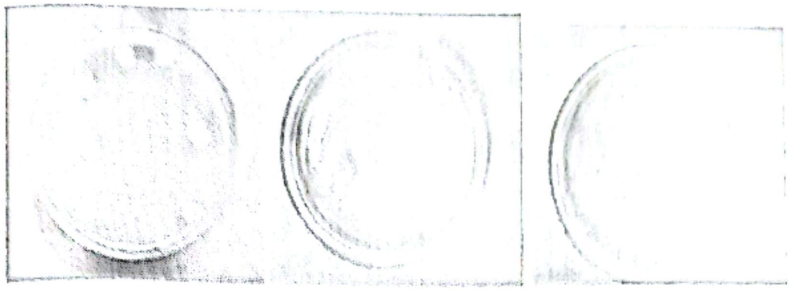




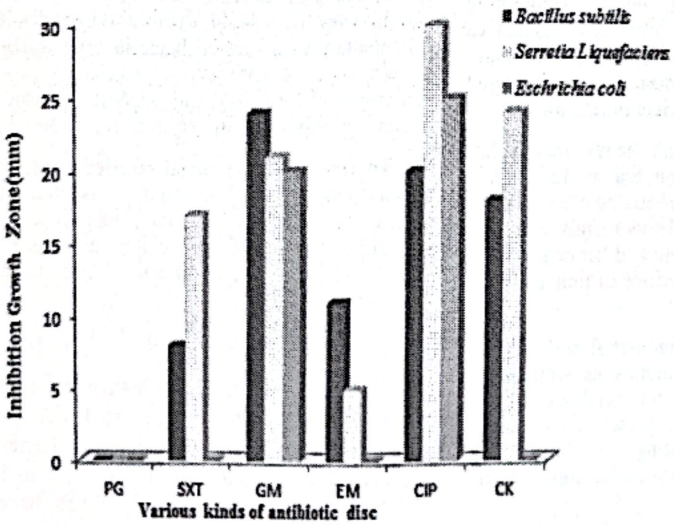
A. *Bacillus subtilis* B. *Serratia liquefaciens* C. *Escherichia coli*

Plate 1. Growth of isolated bacteria on Lead(II)nitrate incorporated nutrient agar

Table 6.Antibiotic sensitivity profile of bacterial isolates

Sr No.	Bacterial isolates	Diameter of inhibition zone(mm)					
		Penicillin 10µg/disc	Cotrimazole 25g/disc	Gentamycin 10µg/disc	Erythromycin 15µg/disc	Ciprofloxacin 5mcg/disc	Chlophinikol 30µg/disc
1.	*Bacillus subtilis*	R	R	S	R	I	S
2.	*Serretia liguefaciens*	R	S	S	R	S	S
3.	*Escherichia coli*	R	R	S	R	S	R

R=Resistant (≤12) S=Sensitive (≥14) I=Intermediate(12-14)



PG=Penicillin
ER =Erythromycin
SXT=Co-trimazole
CIP=Ciprofloxacin
GM=Gentamycin
CK=Chloramphenicol

Fig. 2 Comparison of antibiotic susceptibility patterns of bacterial isolates

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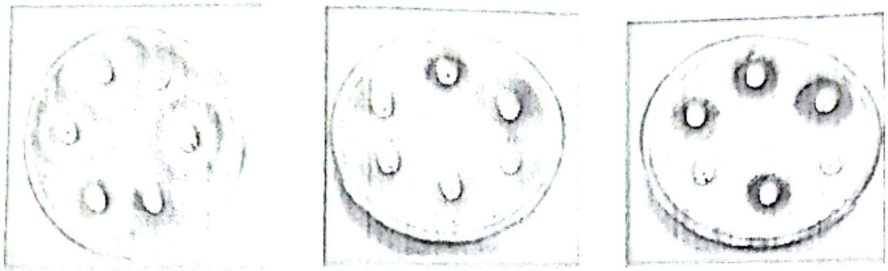

A. *Bacillus subtilis* B. *Serratia liquefaciens* C *Escherichia coli*

Plate 2.Antibiotic susceptibility tests patterns of the lead resistant isolates on Muller Hington agar

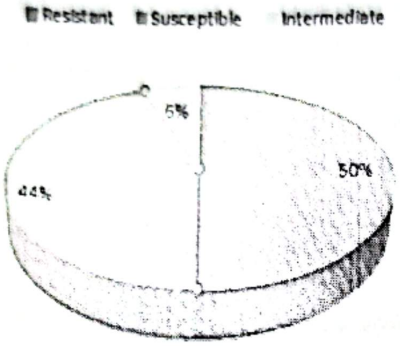

Fig.3 Antibiotic susceptibility tests patterns of the lead resistant isolates on Muller Hington agar

Discussion

Contamination of the heavy meal is a major environmental problem because of their toxicity .Heavy metals are threat to human life and environment.Much research has been conducted on heavy metals contamination in soil from various sources such as Industrial waste, Automobile emission and agricultural practices. Excessive levels of Heavy metals like Zinc, Cadmium, Copper, Lead, Nickel and Mercury are considered as mainly toxic pollutants(Xie*et al*.,2010).

Soil contamination with heavy metals has become a worldwide problem, leading to losses in agricultural yield and hazardous health effects as they enter the food chain. Heavy metals cannot be degraded to be harmless state and hence persist in the environment for long periods of time (Yang *et al*., 2015).

In the present work, industrial soil samples were analyzed for heavy-metals as well as for isolation, identification and total viable cell count of bacteria. A total of heavy-metals compounds were found to be contaminating soils of the studied factory site. Lead, a heavy metal found at the battery factory site .

According to the result, three species of soil bacteria, namely *Bacillus subtilis*, *Escherichia coli*and *Serratia liquefaciens*were isolated and identified.

All isolates bacteria had lead tolerance level of up to 0.2mM but died at 0.3mM.The presence of three lead resistant bacteria thus indicated the lead pollution level of the soil at the studied factory sites.

Onuoha *et al*.;2016 revealed that *E.coli,Klebsiella* sp.,*Staphylococcus* spp *and Shigella* spp., had growth at the lead metal concentration of 0.5mM, but at higher concentration ,there was no growth .

May Sandar Kyaing *et al*.,2019 stated that the MIC value of lead for *E.coli*isolate was 10mM in Screening of Heavy Metal(lead)and Antibiotics Resistant Soil Bacteria from Myanmar Industrial Sites.

In the present finding was not similar to the previous result.Some levels of resistance and the tolerance that was found among the isolates were probably due to the metal contamination in the soil.(Abou-Shannab *et al*.,2007)

In vitro counts revealed that these lead resistant isolates constituted 2.99% to 3.08% of the total viable count of the soil of the battery factory site. In addition, different antibiotic sensitivity patterns found in the three isolates could be useful to differentiate their strains.

In the present result showed 50% Resistant and fallowed after 44.44% tosensitivity and 5.56% intermediate to all tested bacteria. Among these, highest sensitivity against to gentamycin(10µg/disc) and highest resistant to penicillin(10µg/disc) and erythromycin(15µg/disc).

To survive under metal stressed conditions, bacteria have evolved mechanisms to tolerate the uptake of heavy metal ions(Gupta *et al*.,2012).Therefore, these isolates can be used in bioremediation of metal contaminated environments.

Conclusion

All tested soils from the battery factory site was found to be highly contaminated with heavy metals including lead in the study area. Bacterial populations in the site studied ranged $10^7$to 10^9 CFU/ml soil at alkaline pH of 8.78near battery factory. A total of three genera consisting three bacteria species were identified at the site. As identified isolates were resistant to 0.2mM lead, they could be used as indicator organisms to detect lead pollution in other factory sites and for treatment of polluted soil.In addition, antibiotic sensitivity tests of the three isolated bacterial

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species revealed that four antibiotics tested could be useful for differentiation of the strains of isolates obtained.

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Species Composition, Relative Abundance and Seasonal Occurrence of Fish Fauna in Ayeyawady River Segment, Mandalay Region

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Abstract

The study on species composition and seasonal occurrence of Ichthyo Fauna at Ayeyawady River segment, Mandalay Region commenced form June 2017 to May 2018. A total of 50 fish species belong to 38 genera and 18 families under eight orders of freshwater fishes were recorded. The highest of species composition were recorded in the order Cypriniformes and the lowest in Osteoglossiformes and Tetraodontiformes. Members of the order Cypriniformes revealed to be dominant in the study area. During the study period, the highest number of species was collected in cold season and the lowest were observed in hot season. The results of the relative abundane revealed five fish species as very common, seven species as common (C) and 38 species as uncommon (uC). Among all fish species observed, 15 species as commercially important fishes in the study area. According to seasonal occurrence and abundance, the study area may be considered as highly productivity and economically benefit places for people living nearby.

Keywords: fish species, abundance, seasonal occurrence, Ayeyawady River

Introduction

The Ayeyawady River flows from north to south through Myanmar. In Myanmar, the Ayeyawady remains the longest and most important commercial waterway. It is born at the confluence of two rivers, N' mai and Mali rivers about 43 kilometers north of Myitkyina. From this site, Myitsone, it flows for more than 2170 km (1348 miles) from the northern uplands to the southern delta region before finally flowing into the Andaman sea. At the beginning of voyage the Ayeyawady River flows shallow and is an important spawning ground for fish. The Ayeyawady drainage basin of about 404,200 square kilometers (156,100 sq mil) covers a large part of Myanmar (Wikipedia, 2018).

As early as the sixth century, the Ayeyawady River was used for trade and transport. Having developed an extensive network of irrigation canals, the river become important. The river is still as vital today, as a considerable amount of (export) goods and traffic moves by river. Rice is produced in the Ayeyawady Delta, irrigated by water from the river.

No complete and precise list of all the fish in the Ayeyawady river basin currently exists, but in 1996 it was estimated that there are about 200 species. In 2008, it was estimated that the Ayeyawady region is home to 119-195 species of fish found nowhere else in the world (endemic). Several new species of fish have been described from the Ayeyawady river basin in the recent year, and it is likely that undescribed species remain(Wikipedia, 2018).

Fisheries and aquaculture make a significant contribution to Myanmar's economy. The fisheries contributes roughly 2 percent of Myanmar's gross domestic product (GDP), 50 percent of animal protein consumption, 6 percent of employment (World Bank,2019). The freshwater capture fisheries production is 1.6 million tons per year (DOF 2017). Large declines in high value species of freshwater fish were reported by fishers throughout the Ayeyawady Basin, which cover around 60 percent of Myanmar's land area (Baran *et al*, 2018).

As of 2015, Myanmar was the worlds' eighth largest aquaculture producer, producing an estimated 1 million metric tons annually according to FAO (World Bank, 2019). The importance of farmed fish in the domestic market is growing, accounting for around 21 percent of the fish consumed nationally (Belton *et al*. 2015).

Second only to rice, fish is a major contributor to Myanmar's national diet (World Fish, 2014). Fish is rich in essential micronutrients, such as calcium, iodine, and some vitamins, as well as amino acid and oils. Consuming fish also contributes to the bioavailability of micronutrients from other food items in the meal (villain and Baran, 2016) ADM Fish accounts for approximately 60% of animals protein intake in Myanmar (Wilson and wai, 2013). Even in coastal areas, people generally prefer freshwater fish to marine fish for consumption

Ayeyawady River is important to both Myanmar's economy and society. The study of freshwater fishes in Ayeyawady segment may be essential as one of the corner stone for conservation scheme of biological resources in Myanmar. The objective of the present study was to investigate the species composition (of fresh water fish) and their relative abundance of freshwater fish species in Ayeyawady River.

Materials and Methods

Study Area and Study Period

The Ayeyawady River flows through the Mandalay Region and is one of the largest rivers in Southeast Asia including Myanmar. Ayeyawady River segment located at Latitude 21°59' 37.91" N and Longitude 96°3' 39.18" E (Figure 1). The present study was carried out from June 2017 to May 2018.

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Figure1. Map of study Area (Source from Google)

Specimens collection Preservation

The specimens were recorded from a segment of Ayeyawady River, Mandalay Region with the helpfulness of local fishermen on monthly basis throughout the study period. The specimen collections were randomly selected from the catches of different fishing gears in the River. The collected specimens were examined and recorded soon after they were caught before the body color disappeared. Data of fish was noted and coloured photographs were made immediately after capturing the fish. The external morphological characters and measurement were taken from fresh state. The fish were preserved in different formalin percentage of solution according to size of specimens for the future identification. The vernacular names of the species were as informed by the local fishermen.

Identification and Classification

Fishes were identified according to keys in Day (1878), Talwar and Jhingran (1991), Ferraris (1998) and Jayaram (2013). The classification of fish was followed after Jayaram (2013).

Data Analysis

The data were analyzed as following (Bish, *et al*., 2004).

$$\text{Relative Abundance} = \frac{\text{Total number of individuals in each a species}}{\text{Total number of}}$$

The average relative abundance was categorized as:

Uncommon (uC) = having relative abundance less than 0.0100

Common (C) = having relative abundance of 0.0100 and above but less than 0.0500

Very common (VC) = having relative abundance of 0.0500 and above

Status of fish

To assign status, the frequency of occurrence of each species was calculated based on the number of occasions the species was collected during the samplings. The status of these fishes was determined with the help of standard catch frequency chart as present by Tamang, *et al*., 2007.

<5% = Extremely rare 05-14% = Rare species 15-30% = Sporadic 31-59% = Occasional 60-80% = Frequent 81-90% = Abundance 91-100% = Common

Results

Species Composition of Fish

A total of 50 fish species confined to 38 genera belonging to 18 families and eight orders were recorded from Ayeyawady River, during the study period. The percentage species composition Order Cypriniforme was most dominant including 20 species (40%) followed by Siluriformes including 13 species (26%), Perciformes including nine species (18%), Synbranchiformes including three species (6%), Clupeiformes including two species (4%) and Osteoglossiformes, Cyprinodontiformes and Tetraodontiformes including one species (2%) each (Figure 2).

During the study period, dominated families were Cyprinidae with 17 species followed by Bagridae with five species. The other families Cobitidae, Sisoridae, Mastacembelidae and Channidae with three species. The another families Clupeidae, Siluridae, Schilbeidae and Belontidae with two species. The rest of all other families were presented by single specie each from Notopteridae, Loricariidae, Belanidae, Ambassidae, Cichlidae, Gobiidae, Anabantidae and Tetraodontidae (Table 1).

Occurrence and Abundance

In the present study, *Notopterus notopterus*, *Guidusia variegata*, *Catla catla*, *Cirrhinus mrigala*, *Puntius chola*, *Aspidoparia morar*, *Pterygoplichthys disjunctivus*, *Xenetodon cancila*, *Parambassis ranga*, *Oreochromis* sp. and *Tetraodon cutcutia* were found throughout the year in Ayeyawady River, Mandalay Region (Table 2).

The maximum number of fish species (45 species) and individuals (1024, individuals) were recorded in December. The minimum number of fish species (18) and individuals (1127) were found in April. The highest number of individuals was found in *Puntius chola* (15500) and the lowest in *Ctenopharyngodon idellus* (15). Among the collected species *Puntius chola* showed the highest relative abundance (0.2538) and the lowest relative abundance (0.0002) in *Ctenopharyngodon idellus*. Based on the relative abundance, 38 species were found to be as uncommon, seven species common and five species as very common (Table 2).

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Seasonally, during the study period, the maximum number of individuals (33915) and species (50) were found in cold season. The minimum number of individuals (12389) and species (41) were found in hot season (Table 3).

Catch Frequency of Fish Species

In the present study, base on the catch frequency five specie, namely, *Labeo boga, Labeo rohita, Barbonymus gonionotus, Ompok bimaculatus* and *Glossogobius giuris* were recorded as abundant. 10 species, namely *Labeo calbasu, Labeo stoliczkae, Osteobrama belangeri, Osteobrama cunma, Amblypharyngodon atkinsonii, Lepidocephalus berdmorei, Mystus cavasius, Mystus pulcher, Macrognathus aral* and *Colisa labiosus* were considered as frequent. 13 species, namely, *Notopterus notopterus, Gudusia variegata, Catla catla, Cirrhinus mrigala, Puntius chola, Salmophasia sardinella, Aspidoparia morar, Gagata cenia, Pterygoplichthys disjunctivus, Xenentodon cancila, Parambassis ranga, Oreochromis* sp. and *Tetraodon cutcutia* were noted as common. 20 species, namely, *Hilsa ilisha, Labeo angra, Puntius sarana, Raiamas guttatus, Botia berdmorei, Sperata acicularis, Mystus leucophasis, Hemibagrus menoda, Wallago attu, Clupisoma prateri, Eutropiichthys vacha, Gagata melanoptera, Bagarius yarrellii, Macrognathus zebrinus, Mastacembelus armatus, Anabas testudineus, Trichogaster pectoralis, Channa marulias, Channa Orientalis* and *Channa striatus* were assumed as occasional. Two species, namely, *Ctenopharyngodon idellus* and *Acantopsis choirorhynchos* were recorded as sporadic (Table 4).

Table 1. Systematic position of fish species recorded from Ayeyawady River Segment, Mandalay Region

Order	Family	Scientific Name
1. Osteoglossiformes	1. Notopteridae	1. *Notopterus* (Pallas, 1769)
2. Clupeiformes	2. Clupeidae	2. *Hilsa ilisha* (Ham., & Buch., 1822)
		3. *Gudusia variegata* (Day, 1869)
3. Cypriniformes	3. Cyprinidae	4. Catla (Ham., & Buch., 1822)
		5. *Cirrhinus mrigala* (Ham., & Buch., 1822)
		6. *Ctenopharyngodon idellus* (Valenciennes,1844)
		7. *Labeo angra* (Ham., & Buch., 1822)
		8. *Labeo boga* (Ham., & Buch., 1822)
		9. *Labeo calbasu* (Ham., & Buch., 1822)
		10. *Labeo rohita* (Ham., & Buch., 1822)
		11. *Labeo stoliczkae* (Steindachner, 1870)
		12. *Osteobrama belangeri* (Valenciennes, 1844)
		13. *Osteobrama cunma* (Day, 1878)
		14. *Puntius chola* (Ham., & Buch., 1822)
		15. *Puntius sarana* (Ham., & Buch., 1822)
		16 *Barbonymus gonionotus* (Bleeker, 1850)
		17. *Salmophasia sardinella* (Valenciennes,1842)
		18. *Amblypharyngodon atkinsonii* (Blyth, 1861)
		19. *Aspidoparia morar* (Ham., & Buch., 1822)
		20. *Raiamas guttatus* (Day, 1869)
	4. Cobitidae	21. *Acantopsis choirorhynchos* (Bleeker, 1854)
		22. *Botia berdmorei* (Blyth, 1861)
		23. *Lepidocephalus berdmorei* (Blyth, 1861)
4. Siluriformes	5. Bagridae	24. *Sperata acicularis* (Serraris & Runge, 1999)
		25. *Mystus cavasius* (Ham., & Buch., 1822)
		26. *Mystus leucophasis* (Blyth, 1861)
		27. *Mystus pulcher* (Chaudhuri, 1911)
		28. *Hemibagrus menoda* (Ham., & Buch., 1822)
	6. Siluridae	29. *Ompok bimaculatus* (Bloch, 1797)
		30. *Wallago attu* (Schneider, 1801)
	7. Schilbeidae	31. *Clupisoma prateri* (Hora, 1937)
		32. *Eutropiichthys vacha* (Ham., & Buch., 1822)
	8. Sisoridae	33. *Gagata cenia* (Ham, and Buch, 1822)
		34. *Gagata melanoptera* (Roberts & Ferraris, 1998)
		35. *Bagarius yarrellii* (Skyes, 1841)
	9. Loricariidae	36. *Pterygoplichthys disjunctivus* (Weber, 1991)
5.Cyprinodontiformes	10. Belonidae	37. *Xenentodon cancila* (Ham., & Buch., 1822)
6. Synbranchiformes	11.Mastacembelidae	38. *Macrognathus aral* (Bloch & Schneider,1801)
		39. *Macrognathus zebrinus* (Blyth, 1859)
		40. *Mastacembelus armatus* (Lacepede, 1800)
7. Perciformes	12. Ambassidae	41. *Parambassis ranga* (Ham., & Buch., 1822)
	13. Cichlidae	42. *Oreochromis* sp. (Gunther, 1885)
	14. Gobiidae	43. *Glossogobius giuris* (Ham., & Buch., 1822)
	15. Anabantidae	44. *Anabas testudineus* (Bloch, 1795)
	16. Belontidae	45. *Colisa labiosus* (Day, 1876)
		46. *Trichogaster pectoralis* (Regan, 1909)
	17. Channidae	47. *Channa marulius* (Ham., & Buch., 1822)
		48. *Channa orientalis* (Bloch & Schneider, 1801)
		49. *Channa striatus* (Bloch, 1793)
etraodontiformes	18. Tetraodontidae	50. *Tetraodon cutcutia* (Ham., & Buch., 1822)

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Table 2. Monthly occurrence and relative abundance of fish species from Ayeyawady River Segment, Mandalay Region

No	Species name	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Total	Relative abundance	Average relative abundance
1	*Notopterus*	30	28	33	40	39	50	45	38	27	22	12	12	376	0.0062	uC
2	*Hilsa ilisha*	0	0	5	7	8	15	9	10	0	0	0	0	54	0.0009	uC
3	*Gudusia variegata*	100	250	300	350	400	1200	850	700	450	200	90	85	4975	0.0815	vC
4	*Catla*	25	30	25	38	65	110	100	80	65	45	20	20	623	0.0102	C
5	*Cirrhinus mrigala*	20	35	35	50	65	70	58	60	45	30	25	15	508	0.0083	uC
6	*Ctenopharyngodon idellus*	0	0	0	0	0	0	7	5	3	0	0	0	15	0.0002	uC
7	*Labeo angra*	0	7	10	5	8	15	12	6	0	0	0	0	63	0.0010	uC
8	*Labeo boga*	60	75	70	80	85	150	100	150	110	50	0	0	930	0.0152	C
9	*Labeo calbasu*	0	15	20	30	45	110	90	65	50	35	0	0	460	0.0075	uC
10	*Labeo rohita*	0	30	50	55	70	75	60	40	20	10	0	5	415	0.0068	uC
11	*Labeo stoliczkae*	15	0	20	20	25	40	0	0	15	10	8	5	158	0.0026	uC
12	*Osteobrama belangeri*	0	25	110	40	45	130	110	80	75	0	0	15	548	0.0090	uC
13	*Osteobrama cunma*	30	0	55	55	70	110	90	80	0	0	0	25	510	0.0084	uC
14	*Puntius chola*	600	850	2200	1300	1500	2100	1900	1750	1600	1200	750	950	15500	0.2538	vC
15	*Puntius sarana*	350	700	1900	1350	1600	0	2200	1950	1500	0	0	0	10650	0.1744	vC
16	*Barbonymus gonionotus*	0	30	40	35	30	45	38	33	0	25	15	15	301	0.0049	uC
17	*Salmophasia sardinella*	150	470	900	600	750	1200	1100	1000	1050	900	0	100	7870	0.1289	vC
18	*Amblypharyngodon atkinsonii*	175	0	950	450	950	1050	1400	500	400	160	0	0	5085	0.0833	vC
19	*Aspidoparia morar*	125	150	300	160	200	500	600	450	300	200	80	100	3005	0.0492	C
20	*Raiamas guttatus*	30	45	0	0	0	45	20	10	0	0	0	15	165	0.0027	uC
21	*Acantopsis choirorhynchos*	0	0	0	0	4	9	7	0	0	0	0	0	20	0.0003	uC
22	*Botia berdmorei*	0	15	20	30	35	45	0	0	0	0	0	10	155	0.0025	uC
23	*Lepidocephalichthus berdmorei*	20	35	45	50	0	0	50	0	25	19	15	0	259	0.0042	uC
24	*Sperata acicularis*	0	3	2	5	0	10	6	9	5	0	0	0	40	0.0007	uC
25	*Mystus cavasius*	50	0	70	80	0	120	0	150	130	90	0	70	760	0.0124	C
26	*Mystus leucophasis*	2	2	0	4	3	5	0	0	0	0	0	0	16	0.0003	uC
27	*Mystus pulcher*	30	0	35	45	90	180	150	130	0	90	0	40	790	0.0129	C
28	*Hemibagrus menoda*	0	0	4	9	12	15	12	0	0	0	0	0	52	0.0009	uC

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29	*Ompok bimaculatus*	25	35	40	45	35	60	55	45	30	15	0	0	385	0.0063	NC
30	*Wallago attu*	0	9	12	12	15	25	20	0	0	0	0	0	93	0.0015	NC
31	*Clupisoma prateri*	10	15	0	20	25	30	28	0	0	0	0	0	128	0.0021	NC
32	*Eutropiichthys vacha*	15	20	35	35	0	0	45	30	25	0	0	0	205	0.0034	NC
33	*Gagata cenia*	30	35	45	50	60	70	55	30	20	0	5	10	410	0.0067	NC
34	*Gagata melanoptera*	25	25	0	0	30	45	37	25	0	0	0	0	187	0.0031	NC
35	*Bagarius yarrelli*	0	0	0	20	25	40	35	30	15	0	0	0	165	0.0027	NC
36	*Pterygoplichthys disjunctivus*	10	8	9	11	13	15	10	12	10	7	5	8	118	0.0019	NC
37	*Xenentodon cancila*	11	10	25	28	32	42	35	30	18	13	9	15	268	0.0044	NC
38	*Macrognathus aral*	0	20	0	25	30	0	30	20	0	15	5	5	150	0.0025	NC
39	*Macrognathus zebrinus*	39	0	15	18	20	0	0	0	10	0	8	6	92	0.0015	NC
40	*Mastacembelus armatus*	0	15	18	0	0	25	20	18	0	7	0	5	108	0.0018	NC
41	*Parambassis ranga*	90	150	190	225	340	550	475	350	220	80	45	70	2785	0.0456	C
42	*Oreochromis* sp.	20	15	32	30	38	205	198	185	78	50	20	25	896	0.0147	C
43	*Glossogobius giuris*	15	18	20	25	35	95	100	50	0	0	10	15	383	0.0063	NC
44	*Anabas testudineus*	0	0	3	5	5	10	9	0	3	0	0	0	35	0.0006	NC
45	*Colisa labiosus*	0	4	5	9	10	20	15	8	5	0	0	0	76	0.0012	NC
46	*Trichogaster pectoralis*	2	0	3	0	0	10	7	5	3	0	0	0	30	0.0005	NC
47	*Channa marulius*	2	0	0	4	0	5	4	2	1	0	0	0	18	0.0003	NC
48	*Channa orientalis*	0	0	5	9	10	18	15	10	4	0	0	0	71	0.0012	NC
49	*Channa striatus*	5	5	0	8	9	0	15	5	0	0	0	0	47	0.0008	NC
50	*Tetraodon cutcutia*	8	6	9	7	6	10	19	15	18	10	5	8	121	0.0020	NC
	Total number of individuals	2095	3165	4013	5474	6837	8674	10241	6166	6330	3283	1127	1649	61054		
	Total number of species	32	35	39	44	41	43	45	40	33	24	18	25			

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Table 3 Seasonal occurrence and abundance of fish species from Ayeyawady River Segment, Mandalay Region

No.	Species Name	Hot	Rainy	Cold	Total
1	*Notopterus*	73	131	172	376
2	*Hilsa ilisha*	0	12	42	54
3	*Gudusia variegata*	825	1900	1150	3875
4	*Catla*	150	118	355	623
5	*Cirrhinus mrigala*	115	140	253	508
6	*Ctenopharyngodon idellus*	3	0	12	15
7	*Labeo angra*	0	22	41	63
8	*Labeo boga*	160	285	485	930
9	*Labeo calbasu*	85	65	310	460
10	*Labeo rohita*	35	135	245	415
11	*Labeo stoliczkae*	38	55	65	158
12	*Osteobrama belangeri*	90	93	365	548
13	*Osteobrama cunma*	25	135	350	510
14	*Puntius chola*	4500	3750	7250	15500
15	*Puntius sarana*	1500	3400	5750	10650
16	*Barbonymus gonionotus*	55	100	146	301
17	*Salmophasia sardinella*	2050	1770	4050	7870
18	*Amblypharyngodon atkinsonii*	560	625	3900	5085
19	*Aspidoparia morar*	680	575	1750	3005
20	*Raiamas guttatus*	15	75	75	165
21	*Acantopsis choirorhynchos*	0	0	20	20
22	*Botia berdmorei*	10	65	80	155
23	*Lepidocephalichthus berdmorei*	59	150	50	259
24	*Sperata acicularis*	5	10	25	40
25	*Mystus cavasius*	290	200	270	760
26	*Mystus leucophasis*	0	8	8	16
27	*Mystus pulcher*	130	110	550	790
28	*Hemibagrus menoda*	0	13	39	52
29	*Ompok bimaculatus*	45	145	195	385
30	*Wallago attu*	0	33	60	93
31	*Clupisoma prateri*	0	45	83	128
32	*Eutropiichthys vacha*	25	105	75	205
33	*Gagata cenia*	35	160	215	410
34	*Gagata melanoptera*	0	50	137	187
35	*Bagarius yarrellii*	15	20	130	165
36	*Pterygoplichthys disjunctivus*	30	38	50	118
37	*Xenentodon cancila*	55	74	139	268
38	*Macrognathus aral*	25	45	80	150
39	*Macrognathus zebrinus*	24	48	20	92
40	*Mastacembelus armatus*	12	33	63	108
41	*Parambassis ranga*	415	655	1715	2785
42	*Oreochromis* sp.	173	97	626	896
43	*Glossogobius giuris*	25	78	280	383
44	*Anabas testudineus*	3	8	24	35
45	*Colisa labiosus*	5	18	53	76
46	*Trichogaster pectoralis*	3	5	22	30
47	*Channa marulius*	1	6	11	18
48	*Channa orientalis*	4	14	53	71
49	*Channa striatus*	0	18	29	47
50	*Tetraodon cutcutia*	41	30	50	121
	Total number of individuals	12389	14727	33915	61054
	Total number of species	41	48	50	50

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Table 4 List of collected fish species their occurrence frequency (%) and status from Ayeyawady River Segment, Mandalay Region

No	Species name	Occurrence frequency (%)	Status
1	*Notopterus notopterus*	100.00	Common
2	*Hilsa ilisha*	50.00	Occasional
3	*Gudusia variegata*	100.00	Common
4	*Catla catla*	100.00	Common
5	*Cirrhinus mrigala*	100.00	Common
6	*Ctenopharyngodon idellus*	25.00	Sporadic
7	*Labeo angra*	58.33	Occasional
8	*Labeo boga*	83.33	Abundance
9	*Labeo calbasu*	75.00	Frequent
10	*Labeo rohita*	83.33	Abundance
11	*Labeo stoliczkae*	75.00	Frequent
12	*Osteobrama belangeri*	75.00	Frequent
13	*Osteobrama cunma*	66.66	Frequent
14	*Puntius chola*	100.00	Common
15	*Puntius sarana*	50.00	Occasional
16	*Barbonymus gonionotus*	83.33	Abundance
17	*Salmophasia sardinella*	91.66	Common
18	*Amblypharyngodon atkinsonii*	66.66	Frequent
19	*Aspidoparia morar*	100.00	Common
20	*Raiamas guttatus*	50.00	Occasional
21	*Acantopsis choirorhynchos*	25.00	Sporadic
22	*Botia berdmorei*	50.00	Occasional
23	*Lepidocephalichthus berdmorei*	66.66	Frequent
24	*Sperata acicularis*	58.33	Occasional
25	*Mystus cavasius*	66.66	Frequent
26	*Mystus leucophasis*	41.66	Occasional
27	*Mystus pulcher*	75.00	Frequent
28	*Hemibagrus menoda*	41.66	Occasional
29	*Ompok bimaculatus*	83.33	Abundance
30	*Wallago attu*	50.00	Occasional
31	*Clupisoma prateri*	50.00	Occasional
32	*Eutropiichthys vacha*	58.33	Occasional
33	*Gagata cenia*	91.66	Common
34	*Gagata melanoptera*	50.00	Occasional
35	*Bagarius yarrellii*	50.00	Occasional
36	*Pterygoplichthys disjunctivus*	100.00	Common
37	*Xenentodon cancila*	100.00	Common
38	*Macrognathus aral*	66.66	Frequent
39	*Macrognathus zebrinus*	58.33	Occasional
40	*Mastacembelus armatus*	58.33	Occasional
41	*Parambassis ranga*	100.00	Common
42	*Oreochromis* sp.	100.00	Common
43	*Glossogobius giuris*	83.33	Abundance
44	*Anabas testudineus*	50.00	Occasional
45	*Colisa labiosus*	66.66	Frequent
46	*Trichogaster pectoralis*	50.00	Occasional
47	*Channa marulius*	50.00	Occasional
48	*Channa orientalis*	58.33	Occasional
49	*Channa striatus*	50.00	Occasional
50	*Tetraodon cutcutia*	100.00	Common

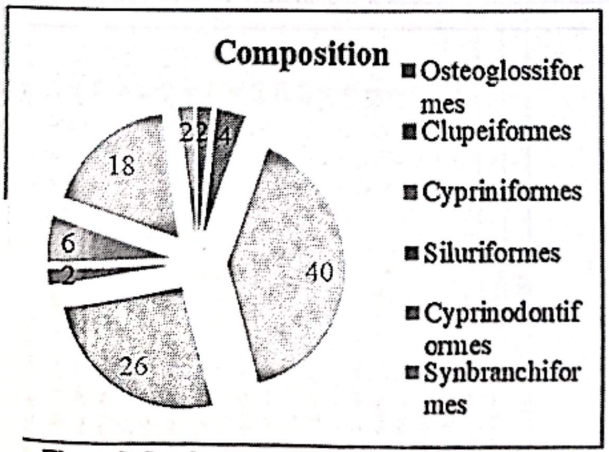

Figure 2. Species composition of fishes in different orders from Ayeyawady River Segment

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Discussion

Ayeyawady is the Myanmar's largest river and most important commercial waterway.In the present ichthyofaunal study, different fish species were observed in the Ayeyawady River segment, Mandalay Region. A total of 50 fish species belonging to 38 genera, 18 families and eight orders were collected during the study period. Many fishes have economic importance and sold after collection in the local fish market. Study showed that, the members of order Cypriniformes dominated by 20 species (40%) followed by Siluriformes 13 species (26%), Perciformes with 9 species (18%), Synbranchiformes with 3 species (6%), Clupeiformes with two species (4%) and Osteoglossiformes, Cyprinodontiformes and Tetraodontiformes with one species (2%) each.

The above study reveals that there is dominance of fish species belonging to order Cypriniformes. The predomenance of Cypriniformes in the Ayeyawady River segment is not surprising, since Cypriniformes is the largest of all fish orders (Day,1889). Many researchers were also reported by working on different localities, Aye Aye Thin (2013), reported 36 fish species in Htanaungdaing In, Myingyan Twonship. Sanda Maung (2013) also reported 43 fish species in Pauk In, Pakokku Township.

In the order Cypriniformes, the number of both genera and species are higher than those of the remaining orders. Even the single family Cyprinidae is represented by 17 species confined to 11 genera. This finding is an agreement with Perveen FK and Uddin A (2015), they reported that cyprinids are the major freshwater fish group and thus become conspicuous parts of the fauna in different water bodies.During the study period, the highest number of species (45) and individuals (10241) in December and the lowest number of species (18) and individuals (1127) in April were recorded. The number of fish species gradually increased start from July to December. The highest both number of species and individuals were captured in December, afterward declined in January. The lowest both number of species and individuals in April were captured.

Seasonally, the maximun number of species (50) and individuals (33915) in cold season and the minimum number of species (41) and individuals (12389) in hot season were observed. Pracitally, inland fisheries can operate all year round but the amount caugh may vary from season to season. Freshwater fish are abundant during June to September of rainy season. During this period rivers, wetland and floodplains are very productive as new water activates spawning.Following the rainy season (October to December) water level in most inland habitat starts leveling off. This enables fishers to easily access grown fish using various fishing gears. Fishing can be done all year round in rivers and lakes (Khin Maung Aye *et al*., 1996; cited by Htay Htay Sein, 2010).

In the present study, 11 species were caughted throughout the year in Ayeyawady River. Among these species, *Pterygoplichthys disjunctivus* and *Tetraodon cutcutia* are of no commerical value because it is generally not consumed as food. The remaining fish species are more or less commercially important in the local markets as nutritious food for the local consumers.

During the study period, based on the relative abundance, five species were recorded as very commom, seven species as commom and 38 species as uncommon. Based on the occurrence frequency, 13 species were as common, 20 species were as occasional, five species were as abundant, 10 species as frequent and two species as sporadic.Fish and other aquatic resources are important to human livelihoods especially in many developing countries. The Ayeyawady River supports diverse and abundant population of freshwater fishes in myanmar. The floodplains of the Ayeyawady River are highly productive and play an important role in the ecology of the river system. Therefore, Ayeyawady River becomes an important role for food and economy of the people in Myanmar. Ayeyawady River also provide livelihood for many population near the river.

Conclusions

The Ayeyawady River is one of the largest rivers in Myanmar and most important commercial waterway. The Ayeyawady is also the engine of the Myanmar economy. It is an important natural shelter for many aquatic flora and fauna. It feeds the country's population with fish and rice and enable good to be transported to people up and down the river. Therefore, Ayeyawady River is important to both Myanmar' economy and society.

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Assessment of Water Quality with Indicators of Zooplanktons and Physico-Chemical Parameters in Moeyungyi Wetland, Myanmar

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Abstract

To be assessed the water quality of Moeyungyi wetland, the study was conducted from June, 2016 to May, 2017. Moeyungyi Wetland Wildlife Sanctuary is located in Bago Division. It is one of the major wetlands since it supports service functions and habitats for many biodiversity. The aim of the present study is to assess the water quality of this wetland and the objectives are (i) to assess monthly fluctuations of zooplankton abundance and diversity, (ii) to analyze the relationship between physico-chemical characteristics and zooplankton fauna and (iii) to evaluate seasonal changes in water quality index (WQI). The data collection of zooplankton was made in three sampling sites monthly and physical parameters of water were also recorded. Water quality index (WQI) is commonly used for the detection and evaluation of water. To be analyzed the data, Shannon Diversity Index "H", Pielou Evenness Index "J", Simpson Diversity Index "D" and Margalef Diversity Index "Ma" were used. In this study, it had been done on the seasonal fluctuations of zooplankton fauna and its relation to physico-chemical characteristics of this freshwater wetland. A total of 47 species of zooplankton were found, the species richness of the group rotifer (57.4%) was highest. The rotifer dominated the overall compositions, it means that water body is mesosaprobic condition. According to Shannon index (H) values and Margalef diversity index almost the habitat structures are polluted and degraded. The computed WQI value 196.4899 also indicated as the water is poor condition. Based on the result, water quality of Moeyungyi wetland is mesosaprobic (slightly polluted with organic matter) and poor condition that provides the aquatic biodiversity.

Keywords: Moeyungyi wetland, zooplanktons, physico-chemical parameters.

Introduction

In ecological point of view wetlands are very important for biodiversity. Wetlands have played an important role for humankind especially in tropical regions. These are characterized by a large number of ecological niches and harbour a significant percentage of world's biological diversity. (Brock and Jarman 2000) The richness of wetlands depends a lot on its plankton community because they are placed on the base of the food pyramid (Groot (1992).

Livestock treading in the wetland physically damages plants, causes soil disturbance, increases turbidity, compacts the soil, and creates bare ground. These changes can alter water clarity, microclimate, the infiltration of water and air into the soil, soil strength and carbon stores. This adversely affects plant growth, results in compositional changes in vegetation, and can affect soil organisms and nutrient processing (van der Valk 1986).

The definition proposed by UNEP (United Nations Environment Programme) emphasizes the contribution of organic matter: "Eutrophication" is defined as an environmental disturbance caused by excessive supply of organic matter. (Karydis 2009)

Moeyungyi wetland is the man-made reservoir. It is one of the major wetlands since it supports services function for many biodiversity and it is the first Ramsar site in Myanmar (2004, Ramsar site No.1431). It has a unique production service. It is a mass production of leech, this production is related to buffalo population. There are over 5000 buffalos grazing into Moeyungyi wetland and they discharge a lot of dung and urine into the water. This can cause the rich of nutrient and organic pollution to the water.

One way to detect disturbance impact upon wetlands is to analyze changes in communities of organisms that are particularly sensitive to environmental change. Zooplankton, consisting of the microcrustacean groups Copepoda and Cladoceran, as well as all individuals from the phylum Rotifera, have been assessed as indicators in freshwater ecological disturbance studies (Holt & Miller, 2011), examining individual groups and their combined communities as a whole.

Zooplankton can also be used as "bioindicators" for water pollution studies, because their occurrence, vitality and responses, change under adverse environmental conditions (Oliver, 1996).

The zooplanktons have short life span and their community often dramatically changes in response to the changes in the physico-chemical properties of the aquatic environment. Pollution firstly affects the physico-chemical characteristics of the wetland then systematically destroys the community structure, disturbing the delicate food web and is also hazardous to the public health (Jindal and Sharma, 2011).

And another way to detect the disturbance impact water quality index (WQI) was used in this study, this method is commonly used for the

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detection and evaluation of water pollution and may be defined as "A rating reflecting index of different quality parameters on the overall quality of water" (Mishra and Patel, 2004).

In Moeyungyi wetland, no systematic work has been done on the seasonal fluctuations of zooplankton fauna and its relation to physico-chemical characteristics of this freshwater wetland. Moreover, it was observed that this wetland has not been exploited earlier for water quality assessments have been carried out during the study period. The present study measures water parameters such as chemical and physical factors of water were expected to have effects on zooplankton community structure.

Aim and objectives-

The aim of the study is to assess the water quality of Moeyungyi wetland and the objectives of this study are-

i) to assess monthly fluctuations of zooplankton abundance and diversity of the study sites
ii) to analyze the relationship between physico-chemical characteristics and zooplankton fauna in this wetland
iii) to evaluate seasonal changes in water quality index (WQI)

Materials and Methods

Study area

Moeyungyi Wetland Wildlife Sanctuary (WWS) is located in the administrative region of Bago in Myanmar, 25 km north-northeast of Bago town. It is located in the latitude 17° 30′ 16″ to 17 36′ 16″ N and longitude 96° 31′ 47″ to 96° 40′ 26″E.The Sanctuary covers 10,360 ha, 82% of which is freshwater marshes, 10% is permanently covered by the lake and 8% is cultivated land in the dry season (rice paddies).

Study period

The study was carried out from June, 2016 to May, 2017. During the study period, sampling was made monthly.

Data collection and preservation of zooplankton samples

To be collected the zooplanktons, three sampling sites were chosen (two buffalo grazing sites and one (non grazing) open water site). In each sampling site, a total of 100 liters of water was being filtered with plankton net (mesh size 100μm) and data collection was carried out monthly. All samples were preserved in 5% formaldehyde solution. The taxonomical identification and numbers of population abundance of water sample were done by drop count method under the microscope.

To be calculated the water quality index (WQI), the physical and chemical water parameters also were recorded monthly.

Identification of zooplankton fauna

Taxonomic identification was carried out following Edmondson (1959), Koste (1987), Segers (1995), Pennak (1966), Pennak (1978) and Sharma(1999).

Data analysis

Species diversity, abundance and richness is determined by following Solow (1993) and May (1975) and used following diversity indices-

1. ***Shannon Diversity Index "H"***

$H = -\Sigma [(ni / N) \times (\ln ni / N)]$

H: Shannon Diversity Index

ni: Number of individuals belonging to *i* species

N: Total number of individuals

2. ***Pielou Evenness Index "J"***

$J = H / Hmax$

J: Pielou evenness index

H: The observed value of Shannon index

Hmax : lnS

S: Total number of species

3. ***Simpson Diversity Index"D"***

Simpson's index of dominance:

$D=\Sigma ni (ni-1)/N (N-1)$

Where, ni = the total number of individuals of a particular species. N = the total number of individuals of all species.

Simpson's index of diversity: 1 – D

4. ***Margalef Diversity Index "Ma"***

$Ma= (S-1) / \ln N$

Ma: Margalef Diversity Index

S: Total number of species

N: Total number of individuals

Where S= total number of species

N= total density, Ni= density of individual species

Study of water quality

For the study of water quality parameters, three samplings were made in the Moeyungyi wetland.

Application of the WQI (Water Quality Indices)

This study is an attempt to evaluate the water quality of Moeyungyi wetland. For this purpose, nine water quality parameters have been selected which are: total dissolved solid (TDS), pH, dissolved oxygen (DO), biological oxygen demand (BOD), ammonia (NH3), turbidity, nitrate (NO3), nitrite (NO2) and Phosphorus. In the formulation of WQI, the importance of various parameters depends on the intended use of water; the 'standards' (permissible values of various parameters) for the water used in this study are those recommended by the WHO. The calculation and formulation of the WQI involved the following steps: In the first step, each of the nine parameters has been assigned a weight (AW_i) ranging from 1 to 4 depending on the references used are shown in Table 6 (Abdul Hameed M. Jawad Alobaidy, Haider S. Abid, Bahram K. Maulood, 2010). In the second step, the relative weight (RW) was calculated by using the following equation:

$$WQI = \sum_{i=1}^{n} SI_i$$

$$RW = \frac{AW_i}{\sum_{i=1}^{n} AW_i} \qquad (1)$$

where, RW = the relative weight, AW = the assigned weight of each parameter, n = the number of parameters. The calculated relative weight (RW) values of each parameter are shown in Table 6.

In the third step, a quality rating scale (Q_i), except

$$Q_i = \left[\frac{C_i}{S_i}\right] \times 100 \qquad (2)$$

pH and DO, for all the parameter was assigned by dividing its concentration in each water sample by its respective standard according to the drinking water guideline recommended by the drinking water standards, the result was then multiplied by 100.

The pH or DO quality rating was computed on the basis of, where, Q_i = the quality rating, C_i = value

$$Q_{pH,DO} = \left[\frac{C_i - V_i}{S_i - V_i}\right] \times 100 \qquad (3)$$

of the water quality parameter get from the recorded and laboratory analysis, S_i = value of the water quality parameter obtained from recommended WHO standard of corresponding parameter, V_i = the ideal value which is considered as 7.0 for pH and 14.6 for DO. Equations (2) and (3), when a pollutant is totally absent in the water sample the Q_i = 0 and when the value of this parameter is just equal to its permissible value the Q_i = 100. Thus the Q_i value is higher, the water is more polluted. Finally, for computing the WQI, the sub indices (SI_i) were first calculated for each parameter, and then used to compute the WQI as in the following equations:

$$SI_i = RW \times Q_i$$

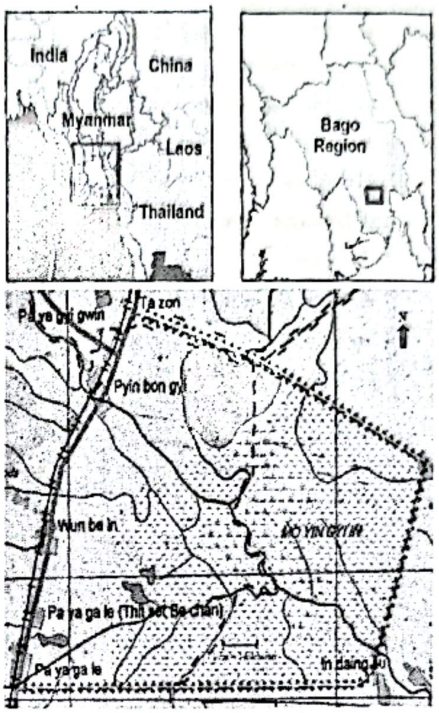

Figure 2. Map of the study site

Result

A total of 47 species of zooplankton were sampled from Moeyuggyi wetland throughout the study period. Which was represented by Rotifera (28 species), Cladocera (13 species) and Copepoda (6 species). Rotifera was represented by the families Brachionidae (14 species), Testudinellidae (4 species), Asplanchnidae (2 species), Tricocercidawe (2 species), Notommatidae, gastropidae, Lecanidae, Synchaetidae, Hexarthridae and Philodinidae were each with only 1 species respectively. The representative Cladocera families were Chydoridae (5 species), Bosminidae (1 species), Daphnidae (5 species) and Sididae (2 species). Copepoda was represented by the families Cyclopoidae (2 species), Diaptomidae (2 species), Calanoidae, Centropagidae and Harpacticoidae, each one with 1species. Monthly dominant species of rotifer in all sampling sites was show in Table 1, for cladoceran in table 2 and for those of copepods in Table 3. The most dominant rotifer species is *Keratella cochlearis* which was found in all sampling sites. *Bosmina coregoni* and *Diaphamosona brachyurum* are the most dominant species of cladocerans in all sites. In the order Copepoda, *Calanoid* sp and *Cyclopoid* sp were found in all sampling sites and they are dominant.

Table. 1. Monthly abundance (Ind/100l) of zooplankton species (Rotifera) in Meoyungyi wetland

ROTIFERA	Jun	July	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Total
Asplanchna priodonta				3	8	32	26	12	8	2	1	1	93
Asplanchna brightwell				1	2		1		1				5
Branchionus angularis					1	1	2			1			5
Branchionus calyciflorus				1				1		1		1	4
Branchionus caudatus					2	2	2	1	1		1		9
Branchionus diversicornis					1	1	3	2		1			8
Branchionus falcatus				1	3	3	1	2	3	2	2	1	18
Branchionus quadridentatus				4		2	1	2	4	2	1	1	17
Cephalodella auriculata	1		1		2		1	4	2	2	1		14
Chromogaster ovalis					1	2	1	2	1		1		8
Dipleuchlanis propatula		1			2		2	2	3	1	2		13
Filinia branchiate					2	2	5	1	1				11
Filinia opoliensis	1	1		2	2	3	3	3	1	2		3	21
Filinia longiseta		1						2	2		1		6
Filinia terminalis	1		1		2	1	4	3	1	2	1	1	17
Keratella cochlearis	3	2		2	5	4	4	41	38	22	10	3	134
Keratella quadrata					3	1	2		2		2	1	11
Keratella valga		1	1	3	8	1	32	3	7	7	5	3	71
Monostyla bulla				2	3		2	4	2		2		15
Notholca acuminate					3	4	1	2		2		1	13
Notholca sp				1	2	2	2	4	3	2		1	17
Pedalia mira				1	1			1		1			4
Philodina sp		1				2	3		1		2		9
Platyias quadricornis	1		2		1	2	2	4	1	2	2		17
Polyarthra vulgaris	4		1	2	4	1	5	6	8	3	3	1	38
Trichocerca capucina					1		3		1				5
Trichocerca cylindrical		1			1	1	3	1	1		2	2	12
Trichocerca longiseta				3	2		7	1	3	1	1		18

Table. 2.Monthly abundance (Ind/100l) of zooplankton species (Cladocera) in Meoyungyi wetland

CLADOCERA	Jun	July	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Total
Alona affinis	1	1		2	3	4	1	1	1	2			16
Alona Karau		1		3			5	5	3	1		1	19
Alona monacantha			1		2	1		2	1	1			8
Bosmina coregoni	30	25	20	44	151	176	151	82	44	36	28	40	827
Chydorus piger	1				2	1		2	2		1		9
Daphnia pulex		1		2		2	4		2	3			14
Diaphamosona brachyurum	5	4	3	20	69	107	57	32	24	25	16	10	372
Diaphomosona leuchtenbergianum		1	1	2	3		7	2	5	3	1	3	28
Leydigia acanthocercoides	2			1	3	7	4	2			1		20
Moinodaphnia macleayti			1	3	1	4	4	4	2	1	1		21
Moina micrura	2	1		5	14	25	1		12	4	1	1	66
Moina sp	1	2	1	1	8	11	6	1	8	3		3	45
Simocephalus vetulus				2	2	3	5		3		1		16

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Table. 3.Monthly abundance (Ind/100l) of zooplankton species (Copepoda) in Meoyungyi wetland

COPEPODA	Jun	July	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Total
Calanoid sp	20	16	17	23	62	91	130	97	53	37	32	27	605
Cyclopoid sp	26	17	15	32	178	296	236	211	146	117	47	46	1367
Harpaticoid sp	2		2	2	2	6	11	9	9	7	4	1	55
Leptodiaphonus sicilis		2		2	7	21	12	6	2			1	53
Limnocalonus macrurus				2	6	11	8	3	4	1	1	1	37
Skistodiaptomus oregonensis	2		1	2	2	5	3	3		2	1		21

Table. 4. Calculation of Species Diversity Indices

Site	Species	Shannon Diversity Index "H"	Pielou Evenness Index "J"	Simpson Index of Diversity "1-D"	Margalef Diversity Index "Ma"
Site 1	Rotifer	2.39334615	0.786115458	0.838579	3.627507
	Cladocera	1.148476152	0.640976745	0.624882	1.792194
	Copepoda	0.885003242	0.493929714	0.508504	0.71187
Site 2	Rotifer	2.681861	0.880880569	0.89508	3.881015
	Cladocera	1.571004117	0.632218565	0.805823	1.940076
	Copepoda	0.963859393	0.53794017	0.491736	0.746737
Site 3	Rotifer	1.975926184	0.729649023	0.810591	2.662865
	Cladocera	0.502417697	0.36241776	0.216391	0.609529
	Copepoda	0.856774761	0.618032349	0.533696	0.375384

Table 5. Correlation coefficient (*r value*) between physic-chemical characteristics of water and zooplankton abundance in Moeyungyi wetland

	TDS (mg/L)	pH	DO (mg/L)	BODs (mg/L)	Ammonia NH3 (mg/L)	Turbidity (FAU)	Nitrate (NO3) (mg/L)	Nitrite (NO2) (mg/L)	Phosphorus (mg/L)
ROTIFER	0.241072*	0.443998*	0.913439*	-0.71985*	0.296369*	-0.70943*	0.357928*	0.436858*	0.633473*
Asplanchna	-0.26703*				-0.0833*		0.325996*	0.295717*	0.37337*
Branchionus	0.08973*	0.37150*	0.8915*	0.66421*		-0.72125*	0.129645*	0.24308*	0.594266*
Cephalodella	0.44066*	0.65473*	0.683491*	-0.44452*		-0.22004*		0.53335*	0.362569*
Chromogaster	0.065714*				0.136075*				0.512949*
Dipleuchlanis			0.720467*	-0.52415*	0.386864*	-0.31575*	0.172898*		0.406391*
Filinia	0.155923*		0.743315*	-0.58372*		-0.71198*	0.539709*	0.590444*	0.489113*
Keratella	0.53125*	0.74616*	0.894061*	-0.75545*	0.514118*	-0.51064*	0.279943*	0.279943*	0.670342*
Monostyla	0.165983*	0.3981*				-0.24117*	0.10493*		0.14914*
Notholca	0.11212*	0.28950*	0.724215*	-0.51742*		-0.65991*		0.388064*	0.495908*

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Pedalia			0.4993*	-0.02777*		-0.066879*	-0.0642*	0.341657*	
Philodina	-0.03882*		0.207615*	-0.35777*		-0.54123*	0.450678*	0.012925*	0.36812*
Platyias	0.317015*	0.32907*				-0.46923*	0.152905*		
Polyarthra	0.200136*	0.60585*	0.76286*	-0.58927*	0.43137*	-0.34747*		0.182419*	0.456536*
Trichocerca	-0.09155*		0.56678*		0.00443*	-0.43275*	0.68852*	0.195879*	
CLADOCERA	-0.36929*	-0.22493*			-0.14226*	-0.63589*	0.135482*		
Alona	-0.01983*	0.29207*				-0.38712*	0.325596*		
Bosmina	-0.3658*	-0.27918*			-0.2256*				
Chydorus	0.015769*	0.35722*				-0.29241*	-0.42355*		
Daphnia	-0.04047*	0.05874*			0.13789*	-0.32181*	0.596922*		
Diaphanosoma	-0.33746*	-0.1925*			-0.06696*		0.05814*		
Leydigia	-0.51068*	-0.4919*				-0.60204*	0.10571*		0.169779*
Moinadaphnia			0.603346*	-0.36082*		-0.52506*	0.362917*		
Moina	-0.4242*		0.29203*			-0.41845*			
Simocephalus	-0.35157*	-0.09398*				-0.47462*	0.422109*		
COPEPODA	-0.045	0.067469*			0.068895*	-0.78009*	0.272655*		
Calanoid sp	0.02821*	0.06744*	0.70713*		0.004965*	-0.75221*	0.479286*	0.561677*	
Cyclopoid sp	-0.04736*	0.09040*			0.103331*	-0.77468*			
Harpacticoid sp			0.838403*	-0.76434*		-0.6699*	0.406479*		0.7264*
Leptodiaptomus sp	-0.35633*	-0.34955*				-0.61922*	0.190304*		
Limnocalanus sp	-0.34434*	-0.1785*				-0.67369*	0.170462*		0.310807*
Skistodiaptomus sp	-0.39551*	-0.33633*	0.343616*	-0.20594*		-0.53564*	0.147477*		0.216694*

*significant at 0.5 level

Table. 6. Assigned weight values

Parameters	References number								Mean Value
	10	23	34	35	36	37	38	39	
pH(pH unit)	4	1	4	1	1	1	4	1	2.1
DO (mg/L)	4	4	4	4	4	4	4	4	4.0
BOD (mg/L)	3	3	3	2	3	3	4	3	3
Turbidity(NTU)	2	2	2	-	-	4	-	2	2.4
Total dissolved solids (TDS)	4	4	4	4	4	4	4	4	4.0
nitrate NO3 (µg/L)	-	2	-	3	2	2	-	2	2.2
nitrite NO2 (µg/L)	-	2	-	-	2	2	-	2	2.0
Phosphorus	-	1	1	-	1	1	-	1	1

Table 7. Calculation of *RW, Q, SI* & *WQI* values from the water quality parameters.

	Water quality standard	Assigned weight (*AW*)	Relative weight (*RW*)	Quality rating (*Q*)	Sub-indices (*SI*)
pH(pH unit)	6.5-8.5 (8.0)	2.1	0.101449	-227.037037	-2.70813
DO (mg/L)	5.0	4.0	0.193237	109.5355903	17.17939
BOD (mg/L)	5.0	3	0.144928	104.3009259	19.32367
Turbidity (NTU)	5.0	2.4	0.115942	3244.398148	159.0982
Total dissolved solids (TDS)	500	4.0	0.193237	4.256018519	1.14117
nitrate NO_3 (µg/L)	50.0	2.2	0.10628	10.76157407	1.508588
nitrite NO_2 (µg/L)	3.0	2.0	0.096618	0.388117284	0.092145
Phosphate	1.0	1.0	0.048309	9.550925926	0.854804
WQI					196.4899

The computed WQI values; 50= Excellent, 50-100 = Good, 100-200 = Poor, 200-300 = Very poor, >300 = Unsuitable

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Discussion

In the result, Shannon index "H" values are the range between 0.50 to 2.68 in all sampling sites, it means that the habitat structures are polluted and degraded. The almost calculated Pielou Evenness Index "J" values of Rotifer are closer to 1 in all sites, it means that the individuals are distributed equally. In sites 1 and 2, "J" vales of Cladocera are above 0.6, it means that the individuals are likely distributed equally. The calculated "J" vales of Copepoda are not closer to 1, it means that the individuals are not distributed equally. The Margalef index commonly varies between 1 and 5, the larger the index indicates the healthier body of water. According to the result of Margalef diversity index towards between 0.3 to 3.8, therefore the wetland water body is moderately polluted.

Physico-Chemical Characteristics

During the study period, the pH values ranges from 6.31 to 7.59. The maximum pH value was recorded in the month of February and minimum in the month of November. pH was alkaline throughout the study period. The values of DO slightly fluctuate; the maximum values were recorded 7.06 mg/l in the month of February and minimum values 4mg/l in the month of November. The high DO is attributed due to high temperature during that month of February. The turbidity of water fluctuated range from 20 to 271NTU. The maximum value was recorded in all grazing sites as this comprises with other non-grazing sites (open water). The maximum turbidity in grazing sites may be due to buffalo grazing activities and lowest water level during the study period. The value of phosphate ranges from 0.05 mg/l to 0.42 mg/l. The value of phosphate was recorded in stabilizing of all study sites. The value of nitrate ranges from 0 to 16 mg/l. The high value of 16 mg/l was observed in grazing site 1due to very shallow water condition, discharge of buffalo sewage (dung and urine) and the fertilizer run off from paddy field. The value of ammonia ranges from 0.25 mg/l to 1.8 mg/l. The amount of ammonia concentration was observed in levels above 0.1 mg/l N, this indicate the possibility of pollution and contamination of water bodies due to the buffalo grazing activities and also used to cultivation of rice field around the dry area of wetland.

The zooplankton population exhibited correlation with nine parameters in Moeyungyi wetland. The parameters of biological oxygen demand (BOD) and turbidity exposed negative correlation with zooplankton population. Turbidity showed the highest negative correlation (r = -0.78009) and dissolved oxygen revealed the highest positive correlation (r = 0.913439).

The calculated valve of WQI 196.4899 is included in the range of 100 – 200. The values of quality rating (Q) and sub-indices (SI) of turbidity are notably higher than other parameters. Grazing is one of the factors that causing turbid water of the wetland. The result of WQI value indicates water quality of the wetland is poor condition.

Conclusion

During the research period, the wetland quality was evaluated with three parameters;

(i) abundance of zooplankton diversity as bio-indicator,

(ii) their relation with physico-chemical characteristics as physical factors and

(iii) water quality index (QWI) assessment.

A total of 47 species of zooplankton were found from the Moeyungyi wetland. The species richness of the group rotifer (57.4%) was highest. A total of 26 species of rotifera belonging to 14 genera and 10 families were found during the period of investigation. These were followed by cladocerans. The rotifera dominated the overall composition of water body followed by the cladocera but copepod species shows comparatively more numerical dominance in Moeyungyi wetland. Physico-chemical parameters indicate prevalence of desirable quality of water in the wetlands but all grazing sites and non-grazing sites having lesser zooplankton diversity but higher zooplankton density stipulates the gradual deterioration of water bodies.

According to the investigation of WQI values is 196.4899, although by overall water quality of wetland is poor levels but individual parametric analysis gives more accurate problems of the wetlands. Hence although by WQI study the Moeyungyi wetland has poor condition, but it is likely to become more contaminated in near future.Understanding of the wetlands and their quality assessment become increasingly more and more important in the future climatic change scenario, hence more accurate and extensive study of water quality of wetlands is worth requirement.

In the present study, both the zooplanktons and physical parameters are indicated Moeyungyi wetland is moderately polluted with organic matter. This condition is good for food chain of wetland ecosystem, it provides the nutrients for the fundamental autotrophs and then higher trophic levels. There are many effects of grazing in wetland but it has input the organic nutrients (from their dung and urine) into wetland and it passively maintains the abundances of biodiversity. Finally, the water quality of Moeyungyi wetland is mesosaprobic and the study will help to conserve the biodiversity of the wetland.

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ZOL 019

Seasonal distribution of fish species in Duya "In" leasable fishery in Hinthada District, Ayeyawady Delta Region

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Abstract

The catch weight quantity of natural fish and replenish fish in Duya "In" leasable Fishery was recorded in respect to different fishing zones of the water depth for three years from January 2016 to December 2018. Relevant to the different fishing zones in Duya has sectioned Zone-I (3.5m) Bay chaung, Zone-II (4.5m) Yin tike kone, Zone- III (5.5m) Phayar gyi kyun, Zone IV (8.5m) Duya, and Zone-V (11.45 m) Pauk yoo respectively. It was identified 23 natural fish species and four replenish fish species from all water depth zones. According to the monthly samples, the total catch weight of natural fish in 2016 was higher than that of 2017 and 2018, but trended was slightly increased again in 2018. Relating to the catch weight of replenished species, it was observed the lowest in 2016, however it was increased in 2017 then slightly decreased in 2018. Within these three years of studied, the total catch weight of replenish and natural fish were significantly different found to be varied between the different water depth zones.

Keywords: leasable fishery, natural fish species, replenish fish species, water depth zones

Introduction

Formally, "Duya leasable fishery" so call traditionally "In" was connected with Ayeyawady River and formed enriched spawning and nursery ground for several natural fish species, which favored the Duya leasable fishery "In" as one of the most productive leasable fisheries in Myanmar.

However, construction of an irrigated dam along the west bank of Ayeyawady River at the segment in Hinthada Township had interfered the migratory path of brood and fingerlings of natural fish species between the "In" and the Ayeyawady River. Over the time, population size of natural fish in the area began to decline and impacted fish production. Moreover, some confined migratory species begun vulnerable from extinct. Nowadays, Duya "In" leasable fishery is formed as oxbow like confined water body or a reservoir.

In view of more fish supply for food security, counter measure against declining catch of natural fish species has been replenishing with common commercial aquaculture species: mainly of hatchery breed *Labeo rohita* (Rohu) and wild collected *Cirrhinus mrigala* (mrigala) and *Catla catla* (Catla), and *Oreochromis niloticus* (Nile tilapia). Also replenish were high market valued but non-aquaculture local species such as carplets, puntius, feather-back, snakehead, mola-carplet, sheat catfish, gobies, calbasu carp, nandina carp were not much as the aquaculture species.

At the present, catch weight from the Duya "In" becomes increase due to the growing of simultaneously replenished and recruited fish species. Naturally breeding of Tilapia, Rohu carp and other replenish local species propagating in the Duya "In" seems boosted fish production from the area.

In this context, present study was carried out to identify the following objectives:

- the natural and replenished fish species found in the study area
- the spatial and temporal distribution of fish between the fishing zones by water depth

Materials and methods

Study area and study period

Duya "In", is one of the famous leasable fisheries at Duya village in Hinthada District in Ayeyawady Delta Region (Fig.1). Study period was lasted three years from January 2016 to December 2018.

Duya "In" is located about 10.8 kilometer to the south of Hinthada Township. The water surface area covered about (427) hectare where a land of about 104 hectares emerged at the center of Duya "In". There are five fishing villages along the perimeter, which are –

- Bay chaung village: (17.57°N - 17.56°N; 95.48°E - 95.49°E) covering about1421.14k m^2, depth ranged about 1.85-3.5 m.
- Yin tike kone village: (17.54° N - 17.55°N; 95.50°E - 95.52°E) covering about 612.37km^2, depth ranged about 1.85-4.5 m.
- Phyar gyi kyun village: (17.55°N -17.57°N; 95.49° E-95.50° E) covering about 1657.567km^2, depth ranged about 1.85-5.5 m.
- Duya village: (17.55° N - 17.56°N; 95.48°E-95.49°E) covering about 2074.19k m^2, depth ranged about 1.85-8.50 m.
- Pauk yoo village (17.54° N - 17.55°N; 95.49° E - 95.50° E) covering about 1634.56 km^2, depth ranged about 1.85-11.45 m .

The bottom topography is varied from flat ground, basin like, steep slopes to a deep narrow channel. Maximum depth of 10.95 m was found in the south western part of the leasable fishery "In". The bottom profile of the eastern and northern parts was found plain. The depth was ranged

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between 1.4 -5.6 m (Taweekiet, 2009).

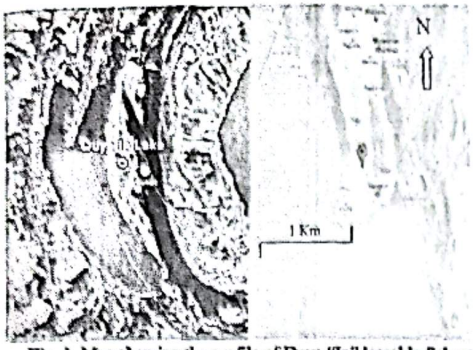

Fig. 1. Map showing the profile of Duya "In" leasable fishery (Source: Google Earth)

Monthly sampling was randomly carried out from the commercial fishing by using different fishing nets. The replenish carp species were captured by cast net of 3 meter diameter, seine net with the mesh sizes of 10.12 cm and 7.62 cm and set gill net with the mesh size of 11.43 cm. Natural fish species were captured by seine net with the mesh size of 1.27 cm and set gill net with the mesh size of 2.54 cm.

At least 20 samples were collected and measured length and weight. Total length was measured by using punch paper and measuring board for the fishes smaller than 50 cm (< 50 cm). Those fishes larger than 50 cm and above were measured by measuring tape. Individual weight of the sampled fishes was measured by a top loading balance and then recorded all measurements. Catch quantities for all species also were recorded. The identification of fish was followed and referred to Carpenter and Niem, (1998) and Talwar and Jhingran (1991).

Results

Throughout the study period from January 2016 to December 2018, it was identified 23 natural fish species and 4 replenished fish species from Duya "In". These species belong to 20 genera from 16 families under 6 orders (Table 1).

The carp and other species use for annually replenishing were identified and listed (Table 2). The natural fish species composition was identified and listed (Table 3).

Table 1. Species composition from the total catch of Duya "In"

Sr. No	Order	Family	Genus	Species		Total Species
				Replenish	Natural	
1	Osteoglossiformes	1	1	-	1	1
2	Clupeiformes	1	1		1	1
3	Cypriniformes	1	8	3	8	10
4	Siluriformes	2	2	-	4	5
5	Cyprinodontiformes	2	2	-	2	2
6	Perciformes	6	6	1	7	8
	Total	16	20	4	23	27

Table 2. Replenish fish species recorded from Duya "In" Leasable Fishery

Sr. No.	Order	Family	Genus	Species
1	Cypriniformes	Cyprinidae	*Catla*	*Catla catla* (Hamilton- Buchanan,1822)
			Cirrhinus	*Cirrhinus mrigala* (Hamilton-Buchanan,1822)
			Labeo	*Labeo rohita* (Hamilton-Buchanan,1822)
2	Perciformes	Chiclidae	*Oreochromis*	*Oreochromis niloticus* (Linnaeus ,1757)

Table 3. Natural fish species recorded from Duya "In" Leasable Fishery

Sr No	Order	Family	Genus	Species
1	Osteoglossiformes	*Notopterus*	*Notopterus*	*Notopterus notopterus* (Pallas, 1769)
2	Clupeiformes	Engraulididae	*Stolephorus*	*Stolephorus sp.*
3	Cypriniformes	Cyprinidae	*Labeo*	*Labeo calbasu* (Hamilton - Buchanan , 1822)
			Osteobrama	*Osteobrama belangeri* (Valenciennes) , 1844
			Osteobrama	*Osteobrama cunma* (Hamilton -Buchanan , 1878)
			Puntius	*Puntius sophore* (Hamilton -Buchanan , 1822)
			Amblypharyngodon	*Amblypharyngodon mola* (Hamilton - Buchanan, 1822)
		Botiinae	*Branchidanio*	*Branchidanio choprai* (Hora ,1928)
		Engraulidae	*Rasbora*	*Rasbora rasbora* (Hamilton -Buchanan , 1822)
		Cobitidae	*Lepidocephalus*	*Lepidocephalus annandalei* (Chaudhuri , 1912)
4	Siluriformes	Bagridae	*Sperata*	*Sperata aor* (F.Hamilton,1822)
			Mystus	*Mystus gulio* (Hamilton -Buchanan , 1822)
		Siluridae	*Ompok*	*Ompok bimaculatus* (Bloch,1797)
			Wallago	*Wallago attu* (Schneider, 1801)
5	Cyprinidontiformes	Hemiramphidae	*Hemiramphidae*	*Hyporhamphus limbatus* (Valenciennes , 1846)
		Belondidae	*Xenentodon*	*Xenodon cancila* (Hamilton - Buchanan ,1822)
6	Perciformes	Ambassidae	*Parambassis*	*Parambassis ranga* (F. Hamilton, 1822)
		Belontidae	*Colisa*	*Colisa fasciatus* (Schneider, 1801)
		Channidae	*Channa*	*Channa striatus* (Bloch , 1793)
				Channa marulius (Bloch , 1793)
		Gobiidae	*Glossogobius*	*Glossogobius giruris* (Hamilton - Buchanan , 1822)
		Mastacembalidae	*Macrognathus*	*Macrognathus zebrinus* (Blyth , 1859)
		Nandinae	*Badis*	*Badis badis* (Hamilton - Buchanan, 1822)

Table 4. Comparison of seasonal total catch weight of natural and replenish fish from Duya "In" 2016

Fishing Zones	2016							
	Natural Fish (Kg)				Replenish Fish (Kg)			
	Hot	Rain	Cool	Total	Hot	Rain	Cool	Total
Z-I, 3.5 m Bay chaung	2085.56	497.89	778.25	3340.01	479.48	423.45	40.67	943.60
Z-II, 4.5 m Yin taik kone	2654.34	638.79	886.62	4179.75	782.63	497.66	86.27	1366.56
Z-III, 5.5 m Phayar gyi kyun	3058.69	405.98	1042.47	4507.14	1185.48	610.34	96.48	1892.30
Z-IV, 8.5 m Duya	3253.45	317.98	756.56	4327.99	3398.77	693.74	117.82	4210.33
Z- V, 11 m Pauk yoo	3496.23	233.98	559.79	4290.00	4284.63	802.24	123.63	5210.50
Total	14548.27 71%	2094.62 10%	4023.69 19%	20168.69 100%	10130.99 57%	3027.43 20%	464.87 23%	13623.29 100%

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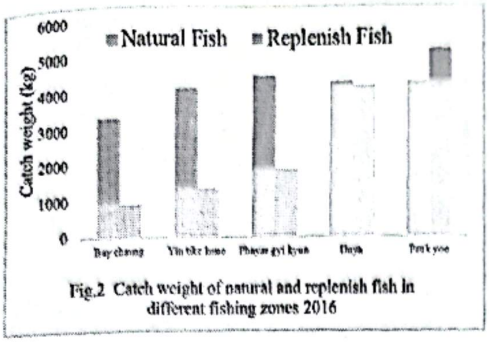

Fig.2 Catch weight of natural and replenish fish in different fishing zones 2016

During the year 2016, total catch weight was recorded (20168.69) kg and (13623.29) kg for natural fish and replenished species respectively.

The seasonal catch weight of natural fish species composition was most 71% in the hot summer during February to May. However, declined to 10% in the monsoon months of June to September; then in the cool season, the catch was again increased to 19%, which is almost double to that of monsoon catch.

Relating to the catch of replenish species in 2016, the highest composition of 57% was captured in hot summer months followed by 20% and 23 % in the rainy and cool respectively (Table. 4 and Fig. 3)

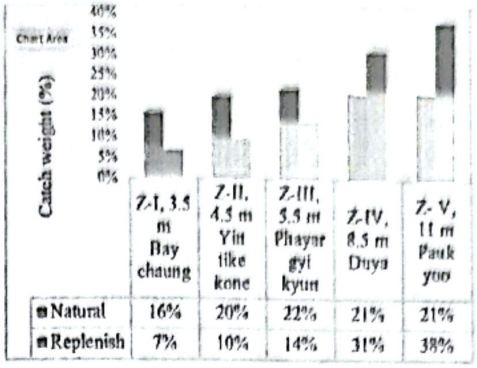

Fig. 3 Catch weight (%) of natural and replenish fish in different fishing zones 2016

During 2016, catch weight composition of natural fish species from the different water depth zone was found, Zone III Phayar gyi kyun stands top of the list with (22%), followed by Duya and Pauk yoo with (21%), while Yin tike kone shared (20%). The least composition of (16%) was found in Bay chaung was observed (Fig. 3).

In the case of the catch weight composition for replenish fishes in 2016, the highest composition of 38% was from Pauk yoo areas, while it was 31% in Duya and only 7% was observed in Bay chaung (Fig. 3).

Table.5 Comparison of seasonal total catch weight of natural and replenish fish from Duya "In" 2017

Fishing Zones	2017							
	Natural Fish (Kg)				Replenished Fish (Kg)			
	Hot	Rain	Cool	Total	Hot	Rain	Cool	Total
Z-I, 3.5 m Bay chaung	899.93	475.94	389.96	1765.83	979.36	647.36	113.76	1740.48
Z-II, 4.5 m Yin taik kone	992.84	512.99	498.61	2004.44	1879.55	707.23	179.82	2766.6
Z-III, 5.5 m Phayar gyi kyun	1098.86	316.93	638.87	2054.66	3848.59	867.34	228.79	4944.72
Z-IV, 8.5 m Duya	1197.86	304.99	369.67	1872.52	8758.70	977.26	227.28	9963.24
Z- V, 11 m Pauk yoo	1295.63	298.14	298.78	1892.55	8988.64	1204.21	282.36	10475.21
Total	5485.12 57%	1908.99 20%	2195.89 23%	9590.25 100%	24454.84 82%	4403.4 15%	1032.01 3%	29890.25 100%

In 2017 as a whole total catch weight for natural fish and replenish were (9590) kg and (29890.25) kg respectively.

The seasonal catch weight composition of natural fish was found the highest in hot season from February to May (57%), while it was the least with 20% in the monsoon months from June to September.

The trends of seasonal catch weight composition for the replenish species was the highest with 82% in the hot summer of February to May. It was declined to 15% in monsoon, then the least of 3% in cool season was recorded (Table 5).

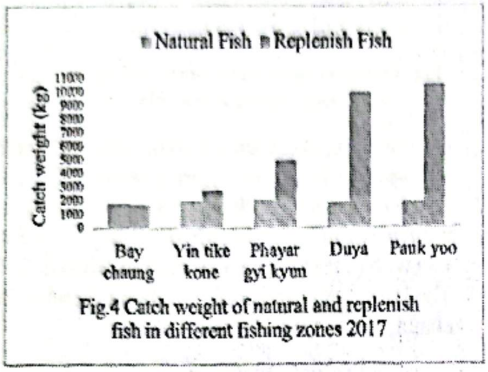

Fig.4 Catch weight of natural and replenish fish in different fishing zones 2017

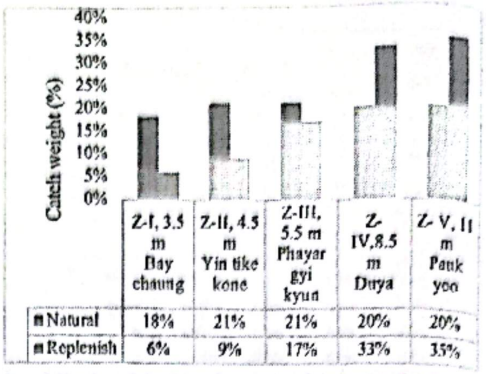

Fig. 5 Catch weight (%) of natural and replenish fish in different fishing zones 2017

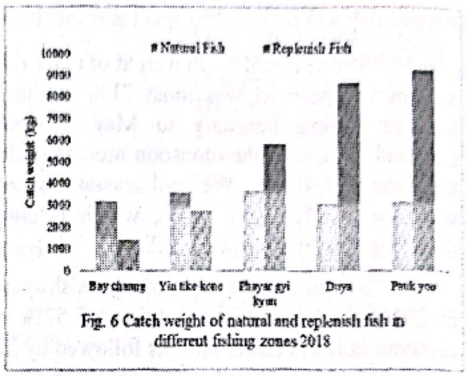

Fig. 6 Catch weight of natural and replenish fish in different fishing zones 2018

Table 6. Comparison of seasonal total catch weight of natural and replenish fish from Duya "In" 2018

Fishing Zones	2018							
	Natural Fish (Kg)				Replenish Fish (Kg)			
	Hot	Rain	Cool	Total	Hot	Rain	Cool	Total
Z-I, 3.5 m Bay Choung	1494.88	639.44	1024.35	3158.67	1114.89	192.78	75.26	1382.93
Z-II, 4.5 m Yin Taik Kone	1568.49	803.78	1216.34	3588.61	2320.63	369.67	82.78	2773.08
Z-III, 5.5 m Phayar gyi Kyun	1667.48	649.86	1404.61	3721.95	4992.36	767.93	102.36	5862.65
Z-IV, 8.5 m Duya	1799.87	398.96	924.65	3123.48	7580.25	896.39	128.79	8680.12
Z- V, 11 m Pauk Yoo	1982.68	307.34	856.83	3146.85	8086.34	977.82	203.48	9267.64
Total	8513.4 51%	2799.38 17%	5426.78 32%	16739.56 100%	24094.47 87%	3204.59 11%	592.67 2%	27891.73 100%

In 2017, overall total catch weight for natural fish from all water depth zones were (9590.25) kg. Of which, the catch composition from Yin tike kone and Phayar gyi kyun shared 21% each as at the top of the list. In Duya and Pauk yoo performed more or less similar catch weight that sharing 20% each of the total catch. The catch in Bay chaung was observed the least with 18% only (Fig 5).

For the replenish fish in 2017, from the highest catch weight composition was found in the deepest zones with 35% and 33% in Pauk yoo and Duya respectively. The moderate composition of 17% was observed in Phayar gyi kyun, while Yin tike kone shared 9%. The least catch composition of 6% was found in Bay Chaung respectively (Fig 5).

In the year 2018, the catch quantity was (16739.56) kg and (27891.73) kg for natural fish species and replenished fish species respectively.

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The trends of seasonal catch weight composition for natural fish was 51% in summer of February to May. The lowest composition 17% in the monsoon of June to September. Then significantly increased up to 32% from October to January.

Seasonal catch weight composition of replenish species was found the highest of 87% in the summer, but it was only 11% in the monsoon followed by lowest catch weight composition of 2% was recorded 2% in cool season (Table. 6 and Fig. 6).

As an overall, the highest total catch weight (44%) of natural fish were recorded in 2016. In 2017 the total catch weight was decreased as almost half (20%) to that 2016. In the year 2018 overall catch weight seemed increased (36%) (Table.7)

Total three years catch of natural fish in different water depth fishing zones, the catch weight was the highest in Z3(22%) followed by Z2(21%), Z4(20%), Z5(20%), and Z1(18%). Total catch weight of natural fish from different fishing zones in three years were significantly different

Table.7 Yearly total catch weight of natural fish in different fishing zones

Sr. No.	Year	Catch weight (kg) of Natural Fish					Total	%
		Z1	Z2	Z3	Z4	Z5		
1	2016	3340.01	4179.75	4507.14	4327.99	4290.00	20644.89	44
2	2017	1765.83	2004.44	2054.66	1872.52	1892.55	9590.00	20
3	2018	3158.67	3588.61	3721.95	3123.48	3146.85	16739.56	36
	Total	8264.51	9772.8	10283.8	9323.99	9329.4	46974.45	100
	%	18	21	22	20	20	100	

Table.8 Yearly total catch weight of replenish fish in different fishing zones

Sr. No.	Year	Catch weight (kg) of Replenish Fish					Total	%
		Z1	Z2	Z3	Z4	Z5		
1	2016	943.60	1366.56	1892.30	4210.33	5210.50	13623.29	19
2	2017	1740.48	2766.60	4944.72	9963.24	10475.21	29890.25	42
3	2018	1382.93	2773.08	5862.65	8680.12	9267.6	27966.42	39
	Total	4067.01	6906.24	12699.67	22853.69	24953.35	71479.96	100
	%	6	10	18	32	35	100	

In 2018, the catch weight composition of natural fish species from different depth was the highest 21% in Zone II (Yin Taik Kone) and 22% in Zone- III (Phayar gyi kyun). In Z-I (Bay chaung), Zone- IV (Duya) and Z-V (Pauk yoo) shared the same composition of 19% each were recorded.

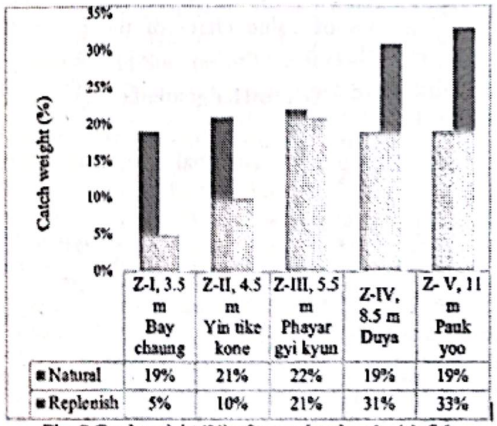


Fig. 7 Catch weight (%) of natural and replenish fish in different fishing zones 2018

During the year, the catch composition of the replenish fish species was found the highest 33% in the deepest depth Zone-V Pauk yoo, and then gradually decreased by shallower depth such s 31% in Duya, 21% in Phayar gyi kyun, and 10% in Yin tike kone and the least 5% was observed in Bay chaung (Table.6 and Fig 7).

(t=5.540, p=0.031 in Z1; t=5.016, p=0.038 in Z2;

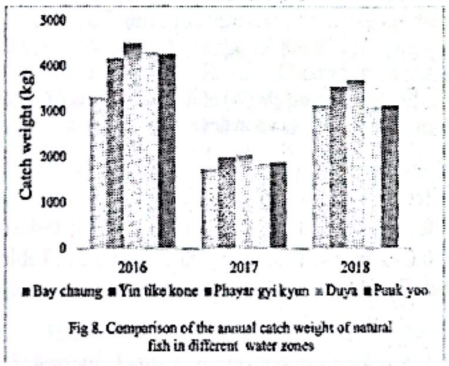


Fig 8. Comparison of the annual catch weight of natural fish in different water zones

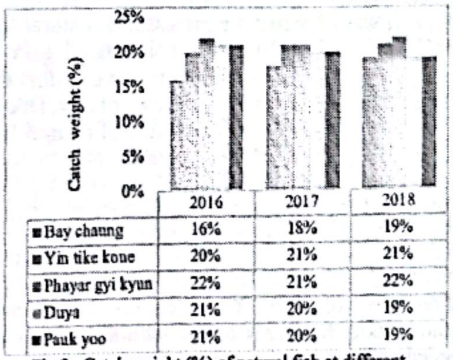


Fig.9 Catch weight (%) of natural fish at different fishing zones in three year

t=4.741, p=0.042 in Z3; t=4.384, p=0.048 in Z4; t=4.492, p=0.046in Z5) (Table.7 and Fig.9)

Relating to the total catch weight of the replenish fish species, the annual catch weight was observed the lowest (19%) in the year 2016. However, it was suddenly increased (42%) in 2017 and then followed by (39%) in 2018 (Table.8).

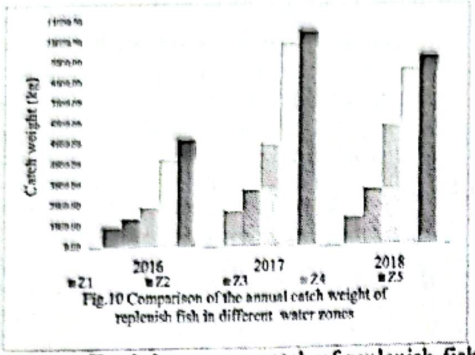
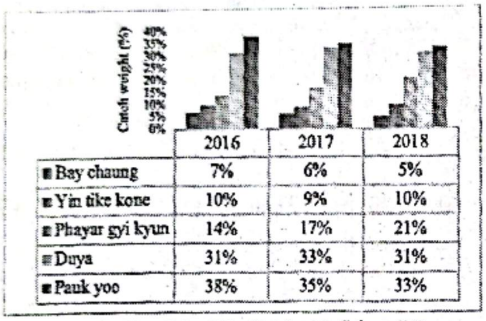


Fig.10 Comparison of the annual catch weight of replenish fish in different water zones

Total three years catch of replenish fish in different water depth fishing zones, the catch weight was the highest in Z5 (35%) followed by Z4(32%), Z3(18%), Z2(10%), and Z1(6%). Total catch weight of replenish fish from different



	2016	2017	2018
Bay chaung	7%	6%	5%
Yin tike kone	10%	9%	10%
Phayar gyi kyun	14%	17%	21%
Duya	31%	33%	31%
Pauk yoo	38%	35%	33%

Fig.11 Catch weight (%) of replenish fish at different fishing zones in three years

fishing zones in three years were significantly different (t=5.883, p=0.028 in Z1; t=4.921, p=0.039 in Z2; t=4.527, p=0.032 in Z3; t=4.369, p=0.049 in Z4; t=5.224, p=0.035 in Z5) (Table.8 and Fig.11).

Discussion

The replenish of valued natural fish species was practiced in 2015 and then resume in 2017. It was reflected the increased of natural fish catch quantity in 2016. Then increased gain in 2018 after almost period of a year for the replenished fish to grow in the water body. Due to not replenishing in 2016, declined of natural fish catch quantity in 2017 was resulted.

The natural fish catches quantity during the study period was observed the highest in 2016 but declined about fifty percent in 2017 however increased again in 2018 were recorded. During the three years of study, Yin tike kone fishing zone stands most favorable as the natural habitats for breed and nursery ground.

The natural fishes such as *Notopterus notopterus* (feather back), *Labeo calbasu* (Calbasu), *Osteobrama belangari* (Barb), *Lepidocephalus annadalei* (loaches), *Sperata aor* (Whistle catfish), *Wallago attu* (Wallago cat fish), *Ompok bimaculatus* (sheat fish), *Xenodon cancila* (half beak), *Channa striatus* (stripped snake head), *C.marulius* (marulius snake head), *Macrongathus zebrinus* (spiny eel) were common natural fish species captured in high catch weight comparably. These fishes are most common in Phayar gyi kyun, Duya, and Pauk yoo, where the water depth is deeper.

Catch weight of replenish carps and tilapia varied in different fishing zone with different water depth. Generally, the larger sizes of replenished carps were captured in Phayar gyi kyun, Duya and Pauk yoo fishing zones.

The catch weight quantities of replenish carps and tilapia was found more in 2017 and 2018. The quantities were more or less the same in theses two years. It was the results and benefits of stocking or replenishing of 14 million carps fingerling in the year 2016. The replenish species included about 65% of Rohu, about 15% of Catla and 15 % of Mrigal and 5% of tilapia.

As an overall reviewing from three years of study, catch quantity of the natural fish was highest in summer months due to the less water volume in the leasable fishery, decline in rainy season due to the more water volume that make uneasy for fishing and increase in the cool season. Also, there may be due the uses of fishing gear and methods.

Thus, the following research works in future has been considered to be carry out.

- the catch efficiencies of fishing gears methods and how its imply to responsible fishing of natural fish in the fishery area of the Duya "In" to sustain the fish food supply for the peoples in the area.
- identify the species composition
- study the breeding biology of existing natural fish species in Duya "In".
- analysis of value chain of the Duya "In" leasable fisher.

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Species Composition and Abundance Status of Small Indigenous Fish Species (SIS) in Bawle Kyun, Htantabin Township, Yangon Region

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Abstract

The present study was aimed to investigate the species composition and abundance status of small indigenous fish species (SIS). The study was conducted at Bawle Kyun in which Kyaman village (17°12′N and 95°48′E) was designated as study site I and Nethamein village as site II (17°2′N and 95°49′E). The study period lasted from June 2017 to June 2018. A total of 30 species belonging to 15 families from six orders were recorded. Maximum species (29) were found in September, October and November and minimum species (9) were in February (site I). Maximum species (19) were found in November and minimum species (9) were in April (site II). *Puntius chola*, *P. sophore*, *Amblypharyngodon mola*, *Mystus dimatus*, *Clarias batrachus*, *Heteropneustes fossilis*, and *Channa* sp. were the highest available SIS during the study in terms of their quantity and monthly occurrence. Among 30 species, 23 fish species (76.66%) are categorized into Least concerned (LC), four species (13.33%) are Not evaluated (NE), two species (6.66%) are Near threatened (NT), one species (3.33%) is as Data deficient (DD). There is a need to conserve biodiversity of these small fishes also as a way to meet food-security needs for the rural people in the study area.

Keywords: Small indigenous fish species (SIS), species composition, abundance, status, food-security needs

Introduction

Fish constitutes almost half of the total number of vertebrates in the world. They live in almost all conceivable aquatic habitats; approximately 21,723 living species of fish have been recorded out of 39,900 species of vertebrates (Jayaram, 1999). Of these, 8,411 are freshwater species and 11,650 are marine (Ker *et al*., 2001). Freshwater fishes also influence nutrient dynamics in freshwater ecosystems (Allan *et al*., 2005).

Fish are often an important ingredient in the diet of people who live in the proximity of water bodies. People have traditionally depended to various varieties of indigenous fish species, easily available from nearby water bodies, as a source of nutrition. A large diversity of small indigenous fish species are found in freshwater systems. These small indigenous fish species (SIS) form a major component of food consumed by people of Myanmar, especially those living closer to freshwater resources (ICSF, International Collective in Support of Fishworkers, 2010).

The small indigenous species of fishes are generally considered which grow to a length of about 25cm, *i.e.*, 9 inches at maturity (Felts *et al.*, 1996, Hossain *et al.*, 1999). Small indigenous freshwater fish species (SIFFS) are defined as fishes which grow to the size of 25-30 cm in mature or adult stage of their life cycle(Felts AA, Fajts F, Akteruzzaman M,1996). Small indigenous fish species are found in all types of natural waterbodies. They inhabit in rivers and tributaries, flood-plains, ponds and tanks, lakes, streams, lowland areas, wetlands and paddy fields (NACA, National Association for Campus Activities, 2011).

The SIS are rich in terms of proteins, micronutrients, vitamins and minerals. Therefore, small indigenous fishes are important for poor and lower income groups in terms of nutrition. The rural poor prefer to eat SIS instead of cultured carps because they can afford to buy a small amount at a time, and it is easier for them to distribute the fish among their family members. Fish, especially SIS, are a rich animal-source food of multiple, essential, highly bioavailable nutrients. They are famous for the local people for their taste, availability, lower market price and nutritional value (Rajts *et al.*, 1997).

The SIS are generally eaten with bones, although some bones may be discarded as plate waste. Small fish are regarded as an excellent source of calcium. Floodplain fisheries are still the main source of fish eaten by rural people, with SIS contributing the most (Roos *et al*., 2007).

Although rural population depend on indigenous species of fish for nutrition in many parts of Myanmar, very little attention has been paid on their role in aquaculture enhancement, nutrition, processing, biology, captive breeding, livelihood security and conservation needs. Therefore, the present study was aimed to investigate diverse fauna of small indigenous fish species in Bawle Kyun, Htantabin Township, Yangon Region. The objectives of the present study are: to record the species composition of small indigenous fish species (SIS) in the study area and to investigate their monthly occurrence and abundance status of studied species.

Materials and Methods

Study area and study sites

Htantabin Township is located in Northern District of Yangon Region, is bounded by Hlaing River in the east and Bawle River in the west. Kokkowa River flows east to west and divides the area into two parts: Bawle Kyun in the north and Tetthit Kyun in the south. The present study was conducted at Bawle Kyun in which Kyaman village (17°12′N and 95°48′E) was designated as study site I and Nethamein village as site II (17°2′N and 95°49′E). The two villages far apart about 11.38km from north to south. The total area of Kyaman village is 9.91sqkm and Nethamein village is 15.69 sqkm, respectively (Fig. 1).

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Study period

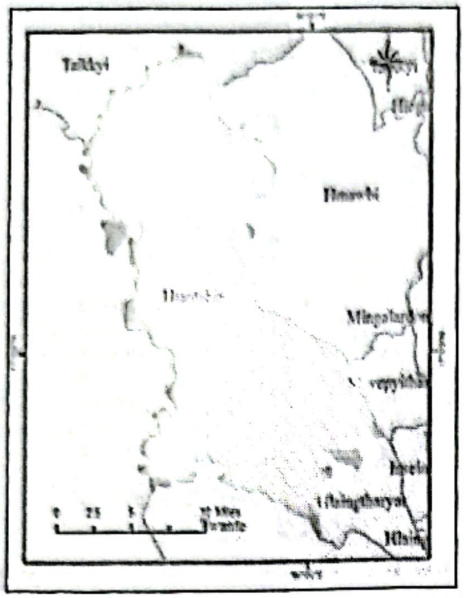

Fig. 1 Map of the study area and study sites (Source: Geography Department, WYU)

The study period lasted from June 2017 to June 2018.

Specimen collection

The fish species were collected from the local fishers in Kyaman and Nethamein villages at Bawle Kyun by traditional fishing methods used in the study sites. The samples of SIS were primarily sorted out in the collection area with the help of fishermen and fish traders. Based on their length of the individual, small indigenous species of the present study were considered as minimum 4cm. The samples which were difficult to identify on the spot, were preserved in 5% formaldehyde solution and brought to the laboratory of West Yangon University for further identification.

Identification and classification

Identification and classification of the studied species was based on Jayaram (1999) and Fish Base website (http://www.fishbase.org).

Data analysis

From the samples, species composition and catch weight were analysed. In addition to this, the percentage composition of each of the species was recorded. Numbers of each fish species was recorded along with the relative biomass of individuals in the sample of 1 kg. Relative abundance of individual species was calculated by the following formula: Number of specimens of particular species X 100/Total number of specimens of all species (Negi and Mamgain, 2013). Abundance status of the species was estimated followed by Kostori *et al.* (2011). The conservation status of the species was adopted after IUCN (2017).

Results

Species composition of small indigenous fish species

A total of 30 species belonging to 15 families from six orders were recorded during the study period (Plate). Fishes belongs to order Perciformes was dominated with 12 species, followed by order Cypriniformes with 7 species, order Siluriformes with 6 species, order Synbranchiformes with 3 species and order Beloniformes and Osteoglossiformes with only one species each (Fig. 2, Table 1). The highest number of species were recorded from the family Cyprinidae (20%), Bagridae, Gobiidae, Osphronemidae, Channidae and Mastacembelidae with (10% each), Notopteridae, Cobitidae, Siluridae, Clariidae, Heteroneustidae, Belonidae, Ambassidae, Badidae, and Anabantidae with (3.33% each) (Fig. 3).

Monthly occurrence

Maximum species (29) were found in September, October and November and minimum species (9) were in February (site I). Maximum species (19) were found in November and minimum species (9) were in April (site II) (Fig. 4). Relative abundance of species in site I was found to be the highest in *Puntius sophore* and *Amblypharyndodon mola* (8.85%) and the lowest in *Notopterus notopterus* (0.15%). On the other hand in site II, it was found to be the highest in *Stigmatogobius sadanundio* (15.4%) and the lowest in *Macrognathus aral, M. zebrinus* and *Mastacembelus armatus* (0.11%) (Table 2).

Abundance status

Puntius chola, P. sophore, Amblypharyngodon mola, Mystus armatus, Clarias batrachus, Heteropneustes fossilis, and *Channa* sp. were the highest available SIS during the investigation period in terms of their quantity and monthly occurrence. Abundance status of recorded 30 SIS was ranked as few (3.33%), common (23.3%) and very common (73.33%) in site I, and few (10.71%), common (21.42%) and very common (67.86%) in site II (Fig. 5, Table 2).

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Conservation status

As far as conservation status (IUCN, 2017) is concerned, out of 30 species, 23 fish species (76.66%) are categorized into Least concerned (LC), four species (13.33%) are Not evaluated (NE), two species (6.66%) are Near threatened (NT), one species (3.33%) is as Data deficient (DD) (Fig. 6, Table 2).

Discussion

The ichthyofaunal study indicates that the waterbody is rich in diversified fish fauna consists of native species, economical, cultivable, ornamental and rare species fishes (Basavaraja *et al.*, 2014). The present study is an outline of the species composition of small indigenous species, their availability, and abundance and conservation status. This study documented a total 30 small indigenous fish species under six orders and 15 families. Perciformes and Cypriniformes were the most dominant orders in the study area. Due to insufficient statistical data on SIS on this study area, no comparison was possible of the present study with previous one.

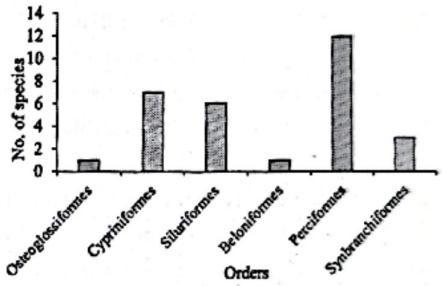
The availability and abundance of the SIS were recorded during the study period. Fishes were more or less available round the year. But all the species were not available in all seasons. The maximum number of species was found to be in September, October and November in both study sites. *Puntius chola, P. sophore, Amblypharyngodon mola, Mystus armatus, Clarias batrachus, Heteropneustes fossilis,* and *Channa* sp. were the highest available fish species. The lowest numbers of species were in February. It is agreed with Ahmad (1997) who observed that seasonal fluctuation in the fish species is a normal phenomenon.

Cyprinidae was the most dominant family including six species, available in June to October. The result may be suggested that the water bodies of the study area were suitable for barbs and carplets. Species like *Channa* sp., *A. testudineus*, *H. fossilis*, *C. batrachus*, and *T. fasciatus* were found in highest amount in November to February when the water is mostly dried up.

Small indigenous fish species (SIS) are those small fishes which attains a maximum length of 25 cm (Felts *et al.*, 1996). There is a contradiction with the definition of SIS as some species of fishes are registered as SIS but they can grow to a maximum size more than 25 cm including *Notopterus notopterus, Channa striata, Mastacembelus armatus* etc.

Abundance status of recorded 30 SIS was ranked as few (3.33%), common (23.3%) and very common (73.33%) in site I, and few (10.71%), common (21.42%) and very common (67.86%) in site II. Bawle Kyun is famous for her fish paste (nga-pi). Fish paste production was found in Bawle, Meipali and Neithamein villages. There are many streams and creeks in Htantabin Township. So, many people in this township are catching fish in rivers and streams (Sonny, 2009). Small indigenous freshwater fishes are highly preferred food in the study area, and are consumed in fresh and processed (fish paste, sun-dried, smoked and fermented) forms. These species have been considered as an excellent source of essential protein, macro and micro-nutrients, vitamins and minerals, which can play a significant role in the fulfilment of nutritional deficiency in human being (Thilsted *et al.*, 1997). The small indigenous fish species play a major role in supplementing the dietary protein requirements of many people in Asian countries (Thilsted *et al.*, 2016). Many of the species qualifying as small indigenous fish species are common species with wide range of distribution in Indian subcontinent (Hossain *et al.*, 2015). As SIS provide required amount of vitamin and minerals in human body, so considering their nutritional value, such type of small fish production needs to be increased through culture and conservation.

Conservation of biodiversity is very essential to maintain the sustainability of ecosystem and to support the maximum yield of living resources. Understanding spatial and temporal patterns in fish species assemblage structure is precarious for the conservation and management of indigenous fish (Jackson *et al.*, 2001). From the conservation point of view, *Anabas testudineus* showed data deficient and *Ompok bimaculatus* and *Osteobrama belangeri* were near threatened. Therefore, education for natural resources and rules and regulations of fishery management should be implemented in the study area.



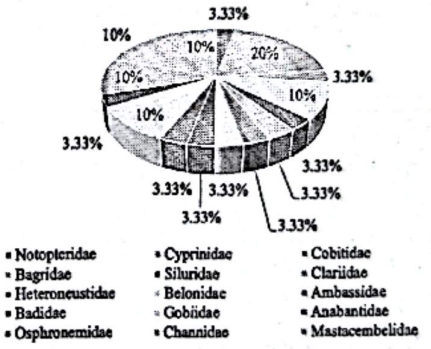


Fig. 3 Percentage contribution of different families in species composition

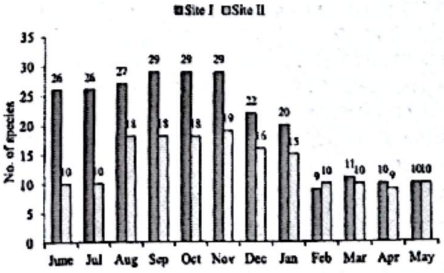


Fig. 4 Monthly occurrence of recorded SIS species

Table 1 Small indigenous fish species recorded in two different study sites

Sr. no	Family	Species	Common name
1	Notopteridae	*Notopterus notopterus* (Pallas, 1769)	Feather back
2	Cyprinidae	*Cirrhinus reba* (Hamilton-Buchanan, 1822)	Reba carp
3		*Osteobrama belangeri* (Valenciennes, 1844)	Carplet
4		*Puntius chola* (Hamilton-Buchanan, 1822)	Swamp barb
5		*P. sophore* (Hamilton-Buchanan, 1822)	Spotfin swamp barb
6		*Amblypharyngodon mola* (Ham-Buch, 1822)	Mola carplet
7		*Rasbora hobelmani* Kottelat, 1984	Kottelat rasbora
8	Cobitidae	*Lepidocephalus berdmorei* (Blyth, 1861)	Burmese loach
9	Bagridae	*Mystus armatus* (Day, 1865)	Kerala mystus
10		*M. cavasius* (Hamilton-Buchanan, 1822)	Gangetic mystus
11		*M. pulcher* (Chaudhuri, 1911)	Pulcher mystus
12	Siluridae	*Ompok bimaculatus* (Bloch, 1797)	Indian butter catfish
13	Clariidae	*Clarias batrachus* (Linnaeus, 1758)	Catfish
14	Heteroneustidae	*Heteropneustes fossilis* (Bloch, 1794)	Scorpion catfish
15	Belonidae	*Xenentodon cancila* (Ham-Buch, 1822)	Freshwater garfish
16	Ambassidae	*Paraambassis ranga* (Ham-Buch, 1822)	Glass fish
17	Badidae	*Badis badis* (Hamilton-Buchanan, 1822)	Spotted field perch
18	Gobiidae	*Glossogobius giuris* (Ham-Buch, 1822)	Bar-eyed-goby
19		*Stigmatogobius sadanundio* (Ham-Buch, 1822)	Nil
20		*Apocryptes bato* (Hamilton,1822)	mudskipper
21	Anabantidae	*Anabas testudineus* (Bloch, 1795)	Climbing perch
22	Osphronemidae	*Trichogaster fasciata* (Schneider, 1801)	Stripled gourami
23		*T. labiosa* (Day, 1876)	Thick-lipped gourami
24		*T. pectoralis* (Regan, 1910)	Snakeskin gourami
25	Channidae	*Channa orientalis* (Bloch &Schneider, 1801)	Asiatic snakehead
26		*C. punctata* (Bloch, 1793)	Spotted snakedhead
27		*C. striata* (Bloch, 1793)	Striped snaked head murel
28	Mastacembelidae	*Macrognathus aral* (Bloch &Schneider, 1801)	Lesser spinyeel
29		*M. zebrinus* (Blyth, 1895)	Zebrus eel
30		*Mastacembelus armatus* (Lacepede, 1800)	Spiny eel

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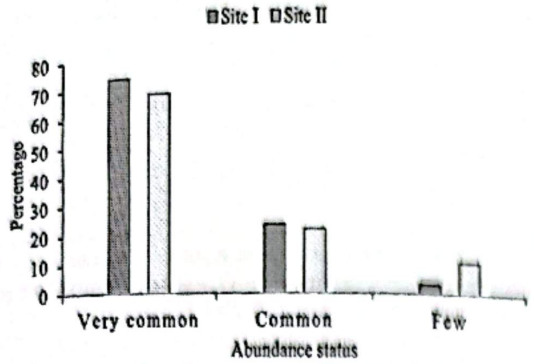

Fig. 5 Abundance status of SIS in two study sites

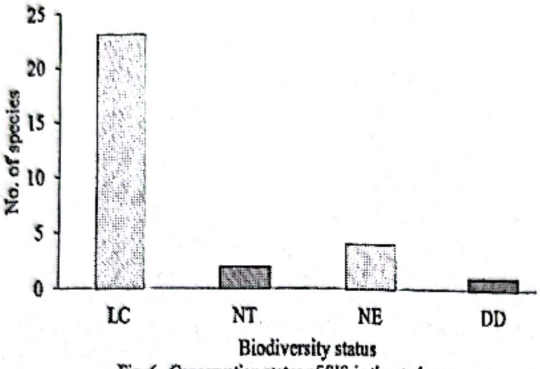

Fig. 6 Conservation status of SIS in the study area

Table 2 Catch rate, relative abundance, abundance status and IUCN status of recorded species in two study sites

Species	Catch weight (Kg)		Relative abundance (%)		Abundance status		IUCN status
	Site I	Site II	Site I	Site II	Site I	Site II	
Notopterus notopterus	32	268.8	0.15	0.65	F	C	LC
Cirrhinus reba	64	768	0.37	2.31	C	VC	LC
Osteobrama belangeri	192	320	1.11	0.96	C	C	NT
Puntius chola	345.6	224	7.97	2.69	VC	VC	LC
P. sophore	384	224	8.85	2.69	VC	VC	LC
Amblypharyngodon mola	384	268.8	8.85	3.24	VC	VC	LC
Rasbora hobelmani	224	268.8	8.6	5.39	VC	VC	NE
Lepidocephalus berdmorei	64	Nil	0.86	0	C	-	LC
Mystus armatus	345.6	64	5.32	0.51	VC	C	LC
M. cavasius	153.6	64	2.37	0.51	VC	C	LC
M. pulcher	307.2	64	4.72	0.51	VC	C	LC
Ompok bimaculatus	179.2	768	0.83	1.85	VC	VC	NT
Clarias batrachus	806.4	1024	4.64	3.08	VC	VC	LC
Heteropneustes fossilis	576	768	7.74	5.39	VC	VC	LC
Xenentodon cancila	192	358.4	2.95	2.87	VC	VC	LC
Parambassis ranga	384	384	6.64	3.46	VC	VC	LC
Badis badis	76.8	Nil	4.44	0	VC	-	LC
Glossogobius giuris	115.2	358.4	0.53	0.86	VC	VC	LC
Stigmatogobius sadanundio	76.8	640	3.55	15.4	VC	VC	NE
Apocryptes bato	76.8	192	1.04	1.35	C	C	NE
Anabas testudineus	230.4	1024	2.65	6.16	VC	VC	DD
Trichogaster fasciata	288	768	3.32	4.62	VC	VC	LC

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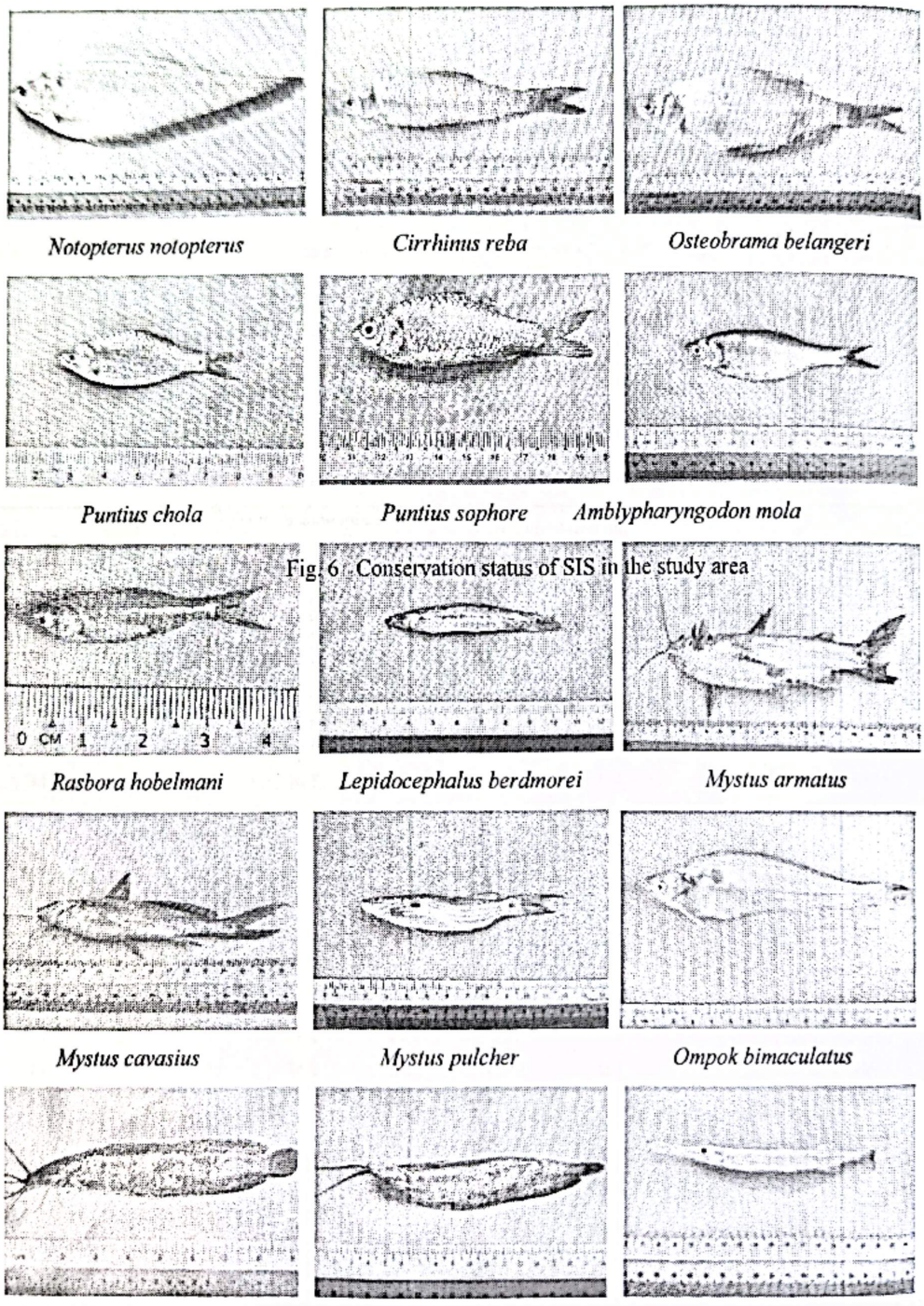
T. labiosa	76.8	768	1.48	7.7	VC	VC	LC
T. pectoralis	115.2	768	2.21	7.7	VC	VC	LC
Channa orientalis	115.2	1280	1.33	7.7	VC	VC	NE
C. punctata	230.4	1280	3.09	8.98	VC	VC	LC
C. striata	576	1280	2.65	3.08	VC	VC	LC
Macrognathus aral	76.8	19.2	0.89	0.11	C	F	LC
M. zebrinus	38.4	19.2	0.44	0.11	C	F	LC
Mastacembelus armatus	38.4	19.2	0.44	0.11	C	F	LC

Note: Abundance status; F- Few (not very rare or rare but available at a low density), C- Common (recorded from almost all the study spots and was not so abundant), VC- very common (frequently available species and large amount of catch was made)
IUCN status; LC- Least concern, NT- Near threatened, NE- Not evaluated, DD - Data Deficient



Notopterus notopterus *Cirrhinus reba* *Osteobrama belangeri*

Puntius chola *Puntius sophore* *Amblypharyngodon mola*

Rasbora hobelmani *Lepidocephalus berdmorei* *Mystus armatus*

Mystus cavasius *Mystus pulcher* *Ompok bimaculatus*

Fig 6 Conservation status of SIS in the study area

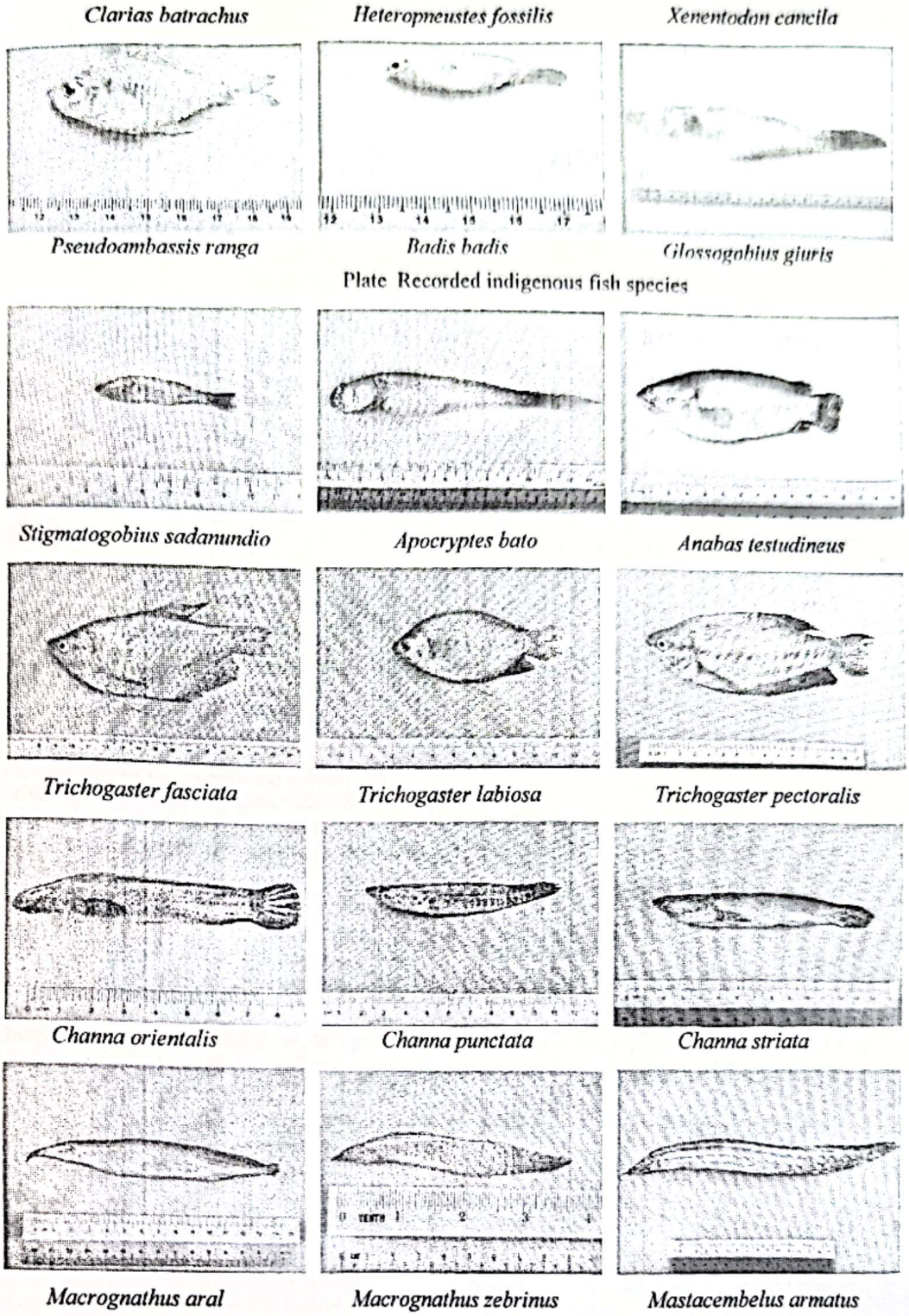


Plate Recorded indigenous fish species

Plate Continued

Conclusion

There is need to conserve biodiversity of these small fishes also as a way to meet food-security needs. It is therefore need to throw light on sustainable use of small indigenous fish species, their role in food security, employment, income and poverty alleviation not only in natural waters but also to actively establish the feasibility of polyculture using small indigenous species of fish.

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University for permitting us to carry out this research work and interesting on our work during the study period.

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Length-weight relationship, Size frequency distribution and sex ratio of *Osteobrama belangeri* (Valenciennes, 1844) in Khun-na-eain-dan Inn, Htantabin Township, Yangon Region

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Abstract

An investigation on the length weight relationship, size frequency distribution, sex ratio of *Osteobrama belangeri* was studied in Khun na eain dan Inn, Htantabin Township, Yangon Region during November 2018 to October 2019. The medium carp *O. belangeri*, is available in India, Myanmar and China. In Indian region, it is endemic to Manipur and listed as a Near Threatened species in the IUCN Red List. The length-weight regression analysis of the studied species showed that the average 'b' value of *O. belangeri* was 6.4, an indication of positive allometric growth. r = 0.901 ($p<0.01$) showed that there was a relationship between total length and total body weight. Size frequency distribution of *O. belangeri* showed minimum number of both male and female were observed in length class 221-240, 241-260, 261-280mm while the maximum number of male and female were found in length class 161-180mm. The monthly sex ratio was 1:1 for almost all the year expect in July when male and female was 1: 2. The overall male and female sex ratio of *O.belangeri* was not significant difference.

Keywords: length weight relationship, size frequency distribution and sex ratio.

Introduction

Osteobrama belangeri is locally known as Nga phan ma or Nga bpe oung. It belongs to the order cypriniformes and family cyprinidae. The medium carp *O. belangeri*, is available in India, Myanmar and China. In Indian region, it is endemic to Manipur and listed as a Near threatened species in the IUCN Red List (Vishwanath , 2010).This fish has good consumer preference due to high food value (Sarojnalini and Vishwanath ,1988) .The length- weight relationship of fish is important fishery management tool. In addition, the data on length and weight can also be used to compare fish life history between regions in species and populations. Mossolin and Bueno (2002) affirmed that knowledge on quantitative aspects such as gonadosomatic index (GSI), hepatosomatic index (HSI), length-Weight relation (LWR), condition factor (K), growth, recruitment, sex ratio, larval development and motility is an important tool for the studying on the reproductive biology of fishes.

Sex ratio is important in predicting the population structure and reproductive performance (Wang *et al*., 2003). Sex ratio and size structure constitute information basic in assessing reproductive potential and estimating stock size populations (Vazzoler, 1991). Very few information is available on *O. belangeri* in the literature from different water bodies of the world. In this reason, *O. belangeri* need to study about their biology, physiology, ecology, fisheries assessment and fish conservation.

This study aims to part of the reproductive biology study such as determine of sex ratio, size frequency distribution and length weight relationship of the *O. belangeri*.

Materials and Methods

Study site

Khun na eain dan Inn is situated in Htantabin Township, south of Yangon- Pathein Highway road. It is located between 17° 0′ 0″ N to 17 ° 3′ 0″ and 95 ° 50′ 0″ E to 96 ° 0′0″ E.

Study period

Field survey and interview of local fisherman was conducted two times per month. Study period lasted from November 2018 to October 2019.

Sample collection

Fish species were collected from landing at fishery depot in Mawthawt village and local fishermen in this study area. The specimens were caught by mean of the Trammel net, Encircling seine net, Beach seine net and Push net.

Identification of fishes

Fish identification was followed after Talwar and Jhingran (1991).

Data analysis

A total of 30 specimens from the study sites were measured in every month. Length of fishes was measured to the nearest centimeters and weight up to the nearest gram by using an electronic digital caliper (Mtrc ISO) and balance (WTP 2000) (Plate 1). The relationship between the length (L) and weight (W) of fish was expressed by exponential (Schneider *et al*., 2000).

$$W = aL^b$$

Where; W = weight of fish (g)
L = total length of fish (cm)
a = constant (intercept)
b = the length exponent (slope)

Values of W usually calculated from the logarithmic form or linear equation: Log W = Log a+ b Log L

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Parameters 'a' and 'b' were determined from the linear regression of the length and weight of fish where 'b' is an exponent with the value always ranged between 2 and 4, and often closer to 3. The value b= 3 indicates that the fish grows symmetrically or isometrically without changing body propotions. Values other than 3 indicate allometri growth: if b>3, the growth is considered as positive allometric and if b<3 is negative allometric. The correlation (r) that is degree of association between the length and the weight was computed from the linear regression analysis.

Size frequency distribution

Size composition of *O. belangeri* was recorded separately in 20mm class interval of total length. A total of 360 samples were used to describe the size frequency distribution of *O. belangeri*.

Sex ratio

The fishes were sexed by morphologically and dissecting out the gonads. The female fishes were found to be larger size than the male in all the seasons. Difference was also observed in the body depth as because the gravid female had enlarged belly during the breeding seasons. A total of 360 samples were used to describe the sex ratio of *O. belangeri*.

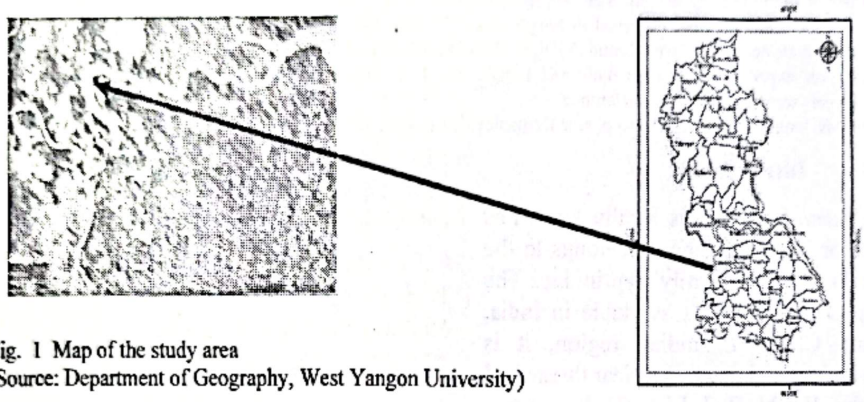

Fig. 1 Map of the study area
(Source: Department of Geography, West Yangon University)

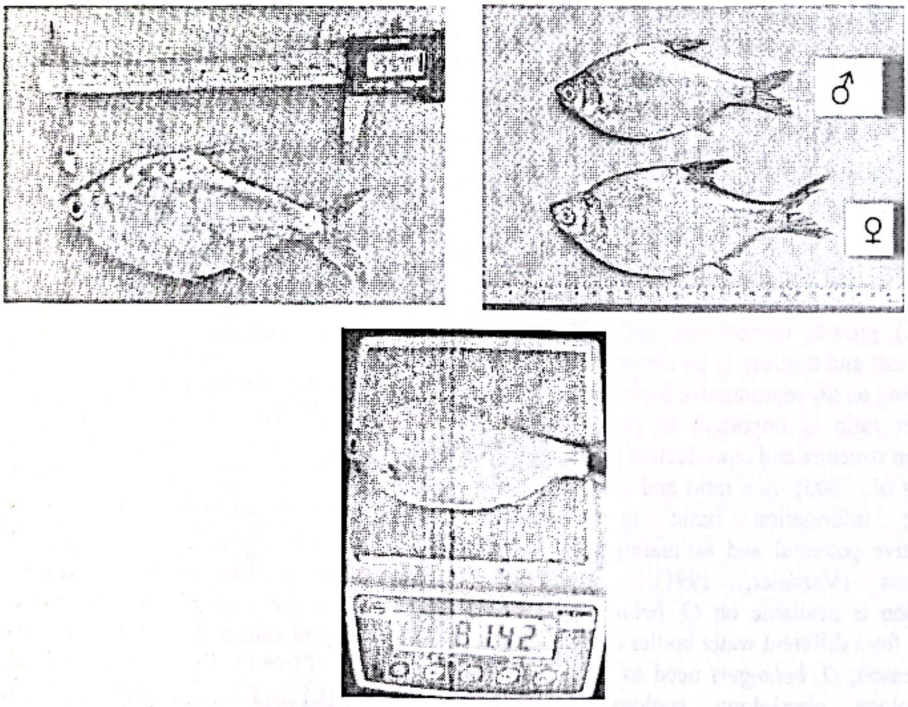

Plate1. Measuring equipment

Results

Length- weight relationship of *O. belangeri*

A twelve month long experiment was performed with a view to observing length- weight relationship of *O. benlangeri*. A total of 360 specimens were collected and analyzed.

The minimum mean total length 9.5cm related to a weight of 20.4g and 30.3g was found in June and September. The maximum mean total length of 28cm with 204.5g in March. The minimum and maximum mean body weight of the species ranged from 29.3±13.4 (May) to 160.1±26.4 (Jul). The minimal and maximum mean total length of the species ranged from 12.5±1.7cm (Sep) to 21.0±2.6cm (July) (Table 2).

Positive Linear relationship between total length and body weight of *O. belangeri* was found. The average 'b' value (b=6.4) is more than 3 indicating the positive allometric growth (Table 1 and Fig.2).

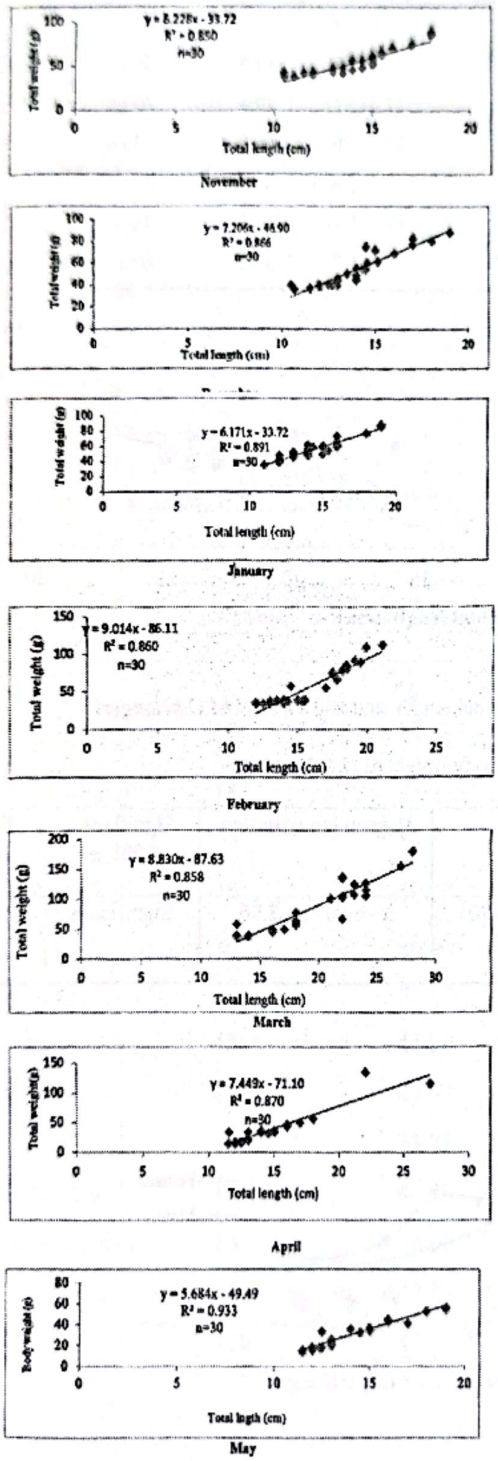

Fig. 2 Variation on Length –weight relationship of *O. belangeri*

Table 1 The length – weight relationship and related statistics of *O. belangeri*

Months	Linear equation (y= a+ bx)	Regression parameters a	b	R^2	Growth type
Nov.	LogW=-33.72+6.228 LogL	-33.72	+6.2	0.850	+allometric
Dec.	LogW=-46.90+7.206 LogL	-46.90	+7.2	0.866	+allometric
Jan.	LogW=-33.72+6.171 LogL	-33.72	+6.2	0.891	+allometric
Feb.	LogW=-86.11+9.014 LogL	-86.11	+9.0	0.860	+allometric
March	LogW= - 87.63+8.83LogL	- 87.63	+8.8	0.858	+allometric
April	LogW= - 71.10+7.449LogL	- 71.75	+7.5	0.870	+allometric
May	LogW= - 49.49+5.684LogL	-49.49	+5.67	0.933	+allometric
June	LogW= - 81.6+9.293LogL	- 81.6	+9.23	0.780	+allometric
July	LogW= - 68.42+7.976LogL	-68.42	+7.97	0.630	+allometric
Aug	LogW= - 5.074+3.355LogL	-5.074	+3.4	0.882	+allometric
Sep	LogW=+12.39+2.045 LogL	+12.39	+2.1	0.861	+allometric
Oct	LogW=-14.62+4.618 LogL	-14.62	+4.6	0.893	+allometric
			Ave = 6.4		+allometric

The correlation coefficient (R^2= 0.811), r = 0.901 ($p<0.01$) showed that there was a relationship between total length and total body weight.

Table 2 Descriptive statistics on length and weight measurements of the *O.balengeri*

Sr. no	Months	No. of Species	Total length (cm)			Body weight (g)		
			Minimum	Maximum	Mean± SD	Minimum	Maximum	Mean± SD
1.	Nov.	30	10.5	18	14.2±1.9	38.1	88.4	54.8±13.5
2.	Dec.	30	10.5	19	13.8±2.0	55.6	88.2	52.9±15.8
3.	Jan.	30	11	19	14.3±2.0	35.7	88.2	54.3±13.4
4.	Feb.	30	12	21	15.7±2.5	35.3	112.6	55.6±24.4
5.	Mar.	30	13	28	19.3± 4.12	37.6	179.8	82.7±39.2
6.	April	30	11.5	27	14.6±3.45	15.6	135.5	38.1±27.6
7.	May	30	11.5	19	13.9±2.3	14.0	56.1	29.3±13.4
8.	Jun.	30	9.5	28	17.4±5.2	20.4	204.5	79.8±54.0
9.	Jul.	30	16	27	21.1±2.6	60.0	156.6	100.1±26.4
10.	Aug.	30	14	17	14.3±1.4	34.5	53.3	42.8±4.9
11.	Sep.	30	9.5	16.2	12.5±1.7	30.3	45.4	37.9±3.8
12.	Oct.	30	12	18.5	14.2±1.7	38.2	67.2	51.1±8.1

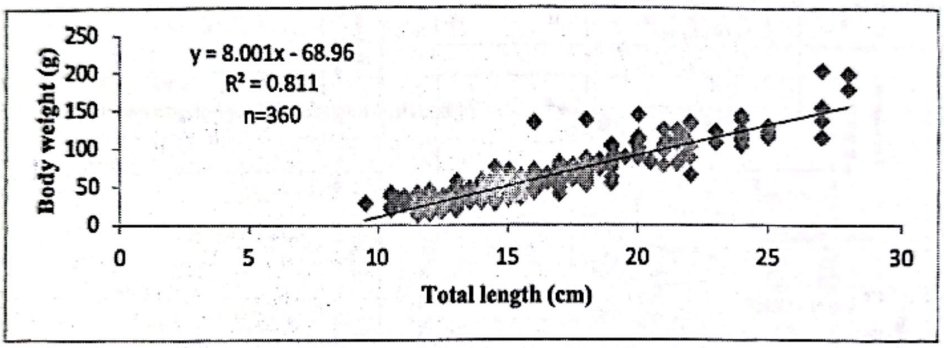

Fig. 3 Relationship between total length and body weight of *O.belangeri*

Table 3 Relationship between total length and body weight of *O.belangeri*

Species	Relationship	R^2	r	Regression equation	Significant at 0.001 level	P value
O. belangeri	total length y and body weight(x)	0.811	0.901	Y=8.001 x-68.96	Significant	P<0.01

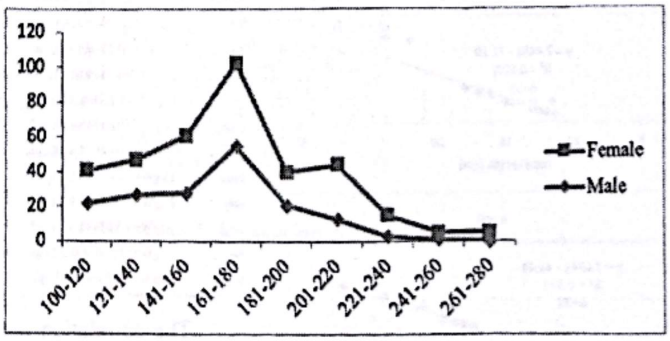

Fig .3 Size frequency distribution of male and female *O.belangeri*

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Table 4 Percentage of occurrence of males and females *O.belangeri* in different classes

Length class	Male		Female		Combined sex	
(mm)	No.	%	No.	%	No.	%
100-120	22	12.94	19	10.00	41	11.38
121-140	27	15.88	20	10.52	47	13.05
141-160	28	16.47	33	17.37	61	16.94
161-180	55	32.35	47	24.74	102	28.33
181-200	21	12.35	19	10.00	40	11.11
201-220	13	7.64	31	16.31	44	12.22
221-240	3	1.76	12	6.32	15	4.16
241-260	1	0.59	4	2.11	5	1.37
261-280	-	-	5	2.63	5	1.37
Total	170	100	190	100	360	100

Table 5 Monthly distribution of sex ratio of *Osteobrama belangeri*

Months	Male		Female		Sex ratio
	No.	%	No.	%	
November	16	53.33	14	46.67	1: 1
December	16	53.33	14	46.67	1: 1
January	17	56.67	13	43.33	1: 1
February	15	50.00	15	50.00	1: 1
March	14	46.66	16	53.33	1: 1
April	15	50.00	15	50.00	1: 1
May	13	43.33	17	56.66	1: 1
June	13	43.33	17	56.66	1: 1
July	10	33.33	20	66.67	1: 2
August	14	46.66	16	53.34	1: 1
September	14	46.66	16	53.34	1: 1.
October	13	43.33	17	56.66	1: 1
Total	170	47.23	190	52.78	1: 1

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Size frequency distribution of *O.belangeri*

In the present study, a total of 360 individuals of *O.belangeri* were used to describe size frequency distribution. The smallest size was recorded 105 mm (male) and 110mm (female) while the largest size were both male and female 280mm in this study period.

The minimum numbers of males and female were length class from 221-240, 241-260, 261-280mm and the maximum numbers of length class were found in 161-180mm.(Table 4, Fig. 3)

Sex ratio

In the present study, overall sex ratio male and female was 1: 1 (Table 5) . Monthly distributions of sex ratio of *O. belangeri* were described from November to October. Among them, sex ratio of male and female was found 1:2 in July. The rest of the month sex ratio were found 1:1 male and female. The overall sex ratio showed no significant difference from the expected value of 1:1.

Discussion

Osteobrama belangeri is known as Nga-bpe-oung in Myanmar and Pengba in Manipur. This fish species was listed endangered fish species of India according to IUCN status and categorized as extinct in the wild (CAMP, 1997).

Length-weight relationship (LWR) can be derived from length and weight measurement of the same fishes throughout their lives or from a sample of fish taken of a particular time (Wootton, 1990).

Laghari (2009) stated that length has an important function for the weight and the weight is considered to be a function of length. Length-weight relationships give information on the condition and growth patterns of fish.

Talwar and Jhingran (1991) and Menon (1999) recorded that the maximum size of *Osteobrama belangeri* was 38 cm (TL). In the present study, the maximum size was recorded as 28 cm (TL).

The study of length-weight relationship of fishes forms the important aspects of fish biology. One important aspect of growth of a fish is the relationship between length and weight of its body. Calculating the mathematical relationship between length and weight provides the expected weight for a given length of individual fish or the relevant group of individuals would be known .In the assessment of relationships between length and weight, the 'b' value of *O. belangeri* was reported as 3.06 positive allometric in Magway environs (Win Mar *et al.*, 2011). In present study, the 'b' value of *O. belangeri* 6.4 was positive allometric. The correlation coefficient (0.811), r = 0.901 ($p<0.01$) showed that there was a relationship between total length and total body weight. The higher values of "b" revealed that, the length-weight relationships might be affected by the general condition such as availability, feeding rate, gonad development and spawning period and are not constant over the entire year.

The size frequency distribution and sex ratio of fishes were estimated to know the status of the fishes which could be helpful for management of the fishery.

Very few information is available on the sex ratio, size frequency distribution of *O. belangeri* in the literature from different water bodies of the world.

The minimum numbers of male and female were found in length class 221-240, 241-260, 261-280mm while the maximum numbers of both male and female were observed in 161-180mm in length class in this study.

Sex ratio is important in predicting the population structure and reproductive performance.

Understanding variation in sex ratio is especially important because it is a key component of population fecundity. Unbalanced sex ratio can drive sexual selection, affect mating system and influence population persistence and conservation status owing to the effect of sex ratio on effective population size (Emlen and Orng, 1977).

Cho Cho Mar (2013) reported that the study of sex ratio of *O.belangeri* used 303 individuals. Among then the males and females 156 and 157 showed that sex ratio was 1:1.

In present study, a total of 360 specimen of *O. belangeri* were collected during the study with 170 (47.23 %) males and 190 (52.78%) females. The monthly sex ratio was 1:1 for almost all the year expect in July when male and female was 1:1.72. This finding similar with Cho Cho Mar (2013) finding.

Conclusion

In the present study, the length-weight regression analysis of the studied species showed that the average 'b' value of *O. belangeri* was 6.4 an indication of positive allometric. The overall male and female sex ratio of *O. belangeri* was not significant difference but July is 1: 2. Both species of female numbers were slightly large in male numbers. Size frequency distribution of *O. belangeri* showed maximum number of male and female were found in length class 161-180mm.

Acknowledgements

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ZOL 023

Seasonal Occurrence and Species diversity of Freshwater Fishfrom Wachet In, Sagaing Region

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Abstract

Investigation on seasonal occurrence and species diversity of freshwater fishes were conducted at Wachet In, Sagaing Region from July 2018 to June 2019. The study area is connected to Ayeyawady River and provides a rich diversity of freshwater fishes. A total of 42 freshwater fish species belonging to 32 genera, 18 families and eight orders were recorded from Wachet In. Order Cypriniformes represented the highest species composition (35.71%) with 15 species and predominant order in the study area. The lowest species composition (2.38%) was found in Osteoglossiformes, Cyprinodontiformes and Tetraodontiformes. The highest species composition was recorded in family Cyprinidae. The highest number of fish species was recorded in cold season and the lowest number of fish species was recorded in hot season. Among the fish species recorded, four endemic species, six introduced species and 32 native species were observed in the study area.

Keywords: seasonal occurrence, species diversity, freshwater fish, endemic, Wachet In

Introduction

Myanmar has impressive freshwaters capture fisheries. Inland freshwater bodies cover 8.1 million ha of which 1.3 million ha are permanent while the rest are seasonally inundated floodplains. There are repeated references to the crucial importance of fish and fish products in the nutrition of the Myanmar people (Htun Thein, 2015).

The fishery sector is considered as the most important one after the agriculture sector to fulfill the protein requirement of the people of Myanmar and to provide the food security as well as to get the opportunity for the employment to a large number of fishery communities and rural dwellers. Moreover, fish is second only to rice in the Myanmar diet. Myanmar is endowed with rich natural resources both in freshwater and marine fisheries. In 2017-2018 fiscal year, the total production of fish was 5.87 million metric tons in Myanmar. In this period, the production of freshwater fish was 2.71 million metric tons (46% of the total fish production) and the production of marine fish was 3.15 million metric tons (54% of the total production of fish in Myanmar) (DOF, 2018).

There are three major inland fishery namely, 1.) leasable fisheries, 2.) tender lot fisheries, and 3.) open access fisheries. The lease system corresponds to the allocation of a fishing area in a floodplain. Leasable fisheries are locally known as "Inn" fisheries in Myanmar. Leasable fisheries are almost exclusively key fishing grounds on floodplains which are primarily fished through the erection of barrage fences around the lease area with fish collected in various collection pens or traps (Baran, *et al.*, 2018).

There are currently 3,717 leasable fisheries in Myanmar. The production from leasable fisheries have increased, albeit gradually, through the year. Myanmar has been actively engaged in biodiversity conservation practices in inland waters. The leasable fisheries in floodplain areas are productive. In the same manner, these also are crucial to biodiversity conservation as these habitats, being the nursery ground for maintaining the viable populations of indigenous wild stocks (Htun Thein, 2015).

Riverine fish resources are fast depleting due to lack of fish resource information and over exploitation. Sustainable exploitation of water bodies require detailed analysis of fish fauna inhabiting lotic water and scientific management through regular monitoring and proper check on fishing pressure, including unscientific fishing methods (Rathon, 2015).

The Ayeyawady River flows over 1,335 miles through the heart of Myanmar and is one of the largest river in Southeast Asia. It is the country's largest river and most important commercial waterway. Originating from the confluence of the N'mai and Mali rivers, it flows relatively straight North- South before emptying through the Ayeyawady Delta into the Andaman sea.

The Ayeyawady is the engine of the Myanmar economy. It feeds the country's population with fish and rice, and enables goods to be transported to people up and down the river. It waters are used to power turbines for electricity, while sand from its basin is a key component for infrastructure like houses, offices and roads. That the Ayeyawady River is important to both Myanmar's economy and society (WWF, 2018).

Wachet In is located in Sagaing Township, Sagaing Region. It is one of the 85 floodplains of sagaing Township in the Dry Zone Belt of Myanmar. Wachet In is connected to Ayeyarwady River. It is a considerably large natural In. During the rainy season, floodwater from Ayeyawady River enters the In via the water channels. Water remains throughout the year and thus form a harbours of fish fauna. Watchet In was chosen as the study area because there was no previous systematic and detail study. The present study has been undertaken, to record the fish species diversity in Wachet In and to assess the seasonal occurrence of fish species.

Materials and Methods

Study Area

Wachet In is situated in Sagaing Township, Sagaing Region. It located between latitude 21° 55' 55.15" N and longitude 96° 0' 34.79" E (Fig. 1).

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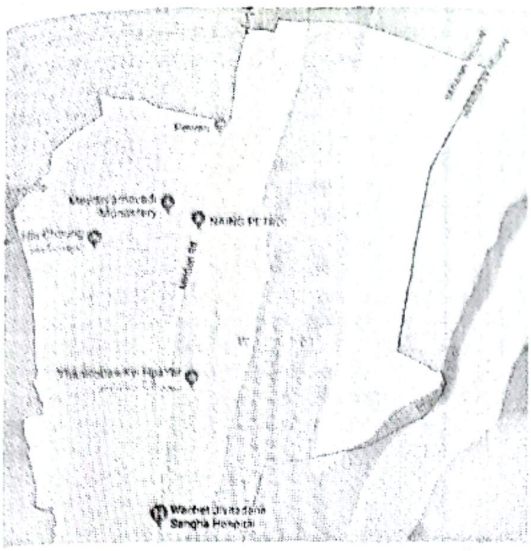

Fig.1 Map of study Area (Source from Google)

Study Period

The collection of specimens was conducted from July 2018 to June 2019.

Collection and Preservation of Specimens

Specimens were collected on the monthly basis throughout the study period. The study specimens were collected with the help of local fishermen. The external appearance of the collected specimens were noted in fresh state. Coloured photographs were also taken immediately after capturing the fish before the body color disappeared. The specimens were preserved in 5% or 10% formalin, depending on the size of specimens for further study. Small size specimens were first preserved in 10% formalin and then transferred into 5% formalin. Normal size specimens were directly preserved in 10% formalin. Large specimens were first injected with 40% formalin in the abdominal cavity and at different points on the body and finally preserved in 10% formalin solution.

Identification and Classification

Identification of fishes species were made according to Day (1878), Jayaram (1981), Talwar and Jhingran (1991), Ferraris (1998) and Jayaram (2013). The classification of fishes was made according to Jayaram (2013).

Status of fish

The status of fishes was determined with the halp of standard catch frequency chart as presented by Tamang, *et al.*,2007 (cited by Patra and Datta, 2010)

Results

In the present study, a total of 42 freshwater fish species confined to 32 genera and dishtributed among 18 families and eight orders were recorded (Table 1).

The recorded eight orders were Osteoglossiformes, Clupeiformes, Cypriniformes, Siluriformes, Cyprinodontiformes, Synbranchiformes, Perciformes and Tetraodontiformes. The most dominant order Cypriniformes was confined to two families, 11 genera and 15 species. The second dominant order Siluriformes was confined to five families, eight genera and 12 species, followed by Perciformes confined to six families, seven genera and eight species and followed by Clupeiformes confined to one family, two genera and two species and Synbranchiformes confined to one family, one genera and two species. The least dominant orders were Osteoglossiformes, Cyprinodontiformes and Tetraodontiformes and each one is confined to one family, one genera and one species (Fig. 2). During the study period, the percentage species composition of recorded fish species was found to be highest 35.71% under the order Cypriniformes, followed by 28.57% in Siluriformes, 19.05% in Perciformes, 4.76% each in Clupeiformes and Synbranchiformes, and 2.38% in each of the remaining three orders, Osteoglossiformes, Cyprinodontiformes and Tetraodontiformes (Fig. 3)

In the present study, the families Cyprinidae was most dominant represented by 14 species (33.33%) followed by Bargridae with 4 species (9.52%) and Siluridae with 3 species (7.14%). The family Clupeidae, Schilbeidae, Sisoridae, Mastacembelidae, Belontidae and Channidae were confined to two species in each (4.76%). Notopteridae, Cobitidae, Loricariidae, Belonidae, Ambassidae, Cichlidae, Gobiidae, Anabantidae and Tetraodontidae were represented by single species in each (2.38%)(Fig. 4 and 5).

During the study period, the most dominant genus was *Labeo* with four species (9.52%) the second dominant genus was *Mystus* with three species (7.14%), the third dominant genus were *Puntius, Ompok, Gagata, Macrognathus* and *Channa* with two species (4.76%) and the rest of all other genera were represented by a single species (2.38%).

Durring the present study period, *Notopterus notopterus*, *Gudusia variegate*, *Labeo rohita*, *Puntius chola*, *Aspidoparia morar*, *Parambassis ranga*, *Oreochromis* sp. and *Glossogobius giuris* were dominant species because they were observed throughout every month of study period.

Based on the monthly recorded data, the lowest number of 20 species was recorded in May. The highest number of 39 species was recorded in December (Fig. 6). Seasonally, a total number of 29 fish species belonging to 23 genera and 16 families of eight orders were recorded in hot season. A total of 37 species belonging to 29 genera and 17 families of eight orders were observed in raining season. A total of 41 fish species belonging to 31 genera and 18 families of eight order were recorded in cold season. The number of fish species were found to be highest in cold season (41 species), followed by rainy season (37 species) and hot season (29 species)(fig. 7). Among the recorded fishes, *Hilsa ilisa* was found only in rainy season. Four species, namely, *Ctenopharyngodon idellus*, *Botia berdmorei*, *Sperata acicularis* and *Mystus leucophasis* were occurred only cold season.

In the present study period, based on the occurrence frequency, eight species, namely, *Notopterus notopterus, Gudusia variegata, Labeo rohita, Puntius chola, Aspidoparia morar, Parambassis ranga, Oreochromis* sp. and *Glossogobius giuris* were recorded as common. Three species, namely, *Barbonymus gonionotus, Amblypharyngodon atkisonii* and *Tetraodon cutcutia* were considered as abundant. Twelve species, namely, *Cirrhinus mrigala, Labeo boga, Labeo calbasu, Osteobrama belangeri, Puntius sophore, Salmophasia sardinella, Mystus pulcher, Ompok bimaculatus, Gagata dolichonema, Pterygoplichthys disjunctivus, Xenentodon cancila* and *Channa striata* were assumed as frequent. Fifteen species, namely, *Catla catla, Labeo stoliczkae, Botia berdmorei, Mystus bleekeri, Ompok pabo, Wallago attu, Clupisoma prateri, Eutropiichthys vacha, Gagata melanoptera, Macrognathus aral, Macrognathus armatus, Anabas testudineus, Colisa labiosus, Trichogaster pectoralis and Channa orientalis* were found as occasional. Four species, namely, *Hilsa ilisa, Clenopharyngodon idellus, Sperata acicularis* and *Mystus leucophasis* were regarded as sporadic (Fig. 8).

Table 1. Systematic position of fish species recorded from Wachet In

	ORDER		FAMILY		SCIENTIFIC NAME
1	Osteoglossiformes	1	Notopteridae	1	*Notopterus notopterus* (Pallas, 1769)
2	Clupeiformes	2	Clupeidae	2	*Hilsa ilisha* (Ham., & Buch., 1822)
				3	*Gudusia variegata* (Day, 1869)
3	Cypriniformes	3	Cyprinidae	4	*Catla catla* (Ham., & Buch., 1822)
				5	*Ctrrhinus mrigala* (Ham., & Buch., 1822)
				6	*Ctenopharyngodon idellus* (Valenciennes, 1844)
				7	*Labeo boga* (Ham., & Buch., 1822)
				8	*Labeo calbasu* (Ham., & Buch., 1822))
				9	*Labeo rohita* (Ham., & Buch., 1822)
				10	*Labeo stoliczkae* (Steindachner, 1870)
				11	*Osteobrama belangeri* (Valencennes, 1844)
				12	*Puntius chola* (Ham., & Buch., 1822)
				13	*Puntius sophore* (Ham., & Buch., 1822)
				14	*Barbonymus gonionotus* (Bleeker, 1850)
				15	*Salmophasia sardinella* (Valenciennes,1842)
				16	*Amblypharyngodon atkinsonii* (Blyth, 1861)
				17	*Aspidoparia morar* (Ham., & Buch., 1822)
			Cobitidae	18	*Botia berdmorei* (Blyth, 1861)
4	Siluriformes	5	Bagridae	19	*Sperata acicularis* (Serraris & Runge, 1999)
				20	*Mystus bleekeri* (Bleeker, 1845)
				21	*Mystus leucophasis* (Blyth, 1861)
				22	*Mystus pulcher* (Chaudhuri, 1911)
		6	Siluridae	23	*Ompok bimaculatus* (Bloch, 1797)
				24	*Ompok pabo* (Ham, & Buch, 1822)
				25	*Wallago attu* (Schneider, 1801)
		7	Schilbeidae	26	*Clupisoma prateri* (Hora, 1937)
				27	*Eutropiichthys vacha* (Ham., & Buch., 1822)
		8	Sisoridae	28	*Gagata dolichonema* (He, 1996)
				29	*Gagata melanoptera* (Roberts & Ferraris, 1998)
		9	Loricariidae	30	*Pterygoplichthys disjunctivus* (Weber, 1991)
5	Cyprinodontiformes	10	Belonidae	31	*Xenentodon cancila* (Ham & Buch, 1822)
6	Synbranchiformes	11	Mastacembelidae	32	*Macrognathus aral* (Bloch & Schneider,1801)
				33	*Macrognathus armatus* (Lacepede, 1800)
7	Perciformes	12	Ambassidae	34	*Parambassis ranga* (Ham., & Buch., 1822)
		13	Cichlidae	35	*Oreochromis* sp. (Gunther, 1885)
		14	Gobiidae	36	*Glossogobius giuris* (Ham., & Buch., 1822)
		15	Anabantidae	37	*Anabas testudineus* (Bloch, 1795)
		16	Belontidae	38	*Colisa labiosus* (Day, 1876)
				39	*Trichogaster pectoralis* (Regan, 1909)
		17	Channidae	40	*Channa orientalis* (Bloch & Schneider, 1801)
				41	*Channa striatus* (Bloch, 1793)
8	Tetraodontiformes	18	Tetraodontidae	42	*Tetraodon cutcutia* (Ham., & Buch., 1822)

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Table 1. Systematic position of fish species recorded from Wachet In

	Order		Family		Scientific Name
1	Osteoglossiformes	1	Notopteridae	1	*Notopterus notopterus* (Pallas, 1769)
2	Clupeiformes	2	Clupeidae	2	*Hilsa ilisha* (Ham., & Buch., 1822)
				3	*Gudusia variegata* (Day, 1869)
3	Cypriniformes	3	Cyprinidae	4	*Catla catla* (Ham., & Buch., 1822)
				5	*Cirrhinus mrigala* (Ham., & Buch., 1822)
				6	*Ctenopharyngodon idellus* (Valenciennes, 1844)
				7	*Labeo boga* (Ham., & Buch., 1822)
				8	*Labeo calbasu* (Ham., & Buch., 1822))
				9	*Labeo rohita* (Ham., & Buch., 1822)
				10	*Labeo stoliczkae* (Steindachner, 1870)
				11	*Osteobrama belangeri* (Valencennes, 1844)
				12	*Puntius chola* (Ham., & Buch., 1822)
				13	*Puntius sophore* (Ham., & Buch., 1822)
				14	*Barbonymus gonionotus* (Bleeker, 1850)
				15	*Salmophasia sardinella* (Valenciennes,1842)
				16	*Amblypharyngodon atkinsonii* (Blyth, 1861)
				17	*Aspidoparia morar* (Ham., & Buch., 1822)
		4	Cobitidae	18	*Botia berdmorei* (Blyth, 1861)
4	Siluriformes	5	Bagridae	19	*Sperata acicularis* (Serraris & Runge, 1999)
				20	*Mystus bleekeri* (Bleeker, 1845)
				21	*Mystus leucophasis* (Blyth, 1861)
				22	*Mystus pulcher* (Chaudhuri, 1911)
		6	Siluridae	23	*Ompok bimaculatus* (Bloch, 1797)
				24	*Ompok pabo* (Ham, & Buch, 1822)
				25	*Wallago attu* (Schneider, 1801)
		7	Schilbeidae	26	*Clupisoma prateri* (Hora, 1937)
				27	*Eutropiichthys vacha* (Ham., & Buch., 1822)
		8	Sisoridae	28	*Gagata dolichonema* (He, 1996)
				29	*Gagata melanoptera* (Roberts & Ferraris, 1998)
		9	Loricariidae	30	*Pterygoplichthys disjunctivus* (Weber, 1991)
5	Cyprinodontiformes	10	Belonidae	31	*Xenentodon cancila* (Ham & Buch, 1822)
6	Synbranchiformes	11	Mastacembelidae	32	*Macrognathus aral* (Bloch & Schneider,1801)
				33	*Macrognathus armatus* (Lacepede, 1800)
7	Perciformes	12	Ambassidae	34	*Parambassis ranga* (Ham., & Buch., 1822)
		13	Cichlidae	35	*Oreochromis* sp. (Gunther, 1885)
		14	Gobiidae	36	*Glossogobius giuris* (Ham., & Buch., 1822)
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8	Tetraodontiformes	18	Tetraodontidae	42	*Tetraodon cutcutia* (Ham., & Buch., 1822)

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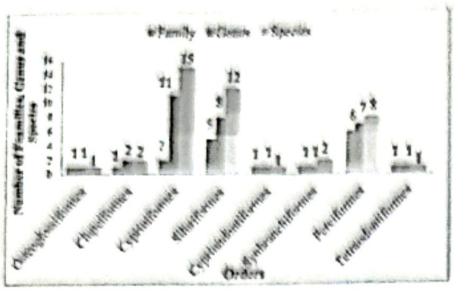

Fig 2 Orderwise freshwater fish composition in Wachet In

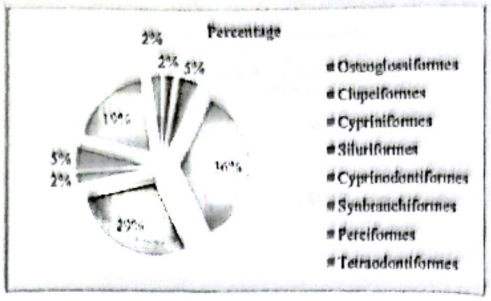

Fig.3 Orderwise freshwater fish percentages in Wachet In

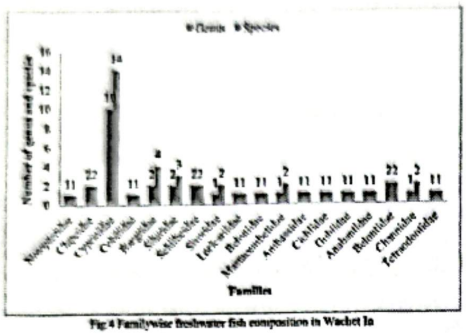

Fig 4 Familywise freshwater fish composition in Wachet In

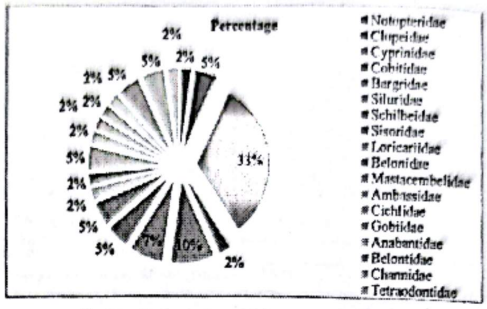

Fig.5 Familywise freshwater fish percentage in Wachet In

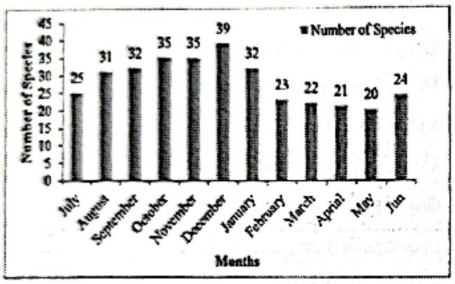

Fig.6 Monthly occurrence of fish species in Wachet In

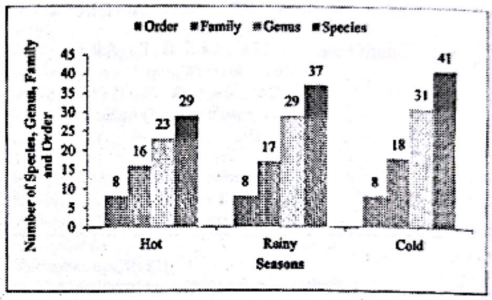

Fig.7 Seasonal occurrence of fish composition in Wachet In

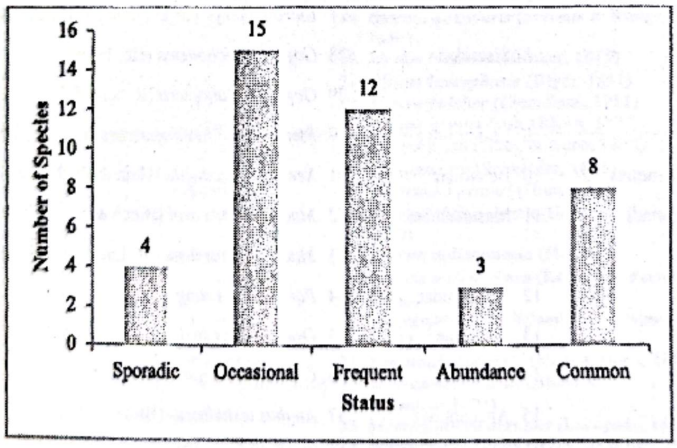

Fig.8 Status of fish species in Wachet In

Discussion

Wachet In is flood plain receiving water from the Ayeyawady River and provides fishes to the local consumers throughout the year. During the study period, a total of 42 fish species, confined to 32 genera and 18 families of eight orders were recorded from Wachet In.

The recorded species in the study area belong to eight orders, Osteoglossiformes (1 species), Clupeiformes (2 species), Cypriniformes (15 species), Siluriformes (12 species), Cyprinodontiformes (1 species), Synbranchiformes (2 species), Perciformes (8 species) and Tetraodontiformes (1 species).

The order Cypriniformes was predominant in the present study because the highest number of both genera and species belong to that order. Then, the second predominant group was observed in order siluriformes and the third predominant group was observed in order Perciformes.

The above finding is an agreement with that of Lagler *et al.* (1962) and Nelson (1984). They reported that the Cyprinids are the major freshwater fish group and thus become conspicuous parts of the fauna in different streams and lakes. Regarding the order Siluriformes, although the numbers of species are less than Cypriniformes, most of the members were regarded as commercially important species. Kullander *et al.* (2004) described that the order Siluriformes is one of the largest order with ten families. Among them, the family Bagridae consists of a diverse group of catfishes which are considered as most commercially important for food consumption and aquarium trade. Das and Sharma (2012) reported that the Cypriniformes was the dominating order and indicated that the order Cypriniformes, Siluriformes and Perciformes were most abundant in all the season in riverine habitats.

Mon Htwe Lwin, (2011), described 41 species of fish belonging to 8 orders in Kaung-Hmu-Daw In, Sagaing Township. Among the recorded orders, the order Cypriniformes was predominant because the highest number of fish species were belong to in that order. Khin Yee Mon Khaing (2017) stated 46 fish species belonging to 8 orders in Are-laung-wei-tode In, Sagaing Township. Among the recorded species, the order Cypriniformes was most dominant. Their studied areas were connected to Ayeyawady River.

Comparison between the data of the above works and also with the data accumulated during the present work revealed that some of the fish species were common to all the In and some were not recorded in some of the In. Thus, the differences may be due to different spatial and temporal factors.

In the present study, the most dominant family was Cyprinidae with 10 genera and 14 species. The second predominant family was Bargridae with 2 genera and 4 species. The third predominant family was siluridae with 2 genera and 3 species. The remaining families were represented with one or two genera and species.

UNEP-WCMC (2008) also described the Cyprinidae family as an important family of freshwater fishes that is distributed throughout Africa (except Madagascar), Asia, Europe and North America and whose species are often dominant where they are found.

With respect to the monthly number of species recorded, it is observed that the highest number of species (39) was encountered in December and the lowest number of species (20) was observed in May. The number of fish species gradually rose from August to December and after which the fish species gradually decline in January to July. The highest number of fish species (41) was recorded in cold season where the lowest number of species (29) was recorded in hot season during the study period.

In the present study, the months of higher incidence can be regarded as the months following the rainy season, when the level of water in the study area, Wachet In was high. The water level in the Wachet In is dependent on the flow of water from the Ayeyawady River, fishes might enter the "In" along with the following water, thus leading to high incidence of fish species following the rainy season. *Hilsa ilisa* was observed only in the raining season, which enters the In from the Ayeyawady with the flowing water. *Hilsa ilisa* is a major migratory fish and enter the river for breeding in the raining season. Thus, during the rainy season the study area is nutrient rich and plays a significant role for many larvae and juvenile fish.

Fluctuation in water level cause rapid alteration in habitat and this can be deleterious to many aquatic populations. Rapidly decreasing of water level may result in the eggs or fry being stranded (Wager and Jackson, 1993). This statement is in agreement with that of the present study, water level sharply declines in the hot season. During this season, the number of fish species decreased in Wachet In.

In the present study, eight fish species were encountered in every months of study period. Among the monthly occurred species, *Notopterus notopterus*, *Labeo rohita* and *Oreochromis* sp. are commercially important in the local markets as nutritious food for the local consumers. The remaining fish species were not commercially important, however their catchment has been abundant, these species were also important for fishery.

Based on the occurrence of frequency, eight species were recorded as common species, three species as abundant, 12 species as frequent, 15 species as occasional and four species as sporadic species.

According to Fishbase (2017), among the study 42 species, four species are endemic species, six species are introduced species and 32 species are native species. The four endemic species are *Gudusia variegata, Labeo stoliczkae, Mystus leucophasis* and *Clupisoma prateri*. The six introduce species are *Ctenopharyngodon idellus, Barbonymus gonionotus, Pterygoplichthys disjunctivus, Oreochromis* sp., *Colisa labiosus,* and *Trichogaster pectoralis*.

During the study period, fishes were found throughout the year. Thus, the fishery of Wachet In play an important role in supplying food and economy of the local people. The floodplain fishery along the Ayeyarwady River is one of the most important sources of fish production in Myanmar. Therefore, Wachet In may have a great strategic importance for the nutrition of the local inhabitants.

Conclusions

Inland fisheries provide a valuable contribution to food security in many parts of the developing countries, including Myanmar. Wachet In provides an ecosystem for sustainable freshwater fish stock and maintenance of its biodiversity of fishes. This assure a continuous supply of a variety of fishes for local people's food and livelihood. So, further investigation on economic important of fish species and their future sustainable resource management startegies could be promoted.

Acknowledgment

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ZOL 024

Species Composition, Occurrence and Conservation of Fish Fauna in Ayeyawady River Segment, from Myitsone to Pammati, Myitkyina, Kachin State

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Abstract

A total of 45 fish species belong to the 37 genera, 18 families and six orders were recorded in Ayeyawady river segment (from Myitsone to Pammati). Among the recorded species, 21 species were included in Cypriniformes, 14 species in Siluriformes and seven species under Perciformes respectively. Only each species was recorded in Mugiliformes, Osteoglossiformes and Cyprinodontiformes. In all study areas, the highest number of collected fish species belong to order Cypriniformes, the second highest number belong to order Siluriformes and followed by Perciformes, Mugiliformes, Osteoglossiformes and Cyprinodontiformes. The order Cypriniformes was found with the highest species composition (47%), followed by Siluriformes (31%), Perciformes (16%) and Mugiliformes, Osteoglossiformes and Cyprinodontiformes were the same percentage (2%). The indices of similarity of recorded species were around 90% in all study sites. According to the IUCN Red List, among the recorded fish species, 35species was assessed at least concern (LC) and one species vulnerable (VU). Six species were categorized as near threatened (NT) and seven species were considered Data Deficient (DD).

Keywords: Ayeyawady, species composition, conservation, IUCN.

Introduction

All fish species play an important role in aquatic ecosystem. Although fish inhabit nearly every permanent water body, each species has own distribution and range (Texas commission on Environmental Quality, 2005).

Of these 21,723 fish species known to science, over 40% live in fresh water and majority of them live in tropics (Talwar and Jhingram, 1991).

Fish biodiversity of lake and river essentially represents the fish found diversity and their abundance. Lake and river conserve a rich variety of fish species which support to the commercial fisheries (Sarwade and Khillore, 2010).

Myanmar is rich in water resources and fishes are one of them. The highest amount of fishes is produced from Ayeyawady River and its floodplains (Smith *et al*., 2002) that flow from north to south through Myanmar. It is the country's largest river and most important commercial waterway. It is the life-blood of the Myanmar people.

The segment of Ayeyawady River from Myitsone to Pammati flows and passes through Myitkyina Township in the west and Waimaw Township in the east. Many people in Myitkyina still depend on fishes from Ayeyawady River for their living. Ayeyawady River is one of the areas where its fish fauna is not full known. Studies of distribution and species composition of freshwater fishes are useful to examine factors influencing the structure of the fish community (Galactos *et al.*, 2004).Therefore the present study has been undertaken with the following objectives;

- to identify and record the fish fauna in the study sites
- to investigate the composition of fish species in the study area
- to record the conservation status of fish species in the study area

Materials and Methods

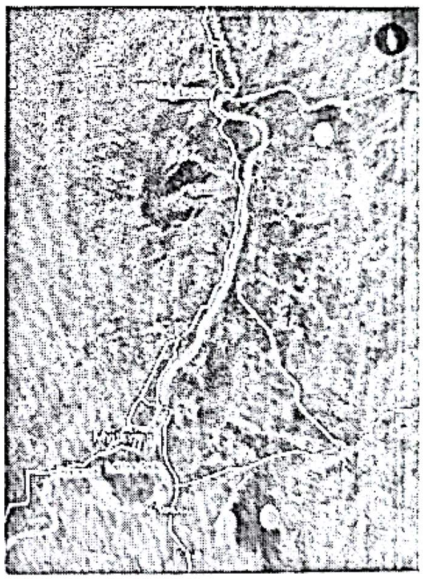
Study site

Kachin state is Northern part of Myanmar. Myitkyina is the capital city of Kachin State. It is located between 24° 32' and 26° 12' North latitude and between 96° 40' and 97° 32' East longitude.It situated at an elevation of 158 m in above sea level.

Ayeyawady River segment was chosen as study site due to the existing vast fresh water resources for floral and fauna. The study sites were devided into three parts along Ayeyawady River segment in Myitkyina area: Myitson, Lahpa seik and Pammati (Plate 1 and 2).

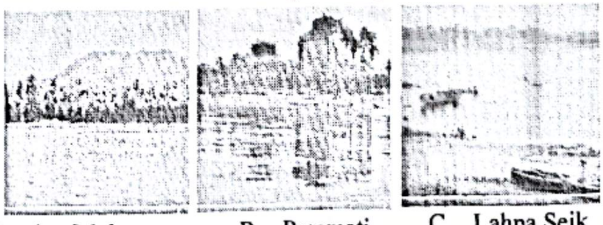
Study period

Field survey and specimens collection were carried out from October 2016 to February 2017.



(Source: Google earth)

Plate 1 Location map of study sites



A. Myitsone B. Pammati C. Lahpa Seik

Plate 2 Study sites

Collection and preservation the specimens

Specimens were collected from local fishermen and fish mongers within study area. Specimen collection was carried out weekly. For each species, at least five specimens were collected to ensure the correct identification. Photographs were taken at fresh condition to obtain the original color. The morphological characters and coloration of the collected specimens were noted down freshly, measured and fin rays and scale counts were recorded. The collected specimens were preserved in different concentrations of formalin solution (5-10 percents) based on the size for further analysis.

Identification of fish species

Identification of the recorded species were followed after Day (1967), Lagler (1977), Talwar and Jhingram (1991) and Jayaram (1981). The local names were noted by Myanmar from the local fishermen.

Data Analysis

SØrensen's original formula was intended to be applied to presence / absence data.

The indices of similarity of recorded species were calculated as follows;

$$S = 2C / A + B$$

Where, C = number of species common (shared by) in study sites

A = the number of species unique to the first study site

B = the number of species unique to the second study site

Results

Species composition and similarity

A total of 45 fish species confined to 37 genera, 18 families and distributed under six orders were identified and recorded in three study sites during October 2016 to February 2017 (Table 1 and Plate 3, 4).

Among the recorded species 21 species were included in Cypriniformes, 14 species in Siluriformes and seven species under Perciformes respectively. Only each species was recorded in mugiliformes, Osteoglossiformes and Cyprinodontiformes.

During the study period, the order Cypriniformes was found with the highest species composition (47%) and was represented by 21 species, followed by Siluriformes (31%) with 14 species, Perciformes (16 %) with seven species and Mugiliformes, Osteoglossiformes, and Cyprinodontiformes were the same percentage (2%) represented with one species respectively (Fig. 1,).

All recorded fish species were collected in Lahpa seik area except Glossogobius giuris and 35 species in Myitson and 42 species in Pammati areas respectively (Table 2).

Based on the indices of similarity (Sorensen's index), Laha seik and Pammati were the most similar fish assemblages (95.35%), Myitson and Pammati were stand second similar fish assemblages (90.91%) and Myitson and Lahpa seik were the least similar fish assemblages (88.60%) during the study period (Table 3).

According to the IUCN Red List, among the recorded fish species, 35 species was assessed at least concern (LC) and one species vulnerable (VU). Six species were categorized as near threatened (NT) and seven species were considered Data Deficient (DD) (Table 1).

Table 1 List of some fish species recorded from the Ayeyawady River segment during October 2016 to February 2017

Sr. No.	Order	Family	Scientific Name	Common Name	Local Name	IUCN Status
1	Osteoglossiformes	Notopteridae	*Notopterus notopterus*	Feather back	Nga-phe	LC
2	Cypriniformes	Cyprinidae	*Labeo angra*	Angra labeo	Nga-lue-myie-net	LC
3			*Labeo boga*	Boga labeo	Kyauk-nga-lue	LC
4			*Labeo calbasu*	Black-rohu	Nga-net-pyar	LC
5			*Labeo gonius*	Kuria labeo	Nga-deing	LC
6			*Labeo stoliczkae*	Moulmein labeo	Nga-le	LC
7			*Osteobrama belangeri*	Manipur osteobrama	Nga-phan-ma	NT
8			*Osteobrama cunma*	Cunma osteobrama	Nga-lay-daunk	LC
9			*Osteobrama feae*	Burmese osteobrama	Nga-phan-ma	LC
10			*Puntius chola*	Chala barb	Nga-khone-ma-gee	LC
11			*Barilius barna*	Barna baril	Ye-maung-sa	LC
12			*Raiamas guttatus*	Burmese trout	Nga-la-war	LC

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Sr. No.	Order	Family	Scientific Name	Common Name	Local Name	IUCN Status
13			*Rasbora daniconius*	Black line rasbora	Nga-nan-gyaung	LC
14			*Amblypharyngodon atkinsonii*	Burmese catplet	Nga-hyet	LC
15			*Cyprinus carpio*	Common carp	Shwe-war-nga-gyin	VU
16			*Tor tambroides*	Thai mahseer	Nga-ni	DD
17			*Crossocheilus burmanicus*	Burmese latia	Nga-lone	LC
18			*Systomus sewelli*		Nga Shwe	
19		Balitoridae	*Acanthocobitis zonalternans*	Loach	Nga-tha-lae-toe	LC
20		Cobitidae	*Syncrossus berdmorei*	Blyth's loach	Nga-tha-lae-toe	NT
21			*Botia histrionica*	Burmese loach	Nga-shwe-yee	LC
22			*Acantopsis choirorhynchos*	Banana fish	Nga-pyaw-myit	NT
23	Mugiliformes	Mugilidae	*Rhinomugil corsula*		Nga taing tet	LC
24	Cyprinodontiformes	Belonidae	*Xenenthodon cancila*	Freshwater garfish	Nga-phaung-yoe	LC
25	Siluriformes	Bagridae	*Seperata aor*	Giant river-catfish	Nga-gyaung	LC
26			*Mystus cavasius*	Gangetic mystus	Nga-zin-yaing-phyu	LC
27			*Mystus leucophasis*	Sittang mystus	Nga-nout-thwar	LC
28			*Hemibagrus menoda*	Menoda catfish	Nga-ngike	LC
29		Siluridae	*Ompok pabo*	Pabo catfish	Nga-nu-than	NT
30			*Wallago attu*	Boal	Nga-butt	NT
31		Schibeidae	*Eutropiichthys burmanicus*	Batchwa vacha	Nga-myin-kun-mar	LC
32			*Clupisoma prateri*	Burmese garua	Nga-myin-kyawl-shae	LC
33		Akysidae	*Akysis prashadi*	Indawgyi stream catfish	Ta-nga-ngo	LC
34		Sisoridae	*Bagarius bagarius*	Yellow cat fish	Nga-mawng-ma	NT
35			*Gagata dolichonema*	Indian gagata	Nga-than-chate	LC
36			*Glyptothorax cavia*	Heart throat catfish	Nga-ywe	LC
37		Clariidae	*Clarias batrachus*	Magur	Nga-khu	LC
38			*Heteropneustes fossilis*	Stinging catfish	Nga-kyee	LC

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Sr. No.	Order	Family	Scientific Name	Common Name	Local Name	IUCN Status
39	Perciformes	Ambassidae	*Pseudambassis ranga*	Indian glassy fish	Nga-zin-sat	LC
40		Cichlidae	*Oreochromis niloticus*	Nile tilapia	Salapia	LC
41		Gobiidae	*Glossogobius giuris*	Tank goby	Ka-tha-bore	LC
42		Anabantidae	*Anabas testudineus*	Climbing-perch	Nga-pye-ma	DD
43		Channidae	*Channa marulius*	Giant snakehead	Nga-yant-daing	LC
44			*Channa punctatus*	Spotted snakehead	Nga-yant-pa-naw	LC
45		Mastacembelidae	*Mastacembelus armatus*	Tire track spiny eel	Nga-mway-na-gar	LC

Table 2 Occurrence of fish species in the three study sites of Ayeyawady River segment during October 2016 to February 2017.

Sr. No.	Name of Species	Study Site		
		Myitsone	Lahpaseik	Pammati
1	*Notopterus notopterus*	√	√	√
2	*Labeo angra*	√	√	√
3	*Labeo boga*	√	√	√
4	*Labeo calbasu*	√	√	√
5	*Labeo gonius*	√	√	√
6	*Labeo stoliczkae*	√	√	√
7	*Osteobrama belangeri*	√	√	√
8	*Osteobrama cunma*	√	√	√
9	*Osteobrama feae*	√	√	√
10	*Puntius chola*	-	√	√
11	*Barilius barna*	√	√	√
12	*Raiamas guttatus*	√	√	√
13	*Rasbora daniconius*	-	√	√
14	*Amblypharyngodon atkinsonii*	√	√	√
15	*Cyprinus carpio*	√	√	√
16	*Tor tambroides*	√	√	√
17	*Crossocheilus burmanicus*	√	√	√
18	*Systomus sewelli*	-	√	√
19	*Acanthocobitis zonalternans*	√	√	√
20	*Syncrossus berdmorei*	√	√	√
21	*Botia histrionica*	√	√	√
22	*Acantopsis choirorhynchos*	√	√	√
23	*Rhinomugil corsula*	-	√	√
24	*Xenenthodon cancila*	√	√	√
25	*Seperata aor*	√	√	√
26	*Mystus cavasius*	√	√	√
27	*Mystus leucophasis*	-	√	√
28	*Hemibagrus menoda*	√	√	√
29	*Ompok pabo*	√	√	√
30	*Wallago attu*	√	√	√
31	*Eutropiichthys burmanicus*	√	√	√
32	*Clupisoma prateri*	√	√	√

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Sr. No	Name of Species	Study Site		
		Myitsone	Lahpaseik	Pammati
33	*Alysis prashadi*	√	√	√
34	*Bagarius bagarius*	√	√	√
35	*Gagata dolichonema*	√	√	√
36	*Glyptothorax cavia*	-	√	√
37	*Clarias batrachus*	-	√	-
38	*Heteropneustes fossilis*	-	√	-
39	*Pseudambassis ranga*	√	√	√
40	*Oreochromis niloticus*	√	√	√
41	*Glossogobius giuris*	-	-	√
42	*Anabas testudineus*	-	√	-
43	*Channa marulius*	√	√	√
44	*Channa punctatus*	√	√	√
45	*Mastacembelus armatus*	√	√	√

Table 3 Similarity Sorenson's indices (%) of fish species among different study sites during study period

		Myitsone	Lahpaseik	Pammati
Total Species		35	44	42
Lahpaseik	Shared Species	35		
	Similarity	88.60%		
Pammati	Shared Species	35	41	
	Similarity	90.91%	95.35%	

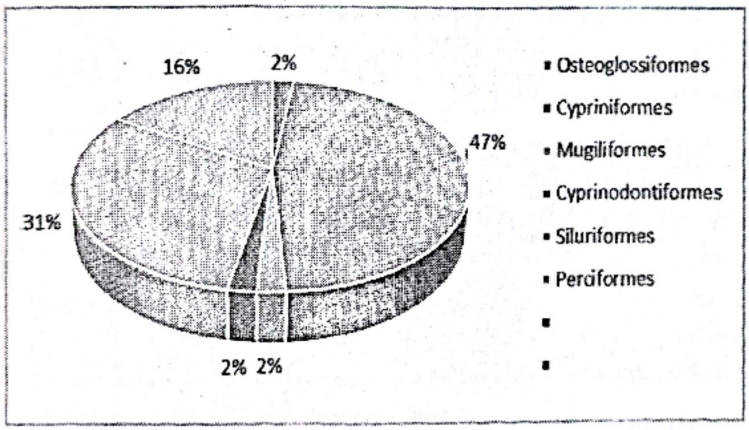

Fig.1 Species composition of the recorded orders in percentage

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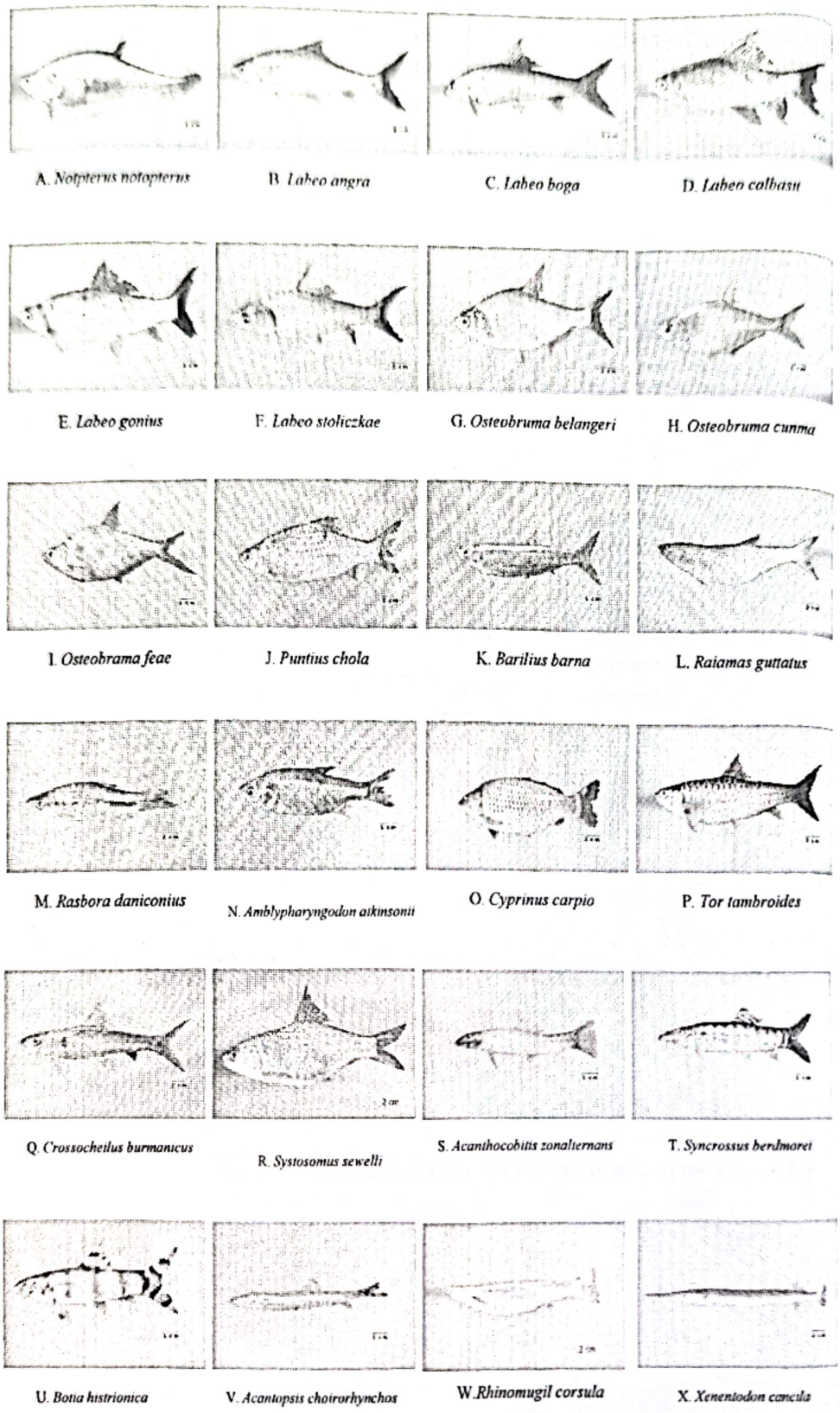

Plate 3 Study species of order – Osteoglossiformes (A), Cypriniformes (B to V), Mugiliformes (W) and Cyprinodontiformes (X)

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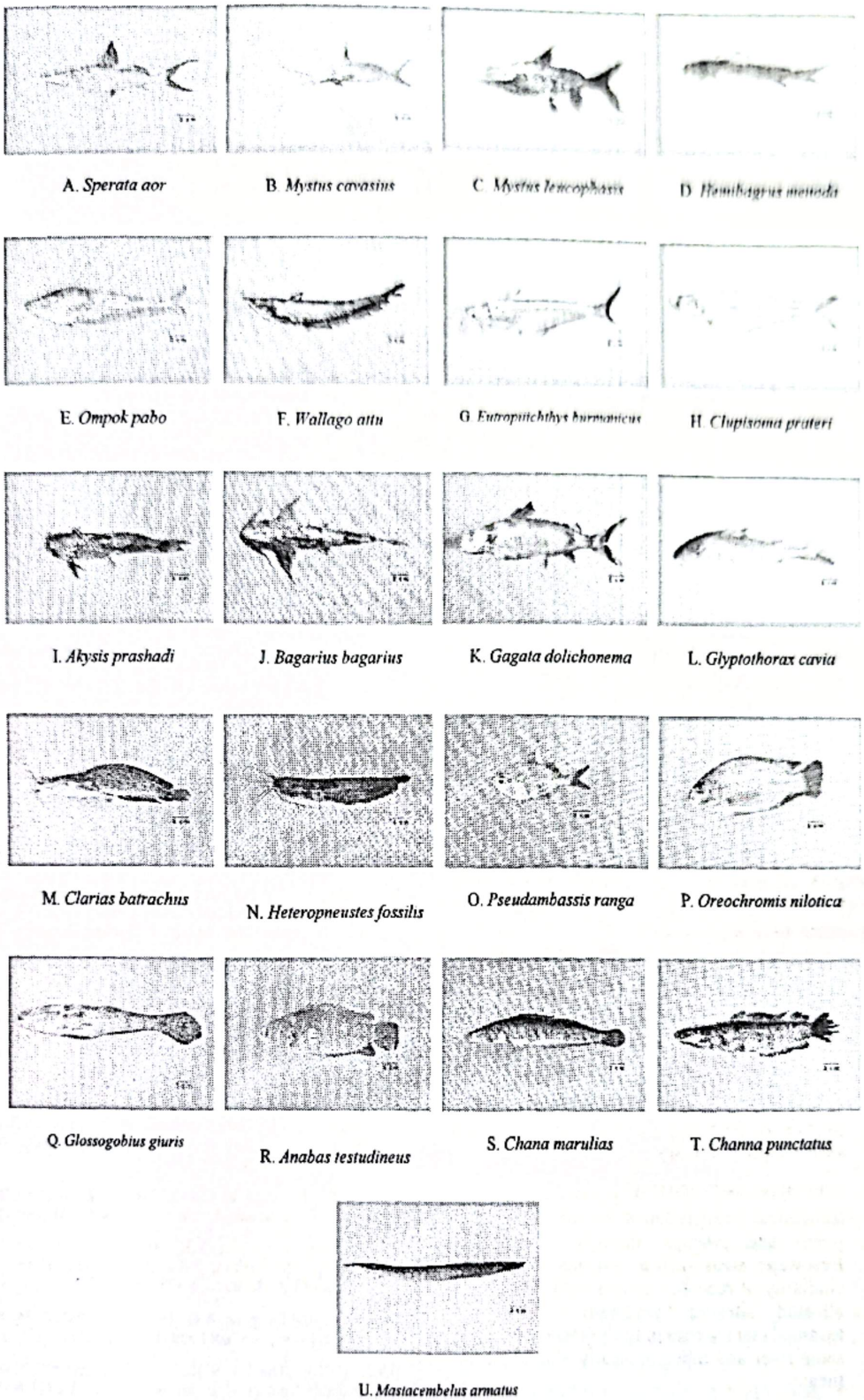

A. *Sperata aor*
B. *Mystus cavasius*
C. *Mystus leucophasis*
D. *Hemibagrus menoda*
E. *Ompok pabo*
F. *Wallago attu*
G. *Eutropiichthys burmanicus*
H. *Clupisoma prateri*
I. *Akysis prashadi*
J. *Bagarius bagarius*
K. *Gagata dolichonema*
L. *Glyptothorax cavia*
M. *Clarias batrachus*
N. *Heteropneustes fossilis*
O. *Pseudambassis ranga*
P. *Oreochromis nilotica*
Q. *Glossogobius giuris*
R. *Anabas testudineus*
S. *Chana marulias*
T. *Channa punctatus*
U. *Mastacembelus armatus*

Plate 4 Study species of order – Siluriformes (A to N), Perciformes (O to U)

Discussion

In all study areas, highest number of collected fish species were belong to order Cypriniformes, the second highest number belong to order Siluriformes and followed by Perciformes, Mugiliformes, Osteoglossiformes and Cyprinodontiformes.

The species composition of Cypriniformes is higher than those of remaining orders in the study sites .This finding was in consistency with the statement of Lagler *et.at.*, (1962) and Nelson (1984). They reported that the Cyprinids are the major freshwater fish group.

According to Das and Sharma (2007), the Cypriniformes were the dominating order and Cyprinodontiformes contribute lowest in the river of Kopili and Jamara River. Rahim *et al.* (2009) mentioned that the unequal fish species composition and abundance in floodplain could be attributed to many factors. Most recorded fish species were common any water body of study areas.

Mystus leucophasis, Akysis prashadi and *Glossogobius giuris* were rarely found in this study sites. Vidthayanon *et.al* (2005) mentioned that *Mystus leucophasis* inhabits larger rivers in the lowlands.

Akysis are small secretive fishes that occupy a variety of habitats (htt://en.m.wikipedia.org/wiki/Akysis). Larson (2013), Mauge' (1986) and Riede (2004) stated that *Glossogobius giuris* is a benthopelagic and amphidromous species that is mainly found in estuaries and fresh water river systems that extend well in land, but is also found in marine habitats.

Clarias batrachus, Heteropneustes fossilis and *Anabas testudineus* were found only in Lahpaseik area. Normally, they inhabit in lake but enter to Ayeyawady River when flooded from connected streams and adjacent lakes and ponds.

These results were agreeable with Talwar and Jhingram (1991). They stated that *Clarias batrachus* is abundant in ponds and rivers, and in the mud, they lie concealed for hours found in all types of water but so in derelict and swampy waters. *Heteropneustes fossilis* is primarily a fish of ponds, ditches, swamps and marshes, but it is sometimes found in muddy river.

Jayaram (2013) pointed that *Anabas testudineus* flourishes most in canals, ditches, lakes, ponds and swamps, through found in other freshwater areas such as streams. The indices of similarity of recorded species were around 90% in all study sites of Ayeyawady river segment. It assumed that the chosen study sites were parts of the same river and topographically almost uniform in them.

According to the IUCN Red List, there are six near threatened (NT) species in the study sites, and the rest are under vulnerable (VU), least concern (LC), and data deficient (DD) categories. These six near threatened speces are common species in this study sites during the study period. There have been many conservation and protection efforts to preserve the Ayeyawady River resourses. Among these are, the suspension of dam construction, enacting freshwater fisheries law and prohibition of gold mining along the river.

Conclusion

Findings were in general agreement with theoretical expressions. The information obtained this inverstigation could be used the desirable management measure of fish fauna in Ayeyawady River.

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ZOL 025

Occurrence of Some Migratory Birds from Myitkyina and Mogaung Environs

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Abstract

Throughout the observation period from October 2014 to September 2015, a total of 42 species and 1610 individuals of migratory birds in Myitkyina and Mogaung environs were recorded. Among them, 25 species, including 1197 individuals, were terrestrial birds and 18 species including 413 individuals were water birds. There were seven Orders, nine Families, and 15 Genera of water birds. Then, four Orders, 11 Families and 19 Genera of terrestrial birds were recorded. According to the occurrence of bird species, 16 species of water birds were winter visitors except for *Anhinga melanogaster* (Oriental Darter) and *Phalacrocorax carbo* (Great Cormorant) were a non-breeding migrant. All species of recorded migratory terrestrial birds were local migrants. Among the recorded water birds, *Aythya nyroca* (Ferruginous Pochard) and *Anhinga melanogaster* (Oriental Darter), whereas in the terrestrial birds, *Motacilla samveasnae* (Mekong Wagtail) were globally near threatened species. All recorded species of water birds were totally protected. Among the recorded terrestrial birds, two species were totally protected, six species were seasonally protected and one species was normally protected.

Keywords: occurrence, migratory, near threatened species, seasonally protected, normally protected

Introduction

Apart from mammals, birds are the only other class of warm-blooded vertebrates and conquer the most difficult environment. They explore almost the whole earth of 1114 species in 2015, and sweeping served have been conducting (http:// www. audubon. org.news). Birds live in place where there are water and vegetation. Through mobile and air born birds select the habitat whether on migration or through cycles of wondering in search of food or through protracted residence which most nearly suits their individual, their adaptation for food gathering, roosting, nesting or protection from predators and for adaptation to climate (Urfi, 2004).

The majority of birds have the inherent quality to move from one place to another to obtain the advantages of a favorable condition(Jordan & Verma, 1965). Many millions of water birds in the north depart on a long journey southwards. They pass through many Asian countries between October and February to spend the cold northern winter in milder climates in the tropical and warm temperate areas such as eastern and southern Asia, Australia and New Zealand (Bhushan et al., 1993).

Among the vast routes of waterbird migration paths, Central Asian Flyway and East Asian Australasian Flyway and flock to Myanmar to rest and feed during the winter season (www.fauna-flora.org. 2014) Global diversity of resident and migratory waterbirds represented over 784 species and over 327 species in Asia (Bhushan et al., 1993). Myanmar possesses a great diversity of aquatic habitats and has approximately 1114 species of birds, in which 200 are true migrants occurring only as winter visitors. The remainders are residents though many may be classed as a local migrant (King and Dickinson,1975). There are 188 species of waterbirds in which 88 species are winter visitors in Myanmar (Biodiversity And Nature Conservation Association, 2009).

Therefore, Myanmar is a haven fall all kinds of bird species, including migratory birds who like to spend a good part of the winter in lakes, ponds, rivers, wetlands, mangroves, and coastal areas (www. mmtimes.com).Abundance and diversity of birds may be able to tell us whether a site is still good for wildlife (Welty and Beptista, 1990). Annual differences in bird-habitat relationships occurred because environmental conditions can vary annually, affecting the abundance of individuals and their habitat use (Louise et al., 2002).

Myitkyina and Mogaung Townships are situated in Kachin State at 145 meters above sea level. It lies on the west bank of Ayeyarwady River. Mogaung Township is included in the Mohnyin District and situated on the Mandalay- Myitkyina railway line. It has a subtropical humid climate, having the unusual types of plant community containing broadleaved forests and alpine forests in the north and dry deciduous forest of the total area. Nevertheless, the destruction and alteration of habitats significantly threatened in the northern part of Myanmar, coupled with human impacts and climatic changes may lead to decrease in migratory and resident birds.

This paper describes the occurrence of migratory birds in Myitkyina and Mogaung environs during the study periods with the following objectives.

- to observe some wintering water birds and migratory terrestrial birds in Myitkyina and Mogaung environs
- to record the number of individuals birds species in the study areas
- to study the monthly occurrence of the studied species

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Materials and Methods

Study area

Myitkyina and Mogaung are situated in the Kachin State which lying the northern part of Myanmar. Myitkyina is the capital of Kachin State and lies on the west bank of Ayeyarwady River. Myitkyina is located between latitude 25° 23' 0" N and longitude 97° 24' 0" E. Mogaung Townships is at latitude 25° 18' 0" N and longitude 96° 56' 0" E. Present study was carried out of the environs of Myitkyina especially in the University Campus and Nant-tant "In" and its environs in Mogaung.

Study period

The study period of observations were carried out from October 2014 to September 2015.

Method

Data collection was made monthly during October 2014 and September 2015. Bird samplings were carried out from 06:00 to 9:00 am using by point count method (Bibby *et al*., 2000). Positions of the sample points were based on the habitat of the birds and better assessment of the bird species (Thakur *et al*., 2010). Birds were viewed with naked eyes or sometimes with binoculars, and photographs were taken. Number of individual of birds were counted with one man power on sampling point.

Identification

Recorded bird species were identified by Robson (2015). Classification and conservation status were adopted from Bird Life International (2014) and Myanmar Life Protection Act 583/94 (Ministry of Forest (1994).Status of recorded bird species has been assigned strictly regarding the study area on the basis of presence or absence method (Thakur, 2008) (cited in Thakur *et al*., 2010

Results

From October 2014 to September 2015, a total of 43 species and 1610 individuals of birds were recorded. Among them, 25 species representing 1197 individuals were terrestrial birds, and 18 species representing 414 individuals were water birds. Recorded water birds were included in seven Orders, nine Families, and 14 Genera. All species of terrestrial birds were included in four Orders, 11 Families, and 18 Genera (Table.1,2,3,4).

Among the recorded water birds, *Aythya nyroca* (Ferruginous Pochard) and *Anhinga melanogaster* (Oriental Darter) whereas in the terrestrial birds, *Motacilla samveasnae* (Mekong Wagtail) were globally near threatened species according to IUCN Red List 2014 (Table.1,2,3,4).

Among the recorded terrestrial birds, *Falco tinnunculus* (Common Kestrel) and *Upupa epops* (Common Hoopoe) were totally protected, *Eudynamic scolopacea* (Asian Koel), *Cacomantis merulinus* (Plaintive Cuckoo), *Cuculus micropterus* (Indian Cuckoo), *Pycnonotus jocosus* (Red-whiskered Bulbul), *Pycnonotus xanthorrhous* (Brown-breasted Bulbul) and *Hypsipetes leucocephalus* (Himalayan Black Bulbul) were seasonally protected and *Cinclus pallasii* (Brown Dipper) was normally protected (Table. 2).

Among water bird species, *Tadorna ferruginea* (Ruddy Shelduck), *Tadorna tadorna* (Common Shelduck), *Dendrocygna javanica* (Lesser Whistling Duck), *Nettapus coromandelianus* (Cotton Pigmy Goose), *Anas platyrhynchos* (Mallard), *Anas zonorhyncha* (Chinese Spot-billed Duck), *Anas clypeata* (Nothern Shoveler), *Athya nyroca* (Ferrugineous Pochard), *Athya fuligula* (Tufted Duck), *Tachybaptus ruficollis* (Little Greebe), *Anastomus oscitans* (Asian Openbill), *Threskiornis melanocephalus* (Black-headed Ibis), *Tringa glareola* (Wood Sandpiper)and *Larus brunnicephalus* (Brown-headed Gull) were totally protected (Table.1,3).

Concerning to terrestrial birds, two species were totally protected, eight species were seasonally protected, and one species was normally protected according to the Act of Ministry of Forest (1994). Then, in water birds, there 13 species were totally protected, and one species was seasonally protected (Table.2).

According to the occurrence of bird species, 16 water bird species were winter visitors except for *Anhinga melanogaster* (Oriental Darter) was non-breeding migrant respectively (Table.3). All 25 species of recorded migratory terrestrial birds were local migrants (Table. 4).

The highest species of recorded migratory water birds were comprised under the Order Anseriformes and Family Anatidae, including ten species but only one species each in other families (Table.1). Out of all waterbird species, *Dendrocygna javanica* (Lesser Whistling Duck) were the most abundant species and then followed by *Fulica atra* (Common Coot), *Fulica atra* (Common Coot)and so on (Table 3).

The highest species of recorded migratory terrestrial birds were under the Order Passeriformes and Family Motacillidae, including six species and then followed by three species in both Cuculidae and Passeridae (Table. 2). With regard to terrestrial species, (Black-collared Starling) was the most abundant species and then followed by *Motacilla alba* (White Wagtail), and *Lanius tephronotus* (Grey-backed Shrike) were the most abundant.

Throughout the study period, the number of bird species and individuals were more recorded in Mogaung than in Myitkyina (Table.3,4, and Fig. 1,2).

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Table.1 Classification of the recorded migratory water birds in Myitkyina and Mogaung Environs

No.	Order	Family	Scientific name	Common name	CS
1	Anseriformes	Anatidae	* *Answer cygnoides*(Linnaeus,1758)	Grey-legged Goose	LC
2			* *Tadorna ferruginea*(Pallas, 1764)	Ruddy Sheldek	LC
3			* *Tadorna tadorna* (Linnaeus,1758)	Common Shelduck	LC
4			* *Dendrocygna javanica* (Horsfield,1821)	Lesser Whistling Duck	LC
5			* *Nettapus coromandelianus* (Gmelin,1789)	Cotton Pigmy-goose	LC
6			* *Anas platyrhynchos* Linnaeus, 1758	Mallard	LC
7			* *Anas zonorhyncha* Swinhoe,1866	Spot-billed Duck	LC
8			* *Spatula clipeata* Linnaeus,1758	Nothern Shoveler	LC
9			* *Aythya nyroca* (Guldenstdt,1770)	Ferrugineous Pochard	NT
10			* *Aythya fuligula* (Linnaeus,1758)	Tufted Duck	LC
11	Podicipidiformes	Podicipidae	* *Tachybaptus ruficollis* (Pallas,1764)	Little Greebe	LC
12	Ciconiiformes	Ciconiidae	* *Anastomus oscitans* (Boddaret,1781)	Asian Openbill	LC
13	Suliformes	Anhingidae	* *Anhinga melanogaster* Pennant,1969	Oriental Darter	NT
14	Suliformes	Phalacrocoracidae	* *Phalacrocorax carbo*	Great Cormorant	LC
15	Gruiformes	Rallidae	* *Fulica atra* Linnaeus,1758	Common Coot	LC
16	Charadriiformes	Recurvirostridae	* *Himantopus himantopus* (Linnaeus,1758)	Black-winged Stilt	LC
17		Scolopacidae	* *Tringa glareola* (lesson,1826)	Wood Sandpiper	LC
18		Laridae	* *Chrococephalus brunnicephalus*	Brown-headed Gull	LC

NT = Near threatened , LC = Least concerned * = Totally protected , ♦ = Seasonally protected , ● = normally protected

Table.2 Classification of the recorded migratory terrestrial birds in Myitkyina and Mogaung Environs

No.	Order	Family	Scientific name	Common name	CS
1	Falconiformes	Falconidae	* *Falco tinnuculus* Linnaeus,1758	Common Kestrel	LC
2	*Bucerotiformes*	Upupidae	* *Upupa epops* Linnaeus,1758	Common Hoopoe	LC
3	*Cuculiformes*	Cuculidae	♦ *Eudynamis scolopaceus*(Linnaeus,1758)	Asian Koel	LC
4			♦ *Cacomantis merulinus* (Scopoli,1786)	Plaintive Cuckoo	LC
5			♦ *Cuculus micropterus* Gould,1837	Indian Cuckoo	LC
6	*Passeriformes*	Passeridae	*Lanius tigrinus* Drapiez,1828	Tiger Shrike	LC
7			*Lanius cristatus* Linnaeus,1758	Brown Shrike	LC
8			*Lanius tephronotus* (Vigors,1831)	Grey-backed Shrike	LC
9		Motacillidae	*Anthus richardi* Vieillot,1812	Richard Pipit	LC
10			*Motacilla alba* Linnaeus,1758	White Wagtail	LC
11			*Motacilla alboides* Hodgson,1836	White Wagtail	LC
12			*Motacilla baicalensis* Swinhoe,1871	White Wagtail	LC
13			*Motacilla samveasnae* Duckworth, 2001	Mekong Wagtail	NT
14			*Motacilla cinerea* Tunstall,1771	Grey Wagtail	LC
15		Cinclidae	● *Cinclus pallasii* Timminick,1820	Brown Dipper	LC
16		Fringillidae	*Serinus thibetana* (Hume,1872)	Tibetan Serin	LC
17		Sturnidae	*Gracupica nigricollis* (Paykull,1807)	Black-collared Starling	LC
18			*Acredotheres albocinctus* Godwin-Austen&Walden,1875	Collared Myna	LC
19		Muscipidae	*Luscinia calliope* (Pallas,1776)	Siberian Rubythroat	LC
20			*Ficedula albicilla* (Pallas,1811)	Taiga Flycatcher	LC
21		Pycnonotidae	♦ *Pycnonotus jocosus*	Red-whiskered Bulbul	LC
22			♦ *Pycnonotus xanthorrhous*	Brown-breasted Bulbul	LC
23			♦ *Hypsipetes leucocephalus*	Himalayan Black Bulbul	LC
24			*Acrocephalus dumetorum*	Blyth's Reed Warbler	LC
25		Timallidae	*Chysomma sinense* (Gmelin,1789)	Yellow-eyed Babbler	LC

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Table 3. Occurrence of migratory water bird species and individuals in Myitkyina and Mogaung environs between 2014 and 2015

No.	Scientific name	Common name	Status	Occurrence of birds	
				Myitkyina	Mogaung
1	* *Answer cygnoides*	Grey-legged Goose	WV	0	15
2	* *Tadorna ferruginea*	Ruddy Sheldck	WV	10	25
3	* *Tadorna tadorna*	Common Shelduck	WV	0	7
4	* *Dendrocygna javanica*	Lesser Whistling Duck	WV	31	78
5	* *Nettapus coromandelianus*	Cotton Pigmy-goose	WV	0	12
6	* *Anas platyrhynchos*	Mallard	WV	4	8
7	* *Anas zonorhyncha*	Spot-billed Duck	WV	2	6
8	* *Anas clipeata*	Nothern Shoveler	WV	2	2
9	* *Aythya nyroca*	Ferrugineous Pochard	WV	13	26
10	* *Aythya fuligula*	Tufted Duck	WV	0	15
11	* *Tachybaptus ruficollis*	Little Greebe	WV	0	8
12	* *Anastomus oscitans*	Asian Openbill	WV	0	5
13	* *Anhinga melanogaster*	Oriental Darter	NBV	2	5
14	* *Phalacrocorax carbo*	Great Cormorant	NBV	5	10
15	* *Fulica atra*	Common Coot	WV	15	53
16	* *Himantopus himantopus*	Black-winged Stilt	WV	10	13
17	* *Tringa glareola*	Wood Sandpiper	WV	4	6
18	* *Chrococephalus brunnicephalus*	Brown-headed Gull	WV	22	0
			Total	120	294

WV = Winter visitor, * Totally protected, NBV = Non breeding visitor, LM = Local migrant

Table 4. Occurrence of migratory terrestrial bird species and individuals in Myitkyina and Mogaung environs

No.	Scientific name	Common name	Status	Occurrence of birds	
				Myitkyina	Mogaung
1	* *Falco tinnuculus*	Common Kestrel	LM	2	1
2	♦ *Eudynamys scolopacea*	Asian Koel	LM	7	2
3	* *Upupa epops*	Common Hoopoe	LM	6	5
4	♦ *Cacomantis merulinus*	Plaintive Cuckoo	LM	5	2
5	♦ *Cuculus micropterus*	Indian Cuckoo	LM	2	1
6	*Lanius tigrinus*	Tiger Shrike	LM	3	2
7	*Lanius cristatus*	Brown Shrike	LM	5	10
8	*Lanius tephronotus*	Grey-backed Shrike	LM	45	70
9	*Anthus richardi*	Richard Pipit	LM	5	35
10	*Motacilla alba*	White Wagtail	LM	70	75
11	*Motacilla alboides*	White Wagtail	LM	54	30
12	*Motacilla baicalensis*	White Wagtail	LM	30	20
13	*Motacilla samveasnae*	Mekong Wagtail	LM	21	10
14	*Motacilla cinerea*	Grey Wagtail	LM	35	20
15	• *Cinclus pallasii*	Brown Dipper	LM	3	1
16	*Serinus thibetana*	Tibetan Serin	LM	3	5
17	*Gracupica nigricollis*	Black-collared	LM	165	190
18	*Acredotheres albocinctus*	Collared Myna	LM	10	34
19	*Luscinia calliope*	Siberian Rubythroat	LM	23	25
20	*Ficedula albicilla*	Taiga Flycatcher	LM	45	32
21	♦ *Pycnonotus jocosus*	Red-whiskered Bulbul	LM	5	15
22	♦ *Pycnonotus xanthorrhous*	Brown-breasted	LM	15	12
23	♦ *Hypsipetes leucocephalus*	Himalayan Black	LM	1	1
24	*Acrocephalus dumetorum*	Blyth's Reed Warbler	LM	10	12
25	*Chysomma sinense*	Yellow-eyed Babbler	LM	5	7
			Total	580	617

* Totally protected, ♦ Seasonally protected, • Normally protected, LM = Local migrant

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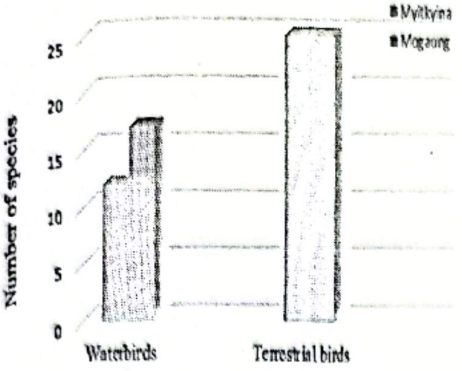


Fig.1.Recorded number of species for water birds and terrestrial birds in Myitkyina and Mogaung environs throughout the study period

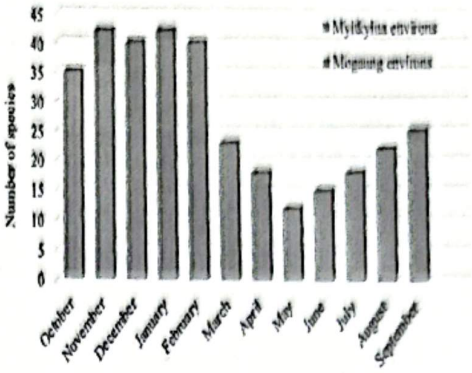
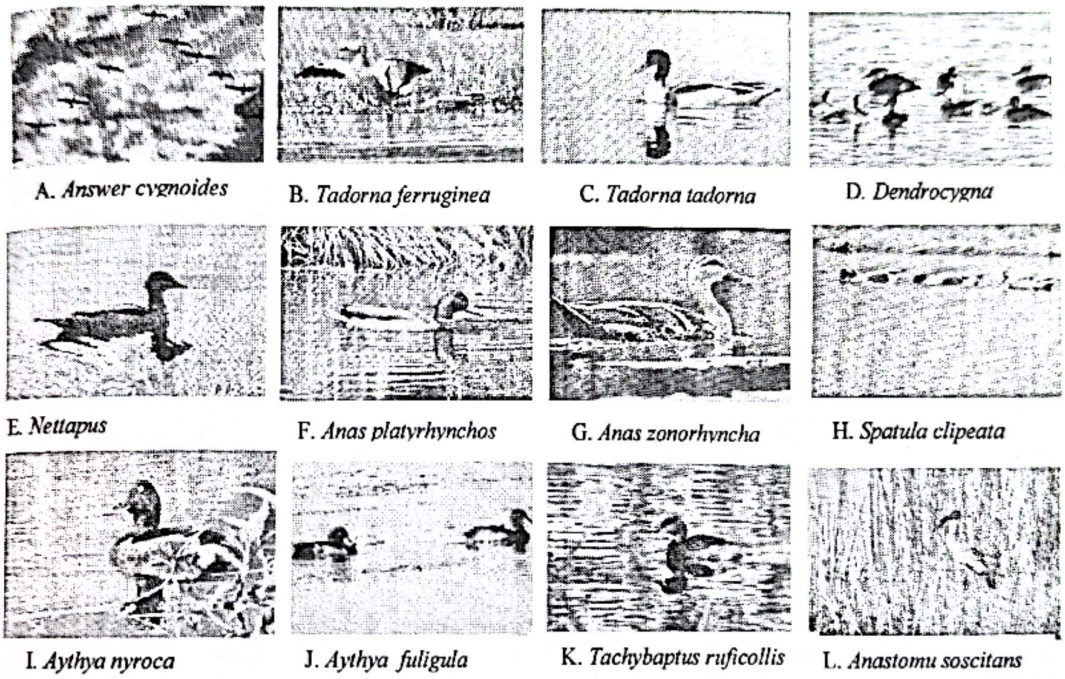


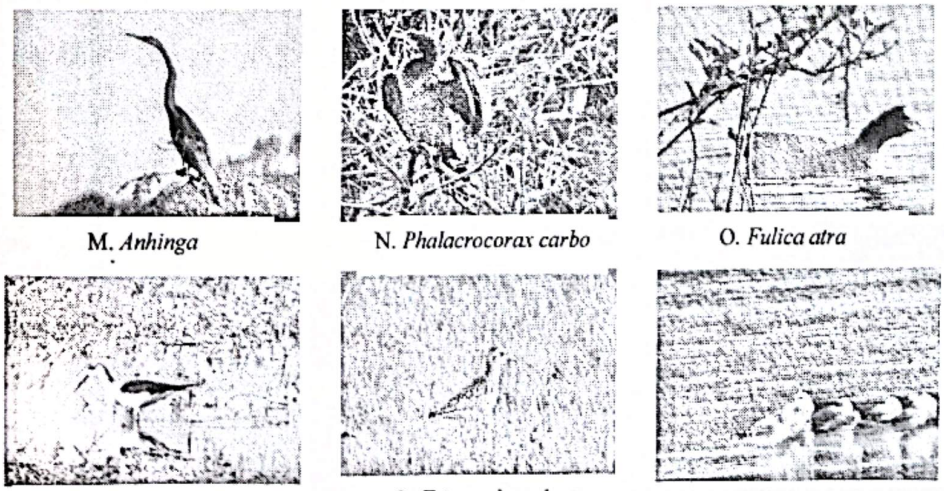
Fig.2. Occurrence of migratory bird species from Myitkyina and Mogaung environs throughout the study period



A. *Answer cygnoides* B. *Tadorna ferruginea* C. *Tadorna tadorna* D. *Dendrocygna*

E. *Nettapus* F. *Anas platyrhynchos* G. *Anas zonorhyncha* H. *Spatula clipeata*

I. *Aythya nyroca* J. *Aythya fuligula* K. *Tachybaptus ruficollis* L. *Anastomu soscitans*



M. *Anhinga* N. *Phalacrocorax carbo* O. *Fulica atra*

P. *Himantopus himantopus* Q. *Tringa glareola* R.*Chrococephalus brunnicephalus*

Recorded of waterbirds

A. *Falco tinnuculus*

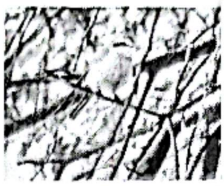
B. *Upupa epops*

C. *Eudynamis scolopaceu*

D. *Cacomantis merulinus*

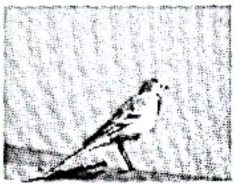
E. *Cuculus micropterus*

F. *Lanius tigrinus*

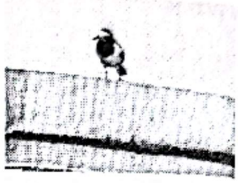

G. *Lanius cristatus*

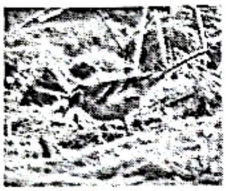
H. *Lanius tephronotus*

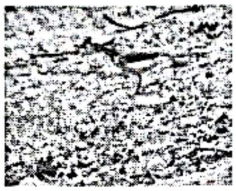
I. *Anthus richardi*

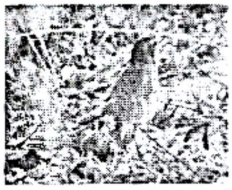

J. *Motacilla alba*

K. *Motacilla alboides*


L. *Motacilla baicalensis*

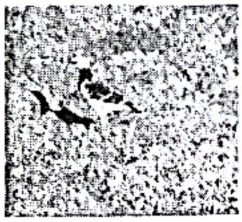

M. *Motacilla samveasnae*


N. *Motacilla cinerea*

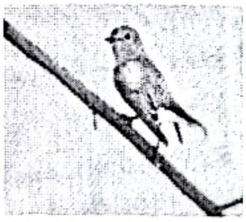

O. *Cinclus pallasii*

P. *Serinus thibetana*

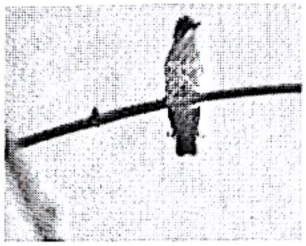
Q. *Gracupica nigricollis*

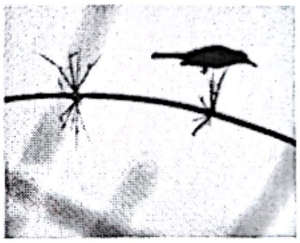

R. *Acredotheres albocinctus*

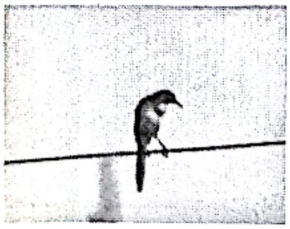
S. *Luscinia calliope*

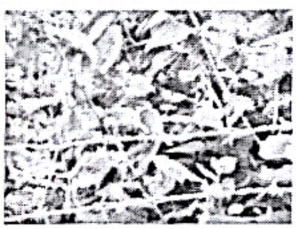

T. *Ficedula albicilla*

U. *Pycnonotus jocosus*


V. *Pycnonotus xanthorrhous*


W. *Hypsipetes leucocephalus*


X. *Acrocephalus dumetorum*


Y. *Chysomma sinense*

Recorded of terrestrial birds species

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Discussions

Throughout the observation period from October 2014 to September 2015, a total of 43 species and 1610 individuals of birds were recorded. Among them, 25 species, including 1197 individuals were terrestrial birds and 18 species including 414 individuals were water birds. There were seven Orders, nine Families, and 14 Genera of water birds. Then, four Orders, 11 Families and 18 Genera of terrestrial birds were recorded. According to the occurrence of bird species, 16 species of water birds were winter visitors except for *Anhinga melanogaster* (Oriental Darter), and *Phalacrocorax carbo* (Great Cormorant) were a non-breeding migrant. But all the recorded migratory terrestrial birds (25 species) were local migrants.

Throughout the study period, 12 species of migratory waterbirds, including 120 individuals, were recorded from Myitkyina, whereas 17 species including 294, individuals from Mogaung. Moreover, 25 species of migratory terrestrial birds including 580 individuals, were recorded from Myitkyina and 25 species of those including 617 individuals, were recorded from Mogaung, respectively.

Among the recorded water birds, *Aythya nyroca* (Ferrugineous Pochard) and *Anhinga melanogaster* (Oriental Darter), whereas in the terrestrial birds, *Motacilla samveasnae* (Mekong Wagtail) were globally near threatened species according to IUCN Red List 2014.

Among the recorded terrestrial birds, *Falco tinnunculus* (Common Kestrel) and *Upupa epops* (Common Hoopoe) were totally protected, *Eudynamic scolopacea* (Asian Koel), *Cacomantis merulinus* (Plaintive Cuckoo), *Cuculus micropterus* (Indian Cuckoo), *Pycnonotus jocosus* (Red-whiskered Bulbul), *Pycnonotus xanthorrhous* (Brown-breasted Bulbul) and *Hypsipetes leucocephalus* (Himalayan Black Bulbul) were seasonally protected and *Cinclus pallasii* (Brown Dipper) was normally protected.

Most of the recorded water birds were under the family Anatidae including Ducks such as *Tadorna ferruginea* (Ruddy Shelduck), *Tadorna tadorna* (Common Shelduck), *Dendrocygna javanica* (Lesser Whistling Duck), *Nettapus coromandelianus* (Cotton Pigmy Goose), *Anas platyrhynchos* (Mallard), *Anas zonorhyncha* (Chinese Spot-billed Duck), *Anas clypeata* (Nothern Shoveler), *Athya nyroca* (Ferrugineous Pochard), *Athya fuligula* (Tufted Duck), and *Tachybaptus ruficollis* (Little Grebe). Because of most aquatic areas are shallow and open water are dominated by their favorable food floating, there are many emergent aquatic plants and other aquatic invertebrates and vertebrates. These conditions enhance the abundance of favorable food and as well as shelter for these migratory birds.

With regard to terrestrial birds, two species were totally protected, six species were seasonally protected and one species was normally protected according to the Act of Myanmar Forest and Wildlife Conservation(1994). Moreover, in water birds, there 12 species were totally protected, and one species was seasonally protected.

Out of all waterbird species, *Dendrocygna javanica* (Lesser Whistling Duck) was the most abundant species and then followed by *Fulica atra* (Common Coot), and so on (Table 1). Because, *Dendrocygna javanica*, *Fulica atra* and *Larus brunnicephalus* (Brown-headed Gull) were the most common species among winter visitors in study area . With regard to terrestrial species, (Black-collared Starling) was the most abundant species and then followed by (White Wagtail), and (Grey-backed Shrike) were the most abundant. There were seasonal fruiting plants and grass grounds were plentiful insects and worms during the rainy and cold season.

While the study period, the number of bird species and individuals were more recorded in Mogaung than in Myitkyina. Because of many wetlands are nearby Nant-tant "In" in Mogaung and more favorable vegetative conditions around the town, that creates well residential areas for the birds and many habitats are less disturbed than those of Myitkyina. Moreover, wetlands in Mogaung Township may be one of the migration stop-over sites between the migratory route to"Indawgyi" wetland. On the other hand, most favorable vegetative conditions were found in Myitkyina University Campus, and "Panmati" residential area in Myitkyina environs except forested mountain ranges were only far from the town. Especially, "Panmati" residential area lies just beside the Ayeyarwady River various migratory waterbirds were recorded from there in the present study. Nevertheless, a large number of migratory birds were found in the study areas even the present study was carried out only in two study areas in Myitkyina and one wetland in Mogaung environs.

Welty and Beptista (1990) stated that "among all the limiting environmental factors that such as temperature, rainfall etc may operate as limiting factors and may reduce in the population". On the other hand, the most obvious and important advantage provided by migration is the securing of a better climate for living (Welty and Beptista, 1990). However, there were less impact on climate and human-induce factors in Myitkyina and Mogaung environs than in the other part of country.

Actually, the diversity of natural ecological communities has never been more valued than they are now, as they become increasingly threatened by the environmental crisis (Urfi, 2004). By this very nature, there will always be a degree of uncertainty about how, when and where climate and human-induced factors will affect the natural systems. Therefore, monitoring and research on known of environmental impacts on species and habitats will help close the gap in knowledge about its fauna and flora, but also a greater stake in protecting their environment.

In conclusion, as more and more habitats are subjected to environmental effects in most part of the country, it is imperative to assess current species distribution and population trends that provide ample opportunities for conservation and management strategies thereby helping to protect Myanmar's precious biodiversity.

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Acknowledgement

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ZOL 027

Expatiation of Amphibian, Reptile and Bird Species in Inkhibum National Park Environs, Kachin State

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Abstract

The report of expatiation of amphibian, reptile and bird species in Inkhibum National Park environs, Kachin State including Ubyit, Alam, Dumgan, Lungga Zup, Aung Myin Thar, Ching Khrang and Tang Hpare Villages focusing on amphibians, reptiles and birds was conducted from March 2018 to February 2019 to record terrestrial vertebrate fauna and to determine species composition of different vertebrate orders. In this study a total of 14 species of amphibians (23.33%) including 10 genera and five families under order Anura, nine species of reptiles (15%) belonging to eight genera and four families under order Testudines and Squamata, 37 species of birds (61.66%) confirmed to 31 genera, 20 families and 11 orders were recorded through interview surveys from the villagers and hunters in the study sites. According to analysis, significant difference was found in reptile species (t (6) = 2.71, p < .05) among the study sites. *Keywords*: amphibians, reptiles, birds, Inkhibum National Park, species composition

Introduction

Myanmar is one of the largest land areas in South East Asia and contains many globally important species and ecosystems. Myanmar support some of the most intact nature habitats and species communities remaining in the Indo-Myanmar Hotspot, including many globally threatened species that are found in few or other places in the world (Tordoff *et al*., 2005)

Dinerstein and Wikramanayake (1993) declared that high species diversity and endemism, together with vast intact landscapes, make Myanmar one of the most important Indo-pacific mainland countries for biodiversity conservation (cited by Rao *et al*., 2002). In particular, Kachin State is one of the most densely forested and inaccessible parts of mainland Southeast Asia (Brunner *et al*., 1998). Again, Leimgruber *et al*. (2003) noted that this region holds one of the Southeast Asia's last large tracts of relatively undisturbed forest.

Amphibians play an important role in food chains where they may constitute large portions of other animals. They also are economically important locally and regionally (Fischer *et al*., 1999). \

Birds are also known as good indicators, and can be used to identify the most biologically rich area, as well as environmental changes and problems (Gill, 1990).

The study area had been announced as Inkhibum National Park since 2nd February 2017 by Ministry of Natural Resources and Environmental Conservation. The area has 116.03 square miles (300.52 km^2). It appeared as a safe heaven providing places to take refuge, for roosting and opportunities for foraging for various wildlife species. However, there is no proper study on the diversity and distribution of fauna, so that there is need to record the natural assets before some will be lost forever, even before being discovered. The types of climate found in Myitkyina Township are subtropical humid type of climate and humid cold temperate type of climate. The types of forest can be classified into hill forests, evergreen forest and mixed deciduous forest, bamboo grooves, shrubs, scrubs, streams and tributaries of Ayeyawady traversed the Park (Ja Hkam, 1992).

Richness of fauna and flora in this area is important for wildlife ecology. It is an essential to study and record wildlife from the study area. The present study was expatiation of amphibian, reptile and bird species. Thus, the main objectives are:

- to record vertebrate fauna around Inkhibum National Park environs
- to determine the species composition of different amphibians, reptiles and birds orders recorded

Materials and Methods

Study area

The present study was conducted around Inkhibum National Park environs, Myitkyina Township, Kachin State. It is approximately far from Myitkyina about 17.609 kilometres (11miles) and located North to South between 25.787465°N 97.45670° E and 25.54100° N 97.43639° E and East to West between 25.66921° N 97.34203°E and 25.62528° N 97.34203° E bordered by the villages of Ubyit, Alam, Dumgan, Lungga Zup, Aung Myin Thar, Ching Khrang and Tang Hpre which are located in the eastern side of the Inkhibum National Park along the Ayeyawady River (Fig. 1).

Study period

The study period commenced from March 2018 to February 2019.

Collection of data

Data collection was based on interview surveys which were conducted fortnightly by using a structure of questionnaires to hunters and villagers who live in Ubyit, Alam, Dumgan, Lungga Zup, Aung Myin Thar, Ching Khrang and Tang Hpare Villages during the study period. Photographic records were taken on some collected specimens and some from the wild.

Identification

Identification of the species was based on Taylor (1962), Blanford (1895), Zug (2003), Inger and Stuebing (2005) for amphibians, Ernst and

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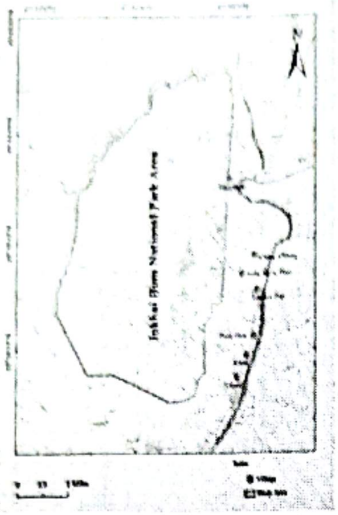
Barbour (1989), CITES (1989), Smith (1943) for reptiles and Smythies (1953), Robson (2008) for birds respectively.

Data Analysis

Student's *t*-test was used to compare the numbers of species among the study sites using SPSS software (version 11.5).



Source: Settlement and Land records Department of Myitkyina

Fig. 1 Location map of Inkhibum Area showing the study sites

Results

Species composition

During the study period, from March 2018 to February 2019, surveys were conducted in survey sites, Ubyit, Alam, Dumgan, Lungga Zup, Aung Myin Thar, Ching Khrang and Tang Hpare. During this study, a total of 14 species of amphibians (23.33%) belonging to 10 genera and five families under order Anura, nine species of reptiles (15%) belonging to eight genera and four families under order Testudines and Squamata, 37 species of birds (61.66%) confirmed to 31 genera, 20 families and 11 orders were recorded (Table 1, 2, 3, Fig 2 and Plate 1, 2, 3).

Occurrence of species recorded

In the present study, seven species of amphibians including Asian common toad (*Duttaphrynus melanostictus*), Grass Frog (*Fejervarya greenii*), Indian Bull Frog (*Hoplobattrachus tigerinus*), Common Bull Frog (*Kaloula pulchra*), Bronzed Frog (*Hylarana temporalis*), Kaing Land Frog (*Rana tigrina pantherina*) and Common Tree Frog (*Polypedates leucomystax*) were both encountered and interview recorded and the rest species were collected by only interviewed from the study sites (Table 1 and Plate 1).

In reptiles, two recorded species (*Drgophis nasutus* and *Natrix hamalayana*) were encountered except Reticulated Python (*Python reticulatus*). A carapace of Myanmar Narrow-Headed Soft Shell Turtle (*Chitra vandijki*) encountered from Ubyit Village, Two Myanmar brown leaf turtle specimen from the farm of Inkhibum near by Aung Myin Thar Village, Keeled Box Turtle (*Cuora mouhotii*) and another *Cuora* sp. from Aung Myin Thar Village, and Yellowed Tortoise (*Indotestudo elongata*) from Ubyit Village, an Impressed Tortoise *Manouria impressa* from Ching Khrang Village respectively. Moreover, Green Vine Snake (*Drgophis nasutus*) and Grass Snake (*Natrix hamalayana*) were also recorded from Aung Myin Thar Village (Table 2 and Plate 2).

Among birds, two smoked Red jungle fowls, Kalij Pheasant (*Lophura leucomelanos*), Lineated Barbet (*Megalaima lineatus*), Spotted-Dove (*Streptopelia chinensis*), Yellow-Footed Green Pigeon (*Treron phoenicopterus*), Indian Roller (*Coracias benghalensis*), Greater Coucal (*Centropus sinensis*), Eastern Cattle Egret (*Bubulcus coromandus*), Intermediate Egret (*Mesophoyx intermedia*), Ashy Drango (*Dicrurus leucophaeus*), Hair-Crested Drongo (*Dicrurus hottentottus*), Large-Billed Crow (*Corvus macrorhynchus*), Rofous Treepie (*Dendrocitta vagabunda*), Grey- Back Shrike (*Lanius tephronotus*), White Wagtail (*Motacilla alba*), Grey Wagtail (*Motacilla cinerea*), Paddyfield Pipit (*Anthus rufulus*), Olive backed Pipit (*Anthus hodgsoni*), Common Myna (*Acridotheres tristis*), Vinous-Breasted Myna (*Acridotheres burmannicus*), Hog Badger (*Arctonyx collaris*), Oriental Magpie Robin (*Copsychus saularis*), Pied Bushchat (*Saxicola caprata*), Blue-Rock Thrush (*Monticola solitaries*), Grey-headed Canary-Flycatcher (*Culicicapa ceylonensis*) Red Vented Bulbul (*Pycnonotus cafer*) were recorded from Ubyit, Aung Myin Thar and Tang Phare Villages. Among them, Common Myna (*Acridotheres tristis*) and Red Vented Bulbul (*Pycnonotus cafer*) were both encountered and interview recorded and the rest seven species were collected by only interviewed from the study area (Table 3 and Plate 3).

Comparison of analysis

According to comparison of analysis on numbers of species among the study sites, there was no significant difference between the number of amphibians ($t(6) = 2.21$ $p > .05$) and Aves ($t(6) = -.95$, $p > .05$), however significant difference was found in reptile species ($t(6) = 2.71$, $p < .05$) among the study sites.

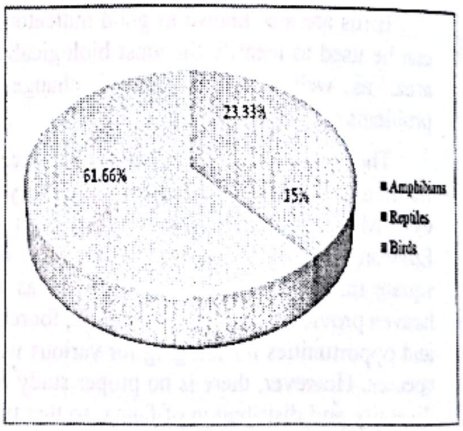
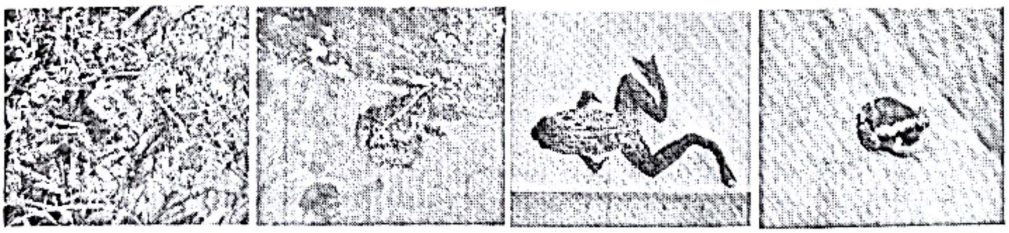


Fig. 2 Relative species composition of Amphibians, Reptiles and Birds

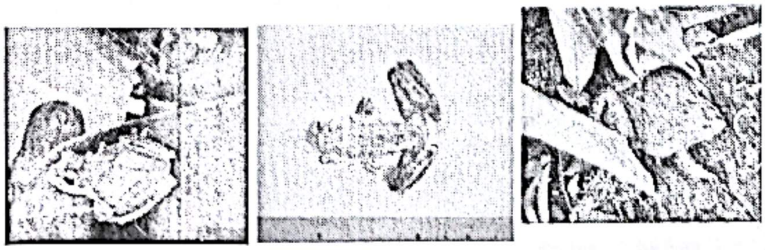
Table 1 The Amphibian species recorded from Inkhibum National Park environs

Sr. No.	Order	Family	Scientific Name	Common Name	Myanmar Name	Interview Site	Encountered Site	IUCN Status
1.	Anura	Bufonidae	*Duttaphrynus melanostictus*	Asian Common Toad	Phar-Pyoke	All Sites	S I	LC
2.		Dicroglossidae	*Fejervarya limnocharis*	Grass Frog/addy Frog	Kyaw-San-Kay	All Sites		LC
3.			*Fejervarya greenii*	Grass Frog/ Paddy Frog	Kyaw-San-Kay	All Sites	S II	
4.			*Fejervarya rufescens*	Grass Frog/ Paddy Frog	Kyaw-San-Kay	All Sites		LC
5.			*Fejervarya syhadrensis*	Asian Cricket Frog/Small Cricket Frog		All Sites		LC
6.			*Hoplobattrachus tigerinus*	Indian Bull Frog	Sar-Phar-Gyi	All Sites	S V	LC
7.			*Occidozyga lima*	Floating Frog/Green Puddle Frog	Phar-Than-Latt/The-Phar	All Sites		LC
8.		Microhylidae	*Kaloula pulchra*	Common Bull Frog	Phar-Gon-Nyin	All Sites	S I, S V	
9.			*Microhyla ornata*	Ornate Narrow-mouthed Frog	Phar-La-Tat	All Sites		LC
10.		Ranidae	*Hylarana erythraea*	Red-Ear Frog	Nar-Ni-Chauk Phar	All Sites		LC
11.			*Hylarana temporalis*	Bronzed Frog/ Günther's Golden-backed Frog		All Sites	S V	NT
12.			*Rana tigrina pantherina*	Kaing Land Frog	Kaing-Phar	All Sites	S I	
13.		Rhacophoridae	*Chiromantis doriae*	Doria's Asian Tree Frog	Phar-Pyan	All Sites		LC
14.			*Polypedates leucomystax*	Common Tree Frog	Phar-Pyan	All Sites	S V	LC

SI = Ubyit, SII = Alam, SIII = Dumgan, SIV = Lungga Zup
SV = Aung Myin Thar, SVI = Ching Khrang , SVII = Tang Phare



A. *Duttaphrynus melanostictus* B. *Fejervarya greenii* C. *Hoplobatrachus tigerinus* D. *Kaloula pulchra*



E. *Hylarana temporalis* F. *Rana tigrina pantherina* G. *Polypedates leucomystax*

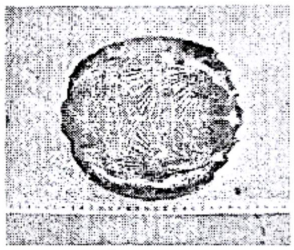
Plate 1 Encountered species of amphibians

Table 2 The Reptile species recorded from Inkhibum National Park environs

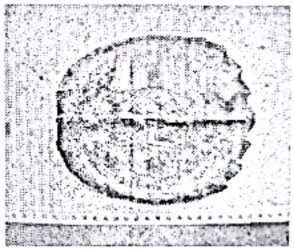
Sr. No.	Order	Family	Scientific Name	Common Name	Type/Myanmar Name	Interview Site	Encountered Site	IUCN Status
1.	Testudines	Trionychidae	*Chitra vandijki*	Myanmar narrow-headed soft shell turtle	Soft Shell Turtle/ Sin-Kyar-Leik/ Gaung-thay-Liek	All Sites	SI	-
2.		Geoemydidae	*Cyclemys fusca*	Myanmar brown leaf turtle	Hard Shell turtle/ Leik-Pu/ Phat-Leik/ Leik-Pok	All Sites	S V	NT
3.			*Cuora mouhotii*	Keeled box turtle	Hard shell turtle/ Kan-Leik/ Taung-Leik Thay	All Sites	S V	EN
4.			*Cuora* sp.			All Sites	S V	
5.		Testudinidae	*Indotestudo elongata*	Yellowed Tortoise	Tortoise/ Leik Wah/ Se-Cho-Leik/ Gin-Leik/ Leik-na-khaung Ni/Taung-Leik	All Sites	S I	EN
6.			*Manouria impressa*	Impressed Tortoise	Tortoise/ Leik-Tat/ Taung-Leik-Gyi	All Sites	S VI	VU
7.	Squamata	Pythonidae	*Python reticulatus*	Reticulated Python	Sa-Pa-Gyi - Mgwe	All Sites		VU
8.			*Drgophis nasutus*	Green whip Snake	Mgwe-Sein-Gaung-Chun	All Sites	S V	-
9.			*Natrix hamalayana*			All Sites	S V	-

SI = Ubyit, SII = Alam, SIII = Dumgan, SIV = Lungga Zup
SV = Aung Myin Thar, SVI = Ching Khrang, SVII = Tang Phare

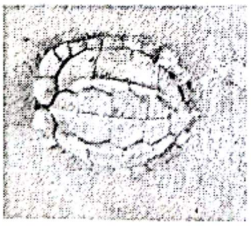
A. Carapace *of Chitra vandijkii*



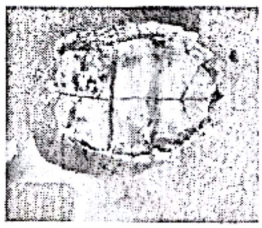
B. *Cyclemys fusca* (Dorsal View)



C. *Cyclemys fusca* (Ventral View)



D. *Cuora mouhotii* (Dorsal View)



E. *Cuora mouhotii* (Ventral View)

F. *Cuora* sp. (Dorsal View)

G. *Cuora* sp. (Ventral Vi

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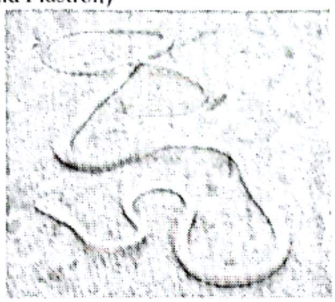
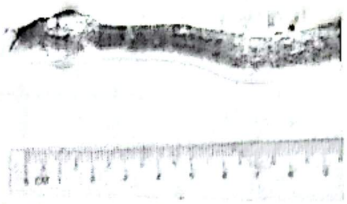
H. *Indotestudo elongata* (Carapace and Plastron)

I. *Manouria impressa* (Dorsal View)

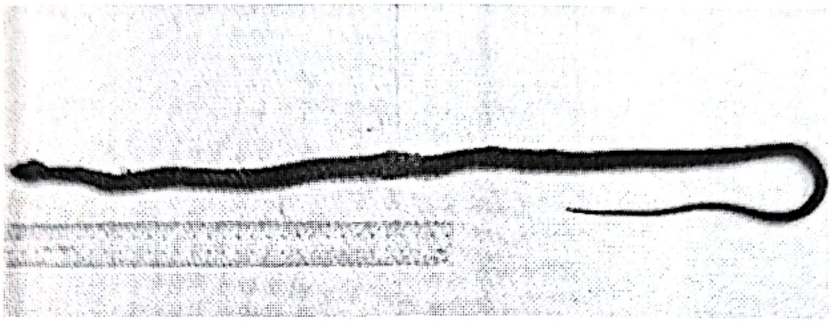
J. *Manouria impressa* (Ventral View)



K. *Dryophis nasutus* (Green Vine Snake)



L. *Natrix hamalayana* (Grass snake) (Head)



M. *Natrix hamalayana* (Grass snake) (Entire length)

Plate 2 Encountered species of reptiles

Table 3. The Bird species recorded from Inkhibum National Park environs

Sr. No.	Order	Family	Scientific Name	Common Name	Myanmar Name	Interview Site	Encountered Site	IUCN Status
1.	Galliformes	Phasianidae	*Gallus gallus*	Red Junglefowl	Taw-Kyet	All Sites	SVII	LC
2.			*Lophura leucomelanos*	Kalij Pheasant	Yit	All Sites	SV, SVII	LC
3.	Piciformes	Megalaimidae	*Megalaima lineatus*	Lineated Barbet	Hpo-Khaung-Hnget	All Sites	SI, SV	LC
4.	Coraciiformes	Coraciidae	*Coracias benghalensis*	Indian Roller	Hnget-Khar	All Sites	SI, SV	LC
5.	Bucerotiformes	Upupidae	*Upupa epops*	Common Hoopoe	Bi-daung-bo	All Sites		-
6.		Bucerotidae	*Megalaima virens*	Great Horn Bill	Aung Laung Hnget	All Sites		VU
7.	Cuculiformes	Cuculidae	*Centropus sinensis*	Greater Coucal	Boke - Hnget	All Sites	SV	LC
8.	Psittaciformes	Psittaculidae	*Psittacula alexandri*	Red Breasted Parakeet	Kyet-Tu - Yway	All Sites	SI	NT
9.	Strigiformes	Strigidae	*Glaucidium brodiei*	Collared Owlet	Ze-Gwet	All Sites		LC
10.			*Ketupa zeylonensis*	Brown Fish Owl		All Sites	SI	LC
11.	Falconiformes	Falconidae	*Microhierax coerulescens*	Collared Falconet	Sar-Thein	All Sites		LC

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Table 3 Continued

Sr No	Order	Family	Scientific Name	Common Name	Myanmar Name	Interview Site	Encountered Site	IUCN Status
12			*Pernis ptilorhynchus*	Oriental Honey-Buzzard	Suen	All Sites		LC
13			*Spilornis cheela*	Crested Serpent - Egale	Lin Yung	All Sites		LC
14	Columbiformes	Columbidae	*Streptopelia chinensis*	Spotted-Dove	Joe-Le-Byauk	All Sites	SV, SVI	LC
15			*Treron phoenicopterus*	Yellow-Footed Green Pigeon	Ngu (Bungmat i Hnget)	All Sites	SV	LC
16	Pelecaniformes	Ardeidae	*Bubulcus coromandus*	Eastern Cattle Egret	Kywal-Kyaung-Byaing	All Sites	SV	-
17			*Egretta garzetta*	Little Egret	Byaing	All Sites		LC
18			*Mesophoyx intermedia*	Intermediat e Egret	Tharyawa ti Byaing	All Sites	SV	LC
19	Passeriformes	Dicruridae	*Dicrurus leucophaeus*	Ashy Drongo		All Sites	SV	LC
20			*Dicrurus hottentottus*	Hair-Crested Drongo		All Sites	SV	LC
21		Corvidae	*Corvus splendens*	House Crow	Kyi-Gan	All Sites		LC
22			*Corvus macrorhynchos*	Large billed Crow	Taw-Kyi-Gan	All Sites	SV, SVII	-
23			*Dendrocitta vagabunda*	Rofous Treepie	Na-Hpa-Kyi	All Sites	SV	LC
24		Laniidae	*Lanius tephronotus*	Grey-Back Shrike		All Sites	SII, SV	LC
25		Nectariniidae	*Aethopyga saturata*	Black-Throated Sunbird	Wut-ye-sock-Hnget	All Sites		LC
26		Motacillidae	*Motacilla alba*	White Wagtail	Mi-Nyaunt-Hnget	All Sites	SV	LC
27			*Motacilla cinerea*	Grey Wagtail	Mi-Nyaunt-Mwal	All Sites	SV	LC
28			*Anthus rufulus*	Paddyfield Pipit		All Sites	SV	LC
29			*Anthus hodgsoni*	Olive-Backed Pipit		All Sites	SV	LC
30		Sturnidae	*Acridotheres tristis*	Common Myna	Za-Yet	All Sites	All Sites	LC
31			*Acridotheres burmannicus*	Vinous-Breasted Starling	Za-Yet Gaung-Phyu	All Sites	SV, SVI	-
32			Acridotheres albocinctus	Collared Myna	Za-Yet Lel-Phyu	All Sites	SVI	LC
33		Muscicapidae	Copsychus saularis	Oriental Magpie Robin	Ta-Baik Lwal	All Sites	SV	LC
34			Saxicola caprata	Pied Bush Chat	Hnget-Mel-Lone	All Sites	SV	LC
35			Monticola solitarius	Blue-Rock Thrush	Bo-Te	All Sites	SV	LC
36		Stenostiridae	Culicicapa ceylonensis	Grey-headed Canary-Flycatcher		All Sites	SV	LC
37		Pycnonotidae	Pycnonotus cafer	Red Vented Bulbul	Buk-phin-ni	All Sites	All Sites	LC

SI = Ubyit, SII = Alam, SIII = Dumgan, SIV = Lungga Zup
SV = Aung Myin Thar, SVI = Ching Khrang , SVII = Tang Phare

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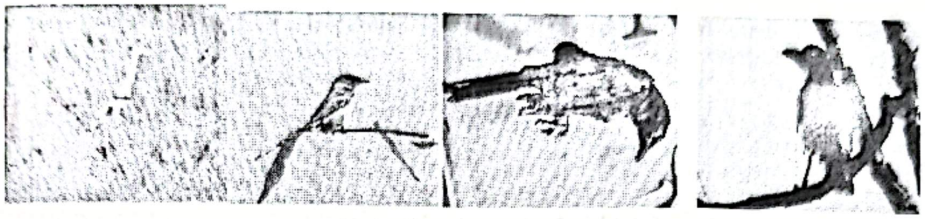
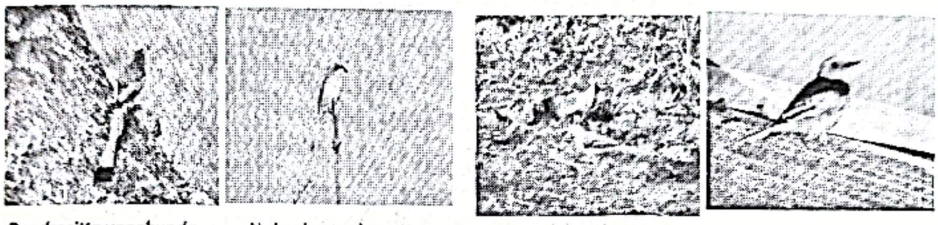
A. *Megalaima lineatus* B. *Coracias benghalensis* C. *Centropas sinensis* D. *Psittacula alexandri*

E. *Ketupa zeylonensis* F. *Spilopelia chinensis* G. *Treron phoenicopterus* H. *Bubulcus coromandus*



I. *Mesophoyx intermedia* J. *Dicrurus laucophaens* K. *Dicrurus hottentottus* L. *Corvus macrorhynchus*



M. *Dendrocitta vagabunda* N. *Lanius tephronotus* O. *Motacilla alba* P. *Motacilla cinerea*

Q. *Antbus rufulus* R. *Anthus hodgsoni* S. *Acridotheres tristis* T. *Acridotheres burmannicus*

U. *Copsychus saularis* V. *Acridotheres albocinctus* W. *Saxicola caprata* X. *Monticola solitaries*

Y. *Culicicapa ceylonensis* Z. *Pycnontus cafer*

Plate 3 Some encountered species of birds

Discussion

The current survey on fauna expatiation in Inkhibum National Park environs, Kachin State focusing on amphibians, reptiles and birds were conducted from March 2018 to February 2019.

The total number of amphibians in Myanmar is 93 species and the order anura, 89 species under seven families are recognized (Frost, 2015). Moreover, approximately 32 species of turtles and tortoises including 27 species of freshwater turtles and tortoises and five species of sea turtles were recorded in Myanmar. Of these, 13 species are also found in Kachin State (Win Maung and Win Ko Ko, 2002). Myanmar includes a total of 1114 species of birds of which six are endemic (IUCN, 2015).

During the study, the species from three classes of vertebrates recorded revealed that the numbers of 37 species confirmed to the class Aves outnumbered those from the remaining two classes (Reptilia with 9 species and Amphibia with 14 species).

Previously, a total of nine species of anurans in Waing Maw Township, Kachin State reported by Group I (2005). Besides, Htoi Mai (2017) also observed the 13 species of anurans in Hante and Shwe Pyi Thar Quarters, Banmaw Township, Kachin State. In the present study, the 14 species of amphibians were recorded. Among them, five species (*Duttaphrynus melanostictus*, *Fejervarya limnocharis*, *Occidozyga lima*, *Kaloula pulchra* and *Polypedates leucomystax*) were coinside with the previous record.

In reptiles, two species of turtle from Myitsone area, Kachin State were reported by BANCA (2009). In the present survey *Cuora mouhotii* was coinsided species with the previous study. Three species of snakes such as Reticulated Python (*Python reticulatus*), Green whip Snake (*Drgophis nasutus*) and *Natrix hamalayana* were recorded in the present survey. However, there was no previous recorded of snakes in the study area.

The pre-survey reported of (111) bird species were recorded by Ministry of Natural Resource and Environmental Conservation, Fauna and Flora International and Biodiversity and Nature Conservation Association in 2013. In the previous study, Rufous-Neeked Hornbill was stated as vulnerable and White-Cheeked Partridge and Great Hornbill as near threatened status by International Union for the Conservation of Nature.

In the present study, according to IUCN Red List, Bronzed Frog (*Hylarana temporalis*) was recorded as nearly threatened, Keeled Box Turtle (*Cuora mouhotii*) and Yellowed Tortoise (*Indotestudo enlongata*) appeared as endangered, Myanmar Brown Leaf Turtle (*Cyclemys fusca*) was nearly threatened, and Impressed Tortoise (*Manouria impressa*) and Reticulated Pythonas (*Python reticulatus*) vulnerable species among the reptiles recorded. In birds, Red breasted parakeet (*Psittacula alexandri*) encountered as nearly threatened and Great Horn Bill (*Megalaima virens*) as vulnerable species.

According to interview survey, a total of 14 species in amphibians, nine species in reptiles and 37 species in birds, however, seven species in amphibians, eight species in reptiles and 30 species in birds were encountered survey. The result indicated that most of the local people go after wild animals gave both for consumption and medicinal purpose and as well as supplementary income through local market and the trade across the border. Thus, need to share the knowledge of protecting wildlife and conservation values to local peoples.

In the present study area, Inkhibum National Park environs, with full complement of natural resources could create roosting sites and foraging sites for various species of wild animals. According to the interview information gathered from local people and local hunters, it was known that illegal trade and hunting, logging for their livelihoods were going in earnest. Human activities however, lead to habitat loss leading to decline in the population and number of species. Thus, there is a need not only to maintain the sustainability of fauna but also all the natural asserts as well, that thrive habitat of the Kachin State.

Conclusion

The study area is considered as an important resource by community around protected area. There is a need to sustain the wild flora and fauna in Inkhibum Wildlife National Park. Even within the present study sites, further research is still required to detail study and record of wildlife in order to get the more information, so essential for sound conservation and management programmes.

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ZOL 028

Genetic Diversity of ABO Blood Group System Parents of Zoology Students From West Yangon University

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Abstract

Blood group percent and allelic frequency of I^A , I^B and i of parents of Zoology students from West Yangon University were calculated. Total of sample number was 1178 peoples represented 428 parents of 1st year , 2nd year(302) , 3rd year (194) , 4th year (144) ,Hon and Msc students (110) analyzed. Total of blood group A was 292 parents, total of blood group B was 331 parents, total of blood group AB was 157 parents and total of blood group O was 398 parent. Phenotypic frequency of parents of Zoology students were 0.25 of blood group A , 0.28 of blood group B , 0.13 of blood group AB and 0.34 of blood group O. Genotypic frequency of parents of Zoology students were I^AI^A (p^2 = 0.0339), I^AI ($2pr$ = 0.2142), I^BI^B (r^2 = 0.3383), I^BI ($2qr$ = 0.2724), I^AI^B ($2pq$ = 0.0862), ii(q^2 = 0.5484). Allelic frequency of ABO blood group system recorded from this observation was I^A =0.183 , I^B = 0.235 and i = 0.582. According to the blood group system of 18different tribes of Myanmar peoplesBurman, Kayah,Kayin,Chin, Mon,Rakhine, Shan,Burma/KayinBurma/RakhineBurma/Mon , Indian tribe (Gawrakha,Hindu, Muslim)allelic frequency was I^A=3.182, I^B = 3.379and i= 8.173 In combining the previous data from Term papers of fourth year of Zoology students, Dagon University, we can concluded that allelic frequency of blood was approximately 0.5, it means that A group is majority.We can conclude that allelic frequency of "O" blood group of Myanmar peoples was highest approximately r = "I"= 0.5 of blood group "O".

Keywords: genetic frequency, allelic frequency, ABO blood groups, ethnic groups, West Yangon University

Introduction

In 1901, Karl Landsteiner discovered three human blood groups: A, B and O. A fourth blood group, AB, was discovered later by Alfred Von Decastello and Adriano Sturli, in 1902. Karl Landsteiner discovered that blood clumping was an immunological reaction. For this discovery the Noble Prize in Physiology or Medicine in 1930.

ABO blood group system was the first human red-cell antigen system to be characterized. The ABO blood group substances are glycopeptides with oligosaccharide side chains(GanongWf).The ABO blood group specificity is determined by die presence of terminal sugar in an oligosaccharide structure. The terminal sugars of the oligosaccharides are specific for blood groups A and B. They are also immunogenic. The red cells express either A, B, both A and B, or neither, and antibodies are found in serum to antigens not expressed by the red cells.(Tropical Doctor ,Dean, M.D 2005)

The blood group of their parents was taken from the information of National Registration Card (NRC).

The I^Aallele gives blood type A, I^B gives type B, and i gives type O. As that I^AandI^B are dominant over I, only ii people have type O blood. Individuals with I^AI^A or I^Ai have type A blood and individuals with or i have the B blood *of* people have both phenotypes, because A and B express a special dominance relationship, codominance ($I^A = I^B$), which means that type A and B parents can have an AB child. A couple with type A and type B can also have a type 0 child if they are heterozygous *(i,* has a single enzyme that creates both A and B antigens.(Bhasin, M.K. and S. M. Chahal., 1996).The resulting red blood cells do not usually express A or B antigen at the same level that would be expected on common group A or B red blood cells, which can help solve the problem of an apparently genetically impossible blood group (Wikipedia, 2017).

The ABO blood group system is the important blood type system in human transfusion. Found on platelets epithelium and cells other thanerythrocytes. AOB blood types are also present in some other animals for example rodents and apes such as chimpanzees, bonobos and gorillas (Wikipedia, 2016).

The associated anti-A and anti-B antibodies are usually IgM antibodies. The majority of cell types investigated have A, B, or O antigen on their surfaces. ABO blood group and Ethnics groups systems are hereditary characters and are used widely in human population genetic studies(Landsteiner, k and Weiner, A. S, 1940). In Myanmar, blood test are conducted almost all the people for the diagnostic of diseases. However, allelic frequencies of blood groups are not calculated or very rare. Thus in the present study was under taken with the following objectives:

- To assess the blood group frequency of parents of the Zoology students
- To calculate the allelic frequencies and genotypic frequencies of I^A, I^B, and i
- To record the blood group frequency of different ethnic groups in parents of the students

Materials and methods

Study area and period

Data collection was conducted from West Yangon University Campus. It is located between N 16.9447°and E 96.0133°.The Zoology students of 1st year to MSc classes

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from West Yangon University were examined the ABO blood group system during the study period of July and August 2019.

Blood type data analysis

The blood samples were collected from each student after their consent to participate in this research process. Data form of questionnaires survey was also distributed to all students for the blood groups their parents. Some parents that have no information about blood groups were tested it in nearby clinic.

ABO Blood groups system is governed by multiple allelic system (I^A, I^B and i) and these three alleles is complete and codominant system as ($I^A = I^B > I$). Therefore, four blood types [Group A ($I^AI^A$and I^Ai], [Group B(I^BI^B and I^Bi)], [Group AB ($I^A I^B$)]and [Group O (ii)].The present study examined phenotypic system of blood group, genotypic frequency and allelic frequency of blood groups of the Zoology students. The data were calculated as

A. Phenotypic frequency

A
Phenotypic frequency of blood group A =A = $\frac{\text{Total no. of blood group}}{\text{Total sample number}}$

B
Phenotypic frequency of blood group B = B = $\frac{\text{Total no. of blood group}}{\text{Total sample number}}$

Phenotypic frequency of blood group AB = $\frac{\text{Total no. of blood group AB}}{\text{Total sample number}}$

O
Phenotypic frequency of blood group O = O = $\frac{\text{Total no. of blood group}}{\text{Total sample number}}$

B. Allelic frequency

According to the Hardy-Weinberg law,

Let, p = allelic frequency of "I^A,"
q = allelic frequency of "I^B",
r = allelic frequency of "I",

Hence, $P + q + r = 1$

$P = 1 - \sqrt{B+O}$

$q = 1 - \sqrt{A+O}$

$r = \sqrt{O}$

Allelic frequency of blood group A, B, AB and O were calculated based on Hardy-Weinberg formulae, in which allelic frequency remains consist from one generation to the next.

Results

In concerning with blood group system of the present research, the data represented total numbers 1178consisting 589 males and 589peoples. We observed 292 of blood group A, 331of blood group B, 157 of blood group AB, and 398 of blood group O (Table 1).

The phenotypic frequency was 0.25 0f blood group A, 0.28 0f blood group B, 0.13 0f blood group AB and , 0.34 0f blood group O. hAllelic frequency of blood groups has the lowest of I^A= *0.1842*which followed I^B = 0.2342. The allele "I" has the higest frequency (i = 0.5816). However, the percentage of blood group A (28.05%) was close to that of blood group O (33.89 %)(Table 2)

Gene (allele) frequency I^A= *0.1842*, I^B= 0.2342 and *i*was 0.5816.Genetypic frequency (p^2) of blood group A was 0.339, (2pr) of blood group A was 0.2142,(q^2) of blood group B was 0.5484, (2qr) of blood group B was 0.2724, (2pq) of blood group AB was 0.0862 and (r^2) of blood group AB was 0.3383 (Table 3). The zoology student attending to the West Yangon University are not the same tribe , told of 18 different tribe are included .The allelic frequency of each tribe were calculated separately as follows: In the parents of Zoology students from West Yangon University, 18 different tribes were recorded. Among them Myanmar is the majority group which followed by Kayin tribe.

Five different hybrid pairs of the ethnic groups were assessed. For the Burman tribe in parents of Zoology students, the table 4 showed the individual numbers, percentage and allelic frequency of parents of the Zoology students in relation to blood groups. Allelic frequency of blood groups has the lowestof I^A = 0.1878 which followed I^B = 0.2353.The allele " I " has the highest frequency (i = 0.5769). However, the percentage of blood group B (28.72%) was close to that of blood group O (3.298%).

For the Kayin tribe, allelic frequency of blood groups has the lowest of I^A = 0.1703 which followed I^B = 0.2133. The allele " I" has the highest frequency (i = 0.6164). However, the percentage of blood group B (21.33%) was close to that of blood group O (0.6164%).For the Chin tribe, allelic frequency of blood groups has the lowest of I^A = 0.164 which followed I^B = 0.25. The allele " I " has the highest frequency (i= 0.587). However, the percentage of blood group B (28.13%) was close to that of blood group O (34.37%).

For the Rakhine tribe, allelic frequency of blood groups has the lowest of I^A = 0.162which followed I^B =0.303. The allele " I " has the highest frequency (i = 0.535). However, the percentage of blood group B (28.86%) was close to that of blood groupO (28.86%).

Table 1 Blood group frequency of their parents of Zoology students from WYU

Samples	numbers	Blood group A	Blood group B	Blood group AB	Blood group O
Parents of 1st year students	428	107	122	60	139
Parents of 2nd year students	302	71	81	42	108
Parents of 3rd year students	194	48	65	19	62
Parents of 4th year students	144	42	30	17	55
Parents of Hons and MSc students	110	24	33	19	34
Total	1178	292	331	157	398
Phenotypic frequency	1.00	0.25	0.28	0.13	0.34

Table 2 Allelic frequencies of parents of Zoology students from WYU

Samples	p = Allelic I^A	q =Allelic I^B	r =Allelic i
Parents of 1st year students	0.166	0.259	0.575
Parents of 2nd year students	0.174	0.232	0.594
Parents of 3rd year of students	0.188	0.247	0.565
Parents of 4th year of students	0.203	0.179	0.618
Parents of Hons and MSc students	0.170	0.274	0.556
Mean of allelic frequency	0.1842	0.2342	0.5816

For the Shan tribe, allelic frequency of blood groups has the lowest of I^B =0.368. The allele " I " has the highest frequency (i = 0.632). However, the percentage of blood group B (20%) was close to that of blood group O (40%).

Table 3Genotyple frequency of parents of Zoology students from WYU

No.	Blood group	Genotype	Genotypic frequency
1	A	I^AI^A	p^2 = 0.0576
2	A	I^Ai	$2pr$ =0.2147
3	B	I^BI^B	q^2 =0.0484
4	B	I^Bi	$2qr$ =0.2724
5	AB	I^AI^B	$2pq$ =0.0902
6	O	ii	r^2 = 0.3383

Table 4Frequency of A, B, O blood groups of Ethnic groups of WYU

	Tribes/ Ethnic groups	N=	Group A	Group B	Group AB	Group O
1	Burma	957	242	276	123	316
2	Kachin	1	-	-	-	1
3	Kayah	2	1	-	-	1
4	Kayin	105	25	26	14	40
5	Chin	32	7	9	5	11
6	Mon	7	1	-	1	5
7	Rakhine	35	7	10	8	10
8	Shan	5	-	2	1	2
9	Burma/Kayin	12	4	3	2	3
10	Burma/Rakhine	2	1	1	-	-
11	Burma/Shan	1	1	-	-	-
12	Burma/Mon	2	-	1	-	1
13	Chin/Kayin	1	-	1	-	-
14	Indian tribe (Gurwrakha)	2	1	-	-	1
15	Indian tribe (Hindu)	6	1	1	2	2
16	Indian tribe (Muslim)	6	1	1	1	3
	Total number	1178	292	331	157	398

For the Burman/ Kayin tribe, allelic frequency of blood groups has the lowest of I^A = 0.264 which followed I^B = 0.236. The allele " I " has the highest frequency (i = 0.5). However, the percentage of blood group B (25%) was close to that of blood group O (25%).The allelic frequency of blood groups of Burma tribe was I^A = 0.183, I^B = 0.235 and 'i' = 0.582. In all tribe groups, the maximum allelic frequency was blood group "O".

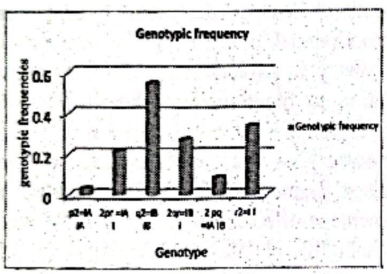

Fig 1 Distribution of A, B, O blood groups with genotypic frequency of ethnic groups

Discussion

In this study, total of 1178parents of Zoology students from West Yangon University was assessed the phenotypic, genotypic and allelic frequencies of ABO blood groups. The percentage of blood groups was 0.25 of blood group A, 0.28 of blood group B, 0.13 of blood group AB, 0.34 of blood group O. ABO allele frequency had been determined in Asian Africa andEuropean populations (Bustan*et al.*, 2002). The estimated allele frequencies were 0.5812for O, 0.227for B and 0.1918for A. These resultsshowed that O gene frequency was higher than that of B or A. Howe showed the global predominance of B gene over O.These findings similar in agreement with Al-Bustan*et.al.*,(2002).They stated that the patterns of early population movements and varying prevalent blood types in different parts of the world.

Blood type B is very common in populations of Asian descent, but rare in populations of Western European descent. There are four main linkages of the ABO genes and that

Table 5 Distribution of A, B, O blood groups with allelic frequency of Ethnic groups

Tribes/ Ethnic groups	N=	Allelic freq I^A	Allelic freq I^B	Allelic freq. i
Burma	957	0.184	0.235	0.577
Kachin	1	-	-	1
Kayah	2	0.184	-	0.817
Kayin	105	0.170	0.213	0.616
Chin	32	0.164	0.250	0.586
Mon	7	0.075	0.079	0.845
Rakhine	35	0.162	0.303	0.534
Shan	5	-	0.368	0.632
Burma/Kayin	12	0.264	0.236	0.5
Burma/Rakhine	2	0.707	0.293	-
Burma/Shan	1	1	-	-
Burma/Mon	2	-	0.293	0.707
Chin/Kayin	1	-	1	-
Indian tribe (Gurwrakha)	2	0.293	-	0.707
Indian tribe (Hindu)	6	0.130	0.293	0.577
Indian tribe (Muslim)	6	0.109	0.184	0.707
Total number	1178	3.182	3.379	8.173

Table 6 Allelic frequency of all data survives

Data sources	Sample	p = Allelic I^A	q =Allelic I^B	r =Allelic i
DU Group I (2017)	298	0.16	0.22	0.62
DU Group -IX (2016)	436	0.25	0.26	0.53
DU Group -XVI (2016)	268	0.20	0.26	0.54
DU Group -XXVI (2016)	481	0.16	0.24	0.60
WYU Group – II (2019)	589	0.19	0.23	0.58
Present data	1178	0.18	0.23	0.54
Total Mean	2188	0.062	0.078	0.192

Table 7Bloodgrouppercentage of all data Sources

Data source	Sample	Blood Group A %	Blood Group B %	Blood Group AB %	Blood Group O %
DU Group I -(2017)	298	20.81	30.87	9.06	39.26
DU Group - IV (2016)	436	26.49	34.91	10.23	28.37
DU Group- XXVI(2016)	268	0.256	34.8	10.4	29.20
DU Group- XXVII (2016)	481	21.69	34.76	7.265	36.29
Students of WYU	589	25.98	28.52	11.71	33.79
Present data	1178	24.75	28.05	13.31	33.90
Total Mean	2188	24.114	32.772	9.733	33.382

mutations creating type O have occurred at least three times in humans (Parvatheesam*et al.*, 1999). The membrane of a human red blood cell contain *a* variety of blood*group*antigen *,themost important and best known of* these *are*A and antigen . *(Race RR, Sanger R, 1962)*
Blood group A is associated with high frequencies in Europe, especially in Scandinavia and central

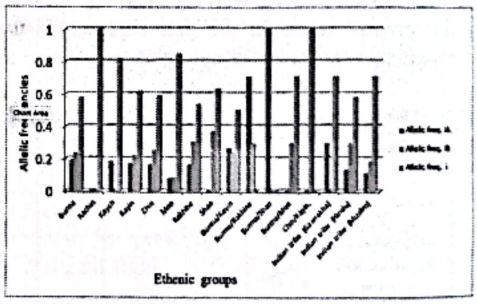

Fig 2 Distribution of A, B, O blood groups with allelic frequency of ethnic groups

Europe, although its highest frequencies occur in some Australian Aborigine populations and the Blood food Indians of Montana (Dean,2005).

In the present study a total of 1178 individuals belonging to 589 males and 589

females were studied. The distribution of ABO blood groups was as follows. The Phenotype frequency of group O was (33.89%) is followed by group B (28.05%) and group A(24.75%), while group AB had the lowest phenotype frequency (13.31%). The order of ABO frequencies was O>B> A >AB in the student population. With regard to distribution of allele frequencies among the students, allele i was observed to have the highest frequency *i* (0.582) follow by I^B (0.235) and I^A (0.183).

Reviewing the ABO phenotype frequencies of other populations of zoology students; it can be observed that the majority of populations analyzed had higher frequencies of blood group O than compared to group B or A, while the lowest frequency was found among students in group AB.

Prakask*et al;* (2013) reported that blood group B is very common in population of Asia descent, but rare in population of western Europe. In the present study results are in agreement above author with these mentions because Myanmar students are also of Asian descent.

In the present study, A blood group is third most frequencies in parent of Zoology students the same prevalence was not found in present study.

Blood group B has its highest frequency in Northern India and Neighboring Central Asia and its incidence diminishes both toward the west and east, falling to single digit percentages in Spain. It is believed to have been entirely absent from Native American and Australian aboriginal populations prior to the arrival of Europeans in those areas (Encyclopedia Britannica, 2012). Encyclopedia Britannica, 2012 stated that blood group "B" has its highest frequency in Southeast Asia. Prakash*et.al*; (2013) reported that blood group B is very common in population of Asia descent. In the present study "B" blood group is second most frequency among parent of Zoology students.

Many other studies have been shown that blood group O was the common blood group and blood group AB was the least common blood group is some ethnic group (Nwauche, and Ejete , 2004) which is the same in the present study.

The O blood group is very common around the world, about 63% of human share it. Blood group O is particularly high in frequency among the indigenous populations of central and South America where it 100% .The lowest frequency of O is found in Eastern Europe and G where B is common (Khan et,al; 2004). In the present study, the blood groupO is the most frequency among Zoology students. International studies outside present study e.g USA, Britain revealed blood group O is the commonly. Predominating blood group B in Pakistan whiles in Nepalespopualations blood group A is the most prevalent.

In the present work, blood groups O and B were found to be more frequent blood groups among the studied students and groups AB was the least frequent. This pattern was also reported to be similar among ABO blood groups of third year and fourth year students (Group IX).

According to blood group percent total number of students and their parents for West Yangon University and Dagon University was 2188Students.According to Allelic frequencies, we can calculate blood group O(0.192) was majority in Myanmar. Second highest percentage was blood group B(0.078). The lowest number of blood group was A(0.18).Table (6) .According to all data collected samples blood groups (14.114%)A,(32.772%)B, (9.733 %) AB, (33.38%) O,Table (7).

Conclusions

Highest frequency of blood group was allelic *"i"*(0.58), second highest one was *"I^B"* (0.23). The least frequency was blood group A*"I^A"* (0.18) of the 1178 parents of Zoology students from West Yangon University.

According to different ethnic groups, highest frequency of was *"i"* (0.577) in Burma, (0.616) in Kayin, (0.586) in Chin, (0.845) in Mon, (0.583) in Rakhine, (0.632) in Shan (0.817) in Kayar.

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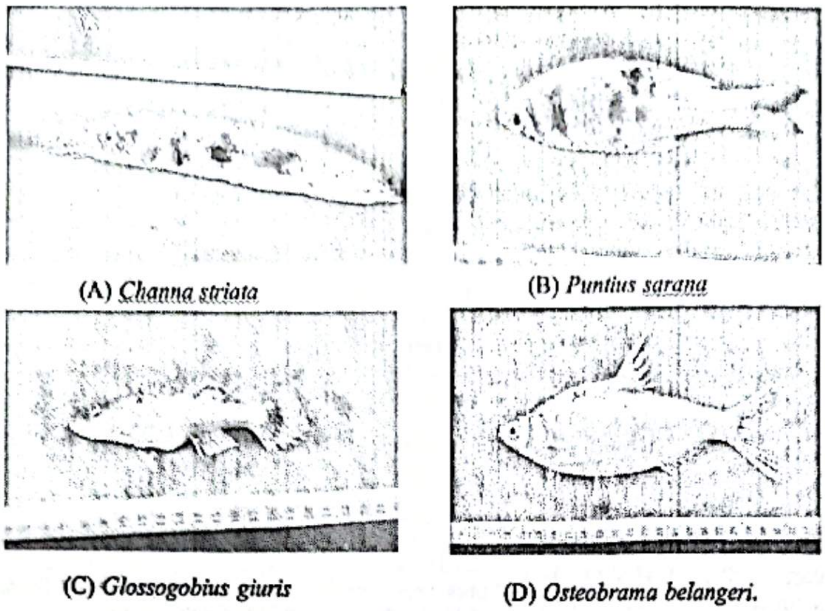

(A) *Channa striata* (B) *Puntius sarana*

(C) *Glossogobius giuris* (D) *Osteobrama belangeri.*

Plate 3 Some skin infected fish species in Pauk Inn

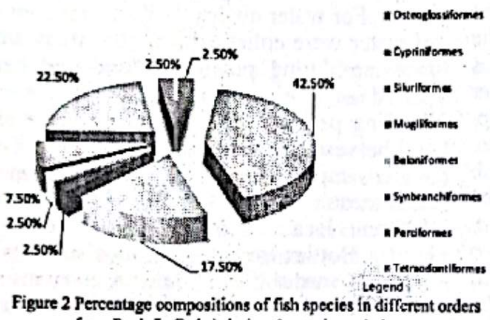

Figure 2 Percentage compositions of fish species in different orders from Pauk In (Lake) during the study period

Table 1 Comparison of Physico-chemical parameters of water recorded from Pauk Inn and EPA standard

Water Parameters	Southern Part		Northern Part		EPA Standard limit for fish
	Planting Period	Harvesting Period	Planting Period	Harvesting Period	
Water temperature (HC)	24	35	24	35	25
pH value	7.5	7.6	7.5	7.6	6.0-9.0
Dissolved Oxygen (DO) (mg/L)	3.58	1.42	2.00	1.50	≥7
Biochemical Oxygen Demand (BOD) (mg/L)	35	32	28	25	≤5
Total Dissolved Solids (TDS) (mg/L)	549	697	493	599	500
Total Alkalinity as CaCO3 (mg/L)	280	308	240	300	50-300
Nitrite (mg/L)	0.1	0.0	0.25	0.0	≤0.03
Salinity (%)	0.5	0.7	0.5	0.6	0.05-0.5
Total Suspended Solids (TSS) (mg/L)	283	384	266	382	≤25

Planting period = December to February
Harvesting period = March to May
EPA = Environmental Protection Agency

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Result

During the course of study, 40 fish species of fishes belonging to 30 genera, 17 families and eight orders were recorded from Pauk Inn, Chaung U Township. Of the eight orders, the order Cypriniformes with (17 species, 42.5%), followed by Perciformes with (nine species, 22.50%), Siluriformes with (seven species, 17.5%), Synbranchiformes with (three species, 7.50%) whereas each of Osteoglossiformes, Mugiliformes, Beloniformes and Tetraodontiformes with (one species, 2.50%) (Fig.2). Among the families, Cyprinidae with (17 species, 42.50%) was dominant family followed by Mastacembelidae and Bagridae with (three species each, 7.50%), and Siluridae, Belontiidae and Channidae with (two species, 5.00%) each and the rest of the families such as Notopteridae, Heteropneustidae, Loricariidae, Mugilidae, Belonidae, Ambassidae, Sciaenidae, Cichlidae, Gobiidae, Anabantidae, and Tetraodontidae with (one species, 2.50%) each. During the study period, the maximum numbers of 37 species were recorded in February 2019 while the highest number (1545180 individuals) was recorded in December 2019. While the minimum numbers of three species and the lowest number of (1871 Individuals) was recorded in May (2019). *Puntius sarana* was the highest total number of 5883946 individuals while *Johnius coitor* was the lowest number of four individuals.

Harvesting of fish

In the present study, monthly production of fish weight (kg) varied according to the demand of local people. Total production of fishes was over (283581.39 kg). According to the recorded data, found in December (70483.2 kg) while the lowest in May (38.4 kg). There were 24 fish species were collected from the study area. In these, the highest price fish species were *Notopterus notopterus* and *Wallago attu* while the lowest price species were *Puntius sp.* and *Oreochromis sp.*. The highest production of fish species were *Puntius sarana* (83209.60 kg) and *Xenentodon cancila* (0.05 kg). All fishes were directly sold to traders, wholesalers and retailer.

Physico-chemical parameters of water from Pauk Inn

Physico-chemical parameters of water were observed in Northern and Southern parts of Inn (Lake) during planting period and harvesting period from the study area (Table 1).

Discussion

In the present study, a total of 40 fish species belonging to 30 genera, 17 families and eight orders were identified. Among the eight orders of fish species, the order Cyrpiniformes represented as the highest species composition of (42.5 %, 17 species). According to the result, it was concluded that the fish species in the order Cypriniformes was a dominant species in Pauk Inn. The result was agreed with Kay Zin Thet (2016), Moh Moh Oo (2017) and Nwe Nwe Aye (2018), they also recorded from Pauk Inn, Chaung U Township. Their results stated that the order Cypriniformes was the largest species composition. It may be assumed that the tropical weather condition is preferred to order Cypriniformes and this order contains more fish species than the other orders.

Kay Zin Thet (2016) reported that a total of 44 species from Pauk Inn, Chaung U Township. Compare with the present study, 32 fish species were similar and 12 species such as *Gudusia variegata, Tenulosa tilo, Salmophasia sardinella, Aspidoparia morar, Osteobrama feae, Puntius chola, Botia histrionica, Lepidocephalus thermalis, Mystus bleckeri, Hemibagrus menoda, Eutropiichthys vacha* and *E. burmanicus* were not found in the present result. Nwe Nwe Aye (2018) reported that a total of 40 species from Pauk Inn, Chaung U Township and compare with the present study, 29 fish species were similar and 11 species such as most of the above species and in addition to *Salmostoma boopis, O. cotio, Raiamas guttatus* and *Syncrossus bredmoeri* were not found in the present study. Most of these absent fish species were natural fishes. It may be due to weather condition was drought in this year and the entrance of water from the river was very low. So, these fish species may not be entered in the study area from river or it may possible that there may be gradual scarcely present in this Inn.

In the present study, a total of 10782931 individuals and about 283581 kg/year of harvested fish species were recorded during the study period. According to individuals of the more harvested fish species were *Puntius sarana* (83210 kg/year), *P. sophore* (53606 kg/year) and *Gibelion catla* (13952 kg/Year). The first two species were small scale fishes and these fishes were dried for poultry farms. *G. catla* was the large scale fish and more preferred to local people. However, most of harvested these fishes were small in size compared with the size of harvested catla fish from river. This may be due to the more cultured fish species were inserted to the Pauk Inn and insufficient food for fish species in the study area.

Lasne *et al.*, 2007 carried out a discriminant analysis on environmental variables revealed that they could be mainly determined by the slope, temperature and depth of the water body. This statement agreed with the present finding. During the course of study, it was found that abundance of fish species was found to be very high in respect to extent of water body. During the months of June to September, the fishes were seeded and then breeding and rearing months for fishes. So, the fishes did not harvested in this months. In the month of October, the fish were start harvested. The harvested fish weight was gradually higher in the months of October to January. The fish fauna were abundant in these months may be due to large water body allow niche segregation in order to enable the fishes to live without facing intra and inter specific competitions. And then gradually decrease and the lowest harvested fish weight was found in the month of May (38kg/year). In May, the level of water was very low due to hot air and high temperature, thus the recorded fish species and harvested fish weight were very low.

Water is the home of fish and its quality is one of the most overlook aspects of fish culture until its affect fish production. Conspicuous variation of the water parameters of the study area reflected well defined planting and harvesting

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period of *Melon* spp. and other crops around the both sides of the study area. The data from the study area were analyzed by the laboratory of water supply and sanitation department, Mandalay Region. Comparison with EPA standard limit for fish, some parameter of the present study such as water temperature, pH and alkalinity were acceptable range and other parameters of DO, BOD, TDS, salinity and nitrites were unsuitable range for fish.

Environmental pollution by chemical fertilizers had been reported by Lioyd, 1992. In the present study no nitrite content was observed in two study sites during the harvesting period of cultivated plants. The nitrites content (0.1 mg/L) was found in the site I and (0.25 mg/L) was in the site II during the planting period. Compared with the EPA standard limit (≤0.03 mg/L), the nitrite content was higher in planting period. This may be assumed that the utilization of fertilizer from the farmland, the materials that contain organic matters and other excreta around the study area.

Ahidur, 2016 stated that the wetland supporting as a homeland for migratory birds. Khin Yadanar Thein, 2018 stated that 35 waterbird species from Pauk Inn. Out of these species 21 were residents, 14 were winter visitors. Htay Khaing *et al.*, 2018 described 35 species and 14710 individuals of waterbirds from the Pauk Inn. Thus, Pauk Inn supported breeding, feeding and spawning ground for most waterbird species. Crossing in water of grazing animals and seeking pasture can also affected water quality both positively and negatively. Thus, these factors may cause major surface water quality problem associated with pathogens by other visiting animals. Moreover, not properly forsaken plastic mulch and other waste materials from the farmland were caused the pollution of the study area.

Indian council of Agricultural Research, 2006 stated that excessive manure and feed wastage have been to increase TDS and often lead to poor water quality. In the present study the limit of BOD was (32 – 35 mg/L) in southern site of the study area and (25 – 28 mg/L) in northern side. The limits of TDS range from 493 – 697 mg/L were a little higher range than the standard EPA limit of 500 mg/L. The range of DO 1.42 – 3.58 mg/L in the southern part and 1.5 – 2.0 mg/L in the Northern side were not unfavorable limit of EPA range (≥7 mg/L). The high population of seeded fishes, weather condition and dissolving organic matter to the water body may be caused poor water body.

American Publish Health Association, 1992 stated that Biological oxygen demand (BOD) indicates a potential for reducing the dissolve oxygen (DO) content in water and this result could be stress for fish and even death. No fish was observed or seen under these conditions in this study. However, except *Gibelion catla*, *Rhinomugil corsula* , *Oreochromis mossambicus* and *Anabus testudineus* , some fishes from the study area such as *Chana striata*, *Puntius* spp., *Glosogobius giuris* and *Osteobrama belangeri* suffered skin infection on the fish body. Noga (2000) stated that skin ulcer on fish are one of the most well recognized indicators of polluted or otherwise stress aquatic environments.

It is observed that the Pauk Inn is encroached by environmental impacts such as agricultural land, overfishing, construction of house around the study area, domesticated animals and visiting wild animals. Encroachment of wetland will also be harmful in near future. If the encroachment will be continue there will be disappeared of wetland. It will create imbalance in the nature.

Conclusion

From the above discussion, fish production of Pauk Inn (Lake) was found benefit for local people. It is concluded that the use of fertilizers for plantations, properly forsaken garbage and plastic mulch to which are used in melon farming are urgently needed. It is clear that wetland (flooded plain) should be protected and state and local governments occupy perhaps the best position to take the lead on wetland (flooded plain) protection because they are more aware of and responsive to local need.

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Habitat Selection and Foraging Habits of Waterbirds at Two Different Wetlands in Monywa Township, Sagaing Region

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Abstract

This study especially focus on the habitat selection and foraging habits of waterbirds at two different wetlands namely Shapyay and Nyaung Kaing wetlands in Monywa Township, Sagaing Region. Bird counting and watching were carried out once a month regularly from January to December, 2018. Direct count and point count methods were used. A total of 34 waterbird species belonging to 27 genera, 11 families and seven orders were recorded. Out of 34 species, 19 species were residents and 15 species were winter visitors. According to IUCN status, one globally near-threatened species of Black-headed Ibis *Threskiornis melanocephalus* was observed. In Shapyay wetland, 23 species were shore birds (Sb), five species were diving birds (Di) and three species were dabbling ducks (Db). In Nyaung Kaing wetland, 25 species were shore birds (Sb), five species were diving birds (Di) and three species were dabbling ducks (Db). The present study indicated that waterbird population were directly influenced by the habitat selection and have preference to different habitats with surface water that supply suitable prey organisms for foraging. It also indicated that habitat destruction due to human activities including construction of houses, roads, agricultural land, overfishing, using pesticides and chemical fertilizers, grazing, brick making and bird hunting had the greatest impacts. Therefore, special attention should be given to protect the habitat characteristics for conservation of waterbirds in Shapyay and Nyaung Kaing wetlands to attract more waterbirds in the future.

Keywords: Habitat selection, Foraging habits, Wetlands, Waterbirds, Residents, Winter visitors

Introduction

Over 50% of wetlands in the world have been lost in the past century, and the remaining wetlands have been degraded to different degrees because of the adverse influences of human activities (Fraser and Keddy, 2005). The loss and degradation of wetlands has negatively affected waterbirds, which depend on wetland habitats (Taft *et al.*, 2002).

Waterbirds are an important component of most of the wetland ecosystems as they occupy several trophic levels in the food web of wetland nutrient cycles. Activities of waterbirds are considered as indicator of quality of the wetland ecosystem and form the terminal links in many aquatic food chains, and as a result they reflect changes originating in several different ecosystem components (Custer and Osborne, 1977).

Habitat selection in birds may greatly vary from species to species, depending upon the morphology of the bill (i.e straight, elongated, slender, curved bills), prey availability (i.e richness and vulnerability to capture) and foraging behaviour such as visual vs tactile foragers (Gawlik, 2002; Kushlan, 2000; White and Main, 2005) (cited by Rajpar and Zakaria, 2013).

Although food abundance is generally used in assessing habitat quality of waterbirds, food accessibility, which often differs from food abundance, greatly influences habitat use by waterbirds. Food accessibility to waterbirds depend on both intrinsic and extrinsic factors. Intrinsic factors include bird morphology (neck length, leg length, body size, and feeding structures), foraging methods, and diet selectivity. Extrinsic factors include water depth, vegetation density, and prey vulnerability. Because these intrinsic and extrinsic factors differ among waterbird species and group, particular species of waterbirds generally feed in particular wetlands with features that maximize the abundance and accessibility of their foods (Taft and Haig 2003; Bolduc and Afton 2004).

In addition to limiting access to foraging habitats, water depth effects the net energy intake of waterbirds because foraging efficiency decreases with increasing water depth. Foraging efficiency for the non-diving herbivores may also be reduced in deeper water. When foraging in shallow water, these birds feed by dipping their heads and necks only (neck-dipping), but when feeding in deeper water, they must tilt their entire body forward (up-ending). The latter results in a lower food intake rate and higher energy expenditure (Nolet *et al.*, 2002).

Diving waterbirds are able to forage over a wider range of depths than non-divers. Some may be limited by a minimum water depth that allows them to forage (Bolduc, 2002). Safran *et al.*, 1997, found a preference by some waterfowl for depths greater than 20 cm. Larger diving birds, such as cormorants require a minimum depth of about 1m (Halse *et al.*, 1993).

The wetlands of Myanmar include rivers and streams, shallow fresh storage reservoirs, fish ponds, seasonal flooded cultivated plains, and estuaries with extensive mangrove swamps. Most of the wetland in Myanmar is directly or indirectly associated with river systems.

The present study of Shapyay and Nyaung Kaing wetlands are directly connected with the Chindwin River and the natural freshwater wetland habitats representative of the flooded plain in Monywa. The main objectives of this study to determine the habitat selection and foraging habits of waterbirds at two different wetlands.

Materials and Methods

Study Site

Monywa Township is located in Sagaing Region which lies between 22° 04' 41.61"N to 22°

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Table 2 Population, foraging habits and feeding types of the waterbird species recorded in Shapyay wetland during January to December 2018

Scientific name	Population	Foraging habits			Feeding Types
Dendrocygna javanica	255	Db			O
Tadorna ferruginea	75	Db			O
Anas poecilorhyncha	146	Db			H
Tachybaptus ruficollis	61		Di		C/I
Amaurornis phoenicurus	83			Sb	O
Porphyrio porphyrio	53			Sb	O
Gallinula chloropus	72		Di		O
Fulica atra	24		Di		O
Anastomus oscitans	102			Sb	C/I
Plegadis falcinellus	0			Sb	C
Ivobrychus sinensis	145			Sb	C/I
Nycticorax nycticorax	34			Sb	C/I
Ardeola grayii	251			Sb	C/I
Ardeola bacchus	141			Sb	C
Bubulcus ibis	147			Sb	C
Ardea cinerea	169			Sb	C
Ardea purpurea	50			Sb	C
Ardea alba	26			Sb	C
Ardea intermedia	45			Sb	C
Egretta garzetta	85			Sb	C
Microcarbo niger	112		Di		P
Phalacrocorax carbo	163		Di		P
Himantopus himantopus	12			Sb	C
Pluvialis fulva	83			Sb	C
Charadrius dubius	0			Sb	C/I
Vanellus cinereus	17			Sb	C/I
Vanellus indicus	9			Sb	C/I
Hydrophasianus chirurgus	31			Sb	C
Gallinago gallinago	44			Sb	C
Actitis hypoleucos	157			Sb	I
Tringa glareola	23			Sb	C/I
Total	2701	3	5	23	
Species Composition		9.68	16.13	74.19	

Db = Dabbling Duck, Di = Diving waterbird, Sb = Shore bird, O = Omnivore, C = Carnivore, I = Insectivore, P = Piscivore, H = Herbivore, C = 12 species, O = 6 species, I = 1 species, H = 1 species, C/I = 9 species, P = 2 species

Table 3 Population, foraging habits and feeding types of the waterbird species recorded in Nyaung Kaing wetland during January to December 2018

Scientific name	Population	Foraging habits			Feeding Type
Dendrocygna javanica	355	Db			O
Tadorna ferruginea	121	Db			O
Anas poecilorhyncha	172	Db			H
Tachybaptus ruficollis	58		Di		C/I
Amaurornis phoenicurus	64			Sb	O
Gallinula chloropus	62		Di		O
Fulica atra	106		Di		O
Anastomus oscitans	344			Sb	C/I
Threskiornis melanocephalus	131			Sb	C
Plegadis falcinellus	195			Sb	C
Ivobrychus sinensis	21			Sb	C/I
Nycticorax nycticorax	301			Sb	C/I
Ardeola grayii	84			Sb	C/I
Ardeola bacchus	62			Sb	C
Bubulcus ibis	251			Sb	C/I
Ardea cinerea	60			Sb	C
Ardea purpurea	15			Sb	C
Ardea alba	92			Sb	C
Ardea intermedia	122			Sb	C
Egretta garzetta	261			Sb	C
Microcarbo niger	339		Di		P
Phalacrocorax carbo	8		Di		P
Himantopus himantopus	376			Sb	C
Himantopus leucocephalus	13			Sb	C
Pluvialis fulva	23			Sb	C
Charadrius dubius	12			Sb	C/I
Vanellus cinereus	36			Sb	C/I
Vanellus indicus	60			Sb	C/I
Hydrophasianus chirurgus	80			Sb	C
Gallinago gallinago	31			Sb	C
Actitis hypoleucos	45			Sb	I
Tringa glareola	86			Sb	C/I
Tringa stagnatilis	52			Sb	C/I
Total individual	4038	3	5	25	
Species Composition		9.09	15.15	75.76	

Db = Dabbling Duck, Di = Diving waterbird, Sb = Shore bird, O = Omnivore, C = Carnivore, I = Insectivore, P = Piscivore, H = Herbivore, C = 13 species, O = 5 species, I = 1 species, H = 1 species, C/I = 11 species, p = 2 species,

Discussion

In the present study, 34 species of waterbirds were recorded at different wetlands (Shapyay and Nyaung Kaing wetlands). Among them, 15 species were winter visitors and 19 species were residents. According to IUCN Red List (2015), among the 34 species recorded 33 waterbird species were recorded as Least Concern and one species as Near Threatened species.

Number of bird species may increase as a result of increased in habitat heterogeneity (He and Legendre, 1996). Habitats complexity may harbor higher resources such as food, perch, shelter and nest due to availability of different microhabitats (Hulbert, 2004). Gill (2001) stated that habitat selection is critical importance to many species. The selection may be based to a large extent on food availability and the presence of competitors. The variation in the bird species diversity reflects differences in habitat composition rather than variation in size of an area.

Mukherjee *et al.* (2002) reported that availability of food sources and safe roosting sites are governing factors that influence the species richness and its composition. In the present study, the highest number of foraging habits of waterbirds were recorded in shore birds followed by diving birds and dabbling ducks.

The present study indicated that the number of waterbird species was depended on habitat variation. Some species of shorebirds such as bitterns and herons hide in thick vegetation in marshy swamp and shallow water to catch variety of aquatic insects, tadpoles and fishes. Herons and Egrets often utilized the trees and shrubs at roosting site. Three species of *Amaurornis phoenicurus, Porphyrio porphyrio* and *Gallinula chloropus* were observed in shrub patch for shelter and roosting but they preferred marshy swamp for foraging site.

Swamphens and morhens used marshy swamp and lotus swamp to feed on soft leafy shoots, seed of reeds. They also feed on small vertebrates such as tadpoles, fishes and invertebrates such as larvae of insects. Jacanas picked snails, insects and invertebrates by walking slowly on the leaves of water lilies. Other species such as plovers, snipes, sandpipers, lapwing and stilts used wet soil for probing or picking up food items such as worms and insects. The results showed that marshy swamp is highly attractive for shorebird species as compared to other habitats since it provides heterogeneous habitats that attracted high diversity of waterbirds through offering shelter, abundant food, suitable nesting and safe roosting sites.

Safran *et al.*, 1997 also stated that the relationship between water depth and foraging habitat use of individual species of wetland bird has been well documented. Three species of dabbling ducks such as *Dendrocygna javanica, Tadorna ferruginea* and *Anas poecilorhyncha* were frequently observed in open water area with shallow water depth and marshy swamp for feeding and resting. Diving waterbirds such as *Tachybaptus ruficollis, Gallinula chloropus, Fulica atra, Microcarbo niger* and *Phalacrocorax carbo* prefered open water body for foraging. Cormorant species such as *Microcarbo niger* and *Phalacrocorax carbo* were often resting and

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Table 1 Status and habitat selection of waterbirds recorded in different wetlands during January to December 2018

Order	Scientific name	Habitat slection (Different Habitats)					IUCN Redlist	Status
		Ms	Ls	O	Pd	Sp		
Anseriformes	**Anatidae**							
	Dendrocygna javanica	+	+	+	-	-	LC	R
	Tadorna ferruginea	+	+	+	-	-	LC	WV
	Anas poecilorhyncha	+	+	+	-	-	LC	R
Podicipediformes	**Podicipedidae**							
	Tachybaptus ruficollis	-	-	+	-	-	LC	R
Gruiformes	**Rallidae**							
	Amaurornis phoenicurus	+	+	-	-	+	LC	R
	Porphyrio porphyrio	+	+	-	-	+	LC	R
	Gallinula chloropus	+	-	+	-	+	LC	R
	Fulica atra	-	-	+	-	-	LC	WV
Ciconiiformes	**Ciconiidae**							
	Anastomus oscitans	+	-	-	+	-	LC	WV
Pelecaniformes	**Threskiornithidae**							
	Threskiornis melanocephalus	+	-	-	+	-	NT	WV
	Plegadis falcinellus	+	-	-	+	-	LC	WV
	Ardeidae							
	Ixobrychus sinensis	+	+	-	-	-	LC	R
	Nycticorax nycticorax	+	-	-	-	+	LC	R
	Ardeola grayii	+	+	-	+	+	LC	R
	Ardeola bacchus	+	+	-	+	+	LC	R
	Bubulcus ibis	+	+	-	+	+	LC	R
	Ardea cinerea	+	+	-	+	+	LC	R
	Ardea purpurea	+	+	-	+	+	LC	R
	Ardea alba	+	+	-	+	+	LC	R
	Ardea intermedia	+	+	-	+	+	LC	R
	Egretta garzetta	+	+	-	+	+	LC	R
Suliformes	**Phalacrocoracidae**							
	Microcarbo niger	-	-	+	-	-	LC	R
	Phalacrocorax carbo	-	-	+	-	-	LC	WV
Charadriiformes	**Recurvirostridae**							
	Himantopus himantopus	+	-	-	-	-	LC	WV
	Himantopus leucocephalus	+	-	-	-	-	LC	WV
	Charadriidae							
	Pluvialis fulva	+	-	-	+	-	LC	WV
	Charadrius dubius	+	-	-	+	-	LC	WV
	Vanellus cinereus	+	-	-	-	-	LC	WV
	Vanellus indicus	+	-	-	-	-	LC	R
	Jacanidae							
	Hydrophasianus chirurgus	+	+	-	-	-	LC	R
	Scolopacidae							
	Gallinago gallinago	+	-	-	+	-	LC	WV
	Actitis hypoleucos	+	-	-	+	-	LC	WV
	Tringa glareola	+	-	-	+	-	LC	WV
	Tringa stagnatilis	+	-	-	+	-	LC	WV

LC = Least Concern, VU = Vulnerable, NT = Near Threatened, R = resident, WV = winter visitor, + present, - = absent, Ms = Marshy swamp, Ls = Lotus swamp, O = Open water body, Pd = Paddy field, Sp = Shrub patch

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10' 48.02"N and 95° 10' 02.74"E to 95° 06' 04.72"E. Two different study sites were designated in Monywa Township (Plate 1).

Site (I) Shapyay wetland, Site (II) Nyaung Kaing wetland

Study Period

Field surveys were conducted from January to December 2018.

(Source: Google Earth, 2018)

Plate 1 Location map of the study site

Field Technique

The field survey was conducted once a month. Birds were observed by using a binocular. The bird photos were taken with digital camera. Bird watching was undertaken two times during the period from 7:00 am to 11:00 am in the morning and from 3:00 pm to 5:00 pm in the evening. Bird watching and counting were carried out using a boat and also walking along marshy swamp. Bird census was made by using direct count and point count method.

Identification and classification

Identification of the bird species was made according to King and Dickinson (1975), Smythies (2001) and Robson (2015). Birds were listed in the classification systems proposed by Bird Life International Checklist Version 9.1 (2017).

Foraging habits of waterbirds

Foraging habits of the waterbird species was recorded on direct observations during every field surveys. The waterbirds were grouped based on foraging behavior and habitats use such as dabbling duck (small or middle size of Anatidae species that require shallow wetland for feeding), diving waterbird (includes all kinds of waterbird species that can dive for feeding) and shorebird (wader species and are not good at swimming) according to Chan-Woo *et al.*, 2006 and based on visual observations.

Analysis of data

Comparison using analysis of variance (ANOVA) test to determine the significant difference of waterbird population between the two different wetlands, was also evaluated using (SPSS version 23).

Results

A total of number of 6739 waterbird individuals accounted from 34 species, 27 genera, 11 families and seven orders were recorded from the two wetlands, namely Shapyay and Nyaung Kaing wetlands. All these species, 31 species were recorded in Shapyay wetland and 33 species were observed in Nyaung Kaing wetland. Among the 34 species of waterbirds, 19 species were residents and 15 species were winter visitors. According to IUCN Red List (2015), *Threskiornis melanocephalus* Balck-headed Ibis was Near Threatened (NT) species (Table 1).

Habitat Selection and Foraging Habits of Waterbirds

In the present study, the waterbird species were grouped based on foraging behaviour and habitats use such as dabbling duck, diving and shorebird. These waterbird species were selected different wetland habitats such as open water body, lotus swamp, marshy swamp, paddy field and shrub patch for foraging, roosting, nesting and resting.

Most individual of shorebirds were frequently observed in lotus swamp, marshy swamp, paddy field and shrub patch for foraging, roosting and nesting sites. Dabbling ducks were frequently observed in open water area with shallow water depth and marshy swamp for feeding and resting. Diving waterbirds prefered open water body for foraging.

A total of 34 species of waterbirds recorded in the different wetlands. In Shapyay wetland, 23 species were shore birds (Sb), five species were diving birds (Di) and three species dabbling ducks (Db) according to foraging behavior of waterbirds. The highest percentage of species composition was found in shorebirds (74.19%) followed by diving waterbirds (16.13%) and dabbling ducks (9.68%). The mode of feeding habit revealed 12 species as carnivores (C), six species represented omnivores (O), one species as insectivore (I), one species as herbivore (H), nine species as carnivores and insectivores (C/I) and two species represented piscivores (P) (Table 2).

In Nyaung Kaing wetland, 25 species of shore birds (Sb), five species of diving birds (Di) and three species of dabbling ducks (Db). The highest percentage of species composition was alsofound in shorebirds (75.76%) followed by diving waterbirds (15.15%) and dabbling ducks (9.09%). Among the 33 species, a total of 13 species as carnivores (C), five species represented omnivores (O), one species as insectivore (I), one species as herbivore (H), 11 species as carnivores and insectivores (C/I) and two species represented piscivores (P) (Table 3).

According to ANOVA test, the population of waterbirds between Shapyay and Nyaung Kaing wetland were insignificantly different ($F_{1,22} = 2.959$, $P=0.99$) but, the waterbird population were more observed in Nyaung Kaing wetland than in Shapyay wetland.

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drying their wings at the edge of open water area and on the twigs.

Gibb *et al.* (1991) found that piscivorous birds were particularly sensitive to wetland surface water area and suggested that larger wetlands may provide more open water for diving species. In the present study, piscivorous species of diving birds as Little Cormorant *Microcarbo niger* were recorded the highest number of individuals in open water body. This may be assumed that these species prefer open water surface area because water depth limits their access to foraging habitats.

Davies *et al.* (2004) pointed out that many species of birds use different habitats at different time of the year. Migratory species, especially may be forced to use different habitats in different regions simply because limited choices are available. Nevertheless, migration birds use similar habitats throughout the year.

In the present study, 15 migratory waterbird species were recorded in the study area. Most of the migratory waterbird species arrived in the cold season of November, December, January and February. Among the migratory waterbird species, Black-headed Ibis *Threskiornis melanocephalus* appeared as the Near Threatened species. It may be due to the prescence of sufficient amount of foods for these species such as crustaceans, mollusks and insects. Moreover, Shapyay and Nyaung Kaing wetlands area supports rich variety of food resources and also good shelter places for migratory waterbird species.

This study indicated that waterbird populations were directly influenced by habitat selection and have preference to wetland habitat with surface water that supply suitable prey organisms for foraging. In the present study, waterbirds in diffrent wetlands faced habitat destruction due to human activities including construction of houses, roads, agricultural land, overfishing, using pesticides and chemical fertilizers, grazing, brick making, and bird hunting had the greatest impacts. Arriving in lotus area for recreation by the local visitors is the main threats to the survival of the waterbirds. Therefore, special attention should be given to protect the habitat characteristics for conservation of waterbirds in Shapyay and Nyaung Kaing wetlands to attract more waterbirds in the future.

Conclusion

In this study, a total of 34 waterbird species belonging to 27 genera, 11 families under seven orders were recorded at two different wetlands (Shapyay and Nyaung Kaing) in Monywa environs during January to December 2018. During the study period, 33 species in Nyaung Kaing wetland and 31 species in Shapyay wetland. The highest number of foraging groups of waterbirds were recorded in shore birds followed by diving birds and dabbling ducks in different wetlands. The results showed that marshy swamp is highly attractive for different waterbird species as compared to other habitats.

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ZOL 032

Occurrence and Abundance of Some Avifauna at Salingyi Reservoir in Salingyi Township, Sagaing Region

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Abstract

Occurrence and abundance of some avifauna was determined using point count method at Salingyi Reservoir in Salingyi Township, Sagaing Region. A total of 72 species of birds belonging to 57 genera, 36 families and 14 orders were recorded in the study area. This study was conducted from September 2018 to August 2019. Out of these recorded species, 23 species were waterbirds and 49 species terrestrial birds. The highest composition of bird species was observed in order Passeriformes while the lowest species composition were observed in orders Suliformes, Stigiformes, Bucerotiformes, Piciformes and Psittaciformes respectively. Five Myanmar endemic species of Burmese Bushlark *Mirafra microptera*, Brown Prinia *Prinia polychroa*, Ayeyarwady bulbul *Pycnonotus blandfordi*, White-throated Babblar *Chararrhaea gularis* and Burmese-collared Dove *Streptopelia xanthocycla* were observed in the study area. According to IUCN status, one globally near threatened species, Black-headed Ibis *Threskiornis melanocephalus* was also observed. Very common species, Lesser Whistling-duck *Dendrocygna javanica* was the highest individual of waterbirds in the study area. The finding of this study highlighted at Salingyi Reservoir has habitat heterogeneity and seasonal fluctuation of water level that had attracted terrestrial and waterbird species to perform various activities such as feeding, roosting and breeding.

Keywords: Occurrence, Abundance, Avifauna, Reservoir, Terrestrial birds, Waterbirds

Introduction

The Class Aves comprises almost 10,000 recognized species of varied forms descended from one another to through the process of adaptation by natural selection. The current classification of living birds is hierarchical arrangement of roughly 29 orders, 187 families, over 2000 genera, and over 9600 species (Gill, 2001). In Southeast Asia, a total of 1327 species are known to occur (Robson, 2015). Birds are found in forests, wetland, deserts, mountains, prairies and over all the oceans. Although they are found in various parts of the world they are not seen all the time because of their migratory habit (Davison and Fook, 1996).

Birds are known as good indicators and can be used to identify the most biologically rich areas, as well as environmental changes and problems (Gill, 1990). Birds are very important to the balance of nature; by consuming insects, many birds help in keeping insects from becoming too numerous, and some kinds of birds help plants reproduce by carrying pollen from one plant to another or by spreading their seeds (Childcraft Annual, 1983). Birds are adapted for aerial life. These highly mobile creatures are travellers of long distance and the short. They are beautiful to watch and fascinating to listen. Birds are among the easiest of animals to census.

Birds are the important consumers in aquatic systems and are indicators of both water quality and biodiversity. Waterbirds are the most conspicuous and significant component of different wetland habitats and their presence or absence may indicate the ecological condition of the particular area (Rajpar and Zakaria, 2011). Water birds are a large and varied group of birds. Most are exclusive to fresh water such as rivers, lakes, dams and wetlands, however many sea and shore birds can also be regularly found in fresh water, e.g. cormorants and many migratory wader. These are many species of waterbirds, having flat beaks such as swan and ducks eat mainly waterweeds, grass, seeds and a variety of beetles and bugs. Ibis and herons, which have sharp pointed beaks, feed on small fish, worms, bugs, crustaceans, flogs and even field mice (Birdlife Australia, 2008).

Composition and species richness of avian communities is associated with habitat structure as well as with abiotic factors such as temperature and precipitation. Seasons impose contrasting demands on animal species, which must respond with behavioral and physiological adaptations, including shifting resource use or migration to other geographical areas with tolerable or more adequate conditions (Seoane *et al.*, 2013). The relative abundance of bird species during season might be related to availability of food, habitat condition and breeding season of the species. Seasonal variation in the abundance of food resource results in seasonal changes in the species abundance of bird. The distribution and abundance of many birds species are determine by the composition of the vegetation that how a major element of their habitats. As vegetation changes along complex geographical and environment gradient, a particular bird species may appear, are increase or decrease in number and disappear as the habitat changes (Shimbelies and Afewk, 2008).

Salingyi Reservoir is located west of the Salingyi, Yinmabin District, Sagaing Region in the Central Dry Zone of Myanmar. The study area was provided different habitat types for terrestrial birds and waterbirds. In addition, water body of reservoir, aquatic plants, tall grasses, paddy fields and various plantations serve rich of food sources for these terrestrial birds and waterbirds. This

Table 1 Species composition of bird in different orders from the study area

No	Order	Number of family	Number of genus	Number of species	Composition (%)
1	Anseriformes	1	4	4	5.56
2	Podicipediformes	1	2	2	2.78
3	Columbiformes	1	3	4	5.56
4	Cuculiformes	1	3	3	4.17
5	Gruiformes	1	3	3	4.17
6	Pelecaniformes	2	5	7	9.72
7	Suliformes	1	1	1	1.39
8	Charadriiformes	5	6	6	8.33
9	Strigiformes	1	1	1	1.39
10	Bucerotiformes	1	1	1	1.39
11	Coraciiformes	3	5	6	8.33
12	Piciformes	1	1	1	1.39
13	Psittaciformes	1	1	1	1.39
14	Passeriformes	17	22	32	44.44
	Total	37	58	72	100

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research was conducted with the following objectives;

- to record the occurrence of bird species in the study area
- to identify the recorded species in the study area
- to investigate the composition and abundance of avifauna

Materials and Methods

Study area and period

Salingyi Reservoir is located between Latitudes 21° 9.177' to 22° 9' 10" N and 95° 9.411' to 95° 9' 24" E. The total surface area is about 8.320 km^2. It is situated in the west of Salingyi, Salingyi Township (Figure 1). This research was conducted from September, 2018 to August, 2019.

Bird watching and data collection

Data were collected using by point count method. Birds watching was carried out once a month; morning between 6:30 to 10:30 am and evening from 3:00 to 5:00 pm. Point count involved a standing in one spot and recording all birds see or heard point count within (10) minutes. The minimum distances between point count was (200m) away. Birds were observed with the aid of binoculars and photographed by Nikon Digital Camera (COOLPIX P900).

Identification and classification of bird species

The identification of the birds were followed by King and Dickinson (1995), Smythies (2001) and Robson (2016) and classification followed after Robson (2016).

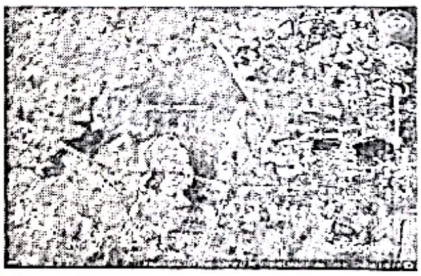
Analysis of data

$$\text{Relative abundance} = \frac{\text{no.of individuals of a species}}{\text{total no.of individual of all species}}$$ (Bisht, *et al.*20(

004)(uncommon) = having relative abundance less than 0.01

C (Common) = having relative abundance of 0.01 and above but less than 0.05

VC (very common) = having relative abundance of 0.05 and above



Source: Google earth, 2019

Figure 1 Map of the study area

Results

A total of 72 species belonging to 58 genera, 37 families, under 14 orders were recorded in Salingyi Reservoir, Salingyi Township. Out of the 72 species recorded, 23 species were waterbirds and 49 species were terrestrial birds. According to IUCN Red List (2015), *Threskiornis melanocephalus* black-headed Ibis was Near Threatened (NT) species.

Species composition of bird in different orders from the study area

A total of 72 species of birds were recorded in the study area from September 2018 to August 2019. These 72 species were confined to 58 genera and distributed among 37 families under 14 orders. Among these, 49 terrestrial species and 23 waterbird species were observed. During the study period, species composition of order Passeriformes (44.44%), Pelecaniformes (9.72%), Charadriiformes and Coraciiformes (8.33% each), Anseriformes and Columbiformes (5.56% each), Cuculiformes and Gruifomes (4.17% each), Podicipediformes (2.77%) and Suliformes, Strigiformes, Bucerotiformes, Piciformes and Psittaciformes (1.39% each) were recorded (Table 1 and Figure 2).

Abundance of species

During the study period, a total of 72 species were recorded from the study site. Analyzing the values of relative abundance three species were regarded as very common (value 0.05 and above) and 15 species were regarded as common (value 0.01 and above less than 0.05) and 54 species were regarded as uncommon (value less than 0.01). *Dendrocygna javanica* (Lesser WhistlingDuck), *Fulia atra* (Common Coot) and *Microcarbo niger* (Little Cormorant) were recorded as very common species (Table 2).

Discussion and Conclusion

A total of 72 bird species confined to 58 genera, distributed among 37 families and 14 orders were recorded from September 2018 to August 2019. Among 14 orders, six orders were waterbirds and eight orders were terrestrial birds. Comparing the data of present study to those of the previous workers, Chan Min Aung (2014) described that 48 species of birds confined to 42 genera and distributed among 32 families and 13 orders from Mye Net Village, Ayadaw Township. Among 13 orders, Passeriformes appeared as the predominant group with 23 species confined to 16 families. In the present study, 14 orders were recorded, among which the order Passeriformes predominant and group with 32 species confined to 17 families.

Khin Hnin Thet (2013) described that the two Myanmar endemic species *Chatarrhaea gularis* (White throated Babbler), *Mirafra microptera* (Burmese Bushlark) were recorded in Monywa Township. Win Win Nu (2016) stated that two Myanmar endemic species of *Chatarrhaea gularis* White throated Babbler and *Mirafra mivroptera* Burmese Bushlark were recorded in Yinmabin Environs. In the present study, five Myanmar endemic species (Burmese Bushlark) *Mirafra microptera*, (Brown Prinia) *Prinia polychroa*, (Ayeyarwady bulbul) *Pycnonotus blanfordi*, (White-throated Babbler), *Chatarrhaea gularis* and (Burmese-collared Dove)

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Table 2 Monthly occurrence and abundance of bird species from the study area

Scientific name	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Total	RA	Average (RA)
*Dendrocygna javanica	163	192	85	170	180	200	480	220	250	60	20	34	2054	0.3821	vC
*Anser anser	0	0	0	0	0	3	3	3	0	0	0	0	9	0.0017	uC
*Tadorna ferruginea	0	4	10	12	8	20	12	0	0	0	0	0	66	0.0123	C
*Anas zonorhyncha	4	8	10	8	6	6	6	16	6	14	4	2	90	0.0167	C
* Tachybaptus ruficollis	10	7	9	10	6	11	10	13	5	3	9	4	97	0.0180	C
*Podiceps cristatus	0	0	0	0	2	2	2	0	0	0	0	0	6	0.0011	uC
Columba livia	14	8	10	4	5	6	6	8	6	8	6	16	97	0.0180	C
Streptopelia xanthocycla	3	5	2	0	4	0	3	0	2	2	2	6	29	0.0054	uC
Streptopelia tranquebarica	5	4	2	6	8	11	7	10	8	4	13	6	84	0.0156	C
Spilopelia chinensis	11	8	6	10	21	13	16	14	18	8	6	12	143	0.0266	C
Centropus sinensis	2	1	0	0	1	0	2	0	1	2	2	1	12	0.0022	uC
Eudynamys scolopaceus	1	0	2	0	0	0	0	4	3	4	0	1	15	0.0028	uC
Caprimulgus macrurus	0	1	0	2	0	1	0	0	1	1	0	2	8	0.0015	uC
*Amaurornis phoenicurus	2	1	3	0	0	2	3	0	2	1	1	0	15	0.0028	uC
*Gallinula chloropus	1	2	1	1	3	5	4	2	4	3	2	4	32	0.0060	uC
*Fulica atra	14	22	34	15	40	36	28	82	60	18	10	16	375	0.0698	vC
*Threskiornis melanocephalus	0	1	0	1	1	2	0	0	0	0	0	0	5	0.0009	uC
*Ardeola grayii	6	5	8	2	3	4	3	7	2	4	3	4	51	0.0095	uC
*Bubulcus ibis	4	7	5	9	3	6	10	9	20	6	6	8	93	0.0173	C
*Ardea cinerea	1	3	1	2	4	4	2	4	3	4	3	1	32	0.0060	uC
*Ardea alba	2	1	3	2	2	3	1	2	4	3	4	1	28	0.0052	uC
*Ardea intermedia	1	0	2	3	2	4	1	4	3	2	4	0	26	0.0048	uC
*Egretta garzetta	14	23	8	14	6	15	7	16	5	11	3	32	154	0.0286	C
*Microcarbo niger	6	12	41	72	80	60	51	32	20	12	6	12	404	0.0751	vC
*Himantopus himantopus	1	2	4	6	2	4	0	0	0	0	0	0	19	0.0035	uC
*Charadrius dubius	0	4	6	8	8	7	5	3	0	0	0	0	41	0.0076	uC
Vanellus indicus	2	6	5	7	4	5	0	2	4	0	0	0	35	0.0065	uC
*Rostratula benghalensis	0	2	1	2	3	5	0	1	1	2	3	0	20	0.0037	uC
*Hydrophasianus chirurgus	0	0	5	4	4	6	12	10	6	1	6	0	54	0.0100	C
* Tringa glareola	0	2	4	12	8	8	6	4	2	0	0	0	46	0.0086	uC
Athene brama	2	0	1	0	0	0	3	0	0	2	2	1	11	0.0020	uC
Upupa epops	0	0	0	1	2	2	1	1	2	1	2	0	12	0.0022	uC
Merops philippinus	4	7	2	5	6	1	1	2	3	1	2	4	38	0.0071	uC
Merops orientalis	1	3	1	2	4	4	2	3	6	3	6	2	37	0.0069	uC
Corvus benghalensis	1	0	2	0	0	1	0	2	2	4	1	1	14	0.0026	uC
Alcedo atthis	1	0	1	2	4	3	2	1	2	1	3	1	21	0.0039	uC
Ceryle rudis	0	0	0	1	1	1	0	0	1	2	2	0	8	0.0015	uC
Halcyon gularis	0	1	2	4	2	4	3	1	2	3	1	2	25	0.0047	uC
Psilotogon haemacephalus	0	0	1	0	0	0	0	0	0	1	0	1	3	0.0006	uC
Pyticacula krameri	0	0	2	2	2	2	2	4	2	4	2	3	25	0.0047	uC
Artamus fuscus	1	3	1	2	1	1	1	2	4	1	1	3	21	0.0039	uC
Aegithina tiphia	0	1	2	0	0	0	0	0	1	0	2	1	7	0.0013	uC
Dicrurus macrocercus	0	2	1	0	4	3	2	3	1	1	2	1	20	0.0037	uC
Lanius collurioides	0	0	0	2	0	1	0	1	0	2	2	0	8	0.0015	uC
Corvus splendens	2	5	4	8	10	6	7	5	6	8	8	3	72	0.0134	C

Scientific name	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Total	RA	Average (RA)
Mirafra microptera	1	3	2	0	2	3	2	1	6	4	6	2	32	0.0060	uC
Cisticola juncidis	0	1	2	1	1	0	1	0	2	1	0	1	10	0.0019	uC
Prinia polychroa	0	1	0	2	1	0	1	1	0	1	0	1	8	0.0015	uC
Prinia hodgsonii	1	0	2	0	0	1	0	0	1	2	2	3	12	0.0022	uC
Prinia inornata	2	3	1	0	2	2	3	1	3	2	1	3	23	0.0043	uC
Orthotomus sutorius	0	1	0	0	0	2	0	0	0	1	1	0	5	0.0009	uC
Pycnonotus cafer	0	2	2	0	4	0	1	3	0	7	8	6	33	0.0061	uC
Pycnonotus blanfordi	2	1	0	0	3	0	5	0	1	4	6	4	26	0.0048	uC
Chrysomma sinense	1	0	0	0	3	0	2	0	1	1	1	2	11	0.0020	uC
Chaimarrhaca gularis	2	4	6	0	8	0	4	0	3	3	3	9	42	0.0078	uC
Graucalus nigricollis	4	0	0	6	3	0	0	2	2	2	0	5	24	0.0045	uC
Acridotheres tristis	5	13	8	6	10	15	18	8	10	15	20	21	149	0.0277	C
Sturnus burmanicus	0	8	14	2	6	10	10	8	7	20	24	12	121	0.0225	C
Acridotheres fuscus	4	2	5	0	0	6	0	1	2	2	2	10	34	0.0063	uC
Copsychus saularis	0	1	1	2	2	0	1	2	1	2	2	0	14	0.0026	uC
Saxicola caprata	2	3	2	4	8	7	6	5	3	2	1	4	47	0.0087	uC
Cinnyris asiaticus	2	1	2	0	1	0	3	0	1	4	2	0	16	0.0030	uC
Ploceus philippinus	0	0	0	1	0	0	1	0	0	2	2	1	7	0.0013	uC
Lonchura punculata	0	1	1	0	0	2	0	0	0	4	1	2	11	0.0020	uC
Lonchura atricapilla	0	1	1	0	0	2	0	0	0	1	1	2	8	0.0015	uC
Passer domesticus	4	7	3	0	6	0	6	8	10	6	10	12	72	0.0134	C
Passer flaveolus	2	3	5	0	0	0	5	5	8	10	14	3	55	0.0102	C
Passer montanus	2	5	3	4	0	0	6	8	10	16	12	6	72	0.0134	C
Anthus richardi	0	0	1	0	1	0	2	1	0	2	2	3	12	0.0022	uC
Anthus rufulus	2	1	0	0	1	1	2	1	2	1	0	1	12	0.0022	uC
Motacilla citreola	0	1	2	6	5	8	2	0	0	0	0	0	24	0.0045	uC
Motacilla alba	0	3	5	8	6	7	5	0	0	0	0	0	34	0.0063	uC
	315	419	355	453	523	544	790	546	541	322	270	298	5376		

* = Water bird, RA = Relative abundance, uC = Uncommon, C = Common, vC = very common

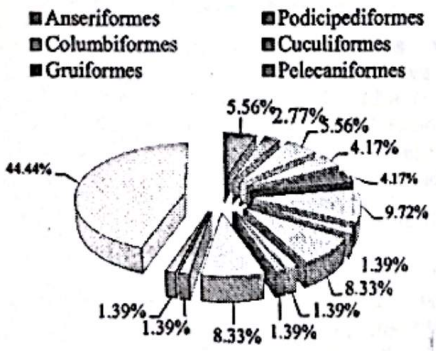

Figure 2 Species composition of bird in different orders from the study area

Streptopelia xanthocycla were recorded during the study period.

According to the above findings, it may be suggested that different species may be due to the different study area and study period.

In the present study, seven species of Pelecaniformes were recorded in the study area. Yan Naing (2017) stated that among 76 species of birds, seven species including of Pelecaniformes in Innwa environs, Tada-U Township, Mandalay Region. Among them, four species of *Bubulcus ibis*, *Ardea alba*, *Ardea intermedia* and *Egretta garzetta* were the same and the remainders was not found in the present study.

In the present study, four species of water birds under order Anseriformes were recorded. Thant Naing Htwe (2017) stated 21 species of waterbirds in Nyaung Kaing In (Lake), Monywa Township, Sagaing Region. She described three species *Dendrocygna javanica*, *Tadorna*

ferruginea and *Anas spoecilorhyncha* in order Anseriformes. Among these species, two species of *D. javanica* and *T. ferruginea* was found and *A. spoecilorhyncha* was not found in the present study.

According to the above findings, it may be suggested that different species may be due to the environmental factors such as rainfall and temperature and habitat types of wetlands such as marshes, swamps, trees, open water area, agricultural fields and other vegetation. Among the recorded species, some are notable in color and size. In this study area, the order Passeriformes were the highest species number than any other orders. Moreover, the species *Dendrocygna javanica* (Lesser Whistling Duck) in the family Anatidae was the highest individuals and *Psilopogon haemacephalus* in the family Megalaimidae was the lowest individuals during the study period.

Salingyi Reservoir was provided different habitats type for terrestrial birds and waterbirds. In addition, water body or reservoir plantations serve rich of food sources for these terrestrial birds and waterbirds. Many birds are important in plant reproduction through their services as pollinators or seed dispersers. Throughout the world, birds are essential seed dispersers for plants that provide us with food, medicine, timber, and recreation.

It may be concluded that many varieties of birds including different sizes, different colors were observed in the study area. The feeding relationships among all the animals in an ecosystem help prevent any one species from becoming too numerous. Birds play a vital role in keeping this balance of nature. Therefore, local people need to have the knowledge on the importance of waterbirds and terrestrial bird habitat which is vital for sustainable conservation. Thus, any activity that could lead to habitats destruction should be prohibited.

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are dispersed by the hyperplastic interstitial tissue, but also exhibit degenerative changes during the course of the disease. Vascular pathology, with possible haemoglobin crystallisation, has also been reported (Clifton-Hadley *et al.*, 1987).

The infected fish may influence the quality of fish. Myxosporean parasites not only infect the kidneys but also the gills, the infection, clumps the gill filaments leading to the lost of gaseous exchange surface area, thus stunting the growth and resulting in the decline in the quality of fish and economic lost. Thus, there is a requisite to investigate myxosporean infection in the fishery sector. Thus, study of myxosporean parasites in the kidneys of major carp as *Labeo rohita*, and *Gibelion catla* is needed to investigate from Ahlone Fish culture Pond, Monywa environs.

The objectives of the present study were,

- to investigate the myxosporean parasites in two carp species from Ahlone Fish culture pond
- to study the prevalence of myxosporean parasites in the study fishes
- to examine the histopathological changes in the kidney of infected fishes

Materials and Methods

Study Site and Study Period

Alone fish culture pond is situated in Alone Township, Monywa environs. It is situated between North latitude 22° 11'11.80" and East longitude 95°05'41.23" (Plate. 1). The study period was conducted from June 2016 to May 2017.

Collection of Specimens

A total of 60 host fish specimens, representing 30 specimens of each species from study site were used. Total length, standard length and body weight of collected fish specimens were recorded. Then the kidneys were cut and fixed in 10% formaldehyde solution and carried to the laboratory of Zoology Department, Monywa University.

Preparation and examination of Myxosporean parasites

The kidneys of fishes were teased with a drop of water on the slide and covered with a cover slip and immediately examined thoroughly for the myxosporean parasites under the microscope with digital camera image analyzer DP-12 Olympus.

Identification and Classification of Myxosporean Parasites

Myxosporean parasites were identified according to Lom and Dykova (1992), (2006), Kaur and Singh (2008), (2009), (2010), (2011), Singh and Kaur (2012) and Szekely *et al.* (2009). The spores (Myxosporean) were classified using the practical key given by Lom and Dykova (1992).

Preparation and Examination for Histopathological Study

Tissue samples of kidney were studied for histopathological effect at tissue level. For histopathological study, myxosporean infected kidneys of the carp species, *Labeo rohita*, and *Gibelion catla* were fixed in 10% formaldehyde solution and embedded in paraffin wax. Sections of 5μ thicked were cut and stained with hematoxylin and eosin. And then, myxosporean uninfected kidneys were also processed for the histological slides. All of these histological slides were examined under light microscope and photomicrographs were taken with digital camera attached to Meiji Biological Microscope (MT 4300H). In this study, the method was used in this studied according to the histological method of Cambell (cited by Kolmer *et al.*, 1969).

Data Analysis

The prevalence rates were calculated follow after Margolis *et al.* (1982):

$$\text{Prevalence}(\%) = \frac{\text{Number of infected fish}}{\text{Total number of fish}} \times 100$$

Source: Goolgle Earth, Geoeye 2015

Plate.1 Map of Ahlone Fish Culture Pond,

Results

A total of 30 fish specimens of each *Labeo rohita*, were examined for myxosporean parasites. The total of five species of myxosporean parasites; three species of *Myxobolus* and one species of *Thelohanellus* were found in the kidney of *Labeo rohita*. The three species of *Myxobolus* (*Myxobolus* sp. 1, *Myxobolus* sp. 2 and *Myxobolus* sp. 3) and one species of *Thelohanellus* sp. in *Labeo rohita* were observed.

Myxosporean parasites found in *Labeo rohita*

***Myxobolus* sp. 1 (Plate 2, A)**

The spore was sub-spherical to ovoid in front view, having two polar capsules was equal in size and tear shaped at the anterior end of the spores

Spore (10.17 ± 0.19 μm × 5.82 ± 0.24 μm)

Polar Capsule (3.75 μm × 2.5 μm)

***Myxobolus* sp. 2 (Plate 2, B)**

The shape of spore was nearly spherical in front view, and having two polar capsules, one was large ovoid or spherical-shaped and the other one was small and slightly long at the anterior end of the spore.

Spore (10.6 ± 0.54 μm × 8.75 ± 0.68 μm)

Large PC (5.0 μm × 3.7 μm)

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ZOL 033

Myxosporean infection in the kidney of *Labeo rohita* and *Gibelion catla* from Ahlone fish culture pond, Monywa Township, Sagaing Region

Khin Mar Lwin, Dr., Lecturer, Department of Zoology, Monywa University

Abstract

Myxosporean infection in the kidney of *Labeo rohita* and *Gibelion catla* from Ahlone fish culture pond, Monywa Township was studied from June 2016 to May 2017. The total of 30 *Labeo rohita* and 30 *Gibelion catla* were examined. Three species of *Myxobolus* and one species of *Thelohanellus* in *L. rohita* and two species of *Myxobolus* in *G. catla* were observed. These parasites were identified down to genus level, the two genera namely *Myxobolus* and *Thelohanellus*. These species differ in shape and dimension with each other depending on fish hosts. Histopathological study showed plasmodia with mature spores or developmental stages in the epithelial cells of renal tubules, in the blood corpuscle, and in the glomerulus of kidney. Histopathological changes were observed of atrophy and shrinkage of glomarulus, cluster of glomerulus, shrinkage of renal tubules, occlusion of lumen in the renal tubules, accumulation of inflammatory cells and necrotic in the kidney tubules. *L. rohita* showed to be infected by more diverse species of myxosporean parasites and appeared more susceptible than *G. catla*. The two carp species were commercial fishes in Monywa Township. Therefore, myxosporean parasites were important disease in culture fish species due to decrease fish production.

Keywords: myxosporean, Histopathology, kidney, *Labeo rohita*, *Gibelion catla*

Introduction

Fish has long been played an important part in man's economy, becoming increasingly important since world population have grown. Many large fishes are important human food and in some parts of the world, fish makes up a large part of the diet of people. Fish is also a rich source of lysine as well as other essential amino acid, vitamin A, essential fatty acids and calcium which are difficult to secure in non-fish products including many meat. In addition to their important as food for human, fish also provide an enjoyable sport and as is the keeping and caring of fish, often small fish species in home aquaria (FAO, 2010).

Myanmar is considered to have some of richest inland fisheries resources in the world. The utilization fisheries resources increase year by year to support the need for food in the local people. Inland capture fisheries provide a valuable contribution to food security in Myanmar (FAO, 1999).

In many lake and fish culture ponds, many species of fishes were cultivated by polyculture system. The most cultivated fish species are *Labeo rohita* (rohu), *Cirrhinus mrigala* (mrigal), *Gibelion catla* (bighead carp), *Ctenopharyngodon idellus* (grass carp), *Cyprinus carpio* (common carp), *Hypophthalmichthys molitrix* (silver carp), *Oreochromis* spp. (tilapia) and *Pangasius pangasius* (nga-dan). Among these fish species *Labeo rohita* and *Gibalion catla* were major cultivated and economically important species in Myanmar.

Labeo rohita is not only found in Myanmar but also common in rivers and freshwater lakes in and around South Asia and South-East Asia. It is the most popular food fish and flesh is delicious. It is relished very much in food and rich in protein content. Therefore, the production of *Labeo rohita* is very high and the price is very low than the other carp species in Myanmar.The distribution of *Gibelion catla* was fresh water rivers throughout India, down to the Krishna River, Pakistan (West Punjab and East Bengal), Myanmar and Nepal (Vishwendu Vida Prasarak Mandal's, 1990). Although the value of the fish is very high in the market, it like Myanmar people because it is fleshy and noted for its delicious.

Fish culture is a fast-developing branch of agriculture in the world. As natural stocks have declined, aquaculture has become increasingly important as a source of fishery products. The healthy populations of any species depend on the control of diseases. A large variety of fishes are vulnerable to various parasitic infections, out of which Myxozoa is emerging as a major group. Myxozoans are one of the economically important groups of microscopic Metazoan parasites as they infect fish hervested for food. New myxosporean pathogens are continually emerging and threatening the development of pisciculture all over the world (Kaur *et al.*, 2010). The protozoan parasite *Myxobolus* is often seen in the fingerlings causing morbidity and mortility in the carp polyculture system (Mukherjee *et al.*, 2000).

Presently, there are more than 2180 species in 62 genera of Myxosporean parasites belong to the phylum Myxozoa has been described from fish (Lom and Dykova, 2006). Among the Myxosporean parasites, the genus *Myxobolus* includes the highest number of species. There areb744 species belong to the genus *Myxobolus* and is the most common genus reported worldwide (Eiras *et al.*, 2005). Several myxosporean infections of cultured fish were reported to be pathogenic. Most notorious is the whirling disease of trout, manifected by skeletal deformites, which is also claimed to have been introduced with rainbow trout into South Africa (Van Wyk, 1968).

In fish, the kidney is the major site of blood production. Kidney disease is one of the most puzzling fish diseases. Several myxosporean species inhabiting the kidney and urinary tract have proved to be highly pathogenic in farmed fish. The kidney may be grossly swollen and straining against the capsule, giving a corrugated appearance. Various histopathological changes of myxosporean infected fish were described by some previous researchers. The principal pathological response is one of chronic inflammation which, in renal tissue, results in the marked proliferation of the interstitial haemopoietic tissue and a reduction in the number of glomeruli and excretory tubules. These elements

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Small PC (2.5 µm × 1.25 µm)

***Myxobolus* sp. 3 (Plate 2, C)**

The spore was pear-shaped in front view. The anterior end of the spore was pointed and the posterior end was rounded. There are equal sizes of two polar capsules.

Spore (7.5 ± 0.73 µm × 3.75 ± 0.31 µm)

PC (3.75 µm × 1.7 µm)

***Thelohanellus* sp. (Plate 2, D)**

The spore was teardrop-shaped in front view. At the anterior end of the spore has only one polar capsule.

Spore (12.8 ± 0.33 µm × 6.25 ± 0.42 µm)

PC (6.25 µm × 3.7 µm)

Table 1 Prevalence of myxosporean parasites in the kidney of *Labeo rohita*

No	Parasite	Examined fish	Infected fish	Prevalence (%)
2	*Myxobolus* sp. 1	30	6	20
3	*Myxobolus* sp. 2	30	5	16.67
4	*Myxobolus* sp. 3	30	2	6.67
5	*Thelohanellus* sp.	30	6	20

Table 2 Prevalence of myxosporean parasites in the kidney of *Gibelion catla*

No	Parasite	Examined fish	Infected fish	Prevalence (%)
1	*Myxobolus* sp. 1	30	3	10
2	*Myxobolus* sp. 2	30	2	6.67

Table 3 Total prevalence of myxosporean parasites from two carp species

No	Host	Examined fish	Infected fish	Prevalence (%)
1	*Labeo rohita*	30	16	53.33
2	*Gibelion catla*	30	4	13.33

Myxosporean parasites found in *Gibelion catla*

A total of 30 fish specimens of each *Gibelion catla* were examined for myxosporean parasites. The two species of *Myxobolus* (*Myxobolus* sp. 1, *Myxobolus* sp. 2) in *Gibelion catla* were observed.

***Myxobolus* sp. 1 (Plate 3, A)**

The spore was ovidal and tapering anterior end in front view. At the anterior end of the spore have two equal polar capsules. The polar capsules were teardrop-shaped, small notches project at the anterior end and reaches behind the middle length of the spore.

Spore (4.92 ± 0.76 µm × 3.69 ± 0.16 µm)

PC (1.85 µm × 1.54 µm)

***Myxobolus* sp. 2 (Plate 3, B)**

The spore was ovidal or ellipsoidal in front view. At the anterior end of the spore have unequal two polar capsules. The polar capsules were teardrop-shaped and reache anterior the middle length of the spore.

Spore (7.38 ± 0.81 µm × 4.92 ± 0.25 µm)

Large PC (3.69 µm × 2.46 µm)

Small PC (2.46 µm × 1.85 µm)

Histopathological effects in the kidney of *Labeo rohita* and *Gibelion catla*

In *Labeo rohita*, the kidney infected with myxosporean parasites showed that the renal tubules were shrinkage and lumen was occlusion (Plate 4 A). The glomerulus was shrunk into atrophy (Plate 4 B). The accumulation of inflammatory cell was observed among the renal tubules (Plate 4 C). In serious infected kidney, the large amount of mature myxosporean parasites was observed in the epithelial cells of renal tubules, in the blood corpuscle of kidney tissue and glomerulus (Plate 4 D to H). In *Gibelion catla*, the kidney tubules were Necrosis and distortion (Plate 6 A), the glomerulus were atrophy of and necrosis found around the glomerulus (Plate 6 B), the glomerulus were Fusion (Plate 6 C) and the lumen in the renal tubule were degeneration and closing (Plate 6 D).

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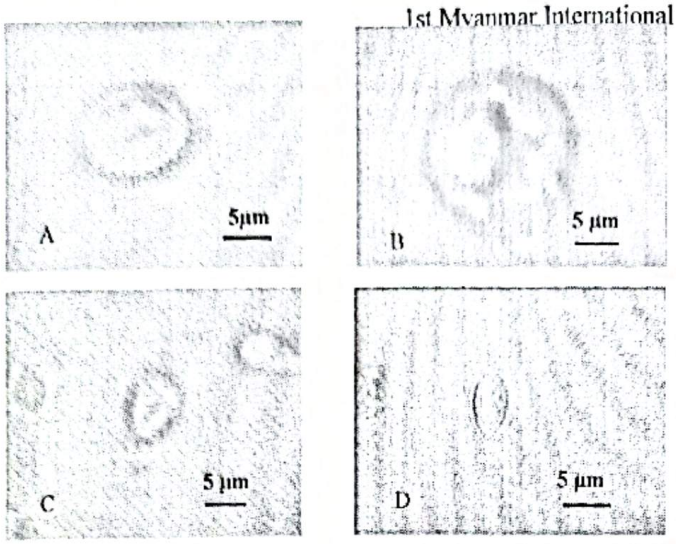


Plate 2 Myxosporean parasites found in the kidney of *Labeo rohita* (A. *Myxobolus* sp. 1, B. *Myxobolus* sp. 2, C. *Myxobolus* sp. 3, D. *Thelohanellus* sp.)

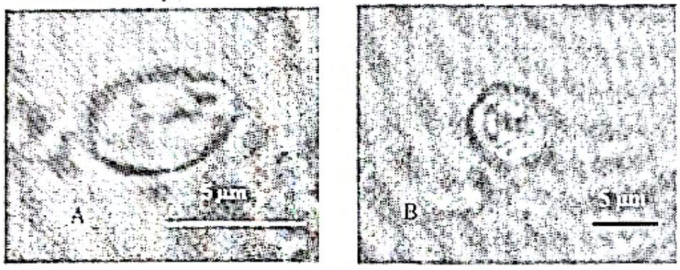
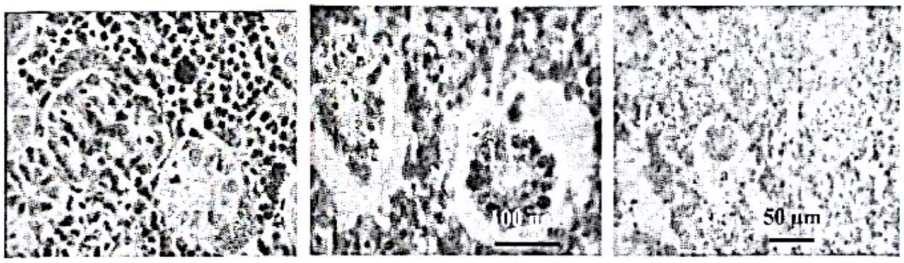


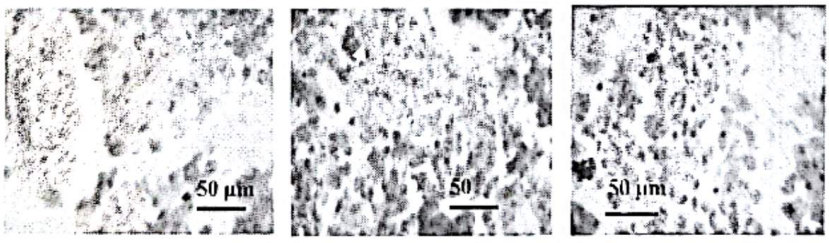
Plate 3 Myxosporean parasites found in the kidney of *Gibelion catla* (A. *Myxobolus* sp.1, B. *Myxobolus* sp.2)



Uninfected normal kidney

A. Infected renal tubules were shrinkaged, lumen in the renal tubule was occlusion

B. the glomerulus was shrinked into atrophy



F. mature myxosporean parasites filled in the kidney tissue librate the *Myxobolus* sp. in renal tubules (yellow arrow)

G. cluster of myxosporean parasites found in the glomerulus (arrow)

H. myxosporean parasites were found in the blood corpuscle of kidney tissue (red arrow)

Plate 4 Histopathological changes in the kidney of *Labeo rohita* by myxosporean parasites

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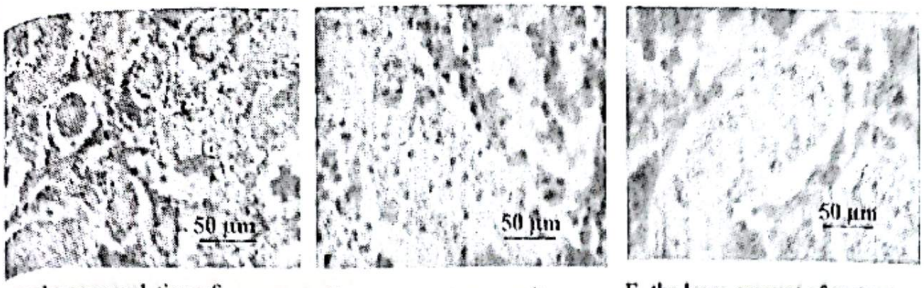
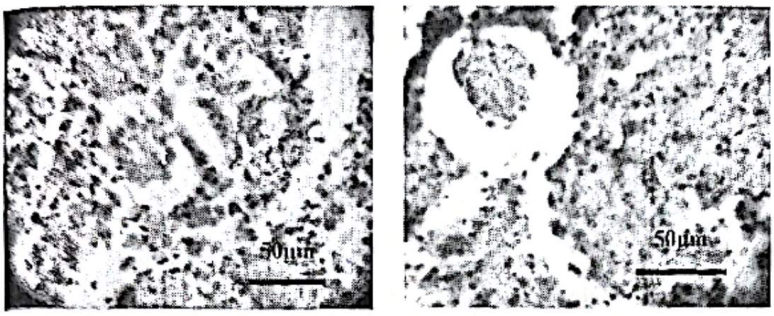


C. the accumulation of inflammatory cell was observed among the renal tubules

D. myxosporean parasites found in the longitudinal section of renal tubule (arrow)

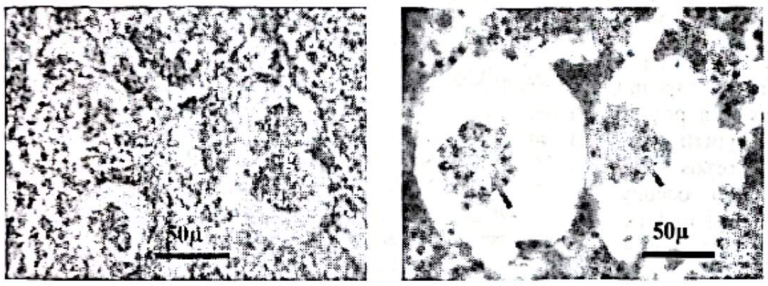
E. the large amount of mature myxosporean parasites were observed in the epithelial cells of renal tubules (arrow)

Plate 5 Histopathological changes in the kidney of *Labeo rohita* by myxosporean parasites



A. Necrosis and distortion of renal tubules
n. Necrosis
t. Renal tubule

B. Atrophy of glomerulus (red arrow) and necrosis around the glomerulus



C. Fusion of glomerulus
g. Glomerulus

D. Degeneration and closing of lumen in the renal tubule (red arrows)

Plate 6 Histopathological changes in the kidney of *Gibelion catla* by myxosporean parasites

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Discussion

The present study, six species of myxosporean parasites were found in the kidney of *Labeo rohita* and *Gibelion catla* at Ahlone Fish Culture Pond, Monywa Township. In the present study, *Myxobolus* sp. 1, *Myxobolu* sp. 2, *Myxobolu* sp. 3 and *Thelohanellus* sp. were found in the kidney of *Labeo rohita*. In the case of *Gibalion catla*, *Myxobolus* sp. 1 and *Myxobolus* sp. 2 were found.

Comparison of myxosporean parasites from polyculture carp species, *Labeo rohita*, and *Gibelion catla* were studied. Four species of myxosporean parasites found in the kidney of *Labeo rohita* and two species in *Gibelion catla* were observed. But the shapes and dimensions of spores were not similar between these species. The polyculture fish host, differences of the myxosporean parasites was observed in the present study.

Lom and Dykova (1992) stated that all functions of the kidney are fluid balance, waste excretion and blood cell production become inexorably compromised and the glomerulus is the main component of the renal corpuscle and it composed of blood capillary loops. The blood is selectively filtered as it flows through the glomerular capillaries.

Moe Kyi Han (2006) reported that the histopathological changes in the kidneys of *Labeo rohita* were early developmental stages of parasites, damages in glomerulus and renal tubules, developmental stages of myxosporean parasites were found in the lumen of renal tubules.

Moser and Kent (1994) revealed that affected myxosporean parasites, *Parvicapsule* sp. in Coho salmon are dark and lethargic and postmortem examination reveals renal hypertrophy and hemorrhage beneath the renal corpusles. Spores and other developmental stages occupy the epithelium and lumen of the renal tubules. The infection is associated with severe dilation and necrosis of the renal tubules.

In the present study, large necrotic lesions, spores and other developmental stages occupy the epithelium and lumina of the renal tubules were found in the kidney tissue of all infected fish hosts. In the histopathological study, serious infected kidney of *Labeo rohita*, the large amount of mature myxosporean parasites were observed in the epithelial cells of renal tubules, in the blood corpuscle of kidney tissue and glomerulus.

Bruno *et al.* (2006) described that myxosporidian infections can cause all categories of regressive and progressive pathological changes in the host including atrophy, dystrophy, hypertrophy, hyperplasia, necrosis and inflammation. Similarily most myxosporidian species cause minimal tissue damage, relatively few species are known to cause serious or fatal infections.

Desser *et al.* (1983) and Supamattaya *et al.*, 1991 also noted vacuolation of renal tubule epithelial cells in fish infected with myxosporean parasites, *Sphaerospora angulata* and *S. epinepheli* respectively. Pathological changes similar to severe cases, led to nephrosis and necrosis of the tubular epithelium. In the present study, large necrotic lesions, spores and other developmental stages occupy the epithelium and lumina of the renal tubules were found in the kidney tissue of all infected fish hosts.

Kent (2002) stated that parasites also infect blood vessels, where they adhere to vessel walls, occlude vessels, and evoke a necrotizing vasculitis.

In the present study, histopathological changes in the kidneys of *Labeo rohita* were observed as deformities; dilation of glomerulus, shrinkage of collecting duct, degeneration of lumen in the renal tubules, hypertrophy and hyperplasia of glomerular cells, swelling of glomerular epithelial cells and *Myxobolus* sp. was found in the blood corpuscles. In the kidney of *Gibelion catla*, the histopathological changes of necrosis and distortion of renal tubules, atrophy of glomerulus and necrosis around the glomerulus, fusion of glomerulus and degeneration and closing of lumen in the renal tubules were observed. The myxosporean infected kidneys of *Labeo rohita* distortion was more occurred and the parasite spores were more incident than *Gibelion catla*.

Conclusion

The studied fish species of *Labeo rohita* and *Gibelion catla* are culture species and economic importance. The enhancements of fish production are depended on healthily growth fish; there is need for adequate knowledge of parasites that infect them. The fish parasites and diseases are the most important problem due to decrease fish production and death. The myxosporean parasites are one of the most important in fish. These parasites were incident in all parts of the body of fish host.

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ZOL 034

Occurrence of Spider Species in the Environs of Inhkaibum, Kachin State

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Abstract

Inhkaibum located on the Northern East of Ayeyarwady River was chosen as the collection site to record and identify the spider fauna based on the morphological characteristics. The duration of study period was taken from February 2018 to January 2019. A total of 35 species distributed among 25 genera, 14 families and one order were recorded during the study period. Seven habitat types such as building, bushes, grasses, ground, shrubs, trees and near water were categorized based on the places from which the spiders countered.
Keywords: Inhkaibum national park, habitat types, spider species

Introduction

Spiders have often been confused with insects, but in truth they belong to the class Arachnida, with major differences being that spiders have two body divisions and eight legs and insects have three body divisions and six legs. Orders within the arachnids include daddy longlegs, scorpions, mites and ticks. Spiders are members of the phylum Arthropoda, the large group of animals with jointed legs and a hard-external body shell, the exoskeleton. The Arthropoda is the dominant phylum of the Invertebrates. Phylum Arthropoda includes five classes: Class Crustacea (Crabs, prawn, lobster etc); Class Insecta (insects); and Class Arachnida (Spiders and other Arachnids). The class includes smaller groups such as the following: order Scorpionida (Scorpions); order Phalangida (Harvestmen); order Achrina (mites and ticks) and order Araneida (spiders) (Koh, 1989).

A spider's body consists of two main parts: an anterior portion, the prosoma or cephalothorax, and a posterior part, the opisthosoma or abdomen. These are connected by a narrow stalk, the pedicle. The prosoma covered by a dorsal and a ventral plate, the carapace and the sternum, respectively. Its serves as the place of attachment for six pairs of extremities: one pair of biting chelicerae and one pair of leg like pedipalps are situated in front of four pairs of walking legs. Each leg has seven segments: coxa, trochanter, femur, patella, tibia, metatarsus and tarsus. The second pair of appendages are the pedipalps or palps. Their segmentation corresponds to that of the legs, except that one segment, the metatarsus, is lacking. Despite their general resemblance to legs, the palps are usually not used for locomotion. In mature male spiders the pedipalps are modified into copulatory organs a quite extraordinary feature, not found in any other arthropod. In the adult male, the terminal segment of palp is usually swollen and easy to distinguish male and female at sight. The coxae of pedipalps represent another specialization, for these have been transformed into chewing mouth parts (maxillae or endites). The maxillae are only slightly modified.

The head parts of the prosoma bear the eyes and the chelicerae. Most spiders have eight eyes, which are arranged in specific patterns in the various families. Usually the eyes lie in two rows (sometimes in three), and according: they are referred to as anterior lateral eyes (ALE), anterior median eyes (AME), posterior lateral eyes (PLE), posterior median eyes (PME). The number position, relative size, and internal structure of the eyes are very important characters for classifying spider families. For example, all jumping spider (Salticidae) possess one row of large frontal eyes, with the AME being the largest; wolf spiders have four uniformly small frontal eyes, but rather large PLE and PME. The area between the anterior row of eyes and the edge of the carapace is called clypeus. Some spiders have fewer than the usual eight eyes. The so-called six-eyed spiders (Dysderidae), the spitting spiders (Scytodidae), dwelling spiders have lost their eyes altogether (Bristowe, 1958).

The chelicerae are the first appendages of the prosoma. Each chelicera consists of two parts; a stout basal part and a movable articulated fang. When the spider bites, the fangs move out of their groove and penetrate the prey. Simultaneously, poison I is injected through a tiny opening at tip of fang. The number and size of the chelicerae teeth are important diagnostic characteristics for the taxonomist.Spiders are abundant and found everywhere; occurring inside and outside of human habitats, wall of building, at neglected corners of houses, in gardens, dried leaves on tree, under bark, under stones, under fallen logs, vegetation and grassland.

Spiders hardly play a major role in the control of insect pest. All spiders are predators and eat only live food. The food of spiders includes a variety of insects such as butterflies, flies, moths, dragonflies, grasshoppers, myriapods, false-scopions and other Arachnids. A hungry spider is liable to accept on insect that it will reject when fully fed, there by indicating that its distaste is relative and not absolute. At least some species avoid earwigs, stoneflies, caddis flies, moths, beetles, bugs and ant (Cloudsley- Thompson, 1958).

Spiders belong to the actively poisonous animals. All spiders except for the family Uloboridae possess a pair of poison glands located in the prosoma. Hunting spiders which are known to kill their vertebrate prey with their poison are obviously potentially dangerous to humans. However, it is unlikely that the large orb-weavers are very poisonous. The prime example is certainly the black widow spider, *Latrodectus mactans*, from the family Theridiidae. The typical symptom is a contorted facial expression which refers to a flushed, sweat covered face, swollen eyelids, inflamed lip and contracted masseter muscles. However, some tropical lycosid spider may well be dangerous. Another well-known spider whose bite is much feared is the American brown recluse *Loxosceles recluse (*Foelx, 1996).

Spiders are dioecious, that is, they invariably have separate sexes. Sexual dimorphism is especially obvious in many tropical orb weavers (e.g *Nephila* where the males appear to be dwarf).

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Growth of a spider requires shedding its exoskeleton, usually 4 to 12 times before maturity. After their last molt the males have conspicuously thickened palpal tarsi and can be distinguished easily from the females. The common belief that spider males are eaten by the females, during or after copulation is only for a very few species. Females usually live much longer, since they must still lay eggs and build cocoons. Most spiders live one to two seasons. Some primitive spiders may live 5 to 10 years.

Different species are adapted in different areas such as air, land, soil and water. Some are wonders throughout their lives, their lives, others are almost entirely sedentary, some are in sunny, air places, others found in obscure caverns. Majority of the spiders are arboreal and moisture loving. Although many species prefer in wet or moist places, a few species have adapted to relatively dry habitats or at least habitat in which seasonal drought occurs. Spiders are very easy to find except Antarctica region. They are usually several in outside of house, especially in any rooms that are not often used and in the shed or garage, at neglected corners of houses, on tree trunks, stilted buildings, on the edges of streams and ponds. Many hides in a folded leaf, whereas others live inconspicuously in the webs of larger spiders. A few waits in ambush of their prey on flower petals. Most spiders live in strictly defined environment. The limitations are set by physical conditions, such as temperature, humidity, wind and light intensity and also by biological factors (Main 1976).

Spiders are abundant, diverse, and with over 34000 recognized species, comprise amongst the largest portions of invertebrate fauna in any habitat (Coddington and Levi, 1991). Spiders are distributed all over the world and conquered all ecological environment. The distribution and population density of spiders in their habitat are therefore not accidental but are functions of a whole range of regarded factors with a given biotope. In the world, taxonomists recognize about 397525 spider species which they group into approximately 111 families (Plantick, 2008). In Myanmar, 523 species are found under 180 genera of 47 families (Ubick, 2000).

Taxonomic classification of the spiders of Myanmar still needs further confirmation by local researchers. It is mainly for this reason; the present work was undusted. The present research intended to record the spiders, since, high diversity of spiders is expected to occur in Myanmar especially in the northern part with different habitat types.

Inkhibum area is designated as the "Inkhibum National Park" and lies adjacent to Aung Mye Thar Ideal Village and therefore is readily accessible, so that it is chosen as the study site for the present study. The objectives of the present study were:

- to identify and record the spider species in the environs of Inkhibum
- to assess the respective habitats types of spiders recorded

Materials and Methods

Study area and study site

The collection of the spider specimens was made from the environs of Inhkaibum in Kachin State. The area of the Inhkaibum is 74260 areas. It is situated between Latitude 25° 39′ 1.14″N to 25° 41′ 21.80″ N and Longitude 97° 27′ 32.38″E to 97° 29′ 35.42″E. Several habitats such as building, bushes, grasses, ground, shrubs, trees and near water were involved in search of the species diversity (Plate I).

Study period

The specimen collections were carried out from February 2018 to January 2019.

Collection method of the spider specimens

Field surveys were conducted at every month starting from February 2018 to January 2019.Since the study area chosen is a hilly place, point count method is not feasible so that spiders were searched at random in the prospective places as indicated by the guides. In most places there were no paths to follow so that, vegetation has to cut to pore paths in search for the spiders. All together 15 sites were allocated for the study.

Specimens were collected by four different ways such as hand collecting, beating, sweeping. Some species were collected through hand collecting. Inactive spiders were caught with gloved hands. Logs and standing stumps are torn open with a large knife. A knife with a long and broad blade is thrust into the burrow and prevents the spider from escaping deep into the burrow. Manual collecting was used to collect spiders, which were found visible on the ground or in web and free-living spiders on the plants and branches of shrubs and tree trunks. Barks were removed and manually collected from trees. Spiders running along the ground were chased after and let into wide mouth glass bottles.

Beating method was used for catching the spiders hidden among the shrubs, bushes and branches of the tree. Their hidden places were beaten with the stick to make the spiders come out of the hidden areas and dropped into a rectangular piece of cloth or unfolded umbrella, inverted beneath the bush or limb. Sweeping method using a broom was practiced for improcuring spiders from vegetation that is too low or too soft for beating. The sweep net, an insect net attached to a slender bamboo pole was also used.

Habitation of spiders

Habitat of spiders were classified based on the places where spiders were encountered and collected.

Preparation and preservation of spider

Fresh specimens of spiders were photographed soon after collection. When spiders die, they soon contract, shrivel and lose their color and other characters, so that they were carefully placed in insect bottles of sufficient size one in each. The collected spiders were then put into wide mouthed bottles containing 50 percent ethyl alcohol for one or two days. Then the specimens were transferred into another bottle containing 75 percent ethyl alcohol for preservation. Specimens were labeled with date, locality, habitat, methods, collector's information and comments.

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Identification

Specimens were identified by using spider keys and literature (Levi and Levi (1990), Levi *et al.* (2002), Pocock (1900), Barrion *et. al.*, (2009), Ubick (2000), Ubick *et al.* (2005), Koh (2001), World Spider Catalog (Version 19.0) and Metzner (2014). Illustrations provided by Dean (2001-2005). of various body parts. Spider length refers to body length measured from the chelicerae to the tip of visible spinnerets.

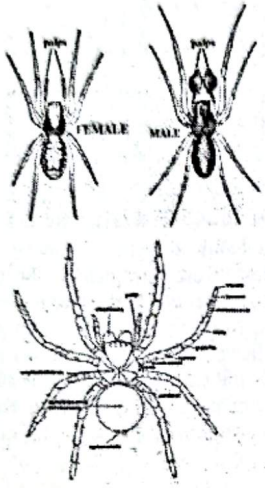

Fig. 1 External features of a spider

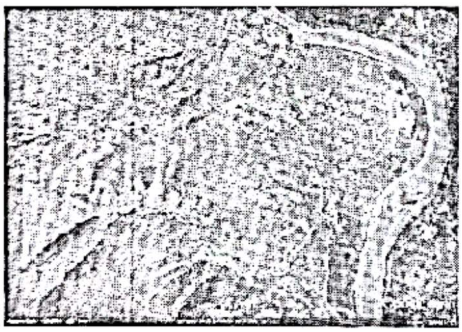

Plate. 1 A. Map of study area (Inkhibum National Park, Kachin State

Plate. 1 B. Study points in study area (Source: Google Earth)

Results

Systematic position

A total of 25 genera which comprise 35 species belonging to 14 families under order Araneae were recorded in the present study. Systematic position of collected spiders was based on Ubick (2000), Ubick *et al.* (2005), Koh (2001), World Spider Catalog (Version 19.0) and Metzner (2014) (Table 1).

Habitat types

During the study, seven habitat types namely (building, bushes, grasses, ground, shrubs, trees and near water) were categorized based on the substrates on spiders were encountered. It was revealed that, 26 species of spiders were recorded among the bushes, followed by 17 species on the trees, and 16 species on the ground, 14 species among shrubs, 13 species in the buildings, ten species in grasses and seven species near water habitat.

Moreover, it was revealed that, among the 35 species of spiders recorded, 14 species were encountered on three habitat types from among the seven categorized habitats; ten species were found using four habitat types. Similarly, ten species were encountered on two types of habitat. Only a single species *Hippasa holmerae* was specific to the ground. (Table 2).

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Table 1 List of spider species recorded in Inhkaibum

Family	Sr. No.	Scientific Name	Common Name
Agelenidae	1.	*Agelenopsis naevia* Walckenaer, 1842	funnel web spider
Araneidae	2.	*Argiope bruennichi* (Scopoli, 1772)	Orb-web spider
	3.	*Argiope catenulata*	
	4.	*Argiope pulchella* Thorell, 1881	Argiope: St Andrew's cross spider
	5.	*Argiope versicolor* (Doleschall) 1859	Multi-Coloured St. Andrew's cross spider
	6.	*Cyclosa insulana* Costa, 1834	Cyclosa spider
	7.	*Cyclosa* sp.	Cyclosa spider
	8.	*Gasteracantha cancriformis* (Linnaeus, 1758)	Spiny backed orbweaver
	9.	*Gasteracantha doriae* Simon, 1877	Doria's spiny spider
	10.	*Gasteracantha hasseltii* C.L Koch, 1837	Hasselt's spiny spider
	11.	*Gasteracantha kuhli* C.L.Koch 1837	black-and-white spiny spider
	12.	*Nesocona nautica* (C.L.Koch, 1875)	Brown sailor spider
	13.	*Parawixia dehaani* (Doleschall, 1859)	Common garden spider
Ctenidae	14.	*Anahita* sp.	White- striped wandering spider
Lycosidae	15.	*Alopecosa* sp.	
	16.	*Hippasa holmerae* Thorell 1895	Bright-green lynx spider
	17.	*Pardosa pseudoannulata* (Boesenberg & Strand) 1906	Pond wolf spider
Nephilidae	18.	*Nephilia maculata* (Fabricius, 1793)	Giant golden orb weaver
Oxyopidae	19.	*Oxyopes birmanicus* Thorell, 1887	Burmese lynx spider
	20.	*Oxypes salticus* (Hentz, 1845)	Common lynx spider
	21.	*Peucetia viridans*	Green-lynx Spider
Pholcidae	22.	*Crossopriza lyoni* (Blackwall, 1867)	Daddy-long-leg spider
Pisauridae	23.	*Eurychoera quadrimaculata* Thorell 1897	Four-spotted nursery spider
Salticidae	24.	*Harmochirus* brachiatus (Thorell) 1877	
	25.	*Plexippus paykulli* (Savingny and Audouin), 1825	Larger housefly catcher
	26.	*Plexippus petersi* (Karsch, 1878)	Common housefly catcher
	27.	*Phintella versicolor* C.L. Koch, 1846	
	28.	*Hasarius adansoni*	Adanson's house jumper
Sparassidae	29.	*Heteropoda venatoria* Linnaeus, 1767	Domestic huntsman spider
Tetragnathidae	30.	*Leucauge* sp.	
	31.	*Tylorida ventralis* (Thoreoo) 1877	Big-bellied tylorida
Theraphosidae	32.	*Phologiellus* sp.	
	33.	*Phologiellus* sp.	
Thomisidae	34.	*Thomisus stoliczka* (Thorell) 1887	Stoliczka's crab spider
Uloboridae	35.	*Zosis geniculatus* (Oliver, 1789)	Grey house spider

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Table 2 Spider species recorded in different habitats

No.	Family	Scientific name	Habitat types							
			Building	Bushes	Grasses	Ground	Shrubs	Trees	Near water	Total
1	Agelenidae	*Agelenopsis naevia*	-	+	-	+	+	+	-	4
2	Araneidae	*Argiope bruennichi*	-	+	+	-	+	-	+	4
		Argiope catenulata	-	+	-	-	-	+	-	2
		Argiope pulchella	+	-	-	-	-	+	-	2
		Argiope versicolor	+	-	-	-	-	+	-	2
		Cyclosa insulana	-	+	-	-	+	+	-	3
		Cyclosa sp.	-	+	-	-	+	+	-	3
		Gasteracantha cancriformis	-	+	-	-	+	+	-	3
		Gasteracantha doriae	-	+	-	-	+	+	-	3
		Gasteracantha hasseltii	-	+	-	-	+	+	-	3
		Gasteracantha kuhli	-	+	-	-	+	+	-	3
		Nesocona nautica	+	+	-	-	-	+	-	3
		Paravixia dehaani	+	+	-	-	-	+	-	3
3	Ctenidae	*Anahita* sp.	-	+	+	+	+	-	-	4
4	Lycosidae	*Alopecosa* sp.	-	+	-	+	+	-	+	4
		Hippasa holmerae	-	-	-	+	-	-	-	1
		Pardosa pseudoannulata	-	+	+	+	-	-	-	3
5	Nephilidae	*Nephilia maculata*	+	+	-	-	-	+	-	3
6	Oxyopidae	*Oxyopes birmanicus*	-	+	+	-	+	-	+	4
		Oxypes salticus	-	+	+	-	+	-	+	4
		Peucetia viridans	-	+	+	+	-	-	-	3
7	Pholcidae	*Crossopriza lyoni*	+	+	-	-	-	-	-	2
8	Pisauridae	*Eurychoera quadrimaculata*	-	+	-	+	-	-	+	3
9	Salticidae	*Harmochirus* brachiatus	-	+	+	+	-	-	+	4
		Plexippus paykulli	+	-	+	+	-	+	-	4
		Plexippus petersi	+	-	+	+	-	+	-	4
		Phintella versicolor	+	+	-	+	-	+	-	4
		Hasarius adansoni	+	+	-	+	-	-	-	3
10.	Sparassidae	*Heteropoda venatoria*	+	-	-	+	-	+	-	3
11.	Tetragnathidae	*Leucauge* sp.	-	+	-	-	+	-	-	2
		Tylorida ventralis	-	+	-	-	+	-	-	2
12.	Theraphosidae	*Phologiellus* sp.	+	-	-	+	-	-	-	2
		Phologiellus sp.	-	-	-	+	-	-	+	2
13.	Thomisidae	*Thomisus stoliczka*	-	-	+	+	-	-	-	2
14	Uloboridae	*Zosis geniculatus*	+	+	-	-	-	-	-	2
		Total	13	26	10	16	14	17	7	103

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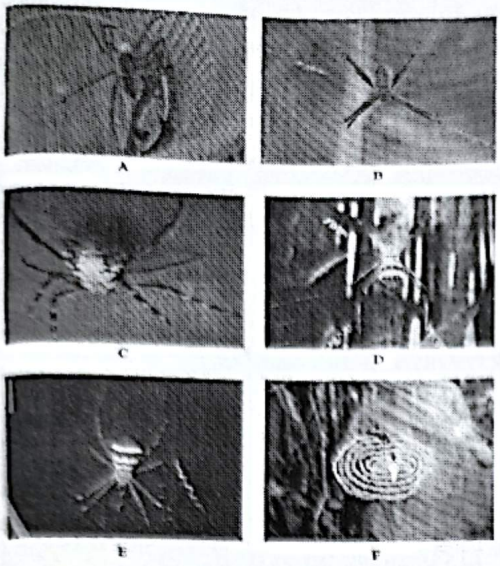

Plate 2 Spider species recorded under families of Agelenidae and Araneidae

Family Agelenidae
- A. *Agelenopsis naevia* (Female),

Family Araneidae
- B. *Argiope bruennichi* (Female)
- C. *Argiope catenulata* (Female)
- D. *Argiope pulchella*
- E. *Argiope versicolor*
- F. *Cyclosa insulana*

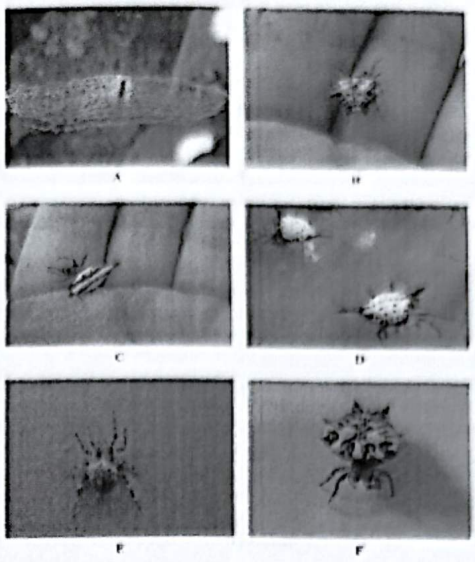

Plate 3 Spider species recorded under family of Araneidae

Family Araneidae
- A. *Cyclosa* sp.
- B. *Gasteracantha cancriformis*
- C. *Gasteracantha doriae* (Female)
- D. *Gasteracantha hasseltii* (Female)
- E. *Nesocona nautica* (Female)
- F. *Gasteracantha kuhli* (Female)

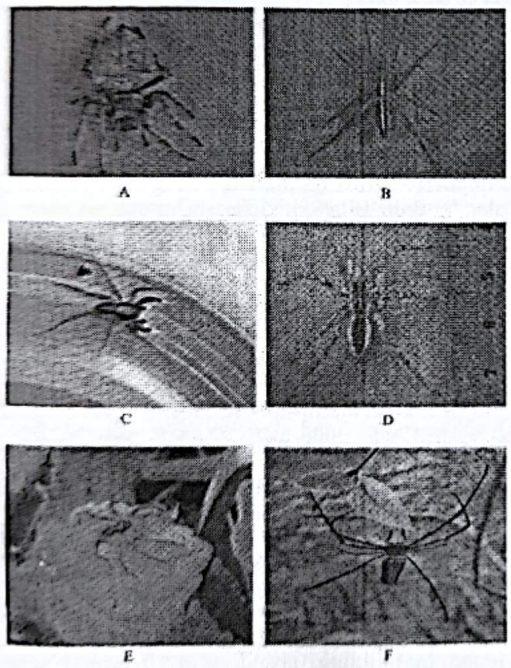

Plate 4 Spider species recorded under families of Araneidae, Ctenidae, Lycosidae and Nephilidae

Family Araneidae
- A. *Parawixia dehaani* (Female)

Family Ctenidae
- B. *Anahita sp.* (Female)

Family Lycosidae
- C. *Alopecosa sp.* (Male)
- D. *Hippasa holmerae* (Male)
- E. *Pardosa pseudoannulata* (Female)

Family Nephilidae
- F. *Nephilia maculata* (Female)

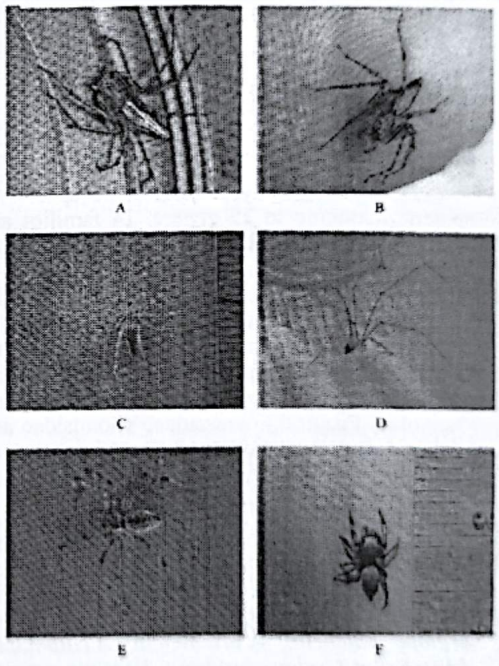

Plate 5 Spider species recorded under families of Oxyopidae, Pholcidae, Pisauridae and Salticidae

Family Oxyopidae
- A. *Oxyopes birmanicus* (Female)
- B. *Oxyopes salticus* (Female)
- C. *Peucetia viridans* (Female)

Family Pholcidae
- D. *Crossopriza lyoni*

Family Pisauridae
- E. *Eurychoera quadrimaculata*

Family Salticidae
- F. *Harmochirus brachiatus* (Male)

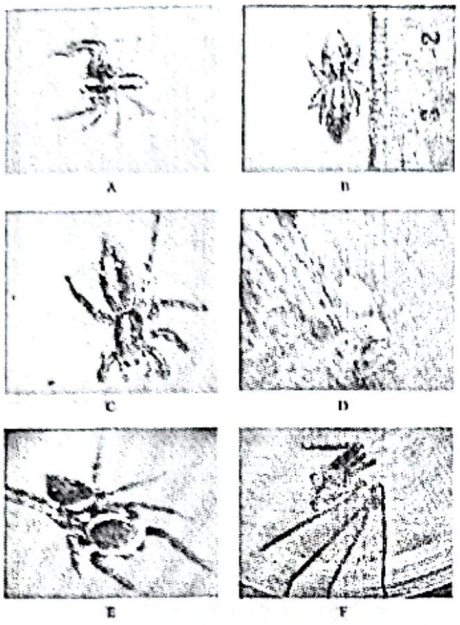

Plate 6 Recorded spider species of Families of Salticidae and Sparassidae

Family Salticidae
A. *Plexippus paykulli* (Male)
B. *Plexippus paykulli* (Female)
C. *Plexippus petersi* (Female)
D. *Phintella versicolor* (Male)
E. *Hasarius adansonic* (Male)
Family Sparassidae
F. *Heteropoda venatoria* (Female)

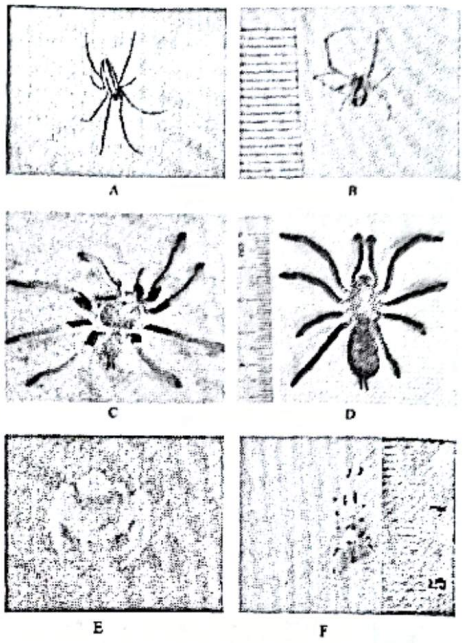

Plate 7 Spider species recorded under families of Tetragnathidae, Theraphosidae, Thomisidae and Uloboridae

Family Tetragnathidae
A. *Leucauge* sp.
B. *Tylorida ventralis*
Family Theraphosidae
C *Phlogiellus* sp.
D. *Phlogiellus* sp.
Family Thomisidae
E. *Thomisus stoliczka*
Family Uloboridae
F. *Zosis geniculatus*

Discussion

During the study, a total of 35 species of spiders belonging to 25 genera, 14 families and one order were recorded in Inhkaine Bum, Kachin State. Species composition was the highest in family Araneidae (12 species), followed by family Salticidae (5 species), the family Lycosidae (3species), the families of Tetragnathidae and Theraphosidae (2 species) and the families Agelenidae, Ctenidae, Nephilia, Nephilidae, Pholcidae, Pisaurid,Sparassidae, Thomisidae and Uloboridae (one species each). Thus, it is assumed that members of the family Araneidae are common in the study area.

Koh (2001) recorded 43 species from Myanmar (Burma) in "A guide to common spiders in Singapore". A total of 23 species are the same to those recorded by Koh (2001). However, *Argiope pulchella, A.bruennichi, A.catanulata, A.versicolor Cyclosa insulana, Nescona nautica, Gasteracantha cancriformis, G.doriae, G. hasseltii, G.kuhlic* and *Parawixia dehaani* encountered during the present study was not included in the recorded of Koh (1989).

In family Araneidae, eyes are usually eight in number and arranged in two rows. Median eyes are close together. Female spider of *A. pulchella* can be easily recognized by x-shaped zig-zag band of white silk in the center of web.

In family Pholcidae, the eyes are also eight in number and with three claws on the tarsus. The chelicerae and fangs are weak. Legs are very long slender. In family Salticidae, the eyes are arranged in three rows. The anterior unequal in size, the anterior median enormously large directing forwards. Their distinctive eyes can all play a part in capture of prey but it is known that their functions and powers of vision vary considerably.

In family Sparassidae, there are dark marking on their abdomen and with conspicuous black spots and rings on their legs. Representatives of the family Uloboridae, possess a cribellum and calamistrum. These found to be absent in the remaining recorded families. Only one species, *Heteropoda venatoria* was recorded under family Sparassidae. It was nocturnal and found on the bark of tree and inside house. Only one species, *Zosis geniculastus* was recorded under family Uloboridae. This species mostly found in building, abandonaed shed and store room.

The habitats of spider fauna were categorized into seven habitat types; building, bushes, grasses, ground, shrubs, trees and near water. Seven species in building, eight species in bushes, four species in grasses, six species in ground, seven species in shrubs, nine species in trees and seven species were not found in near water. The spiders were found to have preference tree habitat followed by bushes. These supported the various types of microhabitat for different

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species spiders as the substrate provided ample places to ambush insect prey and easy access to build webs to trap their prey.

In the present study, *Nephilia* species are found among tree branches, on the shrubs *Nephila kuhlii* was usually found between the tall trees. Koh (2001) reported that *Nephila's* web is found in primary and secondary forests, waste-land and gardens.

The colouration of spider was also found in relation to the diurnal and nocturnal habitats. In diurnal species of *Nephila spp., Argiope spp.*, was bright in colour, whereas nocturnal species, *Heteropoda venatoris, Parawixia dehani* was dull in colour. Than sein (1977) said that the nocturnal species are dull or black in colour but brightly coloured in the diurnal species. Thus, the finding of the present study is in agreement with those of Than Sein (1977).

Koh (2001) reported that, species of Genus *Crossopriza* under family Pholcidae were found overhanging at the dusty and dark and dark corner of the house. Similar phenomenon was also encountered during the present study.

On the whole, the 35 species of spiders recorded during the study, revealed that 26 species were encountered among the bushes, so that it is assumed that, most of the species prefer the bushes as their habitat, followed by those (17 species) that appeared to have a preference to the trees and 14 species among the shrubs. It is allowed that these places offer better chance of trapping prey as most of the insect fly and come to alight in these places. Those inhabiting the buildings have the chance on both diurnal and nocturnal insects which are attract by light in the building. Moreover, most of the species were found in at least two habitat types however only a single species *Hippasa holmerae,* was encountered specifically on the ground and assumed specific to the ground substrate.

As 35 species of spiders were identified and recorded within a single year study period, there is a hope that there will be more to be recorded and some might still be awaiting to be discovered.

Conclusion

A total of 35 species of spiders belonging to 25 genera, 14 families and one order were recorded in Inhkaibum, Kachin State. During this study, 26 species of spiders were recorded among the bushes, followed by 17 species on the trees, and 16 species on the ground, 14 species among shrubs, 13 species in the buildings, ten species in grasses and seven species near water habitat.

Acknowledgements

Firstly, I gratefully acknowledge the support of the Global Environment Facility (gef) and HELMSLEY.I would like to express my profound gratitude to Professor Dr. Thant Zin, Head of Zoology Department, University of Mandalay, for his constant encouragements, invaluable guidance, criticism, supervision and allowing me to conduct this research. I am also thankful to my field companion for helping me in collecting data in the field and showing pathways to prospective sites. I would like to thank U Hla Naing (Researcher) who is working at WCS. He gives me a lot of advice and chance how to prepare this research. Finally, I am very thankful to my sweet mother, Daw Mu Mu Htun who continually prayed for my safely and the opportunity given to pursue my education further.

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ZOL 035

Assessment on Occurrence of Fish Species in Chibwe Township, Kachin State

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Abstract

The study was aimed to assess the occurrence of fish species in Chibwe Township, Kachin State. The survey was conducted at May Hka River, Chibwe and Yitlaw streams in Chibwe Township from May to November 2016. A total of 46 species belonging to 32 genera, under 13 families and six orders have been recorded. Among the recorded fish species, eight species: *Neolissochilus* sp.*Crossocheilus* sp., *Varicorhinus* sp.*Semiplotus* sp., *Tor* sp., *Psilorhynchus* sp., *Garra* sp. and *Glyptothorax* sp. could be identified down to the genus level. *Schizothoraxplagiostomus, Banganadevdevi* and *Neolissochilushexagonlepis* were found to be the most abundant and predominant.*Glyptothorax*sp. was observed very poor in number. According to questionnaires, soil erosion and riverine habitat degradation are now facing due to forest fragmentation by commercial logging, digging of sand used for construction, dam construction, gold panning with dredgerand activities of shifting cultivation along the river. These factors may leading to major threats to decrease number of fish species inhabiting in the river. Thus, there is need an awareness of locals to conserve the habitats of fauna in the study area.

Keywords: Fish species, May Hka River, soil erosion, riverine habitat degradation.

Introduction

Worldwide, human impact has destroyed fish habitat on a wide scale and many populations of rare species have disappeared over the last two centuries. In addition, numerous distinct stocks of common species and a number of important fish communities have become extinct (Maitland, 1986).Fish occupy a significant position. Natural communities are mixture of species. A variety of human activities have caused negative changes in the aquatic community structure. Because fish live underwater, they are more difficult to study than terrestrial animals and plants, and information about fish populations is often unavailable. However, freshwater fish seem particularly threatened because they often live in relatively small water bodies (Wikipedia, 2011). Fish are an important resource for humans worldwide, especially as food. In addition, the second most important element in the diet, after rice, is fish, either fresh fish or preserved fish. Fish is consumed fresh and in various processed forms, fermented fish being a staple part of the daily diet of most people (AungHtayOo, 2012).

Kachin State is known as a "hotspot for biological diversity". The conservation of its natural resources, which cannot be valued in monetary terms, is of international importance. The logging and gold mining has already caused incalculable loss of biodiversity in the riverine and forest ecosystems. Gold mining is taking place in the headwaters of the Irrawaddy, the lifeline of the country and one of the greatest Asian rivers. It threatens the ecosystem of the entire river basin and along with it the livelihoods of about 20 million people (cited by PKDS, 2004).

Chibwearea is located at the hill site including mountain ranges, various valleys, streams and little plain. Thishill siteis on the mountain range at the attitude of 270 m above sea level and 94 miles far away from Myitkyina. May Hka River (N'MaiHka)one of the tributary of Ayeyarwaddy River, is passing through this area in the west of Chibwe. Chibwe River flows into the May Hka River from the south of it.Chibwe is bounded by the area such as at the west of Panwah, at the east ofIngyanyan, at the north ofWaimaw and at the south ofSaulou. Actually, May Hka River is formed by the tributary streams,

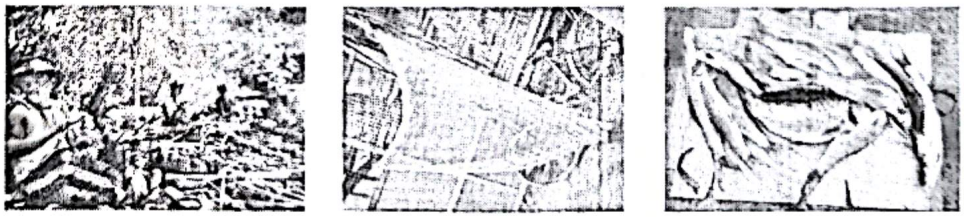

Plate 2 Preparing and trimming bamboo, a drift net and piles of caught fish

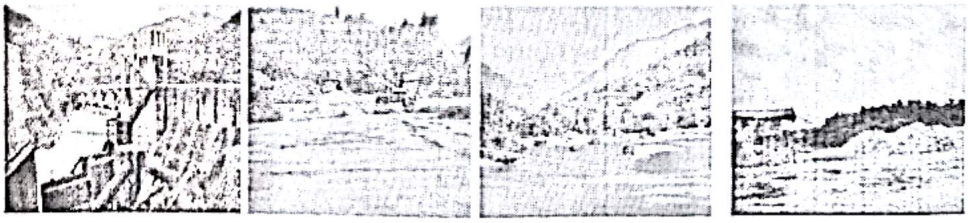

Plate 3 Chibwe dam, digging sand and gold panning with dredger

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Table 1 Recorded fish species from the study sites

Sr. No.	Order	Family	Genus	Species	Local name	Common name
1.	Anguilliformes	Anguillidae	*Anguilla* Garsault, 1764	*A. bengalensis*(Gray, 1831)	Nga long moi	Indian mottled eel
2.	Cypriniformes	Cyprinidae	*Banganal*Hamilton, 1822	*B. devdevi*(Hora, 1936)	Nga le	Malihkalabeo
			Neolissochilus Rainboth, 1985	*N. hexagonolepis* (McClelland, 1839)	Ngasuk	Copper mahseer /Katli
				*Neolissochilus*sp.	Ngasuknae	
			*Crossocheilus*Kuhl & van Hasselt, 1823	*C. latius*(Hamilton, 1822)	Daw lam	Gangeticlatia / Stone roller
				*C. burmanicus*Hora, 1936	Daw lam	Burmese latia
				*Crossocheilus*sp.	Daw lam	
			*Varicorhinus*Ruppel l, 1835	*Varicorhinus*sp.	Daw lam	
			Tor Gray, 1833	*T. mosal*(Hamilton, 1822)	Khyawngha	Mosalmahseer
				Tor sp.		
			*Pethia*Pethiagoda, Meegaskumbura&Maduwage, 2012	*P. tiantian*(Kullander & Fang, 2005)	Ngakyi	Bumblebee barb
			*Systomus*McClellan d, 1839	*S. sarana*(Hamilton, 1822)	Ngakyi	Olive barb

Sr. No.	Order	Family	Genus	Species	Local name	Common name
			*Schizothorax*Heckel, 1838	*S. plagiostomus*Heckel, 1838	Ngayit	Snow trout
			*Semiplotus*Bleeker, 1859	*Semiplotus*sp.	Ngazum	King fish
			*Bartlius*Hamilton, 1822	*B. barna*(Hamilton, 1822)	Shawarat	Barnabaril
				*B. bendelisis*Hamilton, 1807	Shawarat	Hanmilton'sbarila
				*B. barnoides*Vinciguerra, 1890	Shawarat	Burmese baril
			Psilorhynchus McClelland, 1839	*Psilorhynchus*sp.	Nga mat	
			*Garra*Hamilton, 1822	*Garra*sp.	Nga mat	
				*Garra*sp.	Nga mat	
				G. nasuta(McClelland, 1838)	Nga mat	Khasigarra
				G. notata(Blyth, 1860)	Nga mat	Tanasserimgarra
			*Devario*Heckel, 1843	*D. aequipinnatus*McClelland, 1839	Ngakyi	
			*Oreichthys*Smith, 1933	*O.cosuatis*(Hamilton, 1822)	Ngakyi	Cosuatis barb
		Cobitidae	*Acanthopsis*van Hasselt, 1823	*A. spectabilis*	Nga long	Blyth's loach
			*Botia*Gray, 1831	*B. kubotii*Kottelat,2004	Phobak	Burmese border loach
		Balitoridae	*Acanthocobitis*Peters, 1861	*A. botia*(Hamilton, 1822)	Ngaqaung	Zipper loach
			*Schistura*McClelland, 1838	*S. vinciguerrae*(Hora, 1935)	Nga long	
			*Balitora*Gray, 1830	*B. burmanica*Hora, 1932	Nga mat	Burmese stone loach
3.	Siluriformes	Schilbeidae	*Eutropiichthys*Bleeker, 1862	*E. vacha*(Hamilton, 1822)	Ngango	Batchwavacha
		Bagridae	*Batasio*Blyth, 1860	*B. tengana*(Hamilton, 1822)	Nga lo	Assamese batasio
		Siluridae	*Ompok*Lecepede, 1803	*O. pabo*(Hamilton, 1822)	Nga zit	Pabo catfish
				O. pabda Kobayakawa,1989	Ngape	Thailand silurus
			*Silurus*Linnaeus, 1758	*S. torrentis* (Hamilton, 1822)	Nga zit	Pabdah
		Erethistidae	*Erethistes*Muller &Troschel, 1849	*E. maesotensis*Kottelat, 1983	Nga lo	South Asian river catfish
		Sisoridae	*Glyptothorax*Blyth, 1860	*Glyptothorax*sp.	Nga lo	

NgawchangHka, Tamu, Chibwe, Nanmaw and Tangar. The objectives of the present study are as follows;

- to record fish species inChibweenvirons
- toremark fish specimens collected and assessed their roles
- toobtain the new record in this area

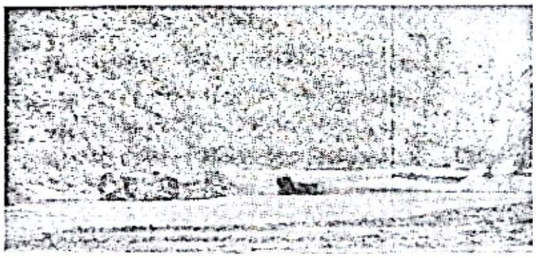
Materials and Methods

Study area

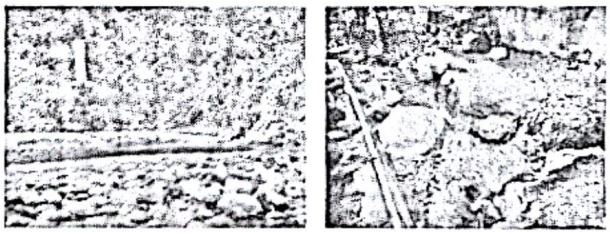
This study was observed in Chibwe, Kachin State, situated at 25° 39' to 26° 30' N and 97° 55' to 98° 45' E. Fishes were observed and sampled at three study sites in the May Hka River, Chibwe and Yitlaw streams. The main river of May Hka is located at 27° 15.36' N and 97° 35.08' E. The type locality of this river is large riffles, rocky and gravel. Chibwe stream is located at 25° 52.62' N and 98° 07.90' E. This stream is filled with sand, rocky substrate, gravels and flows down into the May Hka River. Yitlaw stream is located at 25° 53.19' N and 98° 09.87' E. The bottom has more common rocks and gravels. This stream flows out of the hill forest and down to the May Hka River(Fig 1, Plate 1).

Study period

The study period was lasted from May to November 2016.



May Hka River (N'Mai Hka)



Chibwe stream Yitlaw stream

Plate 1 Study sites

Specimen collection and preparation

The fish species collection and field survey were made with six month. Fish were obtained by set drift net. Some fish species were bought at the nearby market. The photographs of each specimen were taken. Specimens were preserved in (5-10%) formalin solutions based on the size of fish. Local names of the fishes were informed by the local fishermen. The preserved specimens were brought to the laboratory of Zoology Department, University of Myitkyina for identification (Plate 2).

Identification and classification

Identification and classification of the studied fish species was based on Day (1878, 1889), Nichols (1943), Jayaram(1981), Talwar and Jhingran (1991), Rainboth (1996), Ferraris (1998), Jayaram (2013) and FishBasewebsite

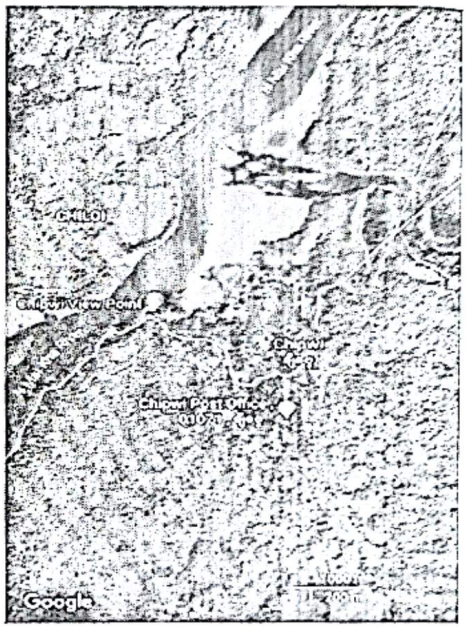


Fig. 1 Map of study area

Results

A total of 46 fish species identified and recorded in the survey area (Table 1), 19 species from May Hka River, 24fish species from Chibwe stream and 22 fish species from Yitlaw streamwere encountered (Plate 4, Table 2). 10 families and four orders were dominant in Yitlaw stream, followed by five families and four orders in Chibwe stream and three families and two orders in May Hka River (Table 3).

Discussion

Among the recorded 46 species, 36 species could be remarked as IUCN status (2016). In three study sites, off 36 species, they could be categorized in following; Nt = 7, Lc = 26, DD = 1, En = 1and not evaluated = 1. In these three study sites, Lcis found in May Hka site (small number of species). Thus, Chibwe and Yitlaw sites are the most interesting in findingLc status.On the aspect of

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				G. cavia(Hamilton, 1822)	Nga lo	Cat fish
				G. nongpangVishwanath &Laitheingambi, 2007	Nga lo	
				*G. nasutus*Hora, 1921	Nga lo	
			Pseudechenaidhly ds, 1860	*P. brachyurus*Zhou, Li & Yang, 2008	Nga la	Sucker throat catfish

Sr. No.	Order	Family	Genus	Species	Local name	Common name
			*Clarias*Scopoli, 1777	*C. batrachus*Chaudhuri, 1919	Balug	Walking catfish
4.	Cyprinodontiformes	Belonidae	*Xenentodon*Regan, 1911	*X. cancila*(Hamilton, 1822)	Hkang da	Freshwater Garfish
5.	Perciformes	Mastacembelidae	*Mastacembelus*Scopoli, 1777	*M. armatus*(Lacepede, 1800)	Zig-zag eel	Tire track spiny eel
		Channidae	*Channa*Scopoli, 1777	*C. harcourtbutleri*(Chaudhuri, 1919)	Gana gant	
				C. orientalis Bloch & Schneider, 1801	Gana gam	Asiatic snakehead
6.	Synbranchiformes	Synbranchidae	*Monopterus*Lacepede, 1800	*M. albus*(Zuiew, 1793)	Chayu	Asian swamp eel

Table 2 Distribution of fish species in the study area

Sr No.	Fish species	May Hka River	Chibwe stream	Yitlaw stream	IUCN Status (2016)
1	*Anguilla bengalensis*	×	√	×	Nt
2	*Banganadevdevi*	√	√	×	Lc
3	*Neolissocheilushexagonolepis*	√	√	×	Nt
4	*Neolissocheilussp.*	√	√	×	
5	*Oreinocheilushotalarius*	√	√	×	Lc
6	*C. burmanicus*	√	√	×	Lc
7	*Crateocheilussp.*	√	√	×	
8	*Varicorhinussp.*	√	√	×	
9	*Tor mosal*	√	√	×	EN
10	*Tor sp.*	√	√	×	
11	*Pethiatanrian*	×	×	√	Nt
12	*Systomussarana*	×	×	√	Lc
13	*Schizothoraxplagiostomus*	√	√	×	Nt
14	*Semilabeosp.*	√	√	×	
15	*Bariliusbarna*	×	×	√	Lc
16	*B. bendelisis*	×	×	√	Lc
17	*B. barnoides*	×	×	√	Lc
18	*Psilorhynchussp.*	×	×	√	
19	*Garrasp.*	×	√	×	
20	*Garrasp.*	×	√	×	
21	*G. nasuta*	√	√	×	Lc
22	*G. annata*	√	√	×	Lc
23	*Devariaequipinnatus*	×	×	√	Lc
24	*Oreichthuscosuatis*	×	×	√	Lc
25	*Acanthopsisspectabilis*	×	×	√	
26	*Botiakubori*	×	×	√	DD
27	*Acanthocobitisbotia*	×	×	√	Lc
28	*Schistura vinciguerrae*	×	×	√	Nt
29	*Balitorburmanica*	×	×	√	Lc
30	*Entropiichthysvacha*	×	√	×	Lc
31	*Batariotengana*	×	×	√	Lc
32	*Ompokpaba*	×	×	√	Nt
33	*O. pabda*	×	×	√	Nt
34	*Siluruturrentis*	×	×	√	Not evaluated
35	*Erethistesmacsonensis*	√	√	×	Lc
36	*Glyptothoraxsp.*	√	√	×	
37	*Glyptothoraxcavia*	√	√	×	Lc
38	*G. ngapang*	√	√	×	Lc
39	*G. siamensis*	√	√	×	Lc
40	*Pseudechenidsbrachyurus*	√	√	×	Lc
41	*Clariasbatrachus*	×	×	√	Lc
42	*Xenentodoncancila*	×	×	√	Lc
43	*Mastacembelusarmatus*	×	×	√	Lc
44	*Channaburmanica*	×	×	√	Lc
45	*C. orientalis*	×	×	√	Lc
46	*Monopterusalbus*	×	√	×	Lc

EN = Endangered, DD = Data deficient, Lc = Least concern, Nt = Nearly threatened, √ = present, × = absent

Table 3 Occurrence of fish species in the study area

Study sites	Number of species	Number of family	Number of order
May Hka River	19	3	2
Chibwe stream	24	5	4
Yitlaw stream	22	10	4

findings in three study sites, in Chibwe and Yitlaw sites are more plentiful specimens than May Hka site. In May Hka river, the fish specimens are lowest in comparison with theChibwe and Yitlaw streams. It is assumed that along the May

Plate 4 The studied fish species in the study sites

Plate 4 Continued

HkaRiver, forming sand bands at the most places, panning for gold particles, logging, dam construction, catching to set up mines, catching to use electric shocks and activities of shifting cultivation along the riversides. Moreover, Chibwe dam was released out the gate at once a week. Consequently, most of the fish species were followed to the fast current. As a result, almost endemic fish species becoming disappearance and some reduces in number.

Among the recorded fish species, *Banganadevdevi, Neolissocheilus*sp., *Varicorhinus*sp., *Schizothoraxplagiostomus,* were common in May Hka River.The distinctive characters of *Glyptothoraxcavia, Glyptothoraxngapang,*

*Glyptothoraxsiamensis*and*Pseudechensisbrachyu rus*were noted by the presenceof adhesive apparatus. They behave upside down position near the bottom of streams and attached to the stones by usingtheir adhesive organ. *Psilorhynchus*sp.was found swimming actively along the streams.

Naturally and artificial culture of *Schizothorax*, *Tor tor*and *Tor putitora*have been reported by Shrestha (1979). Win Oo (2005) pointed out that the mountain regions have an insufficient supply of fish from their own resources, due to the shortage of fish as food in the remote regions of Myanmar. *Neolissocheilushexagonolepis*, commonly known as copper mahseer, is an important sport fish. Jayaram (1981) stated that this species is known from Bangladesh, Pakistan, Thailand, Vietnam and China. Day (1878) described and Barbhuiya*et al.* (2010) also reviewed *Semiplotusmodestus* from Akyab in Myanmar. Talwar and Jhingran (1991) remarked this species as the commercially important rare fish species, which distributed only in Myanmar. Kottelat(2017) reported 388 fish species in the Ayeyarwady basin, of which 311 are present in Myanmar (representing 55 % of the total freshwater fish diversity of Myanmar).

Pan Kachin Development Society (2004) reported that a devastating "gold rush" is ongoing in Kachin State. The main mining centers appear to be along the Irrawaddy River north of the state capital Myitkyina and the areas around Tanai and the Chindwin River.Aside from the obvious pollution, mining causes structural changes to rivers which can cause severe ecological damage. Rivers are diverted for riverbed mining operations, while water blasting of sediments destroys riverbanks. Although gold mines on the N' Mai Hka River are largely depleted, the area around Chibwe town is still being mined. The Chibwe region is severely deforested from gold mines abandoned over ten years ago.

The people want to save for their own incomes by using many ways such as excavating the sands near river banks to get gold particles, commercial logging, digging of sand used for construction, dam construction, and cultivation is done by means of land rotation or shifting cultivationalong the May Hka River, village expansion, this will cause land sliding along the catchment areas and lead to soil erosion,forest fragmentation and the natural habitat damaged. In October when the water level is lower, gold is sought in the river with gold rafts. Some gold particles explorers used by huge boats excavating the bottom of the river, so that the environmental damages might become more spoil rates.

A lot of chemicals like mercury used in the gold panning process for seeking gold are a very dangerous to every kind of organisms including human and harm biodiversity greatly. Mercury deposited on the river bed will severely affect on organisms. For these reasons, the bottom layer and the adjacent river banks were ruined by the activities of mankind. Consequently, the physical features of the surrounding were damaged at all ecosystems.Habitat destruction is a major threat to edible fish and eventually causes stock collapse because the survivors cannot produce enough young to replace those removed. Generally, these activities are tending to be spoiled the environment.

Conclusions

Chibwe area has been an interesting and unspoilt site for precious flora and fish fauna for more than a century. It seems that due to its sparse population and difficult transportation, this location survives in its primitive, untouched state. Since only a few people trek the high mountains and forests, this area still possesses a wealth of natural resources and a good variety of wildlife worth conserving. Since 2013, the monsoon forest has been depleted. Moreover, people dig gold and sand and fell trees. When heavy rain falls, river banks are badly eroded, and terrible landslides occur. Consequently, fewer fish species can be caught now. Previously, a great number of fish could be caught in the Chibwe dam, just 10 miles from Chibwe, but these days there are only a few species left, so no fishing can be done there.

BANCA(2009) reported that along the May Hka River were dominant with cold water genus of *Schizothorax* (snow trout) especially in the upstream areas. Being an insecure and insurgent area, many locations are restricted, and very few sites can be frequented for fish samples. Moreover, the duration for the surveying trip also short time and extremely heavy rain has caused landslides and blocked the road to Chibwe. All habitats for the deep parts of large rivers, small streams in forest and hill streams still need our attention.Further survey work is needed to determine whether which species is experiencing a decline, or is undergoing extreme population fluctuations.

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ZOL 037

Study on Some Fishing Gears as Found in Inle Lake

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Abstract

The four types of fish traps and the two types of gill net are studied in Inle Lake during August, 2011 to July, 2011. Except cylindrical netted Hmyone (Hmyone-aun) is used to catch only *Labeo angra* (Kyauk-nga-lu) The net Hmyone and bamboo Hmyone are only used to catch the *Channa* sp. Tan-swae-pike (Nga-Lu-Pike) is used to catch only *Crossochellus latiu* (Nga Lu).Rod and Line, Nga htoe hmyone and Swae-pike-gyi are used the whole year in Inle Lake, Bamboo trap is used from the month of March to September. Funnel-shaped Hmyone is used from June to August. Cylindrical netted Hmyone and Tan-swae-pike are used in June, July and August. Among them, more efficient gear is conical netted Hmyone, because it can caught highest and different number of fish species and the other three fish traps are non-selective, that are restricted fish only can be caught. In two types of nylon gillnet, Pike-pyawt is selective although Pike-mar is rarely selected for being used the whole year round.

Keyword: Fishing gears, rod and line

Introduction

Fish and other aquatic resources are important to human live hoods especially in many developing countries. Various type of fishing gears arise through the countries to be used and further developed to meet local condition. In many areas of the world, fishing gears remain rooted in tradition and use simple materials.

A common way to classify fishing gears and methods is based on the principle of how the fish or other preys are captured and, to a lesser extent, on the gear construction (FAO, 2005). Choice of gear is important for maximum capture of fishes at a particular depth and a particular season. Many factors enter into the choice of the method and gear used to catch a particular area. (Welcomme, 2001)

Fishing gears used in inland fisheries are traditionally developed for small scale fishing activities. The most widely used includes stationary pot, Hmyone bamboo filter traps, and cast net. This enables fishers to easily access grown fish using various fishing gears. Fishing can be done all gear round in rivers and Inns (Khin Maung Aye *et al*., 1996).

Fish capture methods can be divided into two groups, active and passive. Active methods are those that effectively pursue the fish or are moved in order to capture them. These methods are particularly effective at catching sedentary species, but the efficiency is species and size dependant and they perform best in shallow, smooth booth bottomed rivers and backwaters (Aung Lwin, 2008)

Passive methods rely on the movement of fishes for their capture and have often proved useful for the study fish migration (Htay Htay Sein, 2009)

Inle Lake is the second largest natural lake in Myanmar.It scenic beauty and life style famous. Since fishing activities and fishing gears have improved, the nutrition and income for local people has risen.

In this study the following objectives were aimed.

- to record some of traditional fishing gear used in Inle Lake.
- to record the fish species caught in relation to fishing gear.
- to understand the students about fishing gears that the relevant information.

Materials and Methods

Study area

Inle Lake is located in Naung Shwe Township in Southern Shan State. It is situated between the 20˚ 27' to 20˚ 24' North and 96˚ 52 to 96˚ 57 East (Fig.1). This measurement was made with device of GPS (Global Position System).

Study Period

Study period was conducted from July to August; 2011.Field survey is done with aid of local fishermen. The fishing gears were analyzed after FAO (2005), Khin Maung Aye *et al*., (2006).

Methods of Measurement

The four type of each gear, Rod and line, Nya-htoe-hmyone, fish traps and gillnets, are measured with a measuring tape. Firstly, measured the length bamboo rod, diameter of circular fish entrance, length and width of gillnets but are the mesh size of net measured by a ruler.

After measuring these gears taking photograph is done with a Fuji digital camera.

A total of six fishing gears are recorded in the study area. The types of gear and method used depended on many factors. They were groups based on the structure and function as follows:

1. Rod and line (Nget- hmyar-tan)
2. Nga-htoe-hmyone
3. Fish trap
4. Gill net

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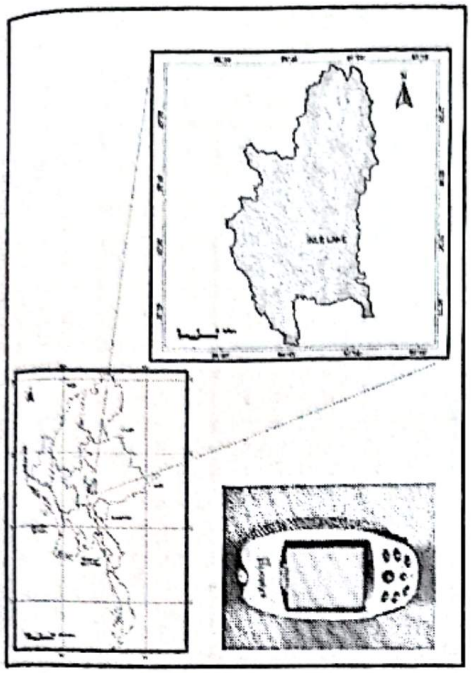

Fig (1) Location Map of Inle Lake

Results and Discussions

1. Rod and line (Nga- hmyar-tan)

Rod and line is commonly known as or Nga-hmyar-tan. It consists of a long bamboo stick, a nylon line with a hook. A float usually made of plastic foam. The length of the bamboo rod is about seven feet long is slightly curved and the hook line is fixed on its end. Thread is four to six feet and the hook is 0.5 inches to 1.5 inches long. One end of the bamboo rod is larger than the other with bamboo pole. The larger is held with the hand and smaller end thread attaching with a hook for catching live small fishes or small shrimps or earthworms or small snail which were used as bait. These were attached to the hook and hang in the water. While the fish eats the bait the bamboo rod is lifted and then the fish is caught. *Tilapia, Channa* sp. fish species are caught by this gear and can be operated the whole year both day and night (Plate.1).

2. Nga-htoe-hmyone(Main)

Nga-htoe-hmyone is traditionally called Shann-yoe or Main. It consists of two parts, bamboo rod part and hooked iron part. It is stout and strong. The length of this gear is about eight feet. The bamboo rod is seven feet and is attached to the iron hooked. It is eleven inches long. Anterior end of the bamboo rod is inserted radical branching iron five hooks. Each hook is seven inches long. At the tip of each hook bears with small inverted sharp spine which is about one inch long. It is used in shallow waters in Inle Lake .This gear was operated throughout the year in any water body at the depth of five feet. The target fish mainly caught by this gear are *Tilipia, Channa* sp. and *Clarias bactrachus* (Plate .2)

3. Fish traps

The fish traps are one of the most useful fishing gears with three types of net Hmyone and one bamboo Hmyone

a. Bamboo Trap (Bamboo -hmyone)
b. Funnel-shaped netted Hmyone (Saung)
c. Cylindrical netted Hmyone (Hmyone - aun)
d. Net hmyone (Nga- yaunt- hmyone)

a. Bamboo trap

Bamboo trap is a conical-shaped basket and traditionally called as Bamboo hmyone. It is about 48 inches long and the entrance is circular in shaped which is 10.5 inches in diameter. A piece of big bamboo is split into long strips. One end of the trap is circular shaped and two entry cone which leads the fish into the capture room. It has pointed bamboo funnel which prevents the fish to escape of the after entering the trap. It was placed in the four feet depth of water and cover with algae. Mostly target fish are *Channa* sp. in Inle Lake. This gear is operated March to September (Plate.3).

b. Funnel- shaped netted Hmyone (Saung)

This fish trap is funnel-shaped and traditionally called Saung and the entrance is circular in shaped is 96 inches in total length and circular are 21.5 inches in diameter. It is made of eight bamboo rods and the inside conical net is inserted. The top of the conical net is attached with circular bamboo ring. This fish trap is dipped into water which is about 8 feet deep and is placed vertical in position with the main rod. This trap of gear is the fish are caught and lifted up from the water. It is mostly used in June to September. The target fishes were *Cyprinus carpio* and *Tilipia* (Plate.4).

c. Cylindrical netted Hmyone (Hmyone-aun)

This fish trap is cylindrical in shaped traditionally called Hmyone-aun. It is made of nylon net with five bamboo rods. The trap is about 68 inches long and width is 30 inches in diameter. Both ends of the trap are two circular entry cones. It is 10 inches in diameter. These cones have pointed bamboo funnel which prevent fish from escaping. The trap is dipped in to the water with hooked rods and placed horizontal in position at shallow waters. It is usually used in June, July and August. The target fish is *Labeo angra* (Kyaut-nga-lu) (Plate.5)

d. Net hmyone (Nga- yaunt- hmyone)

This type of fish trap is similar to those of bamboo trap with cylindrical shape, it is traditionally called Nga-yaunt-hmyone. It is 33 inches long and width of 23 inches. It is cylindrical shaped and is made of five bamboo rod with net. One end of the trap is circular in shaped and one entry cone which leads the fish into the capture room. It has one pointed bamboo funnel which prevents from escaping the fish after entered the trap. The trap is set in horizontal position dipped

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with hooked rods in shallow waters. It is used in June, July and August. The target fish are Channa species such as *Channa gachu, Channa harcourtbutleri* and *Channa striata*. The fishes are caught by the trap in the flowing water (Plate.6).

4. Gillnets

Gillnets are most effectively used in open waters. Although small fish can swim through gillnets, large fishes cannot pass through the meshes as they get entangled in the net. Two types of gillnets are recorded.

a. Tan-swae -pike (Pike-mar)

b. Swae-pike-gyi (Pike-pyawt)

a. Tan –swae-pike (Pike-mar)

This gear is traditionally known as Tan-swae - pike or Nga- lu Pike or pike mar. It consists of the net with one square inch of mesh. It is used in the middle of lake about 8 feet in depth. The length of the Swae-pike is about 30 yards and 34 inches in width. It is made with small nylon thread. The target fish of this gear is mostly *Crosschellus latius* (Nga Lu) and is operated in June, July and August (Plate.7)

b. Swae-pike-gyi (Pike-pyawt)

This gear is traditionally known as Swae-pike-gyi or Pike-pyawt. It consists of the net with 1.5 square inches of mesh. It is used in any part of the lake. This gear is about 40 yards long and is 45 inches width. It is made of nylon rope. Target fishes of this gear is mostly *Tilapia* and *Cyprimus intha* (Nga- hpein) and is operated in June, July and August (Plate .8)

n the present study, traditionally fishing gears were examined for their utility around Inle Lake. Uses of these gears are based on their catching ability, a wide range of fish species and sizes of fishes are recorded.

Pole and line (Nga-hmyar-tan) and Nga-htoe-hmyone are regarded as non-selective fishing gear because few species of fish were caught by this type of gear.

There are four types of fish traps found in this study. One of them is selective gear and the other three are found to be non-selected. Among fish trap, the biggest gear (Saung) is famous for the highest number of species which are recorded to be caught to be highest gear is being observed in the conical netted Hmyone. This type of gear was assumed to be most efficient among the fish traps.

The other fish traps are two horizontal Hmyone, (one conical Net Hmyone and one conical bamboo Hmyome) used to catch of *Channa* sp.and *Tilapia*. The two types of gill net are found in present study; both are Tan–swae–pike. The Tan-swe-pike (Nga-lu-pike) gear is observed to catch only *Crossochellus latius*(Nga-lu).Therefore ,this type of gear is found as Non-selective gear. The other Tan-swae-pike (Pike-pyawt) is found to be selective gear because many fish species are caught by them.

The long line was also used the throughout the year at both day and night. Htay Htay Sein (2009) stated that two types of gill net, pole and line, cylindrical trap were operated the whole year. Therefore, these gears have no particular fishing season and they are effective for fishing throughout the year.

Gillnets are massive underwater curtains held upright by float along the top edge. Nylon gillnets are soft and light weight. Therefore, nylon gills is perfectly acceptable because the fish are extremely rugged and can handle the abrasive materials. More than 90% of commercial fishing requires the use of nylon net.

Conclusion

The four types of fish traps and the two types of gill net are found in the present work. These results indicate that trap gears can be regarded as commonly useful in fishing activities. Except cylindrical netted Hmyone (Hmyone-aun) is used to catch only *Labeo angra* (Kyauk-nga-lu). In some places when water is flowing slowly, the trap is used as a barrage. The net Hmyone and bamboo Hmyone are only used to catch the *Channa* sp. Tan-swae-pike (Nga-Lu-Pike) is used to catch only *Crossochellus latiu*(Nga Lu).

In the present study, rod and Line, Nga htoe hmyone and Swae-pike-gyi are used the whole year in Inle Lake, Bamboo trap is used from the month of March to September. Funnel-shaped Hmyone is used from June to August. Cylindrical netted Hmyone and Tan-swae-pike are used in June, July and August.

Among them, more efficient gear of conical netted Hmyone is selected because it can caught highest and different number of fish species and the other three fish traps are non-selective, that are restricted fish only can be caught.

In two types of nylon gillnet, Pike-pyawt is selective although Pike-mar (Nga-lu-pike) is rarely selected for being used the whole year round and it is very useful and effective for local fishermen.

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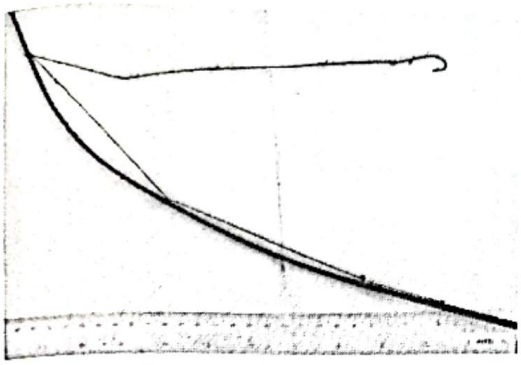
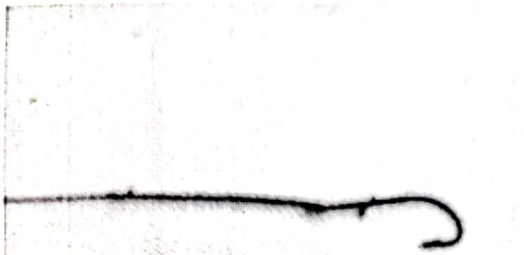


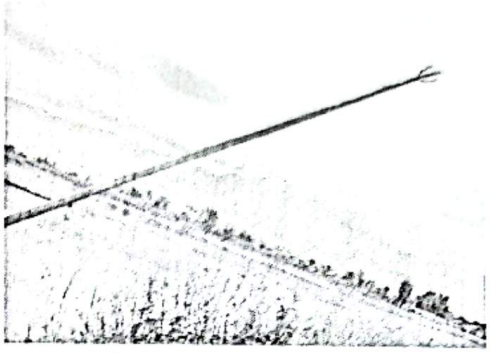
A. Structure of a rod and line

B. Capturing the fish with rod and line

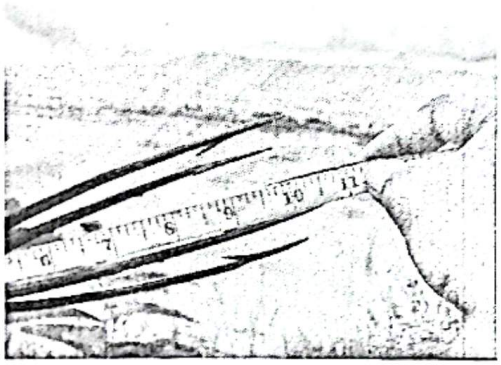


C. Line and hook

Platel Rod and line



A. Structure of a Nga-hote-hmyone



B. Measurement of iron part

C. Opposite direction of hooks

Plate 2 Nga-hote-hmyone

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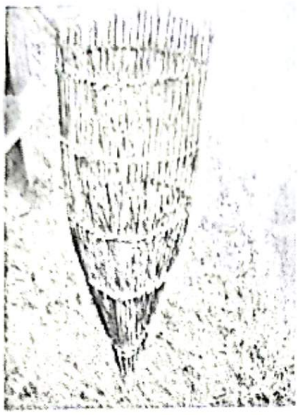
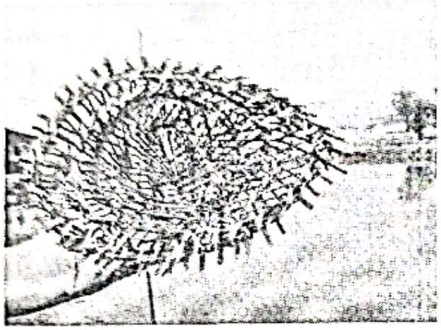
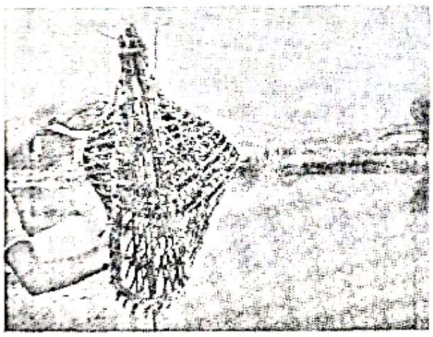


A. Two cones of a bamboo trap

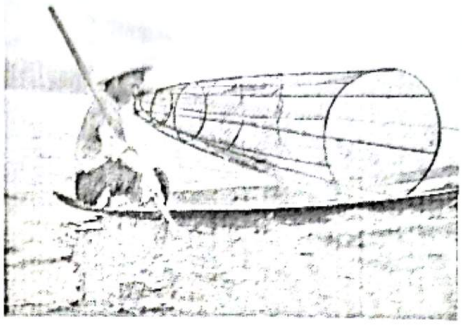


B. Fish entrance of bamboo trap

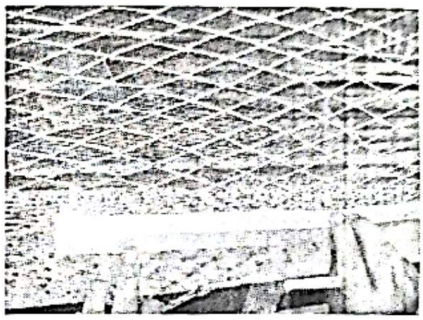


C. Posterior end of a bamboo trap

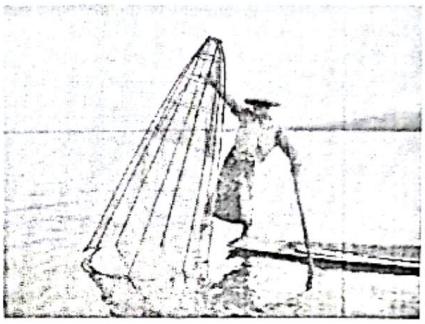
Plate 3 Bamboo trap



A. Structure of funnel-shaped Hmyone



B. Mesh size of a funnel-shaped Hmyone



C. Setting with a funnel-shaped Hmyone

Plate 4 Funnel-shaped Hmyone

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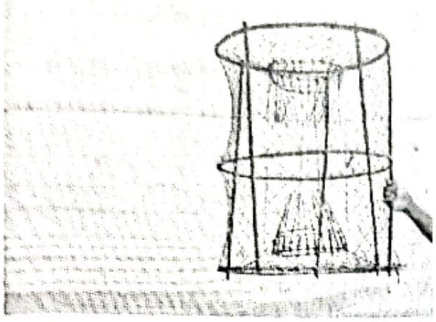
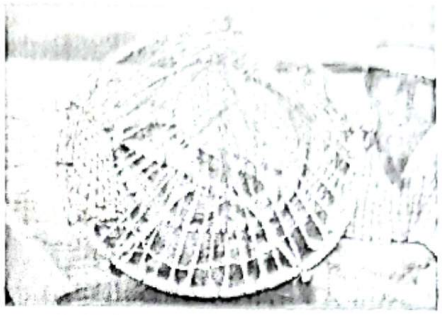
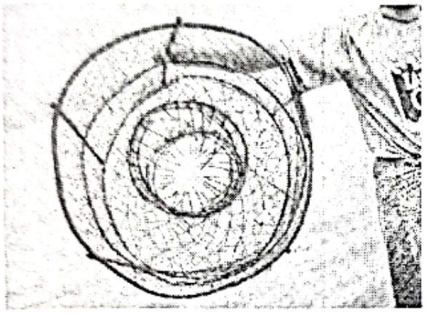


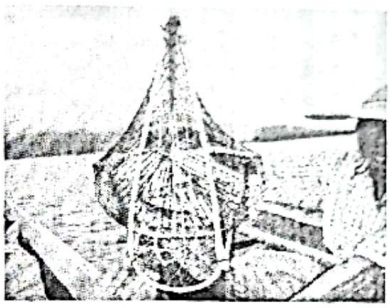
A. Two cones cylindrical netted Hmyone



B. Fish entrance of netted Hmyone

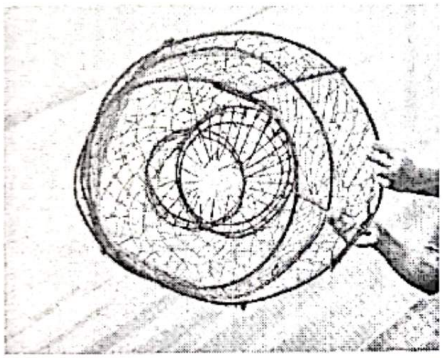


B. Entrance of cylindrical netted Hmyone



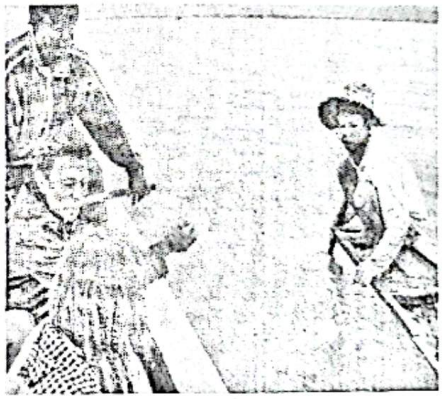
C. Posterior end of netted Hmyone

Plate 6. A cone of cylindrical netted Hmyone

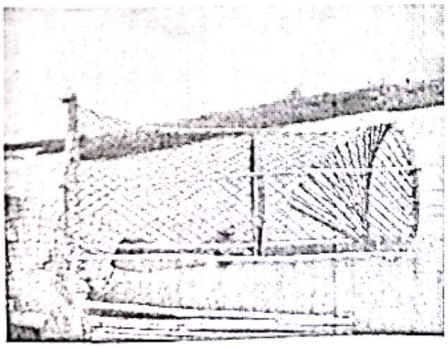


C. Setting horizontal with netted Hmyone

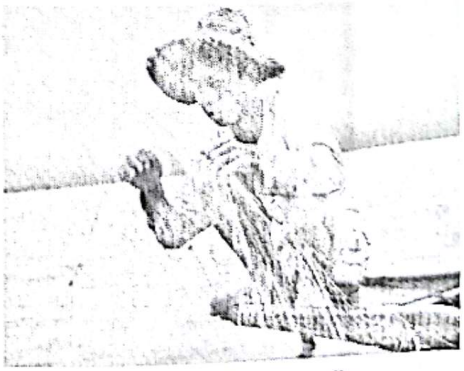
Plate 5 Two cones cylindrical netted Hmyone



A. Pursing in Inle lake



A. A cone of cylindrical netted Hmyone



B. Pulling a Tan-swae-pike

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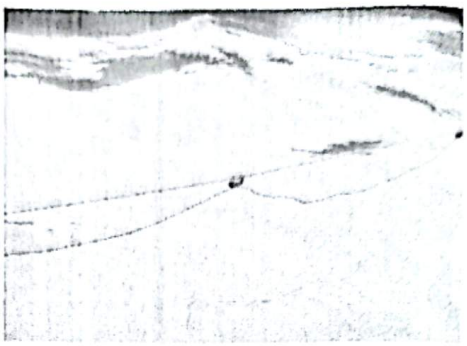
C. Mesh of Tan-swae-pike

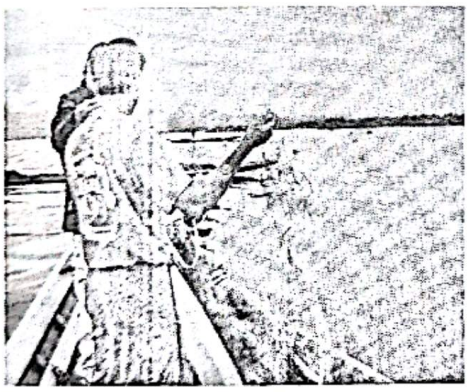
Plate 7 Tan-swae-pike



C. Mesh of Swae-pike-gyi

Plate 8 Swae-pike-gyi

A. Structure of Swae-pike-gyi



B. Measurement of Swae-pike-gyi

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ZOL 038

Butterfly Species Abundance and its Benefits in Panglong University Campus, Shan State

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Abstract

Butterfly species abundance and its benefits were investigated around Panglong University Campus, Shan State during the studied period from December 2017 to November 2018. A total of 14 butterfly species of 12 genera belonging to 5 families were recorded.The studied species were identified according to Bingham (1907), Talbot (1939) and Corbet and Pendlebury (1992). The average relative abundance was categorized as followed by Bisht*et al.* (2004). During the study period, eleven species of butterflies were found to be very common and three species of butterflies to be uncommon. The highest number of butterflies was recorded under family Pieridae while family Satyridae was the lowest in the study area. Butterflies play vital role in the ecosystem, there is co-evolutionary relationship between butterflies and plants. They are the wild indicators of the ecosystem and effective pollinators. These insects tell us everything about the healthier ecosystem and also provide food for other organisms. The objective of this study was to observe the abundance of butterfly species around the Panglong University Campus and to know the important value of butterflies.

Keywords: butterfly species, abundance, highest, lowest, ecosystem

Introduction

Butterflies are found all over the world except in Polar Regions. They are the largest group of order Lepidoptera, containing more than 20,000 described species in the world. In Myanmar, over 1200 species were recorded by Kinyon (2004). Myanmar butterflies were recorded by Bingham (1905, 1907) in a book entitled as the fauna of British India including Ceylon and Burma. Talbot (1939) was able to record 1014 species of Myanmar butterflies. Nevertheless, most people notice only the butterfly species that predominate in their surrounding area (Carter, 1992).

Most butterflies fly by day and a few butterflies are active at dusk and possibly at night. Many butterflies stay close to the ground or spend more time near it and rarely fly higher. They have been studied by many people throughout the world (Kunte, 2000). Butterflies are considered to be fragile and they are unable to withstand extreme climate conditions. However, some butterflies are adapted to climate conditions so that they range widely over the areas (Talbot, 1939). The abundance of butterfly species depends on the conditions of the environment. Favourable habitats of the butterfly species will be in places where flowering and host plants flourished (Monastyrskii and Devyatkin 2002).

Butterflies aid in the cultivation of fruits and vegetables. Butterflies serve as functional pollinators and pollination is important process in the most all productive terrestrial ecosystems. Two third of all flowering plants are depending upon butterflies for pollination. Therefore, butterflies are interest to many naturalists as the movements of these elegant creatures are eye catching (Kinyon, 2004). Pollinators and their habitats provide ecological, cultural, financial, health, human, and social values. They enhance the reproduction and genetic diversity of around 80% of the plant species. More than half of plant species are self-incompatible or dioecious and completely dependent on biotic pollination. These plants are critical for the continued functioning of ecosystems as they provide food, form habitats and provide other resources for a wide range of species. Some mangroves, dominated by obligate outbreeder plants, which provide important services such as preventing coastal erosion, supporting fisheries, protecting from flood and salt intrusion, providing wood fuel and timber (Mukherjee et al. 2014).

Butterflies are also important pollinators to most agricultural crops. Shan State in Myanmar is famous for its garden products of all sorts of fresh fruits and vegetables. Rice and other crops are grown. The present study is an attempt to observe the butterfly species abundance in the Panglong University Campus of Southern Shan State and to know the important value of butterflies.

Materials and Methods

Study Area

Panglong University campus, Panglong Township, Loilem District, Southern Shan State was chosen as the study site. It is located between 20°27' and 21°16' North latitude and between 97°20' and 97°38' East longitude.

Study period

The study period lasted from December 2017 to November 2018.

Collection of the butterfly specimens

The butterflies were captured by an insect net. The captured specimens were gently taken from the net and pinched the undersides of the thorax to immobile and kept in a plastic box and anaesthetized with mild chloroform; Anaesthetized butterflies were transferred to a triangular paper envelope for the specimens cannot be spread immediately. The date of collection locality and the general colouration of each specimen was noted on

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the respective envelope. Butterflies collections were made once a week from 9 am to 3 pm.

Preparation of the specimens for identification

The dead specimens were mounted on spreading board. A spreading board has a groove in the middle with two flat surfaces on either side of it. The body of the butterfly was placed into the groove and the wings were spread on the flat surfaces. Fore wings are more or less triangular and are spread with the hind margin of the fore wings at right angles to the body and the hind wings for enough forward so that there is no longer gap at the side between the front and hind wings (Borror and White 1970).

Strips of butter-paper were used to hold the wings in the right position and then they were set with pins. All the specimens were recorded with scaled photographs after 6 or 7 days. The wings were detached from the specimen and placed in 10% potassium hydroxide (KOH) diluted with water. After 3 or 5 days, the wings became transparent. The transparent wings were rinsed in water to remove the remnants of KOH. The treated wings were dried in room temperature to become visible the veins of the wings. The wing venation is an important source of identification.

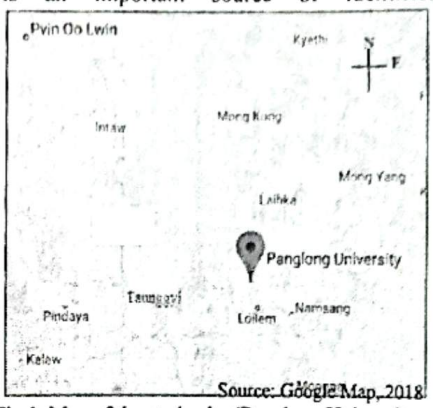


Fig 1. Map of the study site (Panglong University Campus)

Identification and Analysis of the data

Identification is based on wing venation, parts of the head and legs, according to Bingham (1905, 1907), Talbot (1939) and Corbet and Pendlebury, (1992). The average relative abundance was categorized as followed by Bisht*et al.* (2004).

$$\text{Relative abundance} = \frac{\text{No of individual of a species}}{\text{Total no. of individuals of all species}}$$

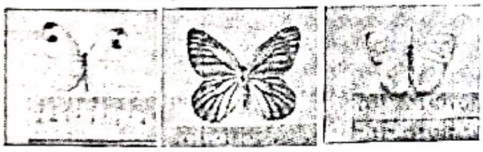
uC= uncommon having relative abundance of less than 0.01

C= common having relative abundance of 0.01 but less than 0.05

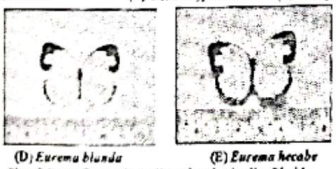
vC= very common having relative abundance of 0.05 and above

(A) *Papilio hipponous* (B) *Papilio polytes*

Plate 1.Butterfly species collected under family - Papilionidae



(A) *Leptosia nina* (B) *Delias hyparete* (C) *Catopsilia florella*

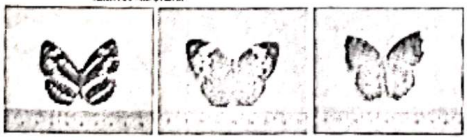


(D) *Eurema blanda* (E) *Eurema hecabe*

Plate 2.Butterfly species collected under family- Pieridae

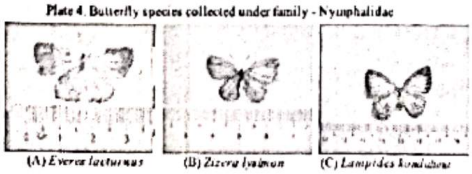
(A) *Mycalesis visala*

Plate 3. Butterfly species collected under family- Satyridae



(A) *Neptis soma* (B)*Cupha erymanthis* (C) *Ariadne ariadne*

Plate 4. Butterfly species collected under family - Nymphalidae



(A) *Everes lacturnus* (B) *Zizera lysimon* (C) *Lampides boeticus*

Plate 5. Butterfly species collected under family - Lycaenidae

Results

Butterfly species abundance

A total of 14 different species of butterflies belonging to 12 genera and 5families were recorded (Table 1). The recorded species included 2 species of Papilionidae,5 species of Pieridae, one species of Satyridae, 3 species of each of Nymphalidae and Lycaenidae. Species numbers of Pieridae were highest and lowest numbers were observed under family Satyridae.

Table 1.The collected butterfly species in the study area

No	Family	Scientific name	Common name
1	Papilionidae	*Papilio hipponous*	The Pitman'Helen
2		*Papilio polytes*	The Common Mormon
3	Pieridae	*Leptosia nina*	The Psyche
4		*Delias hyparete*	The Painted Jezebel
5		*Catopsilia florella*	The African Emigrant
6		*Eurema blanda*	The Common Grass Yellow
7		*Eurema hecabe*	The Common Grass Yellow
8	Satyridae	*Mycalesis visala*	The Long-brand bush brown
9	Nymphalidae	*Neptis soma*	The Sullied Sailer
10		*Cupha erymanthis*	The Rustic
11		*Ariadne ariadne*	The Angled Castor
12	Lycaenidae	*Everes lacturnus*	The Indian Cupid
13		*Zizeria knysna*	The Dark Grass Blue
14		*Lampides boeticus*	Long-tailed Blue

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During the study period, eleven species of butterflies were found to be very common and three species of butterflies to be uncommon.

Benefits of butterflies

Butterflies are pollinators and visit on the flower to eat nectar; tiny scales on their bodies brush against anthers and pollen adhere to these scales and then the butterfly visit to another flower, the pollen which stuck to its scales brush onto the stigma's flower. This helps fruits, vegetables and flowers to produce new seeds. The majority of plants need pollinators like bees and butterflies to reproduce. Butterflies and caterpillars also provide food for other organisms such as birds, spiders, reptiles, amphibians and etc.

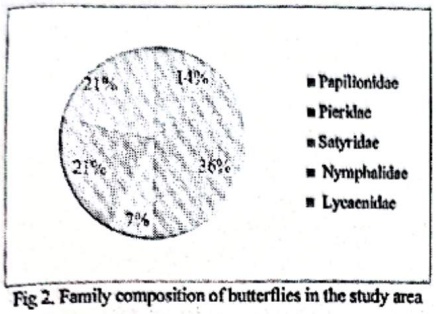

Fig 2. Family composition of butterflies in the study area

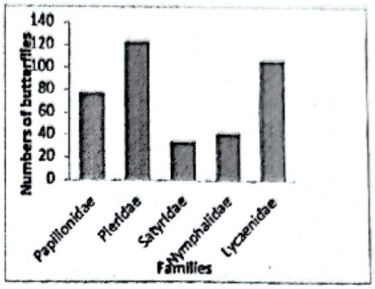

Fig 3. Numbers of the collected butterflies with their respective families

Table 2. Numbers of relative abundance of butterflies in the study area

Species	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Total	Relative Abundance	Status
Papilio hipponous	1	4	5	6	6	4	5	3	2	3	3	1	43	0.0995	vC
Papilio polytes	2	5	4	3	8	4	3	1	3	5	1	0	39	0.0902	vC
Leptosia nina	0	0	2	5	10	6	2	0	0	2	3	0	30	0.0694	vC
Delias hyparete	0	0	1	0	1	0	0	0	0	0	0	0	2	0.0046	uC
Catopsilia florella	2	2	1	2	5	3	3	1	3	4	1	2	29	0.0671	vC
Eurema blanda	3	2	3	7	11	9	5	0	2	3	2	2	49	0.1134	vC
Eurema hecabe	2	2	1	2	0	0	3	5	3	5	2	3	28	0.0648	vC
Mycalesis visala	5	6	4	5	3	5	1	2	1	2	2	4	40	0.0925	vC
Neptis soma	3	2	1	12	7	3	2	1	1	5	0	0	37	0.0856	vC
Cupha erymanthis	0	0	3	0	0	0	0	0	0	1	0	0	4	0.0092	uC
Ariadne ariadne	1	0	0	0	0	0	0	0	0	0	0	0	1	0.0023	uC
Everes lacturnus	10	8	4	11	10	3	2	3	2	4	3	4	64	0.1481	vC
Zizeeriaknysna	3	3	1	5	3	2	1	1	4	2	5	5	35	0.0810	vC
Lampides konduluna	5	3	5	2	3	0	0	3	1	2	3	4	31	0.0717	vC

vC - very common,C – common,uC - uncommon

Discussion

The present study was conducted to observe the butterfly species abundance in the Panglong University Campus and to understand its benefits. The study period lasted from December 2017 to November 2018. A total of 14 species of butterflies of 12 genera belonging to 5 families were identified according to Bingham (1905, 1907), Talbot (1939) and Corbet and Pendlebury (1992).

According to Kunte (1997), butterfly species are directly dependent on plant species composition due to availability of larval and adult food resources in an area. Thus, the abundance of butterfly species depends on the conditions of the environment. Favorable habitats of the butterfly species will be in places where flowering and host plants flourished. Barua (2007) stated that the vegetation can also play an important role for butterfly survival, offering particular structural elements for sun basking or mating and determining certain suitable microclimates.

In the present study, eleven species of butterflies were found to be very common and three species of butterflies to be uncommon. The species number and population size of butterfly were the highest in family Pieridae. It was probably due to abundant of their host plants in the study area.

Butterflies are beneficial to the environment by acting as pollinator, prey, biological pest control, inducing genetic variation in plants, and enhancing environmental beauty. Indeed, the butterflies are beneficial to human for scientific studies. Stephen Dickie (2012) explained that if populations of butterfly diminish, then population of birds, mice and other animals that rely on them as food source will also effect. This loss will collapse the entire ecosystem.

In addition to herbicides reduce butterfly abundance indirectly when they cause the loss of larval food-plant and nectar or pollen resources for adult, particularly in boundary vegetation(Boatman *et al.*, 2007).Owing to habitat

destruction for developmental activities in urban environment and unscientific management of natural resources, much of our native butterflies are fast disappearing and at present, their survival is under threat (Aiswarya *et al.*, 2014).Therefore, we should share the knowledge of butterflies to the people, resulting in a greater understanding of our role in protecting them.

Conclusion

A total 14 species of butterflies of 12 genera belonging to five families were recorded during the study period from December 2017 to November 2018 in Panglong University campus, Southern Shan State. The study species were identified according to Bingham (1905, 1907), Talbot (1939) and Corbet and Pendlebury, (1992). The members of family Pieridae was the highest and the lowest in family Satyridae. During the study period, eleven species of butterflies (*Papilio hipponous, Papilio polytes, Leptosia nina, Catopsilia florella, Eurema blanda. Eurema hecabe, Mycalesis visala, Neptis soma, Everes lacturnus, Zizeeria knysna, Lampides konduluna*) were found to be very common and three species of butterflies (*Delias hyparete, Cupha erymanthis, Ariadne ariadne*) to be uncommon. Butterflies are beneficial to the environment by acting as pollinator, prey, and enhancing environmental beauty. They are also beneficial to human for scientific studies.

Acknowledgement

We would like to thank Rector Dr. Kyaw Kyaw Khaung, East Yangon University, for encouraging to do the present work. We are deeply indebted to Professor Dr. Thet Thet Myaing, Head of Zoology Department, East Yangon University, for her kind permission to conduct this research.

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Occurrence of some Quail Species in Ywa Ton Village, Monywa Township, Sagaing Region

ZOL 039

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Abstract

Two species of quail *Coturnix coromandelica* (Rain Quail) under the order Galliformes and family Phasianidae and *Turnix sylvaticus* (Small Buttonquail) belonging to order Charadriiformes and Turnicidae were recorded from five study sites of Ywa Ton Village, Monywa environs during October 2017 to April 2018. The number of individuals *Coturnix coromandelica* (417) was higher than *Turnix sylvaticus* as (328) for study sites throughout the study period. Based on the spatial variation, higher number of *Coturnix coromandelica* was found in Site I followed by III, V, I and II. This was not dependent upon the cultivated plants but on the abundance and type of ground cover vegetation. With regard to temporal variation, the higher abundance of *Coturnix coromandelica* was in November and the lowest in March. Similarly, the highest number of *Turnix sylvaticus* was in October and the lowest in March. These fluctuations depend on both the plantations and ground cover vegetation as well. Therefore, the number of individuals of quail species was less throughout the summer and slightly decreased in some months when weeds were exterminated. Since, these provided not only food source but also sheltered the quails from the prospective predators.

Keywords: occurrence of quail species

Introduction

Abundance and diversity of birds may be able to tell us whether the site is still good for wildlife. In other words, one of the simplest and obvious ways to preserve a species is to protect it in its habitat. Even base line information of avifauna in an area is a valuable endeavor to prerequisite for assessing the status of birds and habitat quality (Welty and Beptiata, 1990).

Galliformes is an order of heavy-bodied ground-feeding birds that includes turkey, grouse, chicken, New World quail and Old world quail, ptarmigan, partridge, pheasant, jungle fowl. There are 270 species of Galliformes are a remarkable group of birds. As a whole, they are very important to humans and contain some of the most study species in the world (Nijman, 2003) (cited by Mc.Gowan *et al.*, 2012). They can be found around the world except for in Antarctica .Many of the species in this order have been domesticated but others are hunted as game birds (Marchant and Higgins, 1993).

Quails are small avian species belongs to the Pheasant family and they are generalists which can live in a wide range of different habitats. Number of plants, their structure (i.e., short, tall, broad or narrow canopy, etc.) and their arrangement across the landscape all are important features to quail. The quail prefers covers which have dense enough to provide protection (Perennou, 2009).

Old World quail or king quail is a collective name for several genera of mid-sized birds in the pheasant family Phasianidae all the same game birds of Burma except the button quails which are superficial resemblance to quail and from the family Turnicidae. Phasianidae contains 140 species and 45 genera and they live on the ground, but perch and roots on trees and lay their eggs on the ground. The young when hatched are covered with down and can run about within a few moments of emerged from the egg (Smythes, 2001).

The rain quail in the family Phasianidae is a resident or partially migratory bird, found throughout the greater part of India and in the Ayeyarwady Valley in Burma. These birds are generally found in the long grass, but also in the young grain crops environing the field or median. Their absence from certain localities in one season, and their crowding the same locality during another, depends on the presence or absence of the food they like (Fayrer, 2017).

On the other hand, the American species New World quail are placed in the family Odontophoridae. They are small birds only distinctly related to the Old World quail, but named for their similar appearance and habitats.

Monywa and its environs have variety of cultivation areas that still support good quail populations although most of the grassland areas were greatly decreased by urbanizations and global warming and over-exploitation as food. Moreover, there are no research working on quail species and hence the present study was carried out the following objectives.

- to identify the quail species in the study area
- to determine the occurrence of quail species

MATERIALS AND METHODS

Study Area

Monywa is situated at Latitudes 22° 07' 17.7" N and Longitudes 95° 09' 13.3"E. It lies at

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81m above sea level. Ywa Ton Village is located at the Northeastern part of Monywa.

Study Sites

Based on the habitats and information from the local hunters, five study sites were allocated in the study areas Ywa Ton Village is located at the east of Monywa.

Site I = Banana plantation

Site II = Maize plantation

Site III = Congo pea plantation

Site IV = Seasame plantation

Site V = Thanakha plantation

Site I

Area: The total area is about 2428 square meters.

Coordinates: 22° 9′ 29.51″ N and 95° 12′ 33.94″ E.

Location: It lies in the northwestern part of Ywa Ton Village.

Description of habitat: Plantation of banana with ground cover dominated by weeds, Hing-nu-ney-subauk, Hing-nu-ney, Myet-htauk and grasses. Along the east of the site is bordered by bushes.

Sampling units: Two transect lines of (55) m and (46) m in length were placed from north to south on both side of the plantation of banana.

Site II

Area: The total area is about 4856 square meters.

Coordinates: 22° 9′ 30.38″ N and 95° 12′ 25.84″ E.

Location: It lies in the northeastern part of Ywa Ton Village.

Description of habitat: Plantation of maize with the ground cover of weeds, grasses, Myet htauk and mon-nhyin.

Sampling units: Two transect lines (98) m in eastern part and (46) m was fixed across the middle of plantation.

Site III

Area: The total area is about 4856 square meters.

Coordinates: 22° 9′ 55.01″ N and 95° 12′ 44.36″ E.

Location: It lies in the northeastern part of Ywa Ton Village.

Description habitat: Plantation of Congo pea with dense ground cover of weeds, grasses, Krak-mauk, Myet-htauk, Mon-nhyin and Baung-laung-nyo.

Sampling units: Two transect lines of (149) m and (137) m in length were placed from north to south on both side of the plantation of Congo pea.

Site IV

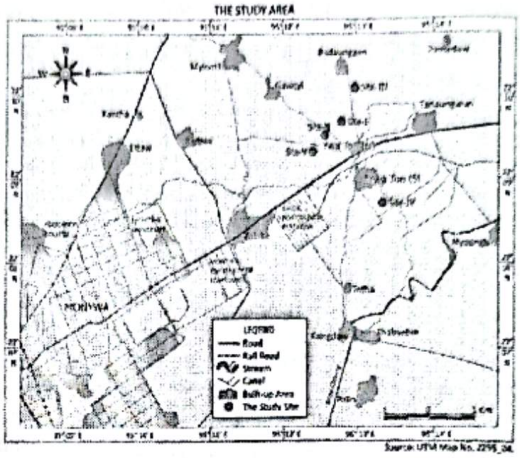

Figure 1. Map of Monywa Township showing Ywa Ton Village

Results

Systematic Position of the Species Recorded

Phylum - Chordata
Class - Aves
Order - Galliformes Temminck, 1820
Family - Pahasianidae Horsfield, 1821
Genus - *Coturnix* Garsault, 1764
Species - *C.coromandelica* (Gmelin, 1789)
Order - Charadriiformes Huxley, 1867
Family - Turnicidae G R Gray, 1840
Genus - *Turnix* Ogilvie-Grant, 1889
Species - *T. sylvaticus* (Desfontaines, 1789)

Table 1. Relative monthly numbers of *Coturnix coromandelica* recorded in the respective study sites of Ywa Ton Village during October 2017 to April 2018

Sr. No.	Month	Site I	Site II	Site III	Site V	Total	Mean
1	Oct	14	13	22	23	72	18 ± 4.52
2	Nov	19	16	23	17	75	18.75 ± 2.68
3	Dec	17	13	17	22	69	17.25 ± 3.19
4	Jan	17	14	17	18	66	16.5 ± 1.50
5	Feb	12	8	14	22	46	11.5 ± 2,17
6	Mar	16	5	13	8	42	10.5 ± 4.27
7	Apr	14	9	14	10	47	11.75 ± 2.27
	Total	109	78	120	110	417	104.25 ± 15.76

Area: The total area is about 9105 square meters.

Coordinates: 22° 8′ 42.64″ N and 95° 13′ 4.37″ E.

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Location: It line in the northeastern part of Ywa Ton Village.

Description of habitat: Plantation of sesame with the spare ground cover of grasses, Krak-mauk and Myet-htauk.

Sampling units: The two transect lines of (450) m and (122) m in length were placed from north to south on both side of the plantation of Sesame.

Site V

Area: total area is about 10117 square meters.

Coordinates: 22° 9' 22.20" N and 95° 12' 16.31" E.

Location: It lies in the western part of Ywa Ton Village.

Description of habitat: Plantation of thanakha, *Hesperathusa cremulata* (Roxb.) Roem.

Long grasses, Kyetsu, Krak-mauk , Mon-nhyin and weeds cover around the all trees. Along the north and west sides are bordered by bushes.

Sampling units: A transect line of (183) m was fixed across the middle of plantation.

Study Period

Survey was conducted from October 2017 to April 2018.

Study Design

Data collection was carried out twice a month in each site from October 2017 to April 2018. The populations of quail species were study based on the line transect method. Based on the method of Rollins *et al.*, 2005, appropriate transect lines was established in each study site and then counting quails was conducted during the first three hours of day light. The number of quails flash in each side of the transect line were recorded while walking through transects. Some of the quails were caught by mist net and taxonomic characters were studied for the identification of the species. Their location, time and habitat conditions were noted. At each site, quail species were recorded by digital camera (Canon, 65x, 16.1 mega pixels)

Identification

Identification and systematic position of the two quail species followed those of Robson (2015) and BirdLife International, Clement Checklist (2017). Identification of plants was referred to staff Botany Department and confirmed by the Myitkyina University.

Analysis of Data

The number of individuals of quail species was pooled for each month from each study site. Then, number of quail species recorded for all months was pooled and comparison was made for each study site. Density of quails in each study was also evaluated.

$$\text{Relative abundance} = \frac{\text{No. of individual of a species}}{\text{No. of individuals of all the species}}$$ (Bisht *et al.*, 2004)

Table 2. Relative monthly numbers of *Turnix sylvaticus* recorded in the respective study sites of Ywa Ton Village during October 2017 to April 2018

Sr. No.	Month	Site I	Site II	Site IV	Site V	Total	Mean
1	Oct	11	15	22	13	61	15.2 ± 4.14
2	Nov	8	10	23	10	51	12.7 ± 5.97
3	Dec	12	11	17	16	56	14 ± 2.55
4	Jan	9	9	17	8	43	10.8± 3.63
5	Feb	10	5	14	10	39	9.8 ± 3.19
6	Mar	10	5	13	7	35	8.8 ± 3.03
7	Apr	12	8	12	11	43	10.8 ± 1.64
	Total	72	63	118	75	328	46.86 ±8.72

Table 3.The number of individuals and density of quail species recorded from five study sites of Ywa Ton Village during October 2017 to April 2018

Sr. No.	Site	*Coturnix coromandelica*	Density (ind/m²)	*Turnix sylvaticus*	Density (ind/m²)	Total	Density (ind/m²)
1.	I	109	0.044	72	0,029	181	0.074
2.	II	78	0.016	63	0.012	141	0.029
3.	III	120	0.008	-	-	120	0.008
4.	IV	-	-	118	0.012	118	0.021
5.	V	110	0.011	75	0.007	185	0.018
		417	0.01	328	0.008	745	0.141

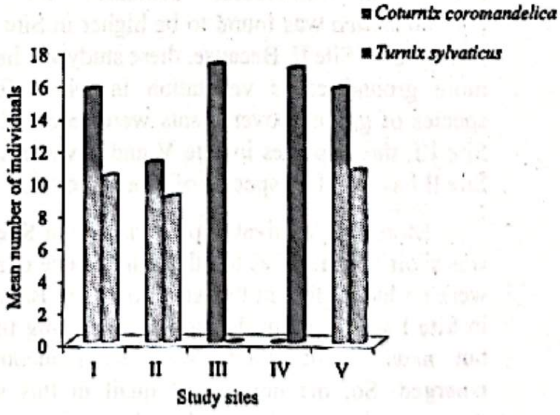

Fig. 4 Relative number of quail species recorded from all study sites of Ywa Ton Village during October 2017 to April 2018

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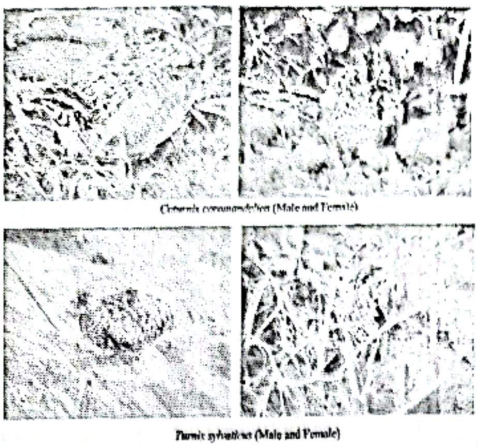

Turnix sylvaticus (Male and Female)

Discussion

Reliable estimates of wildlife populations and population trends are essential in assessing the effects of management activities on target populations (WMA Tracts 2015). The five study sites were chosen because they represented the major physiognomic regions inhabited by quail species in study area. The topographic and vegetative structure differed significantly among areas. The present study was carried out on the species composition and abundance of quail species during October 2017 to April 2018.

Two quail species, *Coturnix coromandelica* and *Turnix sylvaticus* were recorded in Ywa Ton Village especially in Site I, II and V whereas Site III has only *C.coromandelica* and Site IV has only *T.sylvaticus*. With regard to spatial variation, the number of individuals evaluated for *C. coromandelica* was found to be higher in Site III and lower in Site II. Because, these study site have more ground cover vegetation in which four species of ground cover plants were recorded in Site III, three species in Site V and I whereas in Site II has only two species of ground cover.

Moreover, cultivated plant, maize in Site II was short term relative to others and hence quails were no longer live in this site. And then Banana in Site I was also cut during the harvesting time but new banana plants were simultaneously emerged. So, the number of quail in this site depends only on the human disturbance. The same condition was found in *Turnix sylvaticus* that the highest number of *Turnix sylvaticus* was found in Site IV and lower in Site II.

Moreover, present or absence of quail species may not depend on the cultivated plants but depend on abundance and type of ground cover vegetation. Because this ground cover represent nest, refuge and food for quail species. Predator protection is very important for successful quail habitat. The result is that occurrence and abundance of quails match to those of underground vegetation in the cultivations of cereal crops, sesame, maize, Congo pea, banana and thanakha. But in the study site II as maize cultivation, quails depend not only on the underground vegetation but also on the maize grains. So, their temporary movements fit the temporal and spatial variations which constantly affected mostly by the underground vegetation. These are the most widely distributed source of quail food and protection for predators and hence weeds respond most reliably to management of quail habitat.

Similar concept was found in the paper Bobwhite quail in Texas reported by Alfred *et al.*, (https://tpwd.texas.gov, 2018) that occurrence and abundance of quails match to those of underground vegetation and quails cannot be live long without cover just as he cannot live without food and predator protection.

By pooling the number of quails in all study sites during October 2017 to April 2018, the number of *C.coromandelica* 417 was significantly higher than those of *T.sylvaticus* 328. Similar result was found in the Site I, II and V where both quail species were recorded.

Similarly, evaluated densities of quail species in recorded study sites throughout the study period showed that density of *C.coromandelica* was greater than those of *T.sylvaticus*. By pooling the number of all the quails recorded from all study sites, quail density evaluated was 0.141 ind/m^2. Low density estimates of quail species was evaluated in the present study. This may be due to only seven month survey and survey did not cover all season. Brennan *et al.*, 1987 said that population density is an indicator of habitat quality for this quails.

Based on the temporal variation during October 2017 to April 2018, the highest number of individuals for *C.coromandelica* was found in November and the lowest in March. The number of *Turnix sylvaticus* recorded was highest in October and the lowest in March. These fluctuations depend on both the plantation and ground cover vegetation. Because, cultivated plants in Site II, Site III, IV were harvested after cold season. Some of the ground covers are also cleared twice a month especially in Site V and most of the ground cover dried during summer. Therefore, the numbers of quail species evaluated were drop throughout the summer and slightly decreased in some month when weeds were exterminated.

Angelo and Elliot, 2005 said that other than nesting and screening cover, quail need woody cover for protection from predators and adverse weather, and for loafing during non-feeding periods. Similar concept in the present study is that not only the plantation but also ground covers are the important for quails.

Birdlife International (cited by Burfield, 2004) suggests that common quail populations were depleted due to a large historical decrease,

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leading to an unfavorable population status in Europe. However, a global significant decrease was not observed. The common quail has the double category of being both a migratory species and a farmland bird (Sanderson *et al*., 2006) (cited by Puigcerver *et al*., 2012). But, no significant trend was observed for quails in Myanmar.

Certainly more research is needed and ideally more information to support quail in an around the country. Although it is very difficult to determine the population status of quails, reliable population estimates is an important step towards determining their conservation status (IUCN, 2001) (cited by Puigcerver *et al*., 2012).

The study area still supports good habitats and quail populations. Landowners should often use to try to increase quail abundance habitat management techniques and researchers need a way of estimating quail populations on their properties and monitoring population fluctuations over time. By assessing quail population trend consistently for several years, the results can indicate the trend of a local quail population and how it responds to management. So that they can be referred as a biological indication in assessing the quality of the environment

Conclusion

In the study area, there are some quail hunters working for their livelihood, and if their practice prevails there will be a time when quail population will become threatened, so that to keep the ecosystem in balance, there is a need to share knowledge not to overharvest these birds, or simply as living assets these birds have the birth right to live and strive.

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ZOL 040

Diet of Leopard Cat (*Prionailurus bengalensis*) in Western Part of Ayeyarwady Region, Myanmar

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Abstract

In order to analysis the diet from scats of felids this research was carried out around Pathein, Ayeyarwady Region during December 2018 to September 2019. Total of 169 scats were randomly collected within the study area. We get the 44 of felids scats by analysis of their hair colour, banding and texture. We used the two methods for the analysis of felid species (1) the felid's hair from the scat sample and known felid hair by comparing of their hair colour, banding and texture and (2) the felid hair cuticle from the scat sample and from known felid hair cuticle by comparing the SUMP (Suzuki's Universal Micro-Printing) method. Among 44 cat scats, 12 were identified as Leopard cat scats. Collected 12 scats suggest mammal, especially rodents, are principle prey for Leopard cat. During 360 trap nights, 11 mammalian species were detected. Only two felid species (*Catopuma temminckii* and *Prionailurus bengalensis*) were detected in the study areas. Information on diet and distribution of Felids in Myanmar is very scarce despite its importance as the stronghold of the species. A better knowledge of felid diet may be very valuable for conservation not only in Ayeyarwady region but also in Myanmar.

Keywords: Diet, Mangrove, Leopard Cat, *Prionailurus bengalensis*, Ayeyarwady

Introduction

Although the species richness in Asia is high, carnivore community is highly threatened than one in other continents (Dalerum *et al.*, 2008). Despite of the critical importance of this region for biodiversity conservation in Southeast Asia, limited research effort have been allocated for small- and medium-sized mammals. In order to conserve carnivore community, understanding niche is crucial (Creel *et al.*, 2001).

Observation of mammals can be difficult due to their nocturnal habits, elusive, and have diverse life history traits. Carnivores are particularly hard to monitor because of their large home ranges and small populations (Long *et al.*, 2011).

Camera trapping is an effective method in determining occupancy and abundance of carnivores (Thorn *et al.*, 2011), and Balme *et al.* (2007) revealed camera trapping to be more cost effective, when compared to other methods.

The presence of a large assemblage of small carnivores in an area is an indicator of rich biological diversity (Negi, 1998). Despite the importance of research on carnivore guild, carnivore research efforts were biased toward large carnivores (Brooke *et al.*, 2014). While extinction risk of Felidae does not correlate with the body size, research efforts are still skewed towards large cat (Brodie, 2009). It is urgent to study on niche among felids for conservation of carnivore community beyond focal species conservation action.

Felid species including Leopard Cat, in the class Mammalia, Order Carnivora, were generally rare, existed in low densities, and showed secretive behavior. Felids were strictly carnivorous and their feces contained large amounts of prey hairs and/or feathers. Furthermore, felids displayed a characteristic, copious grooming behavior (Malange *et al.*, 2013). In the process of grooming, shed hairs were swallowed and later appear in the feces. Therefore, the identification of guard hairs found in these feces could be an important tool to reveal the species of both the prey and the predator itself and could be applied in ecological studies (Alberts *et al.*, 2017).

The preference of any particular prey type and habitat by carnivores depend upon the reliable analysis of diet and presence of signs of predators in the respective habitat. The analysis of either stomach contents or scats and the presence of signs of predators to estimate prey and habitat preference have become the fundamental tools in carnivore research. Since information is easy to collect and does not involve destruction of animals from the study population for solitary, elusive and shy animals, prey and habitat preference have become the fundamental tools in carnivore research (Bhattarai and Kindlmann, 2018).

Recently, the application of molecular biology techniques to the study of feces allowed new approaches for the management of threatened species. Despite biotechnological progress, the basic initial diagnosis provided by morphometry and the assemblage of signs observed in the field determine the starting point for subsequent studies, and the choice of more sophisticated techniques. So, the study of fecal morphology is important for modern wildlife study (Chame, 2003).

Seton (1925) presented that fecal shape is a valuable and auxiliary consideration in specific diagnosis, and that size and food contents can sometimes separate close related species. Determining trophic relationships within an ecosystem is a key part of many ecological studies; however, obtaining reliable data on diet composition for most species is fraught with difficulties (Deagle *et al.*, 2005).

More recently, scat analysis is increasingly being used to determine the diets of many mammals. The diet of felids has been investigated through analysis of scats and stomach contents in Thailand, Malaysia, the Philippines, Pakistan,

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Japan and Korea. Understanding the diets of carnivores is essential for resolving food web interaction and the population dynamics of both prey and predators and for designing effective strategies for species and ecosystem conservation (Xiong *et al*., 2016).

As effective predators, wild felids play important roles in various ecosystems, but relatively little is known about the dietary habits of felids species in Myanmar and none has been conducted in Ayeyarwady Region. Therefore, present research was carried out with the following objectives: to investigate spatial distribution of Leopard Cat from mangrove to secondary forests, to establish method to identify species from guard hair in scats and to examine the diet of Leopard Cat form the scats.

Materials and Methods

Study Area

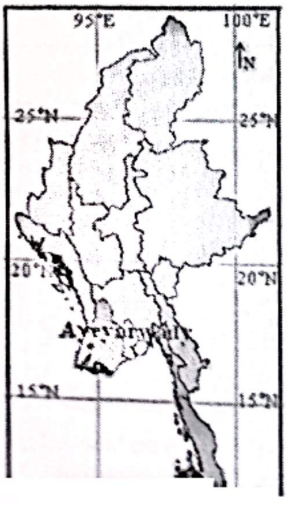
Various types of habitat were observed in Northwest Pathein such as mangrove forests and non-tidal upland forests. Large size of mangrove forests remains around Uto while biodiversity-rich evergreen forest, deciduous forest and secondary forest can be observed in Shawpyar, Seikgyi, Chaukkaung and Uto. Most area lies Chaungtha Reserved Forest and situated between Longitude: 16°58′ 07.70″ to16°56′17.23″ N and Latitude: 94°28′12.21″ to 94°39′34.55″ E (Fig. 1).

Study period

This research was carried out from December 2018 to September 2019.

Collection of Scats

Felid scats were opportunistically collected in the field. Scats were identified based on morphology and odour. Most of the felids scats shape is tubular, smooth and the pointed ends. Viverra scat is very similar shape, size, and smell with felids. Palm civet scats contains a lot of seeds and different odour from felids. When scats were collected, the date of collection and geographical coordinates of each sample were recorded (Garmin GPS) and put into plastic bag with the tags. Only complete scats were collected, i.e. scats with noticeable sections lost to weathering or insect attack were not collected. The diameter of the scats of small felids are likely to be between 10 mm and 25 mm larger than to be 25 mm is more likely to be Golden Jackal's scats (Adhya, 2015).



Diet Composition Analysis

Before analysis, maximum diameters of collected scats were measured by using vernier caliper. Firstly, the feasibility of species identification from the felid hair within scats was examined, and then, scat analysis was conducted to identify prey species. All scats washed with water over a fine wire sieve (1 mm mesh) to separate contents and remove fine particulate matter. Remaining material was dried under the sunlight to examine the contents. After dried, hair, bone, plant, feather, seed and etc. were categorized in the plastic tray by using the method of hand sorting. The prey species in the diet remained were identified (mammals, birds, lizards, snakes and plants) by compared with the some collected samples from the study area. Carnivore hair containing in the scats were identified by two methods. Firstly, hair colour, banding and texture of carnivore hairs from the scats were compared with the sample of carnivore. When these morphological characteristics were not clear, the SUMP (Suzuki's Universal Micro-Printing) method was used by examination of the hair cuticle under the microscope.

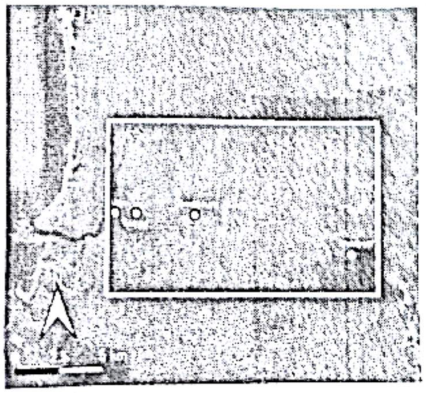
The frequency of occurrence of dietary items per scat assessment was performed with the following equation (Murie, 1944);

$$\text{FoO (\%)} = \frac{\text{the number of collected scat containing of the prey species}}{\text{total number of scats}} * 100$$

FoO (%) = Frequency of occurrence of the prey species (%)

Camera trap surveys

Camera trap survey was conducted from January 2019 to April 2019. Firstly, pre-survey was conducted to find suitable locations for camera traps based on animal tracks such as footprints and scats, and microhabitat by using motor bike and boat and walking. A total of 17 camera traps (L+I Acorn, L+I-6310WC and Recony x, Ultrafire x R6) were set up in the study area during the survey period. These cameras are capable of taking normal color still photos and 20 seconds video clips during the day and at night resulting in black and white. The cameras were set up to cover all habitat types of interest and the locations likely to be used by animals that were determined based on their scats and their footprint. Each camera was set up approximately 30 to 50 cm above ground (Plate 3.8). Camera traps were changed from one site to another site every two weeks. All camera traps were operational 24 hours per day, recorded time and date for each exposure. Photo-captured animals were identified based on Francis (2008) and Hunter (2011).



Results

Main findings from diet analysis

Total of 169 scats were collected within the study area during December 2018 to April 2019. More scats were collected from forests than from mangrove (Fig. 2 and 3). Among 169 scat samples, 44 were cat, 33 civet, 76 unidentified, and 16 no hair of carnivores by hair colour, banding and texture. Cat scat diameters were ranging from 11 to 23 mm. Cat scat diameters were not significantly different from each other ($p = 0.46471$) (Table 1). In 44 samples of cat scats, three were Leopard cat (*Prionailurus bengalensis*) scats and 18 were another species of cat scats by hair colour, banding and texture method. In the remaining 23 samples, nine samples were Leopard cat scats, 14 were another species of cat by using SUMP method (Plate 2). Scat diameter of Leopard cat range from 12 to 21 mm (Table 1). Mammals were the most frequently observed in collected scats than other taxa (Fig. 4). The hairs of felids were more softly than the hair of the civet. The colour of the Leopard cat's hair was light yellow or brownish, black and white. Among 40 scats, frequency of occurrence of the mammals (especially Bamboo rat) in the scats of Leopard cat was 100%. Frequency of occurrence of lizards was 27 % in the Leopard cat (Fig. 4 and Plate 1).

Main findings from camera traps

A total of 17 units of cameras trap were set up in four study areas. Throughout the 87 days sampling survey, 312 photographs were able to capture within 360 trap nights. These detections included 11 mammals, eight small carnivores and three herbivores species. Only two felid species (*Prionailurus bengalensis* and *Catopuma temminckii*) from camera trap were detected per 360 camera trap night in the study areas (Plate 3). Four forest types (evergreen forest, secondary forest, degraded forest and mangrove forest) were found in the study area. Leopard cat's photo was detected twenty-five photos from evergreen forest, three photos from secondary forest and mangrove forest and twelve photos from degraded forest. Leopard cat was detected at camera trap No. 2, 3, 5, 6, 10, 12, 15 and 16. The camera trap No. 2 was put on the tree in the mangrove forest closely the Uto stream. This place had a lot of mangrove plants and shrubs and less human disturbance. The camera trap No.3 was put on the pole in the human using trail. This place has small freshwater pool and a lot of big tree and a little small plant in the secondary forest. The camera trap No.6 was put on the pole in the mangrove forest and closely with the stream and mangrove plants. The camera trap (No. 5, 10, 12 and 15) was put on the tree in the trail that was using by human and closely stream with a lot of shrubs and tree. The camera trap No.16 was put on the tree in the trail with a lot of tree. This place was a lot of human disturbance. All the camera trap stations (No. 2, 3, 5, 6, 10, 12, 15 and 16) were located near the stream. Evergreen forest was easy for camera trap putting than other forest types. Camera trapping time was more in evergreen forest than in other forest types.

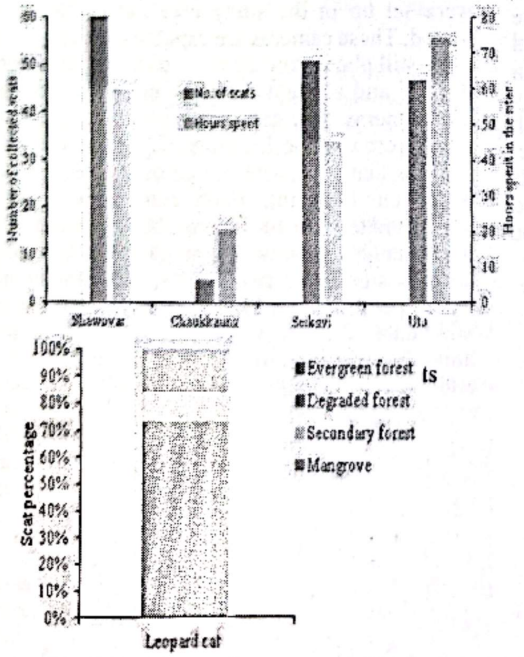


Fig. 3. Percentage of scats recorded by forest types

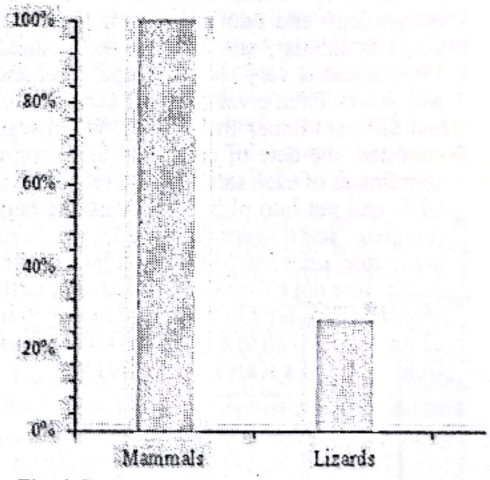
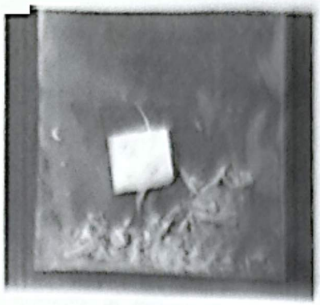


Fig. 4. Frequency of occurrence of the prey species

A. Washed scat samples



B. Prey species bones

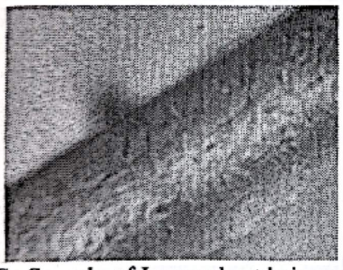
C. Prey species hair

D. Prey species scales

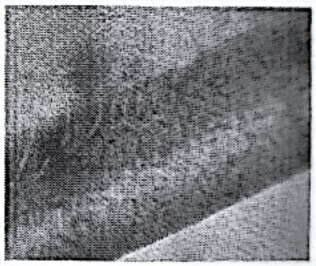
Plate 1. Sample of diet remains by hand sorting of

A. Known sample of Leopard cat hair cuticle (x1000)

B. Known sample of Leopard cat hair cuticle (x1000)

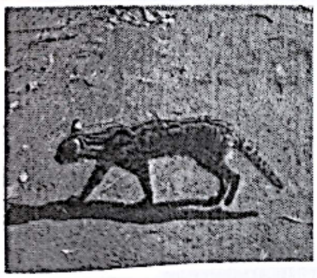


C. Sample of Leopard cat hair cuticle from scats (x1000)

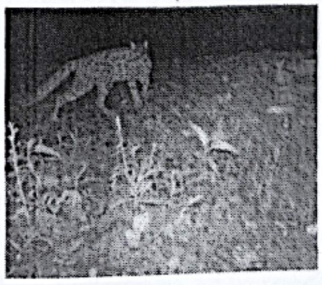


D. Sample of Leopard cat hair cuticle from scats (x1000)

Plate 2. Hair cuticle of Leopard cat



A. Leopard cat (day)



B. Leopard cat (night)

...ard cat recorded by camera trap

Table 1. List of cat scats identified by colour and SUMP methods

Cat Scat No.	Scat Diameter (mm)	Leopard cat	
		Colour Method	SUMP Method
1	21	✓	x
2	20	✓	x
3	18	x	✓
4	19	x	x
5	16	x	x
6	21	x	x
7	21	x	x
8	16	x	✓
9	17	x	x
10	16	x	x
11	16	x	✓
12	19	x	x
13	13	x	x
14	20	x	x
15	15	x	x
16	18	x	x
17	17	x	x
18	12	x	✓
19	15	x	✓
20*	13	x	x
21	17	x	✓
22	15	x	x
23	16	x	x
24	15	x	✓
25	19	x	x
26	19	x	x
27	18	x	x
28	16	x	x
29	20	✓	x
30	21	x	x
31	14	x	✓
32	15	x	x
33	13	x	x
34	22	x	x
35	23	x	x
36	15	x	x
37	17	x	x
38	19	x	✓
39	14	x	x
40	18	x	x
41	19	x	x
42	16	x	x
43	23	x	x
44	21	x	x

Discussion

Total of 169 scats were collected within the study area during December 2018 to March 2019. More than 100 scats is good number to establish species identification methods using hair morphology (colour and banding) and scat diameter (Trites and Joy, 2005). This method would contribute to researchers to study sympatric felids in Southeast Asia without DNA analysis which are often unfeasible due to facility, budget limitation, and DNA degradation of scats.

The preference of any particular prey type and habitat by carnivores depends upon the reliable analysis of diet and presence of signs of predators in the respective habitat. The analysis of either stomach contents or scats and the presence of signs of predators to estimate prey and habitat preference have become the fundamental tools in carnivore research (Bhattarai and Kindlmann, 2018).

Historically, dietary studies of a number of species relied on identifying the stomach contents of individuals that had been shot. More recently, scat analysis (nondestructive methods) is increasingly being used to determine the diets of many mammals. Thus, scats can provide a snapshot of the types of prey that were consumed by an individual animal, and have an advantage over stomach contents because of the relative ease of obtaining samples and the nondestructive nature of the sampling procedure (Trites and Joy, 2005).

Furthermore, carnivore scats have also been used to investigate population genetics, breeding biology, social ecology and spatial ecology (Akrim *et al.*, 2018)

Hence, in this research scat analysis method was chosen to identify felid species and to determine the diets of these species.

The Felidae family feces (scats) can be identified by their compact form with well-defined segments and one of the extremities especially tapered. Other families and subfamilies can be distinguished by the difference of diet remains, such as in pinnipeds and aquatic mustelids (Lutrinae), whose feces are only composed of fish, crustacean, and mollusc remains. Felid feces reflect strictly carnivorous diet. However, grass leaves ingested to aid hair elimination are also found. Fruit, seed, insect, crustacean, plant tissues, and shell fragments are commonly found in omnivorous canids, mustelids, viverids, and procyonids feces (Chame, 2003).

In this research, most collected scats were also compact form with cylindrical (sausage-shaped), with sub-divisions, tapered at one of the extremities. Diet remainedconsists of mammals and reptile.

In North America, felid feces with diameters larger than 2.5 cm (25 mm) can be identified to jaguar (*Panthera onca*) and puma (*Puma concolor*). Feces with smaller diameters are assigned to other felid species. In Brazilian Northeast a diameter larger than 2.1 cm (21 mm) is enough to separate the great felids (*P. onca* and *P. concolor*) from the

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small felids (*Leopardus tigrinus*, *Leopardus wiedii*, *Leopardus pardalis*, and *Herpailurus yaguaroundi*) (Chame, 2003).

In this study, most scat diameters ranged from 11 to 21 mm and some up to 23 mm. Thus, collected scat diameters were in the range of small felid scats.

Prionailurus bengalensis feces in Korea are easy to identify and have a diameter of approximately 1-1.5 cm (10-10.5mm) (Lee *et al.*, 2014). Mean diameter of common leopard scat was wider 1.03 ± 0.04 cm (Akrim *et al.*, 2018). In this observation, the diameter of Leopard cat showed that slightly different from previous works by having 1.2-2.0 cm (12-20 mm) and mean diameter of 1.65 cm (16.5 mm).

On the basic of scat contents and camera trap data, two species of felids Leopard cat (*Prionailurus bengalensis*) and Asiatic Golden cat (*Catopuma temminckii*) were recorded in this study area, Ayeyarwady Region.

Than Zaw *et al.* (2014) reported that Leopard cat was camera-trapped and occurred from the southernmost to the northernmost survey areas of Myanmr but not from Ayeyarwady Region.

The Leopard cat (*Prionailurus bengalensis*) is one of the most widely distributed felids in Asia. This small cat (adult weight: 1.7-7.1 kg) lives in a diversity of habitats, ranging from tropical rainforests in South and Southwestern Asia to boreal forests in North China and the Russian Far East. It can also be found in human-modified landscapes such as farmlands and in human residences (Xiong *et al.*, 2016). In this work Leopard cat was detected from rainforest and mangrove area.

The main finding of this research was two felid species (*Catopuma temminckii* and *Prionailurus bengalensis*) were detected in evergreen, degraded forest, and secondary forest, but only leopard cat was detected in mangrove.

Chua *et al.* (2016) reported based on frequency of occurrence (FOS), mammalian prey dominated found in all scats. Insects were the second most frequently consumed food group and followed by reptiles, birds and amphibians were ranked third through fifth in terms of FOS. Plants (grass) occurred in majority of scats but were not considered diet items as they passed out intact.

In this scat analysis, hairs of mammals, mainly rodents, were also dominated in the remains of diet. Surprisingly, no bird feathers was found from scats of leopard cat.

The importance of rodent prey for the Leopard cat that had been documented in this study was consistent with the results of other studies observed by Chua *et al.* (2016), Lee *et al.* (2014), Grassman *et al.* (2005) and Rajaratnam *et al.* (2007).

Conclusion

In conclusion, range of scat diameter indicated that collected scats were likely to come from different cat species and camera trap survey also detected two different felid species (*Catopuma temminckii* and *Prionailurus bengalensis*). It will provide the first information on diet of Leopard cat (*Prionailurus Bengalensis*) in Myanmar. Furthermore, information on diet and distribution of Felids in Myanmar is very scarce despite its importance as the stronghold of the species. A better knowledge of felid diet may be very valuable for conservation not only in Ayeyarwady region but also in Myanmar.

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Study on Condition Factor and Length-Weight Relationship of *Macrognathus Zebrinus* (Blyth, 1859) from Thiri Yadawar Market, Monywa

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ABSTRACT

A total of 180 specimens of *Macrognathus zebrinus* from Thiri Yadawar market, Monywa were used to investigate the condition factors and length -weight relationship during November 2017 to May 2018. Condition factors showed no significant correlation with increasing length and weight during study period. The standard lengths of the range 12.60 – 21.90 cm and body weight of the range 5.85 – 40.10 g were recorded. The results of regression exponent and correlation coefficients were observed as b = 2.98, r = 0.980 in November 2017, b = 2.82, r = 0.977 in December 2017, b = 2.43, r = 0.811 in January 2018, b = 2.55, r = 0.897 in February 2018, b = 2.98, r = 0.898 in March 2018 and b = 3.52, r = 0.899 in April 2018 respectively. These factors showed the fitness or degree of well-being of fish.

Keywords: Condition factor, Length-Weight Relationship

INTRODUCTION

All fish species play an important role in the aquatic system. More than 70% of the earth's surface is covered with water (Lagler, Bardach, Miller and Passion, 1977). Southeast Asia is one of the world's centers of abundance of freshwater fishes (Taki, 1975).

Fish was an important element in the food supply everywhere in the early Middle Ages. In all periods and at all levels of technological progress, fish has usually played an essential part in man's diets. Fish were one of primitive man's main foods in his earliest days as a food gather. The value of fish and fish waste as a fertilizer and as an animal food was known in early time (Cutting, 1999).

Some of the parameters of fish biology includes condition factor (K) and length-weight relationship (LWR). These parameters are used to assess the reproductive condition of fish.

The condition factor is widely used in fisheries and fish biology studies. This factor is calculated from the relationship between the weight of a fish and its length with the intention of describing the condition of that individual fish (Mir, Sarkar, Dwivedi, Gusain, Pal and Jena, 2012).

Condition factor (K) is quantitative parameters of the well-bing state of the fish and reflects feeding condition. This factor varies according to influence of physiologic factors, fluctuating according to different stages of the development. Differences in the condition factor have been interpreted as a measure of historical events such as fat reservation, adaptation to the environment and gonadal development. Further, the condition factor (K) is the important biological parameters with indicate the suitability of a specific water body for growth of fish (le Crem, 1951).

Length-weight relationships give information on the condition and growth patterns of fish. Condition factor studies take into consideration the health and general well being of a fish as related to its environments (Olurin and Aderibigbe, 2006).

Length-weight relationship (LWR) is an important expression has a paramount role in fishery biology as it serves several purposes. Like any other morphometric characters, the LWR can be used as a character for differentiation of changes with various developmental events in life, such as metamorphosis and onset of maturity (Thomas *et al.*, 2003).

Length-weight relationship (LWR) is of great importance in fishery assessments. Length and weight measurements can give information on the stock composition, life span, mortality, growth and production (Kumar, Singh, Binku and Devashish, 2014).

The objectives of this study were

- to investigate the condition factor and
- to evaluate length-weight relationship of *Macrognathus zebrinus*

Materials and Methods

Study site

The specimens were collected from Thiri Yadanar market, Monywa. It is situated between Latitude 22°06' 41.83" North and Longitude 95°07' 48.08" East (Plate 1).

Study period

This study was conducted from November 2017 to May 2018.

Specimen collection

A total of 180 fish was used in this study. During the study period, thirty fish were collected in each month from Thiri Yadanar market, Monywa.

Identification and classification

Species identification was followed after Talwar and Jhingran (1991).

Collection of data

The total and standard length of collected fish were measured by a plastic ruler to the nearest centimeter and weight to the nearest gram by using electronic balance.

Analysis of data

The condition factor (K) values were calculated according to Salem and Davies (1994).

$$K = \frac{\text{Body weight}}{\text{Length}^3} \times 100$$

Length-weight relationship was assessed using the following formula giving by Racker (1975) (cited by Kamaruddim et al., 2011).

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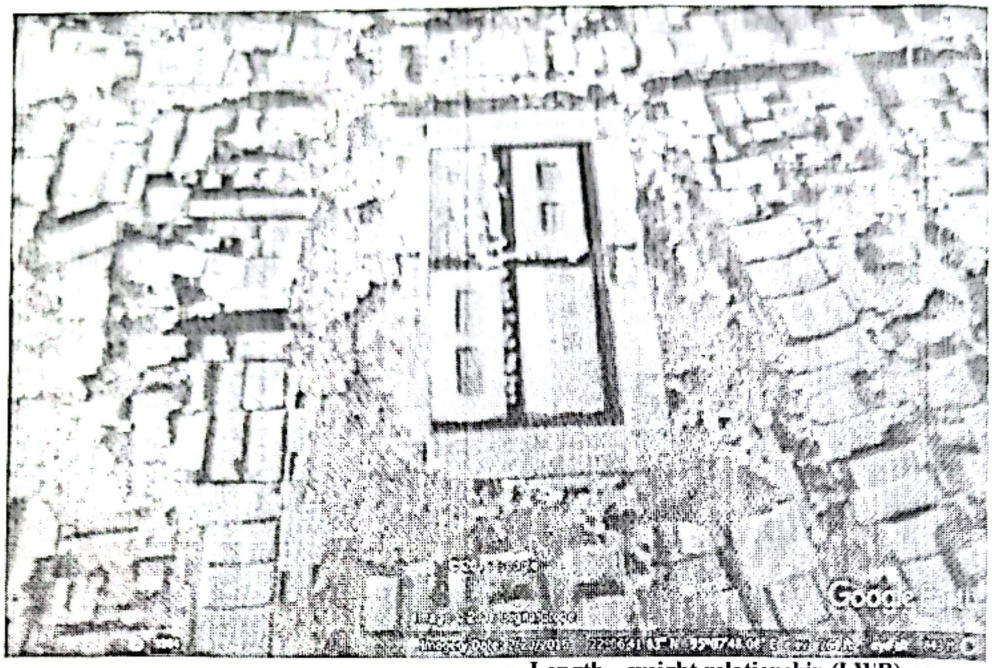
$W = aL^b$

Where W = Total body weight (g)
L = Standard length (cm)
a = Constant
b = Growth exponent

(Source: Google Earth, 2018)

Plate 1 A map showing the specimen collection site of Thiriyadanar market, Monywa



Results

Table 1 Monthly means of standard length and body weight of *Macrognathus zebrinus* from November 2017 to April 2018

Months	No. of fish examined	Standard length (cm)		Body weight (g)		Condition factor (K)	
		Range	Mean ± S.D	Range	Mean ± S.D	Range	Mean ± S.D
Nov., 17	30	12.60 - 17.80	15.60 ± 1.30	9.80 - 27.22	17.59 ± 4.50	0.39 - 0.54	0.45 ± 0.03
Dec., 17	30	12.90 - 20.20	16.12 ± 1.55	10.68 - 30.63	18.96 ± 5.27	0.37 - 0.50	0.44 ± 0.03
Jan., 18	30	15.50 - 19.90	17.10 ± 0.79	18.45 - 38.88	22.42 ± 3.62	0.40 - 0.55	0.45 ± 0.04
Feb., 18	30	16.10 - 21.10	18.32 ± 1.19	19.60 - 40.96	28.49 ± 5.62	0.34 - 0.55	0.46 ± 0.04
Mar., 18	30	16.40 - 20.30	18.36 ± 1.05	18.51 - 37.83	28.88 ± 5.10	0.38 - 0.54	0.46 ± 0.04
Apr., 18	30	15.60 - 21.90	17.95 ± 1.46	15.90 - 60.10	26.85 ± 9.88	0.28 - 0.57	0.45 ± 0.07

A total of 180 specimens belonging to family mastacembelidae were used in this study.

Systematic position of study species

Phylum - Chordata
Class - Osteichthyes
Order - Synbranchiformes
Family - Mastacembelidae
Genus - *Macrognathus* Lacepede, 1800
Species - *M. zebrinus* (Blyth, 1859).

Condition factor (K)

Monthly variations of the condition factor in studied specimens were also shown in Table 1. During study period, the lowest K value was observed in December 2017 (0.44 ± 0.03) and the highest value of K was founded in February and March, 2018 (0.46 ± 0.04).

Length – weight relationship (LWR)

Monthly means of standard length and body weight for the study specimens of *Macrognathus zebrinus were* given in Table 1.

During study period, the lowest mean value of standard length and body weight were found in November 2017 with 15.60 cm and 17.59 g and the highest length was observed in March 2018 with 18.36 cm and 28.88 g (Fig. 7).

The correlation of standard length and body weight in November 2017 to April 2018 was shown in (Fig. 1, 2, 3, 4, 5 and 6). During study period, correlation coefficient r = 0.960, b = 2.98 was found in November 2017, r = 0.977, b = 2.82 in December, r = 0.811, b = 2.43 in January 2018, r = 0.897, b = 2.73 in February, r = 0.898, b = 2.98 in March and r = 0.899, b = 3.74 in April 2018 respectively. The correlation coefficient (r) values of *Macrognathus zebrinus* during the study period were observed closed to '1'. In this study, the exponent (b) values of *M. zebrinus* were greater than '3' in April 2018 and indicated the positive allometric growth pattern. In January 2018, (b) value of that species was less than '3' and it showed the negative allometric growth pattern. In

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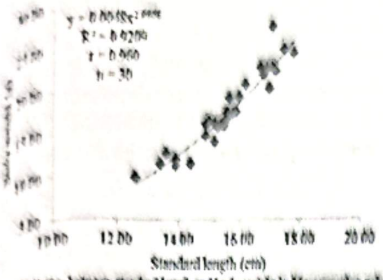
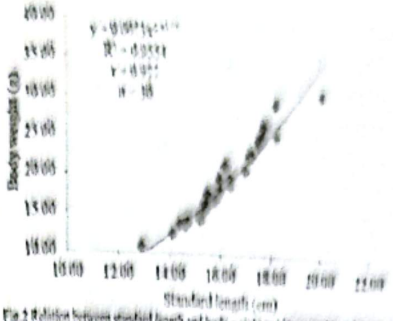
November 2017, December 2017, February 2018 and March 2018, (b) value of *M. zebrinus* was raised to '3'.





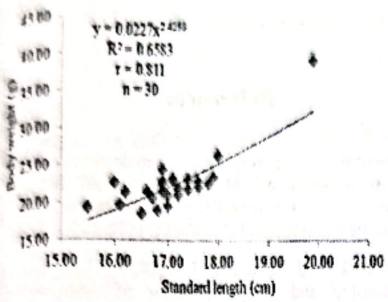


Fig.3 Relation between standard length and body weight in *Macrognathus zebrinus* in January 2018

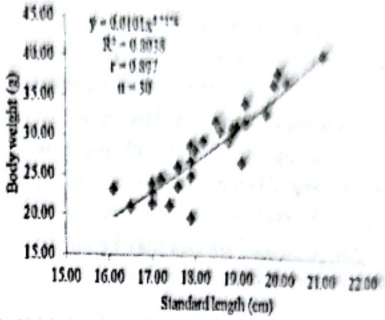


Fig.4 Relation between standard length and body weight in *Macrognathus zebrinus* in February 2018

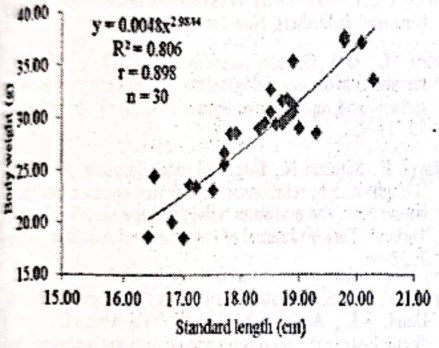


Fig.5 Relation between standard length and body weight in *Macrognathus zebrinus* in March 2018

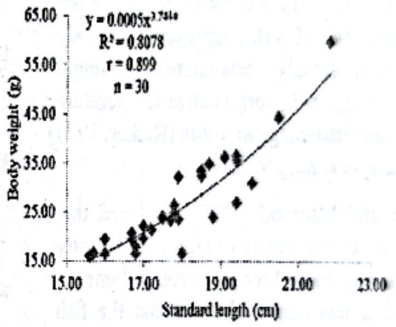


Fig.6 Relation between standard length and body weight in *Macrognathus zebrinus* in April 2018

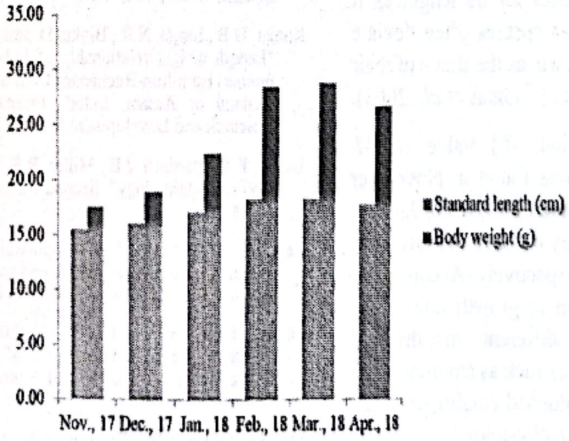


Fig. 7 Relationship between standard length and body weight of *M. zebrinus* during study period

Discussion and Conclusion

The condition index (K) has been used as a simple indicator of physical and physiological status of the fish. The value of K is influenced by age of fish, sex, season, stage of maturation,

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fullness of gut, type of food consumed, amount of fat reserve and degree of muscular development (Encina and Granado-Lorencio, 1997).

Nikos (2004) reported that fish sufficiently fed would have K equal or greater than one while undernourished fish will express K value of less than one (cited by Shakit *et al.*, 2010). Banerjee and Dutta (2016) also describe that condition factor of males ranged (0.32-0.38) and females ranged (0.34-0.42) in their study and they revealed that the condition factor in both male and female specimens exhibited a gradual decrease before spawning period and attained lowest value during the spawning season.

During study period, the condition factor (K) value ranged between 0.44 to 0.46 with mostly of around 1 and there was no significant difference in the mean condition factor of *Macrognathus zebrimus*. The finding of this research paper is similar to the finding of Dutta and Banerjee (2016). Therefore, it can be assumed that less than one in condition factor of studied species may be due to before spawning period of *M. zebrinus*.

Length-weight relationship is of great importance in fishery management, b is the coefficient of the functional regression between length and weight. Also, it is well known that the functional regression b value represents the body form, and it is directly related to the weight affected by ecological factors, such as temperature, food supply and spawning condition (Ricker, 1973) (cited by Kalayci *et al.*, 2007).

Salam and Mamood (1993) disclosed that the regression coefficient (b) value significantly larger or smaller than three indicates allometric growth, if b is less than 3 showed that the fish becomes lighter (negative allometric), if b is greater than 3 indicates that the fish becomes heavier (positive allometric) for its length as it increase in size. Most fish species often deviate from isometric (b = 3) growth as the shape of their bodies change with growth (Thomas *et al.*, 2003).

During study period, (b) value of *M. zebrinus* was b = 2.98 was found in November 2017, b = 2.82 in December, b = 2.43 in January 2018, b = 2.73 in February b = 2.98 in March and b = 3.74 in April 2018 respectively. According to Le Cren (1951) variation in growth rate of the same species during different months are influenced by many factors such as environmental factors, food supply, ecological conditions of the habitats or variation in the physiology.

Costa and Araujo (2003) stated that the value of r = 0.99 was the highest value associated with individuals that present highest weight for a given length. During study period, correlation coefficient for *M. zebrinus* were r = 0.960 was found in November 2017, r = 0.977 in December, r = 0.811 in January 2018, r = 0.897 in February, r = 0.898 in March and r = 0.899 in April 2018 respectively. This result indicates that there was a good correlation between length and weight of the fish. Therefore, it can be assumed that the length-weight relationship of that species had a good adjustment for growth. The environmental factors may be considered as suitable for proper development and wellbeing of these fishes and indicated that the species were in good conditions in their natural habitats.

Acknowledgements

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MS 001

Diversity and Distribution of Ray Fishes in Mon Coastal Water, Southern Myanmar

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Abstract

The diversity and distribution of rays collected on five fish landing sites of Mon coastal areas was studied during June 2018 to May 2019. The collected specimens were preserved and identified, based on the external morphologies and natural habitat. Samples of fishes belonging to three orders was observed, a total of 13 species of rays under six families belonging to family Dasyatidae, Rhinopteridae, Mobulidae, Gymnuridae, Narcinidae and Rhinobatidae were identified respectively. In the present study, *Brevitrygon imbricate* (Bloch & Schneider, 1801), *Maculabatis pastinacoides* (Bleeker, 1852) and *Pateobatis uarnacoides* (Bleeker, 1852) were dominant species of Mon coastal waters. *Sphyrna lewini* (Griffith and Smith, 1834), *Rhinoptera javanica* Muller & Henle, 1841 and *Glaucostegus typus* (Bennett, 1830) are found in only Zeephyuthaung station. One species of *Narcine brunnea* was found in only Sebalar station. Among the study areas, the fish landing sites of Zeeephyuthaung represent the highest species diversity of rays and the least was observed at Ahlayt fish landing sites. In addition, the local distribution and the distinctive features of each species were described.

Keywords: classification, distribution, diversity, external morphologies, Mon coastal waters, rays.

Introduction

Ray fishes spend their entire lives in close contact with the bottom, but many others spend most of their life in the water column. They are located on top of the head and can be used to draw water into the gill chambers while the fish is lying motionless on the bottom, waiting to ambush prey or avoiding predators. The pelagic rays (Myliobatidae) use their pectoral fins for propulsion and literally fill through the water with their wings. The most remarkable rays are the electric rays (Torpendiniformes) which can deliver as much as 200V from electric organs in their head. Although electric rays are rather flabby, they use electric discharge to stun the active fish that make up most of their prey. The eyes of all electric rays are quite small and a number of narcid rays are blind. Therefore, it is possible that they use electricity for navigation. Another group of rays with formidable weapons are stingrays and bat rays (Myliobatiformes). Their sting is a spine modified from a placoid scale with a venom gland at its base. The eagle rays (Myliobatidae) are closely related to the classic stingrays (Dasyatidae) and a number of species have venomus spines. In Southeast Asia, Indonesia also recorded the highest number with 101 species and 17 families followed by Malaysia (82 species; 14 families), Philippines (66 species; 18 families), Thailand (55 species; 12 families), Cambodia (54 species; 14 families), Myanmar (46 species; 11 families), Vietnam (39 species; 12 families) and Brunei Darussalam (35 species; 11 families) (Ahmad *et al.* 2013). In Myanmar, rays fisheries are mainly artisanal fisheries; it is exploited by the fishermen and the incidental catched by the other fisheries. Rays are mainly harvested by hooks and line but sometimes by the set bag net and trammel net. Large number of juvenile rays is caught incidentally by shrimp and fish trawls which remain unreported. In the present study, an attempt has been made on the rays in fish landing sites along the Mon coastal waters. The objectives of the present study are to examine of rays by observing the morphological characters of the collected specimens and to investigate the distribution of rays in the Mon coastal water.

Materials and Methods

All specimens were collected from five fish landing sites of Mon coastal areas namely, Ahlayt, Sebalar, Kyaikkhami, Setse and Zeephyuthaung during June 2018 to May 2019. During the study period, the distribution of rays was also conducted at fish landing sites. The catches of rays from inshore and offshore catches of longline and trawl fisheries were provided. In the field, the samples were washed with fresh water and then preserved in 10% formaldehyde solutions. Photographs of the external morphological structure of fishes were taken with a FUJI digital camera. The samples were arranged for analyzing in fresh condition and measured the total length (TL) by measuring board in centimeter (cm). To continue other identification, all specimens were carried out in the laboratory, Department of Marine Science, Mawlamyine University. The identification was mainly based on FAO identification sheets and catalogue for fishery purposes. Identifications were largely based upon their distinctive morphology.

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assification sys-

coastal water, Southern Myanmar

Chordata
Chondrichthyes
Order Myliobatiformes
Family Dasyatidae
Genus *Brevitrygon*
Species (i) *B. imbricata* (Bloch & Schneider, 1801)
(ii) *B. heterura* (Muller & Henle, 1841)
Genus *Himantura*
Species *Himantura uarnak* (Forsskål, 1775)
Genus *Maculabatis*
Species *Maculabatis pastinacoides* (Bleeker, 1852)
Genus *Pateobatis*
Species *Pateobatis varnacoides* (Bleeker, 1852)
Genus *Neotrygon*
Species *Neotrygon orientalis* Last, White & Seret, 2016
Genus *Pastinachus*
Species *Pastinachus stellurostris* Last, Fahmi & Naylor, 2010
Genus *Urogymnus*
Species *Urogymnus polylepis* (Bleeker, 1852)
Family Gymnuridae
Genus *Gymnura*
Species *Gymnura japonica* (Temminck & Schlegel, 1850)
Family Rhinopteridae
Genus *Rhinoptera*
Species *Rhinoptera javanica* Muller & Henle, 1841
Family Mobulidae
Genus *Mobula*
Species *Mobula japanica* (Muller & Henle, 1841)
Order Torpediniformes
Family Narcinidae
Genus *Narcine*
Species *Narcine brunnea* Annandale, 1909
Order Rhinobatiformes
Family Rhinobatidae
Genus *Glaucostegus*
Species *Glaucostegus typus* (Bennett, 1830)

Results and Discussion

The diversity and distribution of the ray fishes of the Mon coastal water, Southern Myanmar is described. A total of 13 species under 12 genera belonging to 6 families of rays were examined in the present study.

Descriptions of ray fishes in Mon coastal water, Southern Myanmar

Brevitrygon heteruru (Muller & Henle, 1841) (Fig. 2 A)

Disc almost oval, depressed; trunk thin, width subequal to length; snout broadly triangular and pointed; pectoral fin apex broadly rounded; tail base rather broad, depressed, tapering rapidly at sting; filamentous band of flat denticles on central disc wides as compared to *Brevitrygon imbricata*; No thorn on central disc; Mouth are narrow, two small papillae on floor; labial furrows moderate to weakly developed, lower labial folds and papillae feeble; Internasal flip skirt-shaped; moderately elongate, lower jaw deeply concave near symphysis; Teeth are oval-shaped, ridged transversely.

Brevitrygon imbricata (Bloch & Schneider, 1801) (Fig. 2 B)

Disc oval or rhomboidal nearly as wide as long and flat; Spiracles are much larger than eyes. Snout is narrowly triangular, it's medial lobe broad-based and elongate. Head not projecting

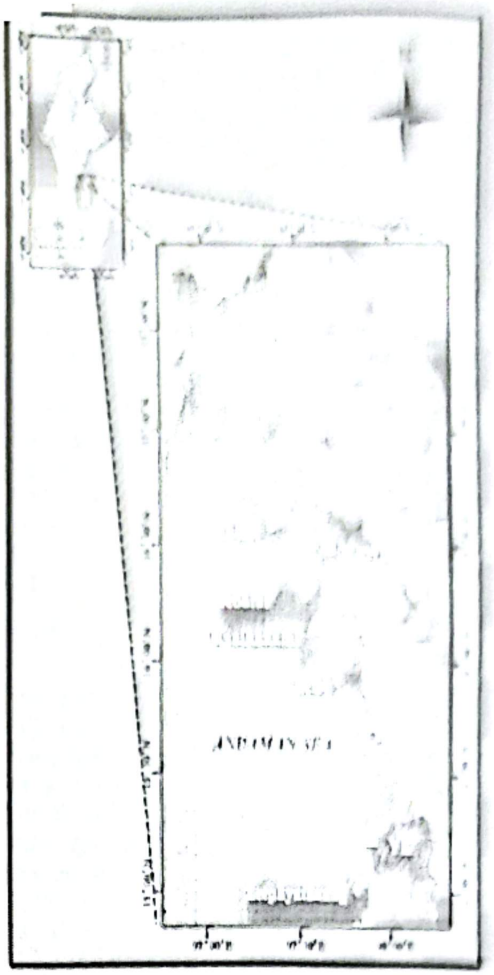

Fig.1. Map showing the collection sites of ray fishes in Mon coastal water

from disc, forming part of disc, broad and depressed. Nostrils just anterior to mouth and connected by broad nasoral grooves with mouth. Five pairs of gill openings persist on underside of front half of pectoral disc. Teeth flattened or with a central point or transverse. No dorsal and caudal fins. Tail is whip-like and fairly thick, several times longer than disc and tapering with poisonus stinging spines. Pectoral fin moderate broad and pelvic fin are small.

Himantura uarnak (Gmelin, 1789) (Fig. 2 C)

Disc rhomboidal and flat; snout broadly triangular, tip distinctly pointed; pectoral fin apex narrowly rounded; anterior margin almost straight. Internasal flap skirt-shaped, relatively short and broad, margin with fine fringe; nostrils long, narrow; lower jaw deeply concave near symphysis. Denticles low, flat, heart-shaped; in a broad band from interorbit, extending along centre of disc and onto tail density increasing with size; 2 prominent pearl thorns in centre of disc but enlarged thorns absent from midline of tail and dorsal surface of disc largely smooth.

Maculabatis pastinacoides (Bleeker, 1852) (Fig. 2 D)

Body are disc oval-shaped and flat; head broad triangular, its medial lobe broad-based and elongated; nostrils broad and eyes are very small; spiracles large and close behind the eyes; mouth are vase-shaped areas of flattened denticles medially; snout narrowly triangular, its medial lobe broad-based and elongated, snout length more than one third of disc length; dorsal surface of disc with a striking denticles along upper surface of tail to spine; scales absent; tail whip-

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like, several times longer than disc, usually with two functional sting; denticle band are very broad and tail are long.

Pateobatis uarnacoides (Bleeker, 1852)

(Fig. 2 F)

Disc subrhomboidal, trunk rather thick, width slightly exceeding length, snout narrowly triangular and moderately long, pectoral fin apex broadly rounded, greyish or brownish above and ventral surface of disc with a broad dark margin; tail very elongate and slender, whip like beyond sting, almost rounded near base, tapering gently to sting. Internasal flap skirt-shaped, short and broad, margin with fine fringe; nostrils long, narrow, not oblique; lower jaw deeply concave near symphysis. Denticles band very low, margin rounded on snout disc and a prominent pearl thorn on central disc; sometimes with slightly enlarged denticles or smaller pearl thorn adjacent, no enlarged thorns on midline of tail.

Neotrygon orientalis Last, White & Seret, 2016(Fig. 2 F)

Disc rhomboidal trunk thickened. Pectoral fins apex angular narrowly rounded in juveniles. Tail is relatively broad based and slightly depressed, selender and rather compressed beyond sting. Its length is mostly longer than disc. Lower tip and internasal flap papillate, internasal flap skirt-shaped, moderately elongate and narrow, nostrils long and narrow. Pectoral fins apex somewhat angular. Pelvic fins moderately large. Cutaneous tail folds prominent, ventral fold low, elongated, dorsal fold short, situated beyond sting, subequal in height into ventral fold.

Pastinachus stellurostris Last, Fahmi & Naylor, 2010 (Fig. 2 G)

Disc rhomboidal, trunk very thick; snout acute and narrowly triangular; apex covered with enlarged, spear-shaped denticles. Pectoral fin apexicesbroadly rounded; anterior margin almost straight to slightly convex. Internasal flap is narrow, rather elongated and lobe-like; nostrils short and narrow. Broad band of flat denticles are on central disc; band extending along mid-disc from near snout tip and onto upper surface of tail; Pelvic fins of moderate size and broadly rounded. Tail very broad-based and depressed; tapering gradually to sting; ventral cutaneous fold very well developed, terminating abruptly about two sting lengths behind sting tip; no dorsal skin fold; tip of tail filaments

Urogymnus polylepis (Bleeker, 1852) (Fig. 2 H)

Disc almost circular to oval, robust though trunk; Pectoral fin apex evenly rounded; snout broadly triangular, tip feebly pointed; anterior margin straight to slightly convex. Internasal flap is skirt-shaped, rather short and broad, margin with very fine fringe; nostrils long and narrow; lower jaw concave at symphysis. Disc surface granular, in two patches; tail base slightly depressed, tapering abruptly before sting; Tail lacking thorns; no skin fold on ventral surface of tail; pelvic fins small, relatively slender. Tail is moderately long, rather broad-based, whip-like behind sting, slightly flattened posteriorly; with 1-2 stings; no cutaneous folds.

Gymnura japonica (Temminck & Schlegel, 1850) (Fig. 2 I)

Disc lozenge-shaped, extremely flattened, much broader than long. Body is entirely naked above and below in most species but with fine denticles (no thorns) on the dorsal surface of a few large species. Head is broad and depressed; snout very broadly angular, with a short, broad fleshy lobe at tip; pectoral fin apexices narrowly rounded. Nostrils just anterior to mouth and separated from it by much less than their own widths, connected by broad nasoral grooves with mouth; Tail filamentous, very flexible and long, tail from cloaca to tip nearly as long as length from snout to cloaca; pelvic fin very small, barely extending beyond disc.

Rhinoptera javanica Muller & Henle, 1841 (Fig. 2 J)

Disc broad and short; anterior margin deeply notched behind eyes. Snout strongly notched medially to form two lobes; Head thick and broad; rostral margin deeply notched; lobe-like rostral flaps partly depressible into shallow grooves. Teeth are plate-like, 7 rows in each jaw; 3 central rows much broader than those laterally. Dorsal fin is origin distinctly behind pectoral fin insertion. Pectoral fin tips angular. Tail is elongated, tail length less than twice that of disc; dorsal fin prominent, origin just in front of pelvic fin insertion; serrated spine about equal in length to dorsal fin base.

Mobula japanica (Muller & Henle, 1841)

(Fig. 2 K)

Disc broad, short, anterior margin of disc striaight or slightly convex. Head short, distance from mod snout to fifth gill slits; spiracles slit-like and elliptical, located above disc edged; disc broad and slightly falcate. Denticle dense. There is no caudal fin and the small dorsal is placed on the base of the whip-like tail. Dorsal fin conspicuously white tipped. Small sting is present on tail base; tail long, when undamased subequal to or longer than disc width; mostly with stinging spine; anterior margin of disc straight or slightly convex.

Narcine brunnea Annandale, 1909 (Fig. 2 L)

Body thick and skin loose. Head broad and depressed; snout moderately elongated, broadly rounded; snout supported by large, anteriorly extended rostral cartilage and by anterolaterally expanded anterorbital cartilages. Pectoral fins expand and fused with head and trunk and forming a disc. Disc is shorter than tail with two dorsal fins. Origin of first dorsal fin is entirely behind the ventral fins. A pair of electric organs is in front of the disc. Two moderately large and almost equal-sized dorsal fins present. First dorsal fin originates behind near tips of pelvic fins. Caudal fin are large, about as large as pelvic fins. No dermal denticles or thorns.

Glucostegus typus (Bennett, 1830) (Fig. 2 M)

Body is disc wedge-shaped, moderately and bluntly pointed, rostra ridges separated by considerable distance throughout their length. Snout long, broad; tip broadly rounded; anterior margin almost straight. Pectoral fin tips broadly rounded. Nostrils moderate and oblique, much longer than internasal space; anterior aperture

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Table 1. Distribution and occurrence of ray fishes in Mon coastal water, southern Myanmar

Sr. No.	Species	Sat. I	Sat. II	Sat. III	Sat. IV	Sat. V
1	*Brevitrygon heterura*	+	+	+	+	+
2	*Brevitrygon imbricate*	+	+	+	+	+
3	*Himantura uarnak*	+	+	+	+	+
4	*Maculabatis pastinacoides*	+	–	+	–	–
5	*Pateobatis uarnacoides*	–	+	+	+	+
6	*Neotrygon orientalis*	–	–	–	–	+
7	*Pastinachus stellurostris*	–	–	–	–	+
8	*Urogymnus polylepis*	–	+	–	–	–
9	*Gymnura japonica*	–	–	–	–	+
10	*Rhinoptera javanica*	–	–	–	–	+
11	*Mobula japanica*	–	–	–	–	+
12	*Narcine brunnea*	–	+	+	+	+
13	*Glucostegus typus*	+	–	–	–	+
	Total	5	6	6	5	11

Sat. I: Ahlayt; Sat. II: Sebalar; Sat. III: Kyaikkhami; Sat. IV: Setse; Sat. V: Zeephyuthaung

Conclusion

In the present study, a total of 13 species of rays belonging to 6 families, 12 genera were recorded along the fish landing sites of Mon coastal waters. As an estuarine nature with a variety of fish species, the water resources in the study area are ideally suited for exploitation by artisanal fishermen using small scale fishing crafts and traditionally gear. This study can contribute to the further study of the different kinds of species and morphological characters, species composition, distribution of rays in Mon coastal waters. The further studies are needed to be done reserachers on the ecology of rays in details and future. In addition, it is also needed to conserve and manage the ray's accidental catch in Mon coastal waters.

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GEOG 001

Areal Development of East Yangon District: The Case of Dagon Myothit Townships

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Abstract

Yangon is the commercial city of the Republic of the Union of Myanmar. Thus economic activities, education and job opportunities have more favorable conditions in the city compared to the rest of the country. Consequently, population is rapidly increasing in Yangon City especially due to high rates of urbanization. The government made city extension schemes after 1989. Among them, four new Myothit townships are included within East Yangon District. The development and in these four Dagon Myothit townships such as changes of settlement pattern, economic activities and infrastructure conditions are different depending on government policy. In this paper, the following questions are analyzed: (1) what are the spatial patterns of four Myothit townships within East Yangon District? (2) When did the change of areal development conditions occur in four Myothit townships? (3) why are there different development types? And (4) which factors control the four Myothit townships in East Yangon District?

Keywords: *Areal Development, Infrastructure,* Myothit, *Condition*

Introduction

Being the commercial city of the Republic of the Union of Myanmar, Yangon is considered the centre of trade, harbour, education, health and management opportunities. It offers chances for employment, health, education, economy, culture and social well-being. The area of Yangon City was 346.13 square kilometers, and its population was more than 2.8 million before 1988. In those years the market-oriented economic system was introduced. Thus, many local and foreign investors, businessmen came to invest in Yangon City which has also led to the establishment of industrial zones. As a consequence, many job opportunities emerged, which were the pull factors for rural-urban migration. The urban characteristics and features developed simultaneously. In 2002 Yangon City came to have an area of 678.78 square kilometers and the area of East Yangon District become 365.18 square kilometers.

Since the primary means of transportation is by train rather than motor vehicles, the railroad from Yangon to Pyay has resulted in Kamaryut, Oakyin, Thamaing, Gyogone, Insein and Thanyin Gone regions which have developed into settlements. Along the Yangon-Mandalay railroad, Thingangyun and Toe Kyaung Galay, settlements developed, and along the Yangon-Mingalardone railroad and Tamwe settlements have also developed. Those settlements were just mere villages except Insein. The development of Yangon is due to those suburban settlements. However, the center of Yangon was concentrated only towards the south. The northern part from the centre is mostly occupied with lower storeyed buildings and its development was stunted due to inadequate waste treatment service and poor water distribution. Although Yangon expanded, most of its area was undeveloped suburban settlements. Hence, only the centre part was mostly referred to as Yangon City.

After 1989, the extension of Yangon City created new towns such as Dagon Myothit, Shwe Pyi Thar and Hlaing Thar Yar, In November 1989, Dagon Myothit Townships were established within Yangon City. Dagon Myothit Township was divided into North Dagon Myothit Township and South Dagon Myothit Township under the notification issued on 4 October 1990 by the Ministry Of Home and Religious Affairs. Again on 19 August 1994 Dagon Myothit (North) was redivided into Dagon Myothit (North) and Dagon Myothit (East), and Dagon Myothit (South) was redivided into Dagon Myothit (South) and Dagon Myothit (Seikkan). After that, according to the Home Ministry's Notification, No1/5/Ah Hta (2), dated (10th November 1992), Yangon Division includes East Yangon District, West Yangon District, South Yangon District and North Yangon District. These Myothit Townships are situated between Ngamoeyeik Creek and Bago River which were former cultivated low land areas with an average elevation of about 9.144 meters (30 feet) above sea level. These townships are found in different types of area development. Most of the residential area is resettled area and industrial area. According to the town plan, some land plots were distributed to departmental personal for becoming landowners and house owners. The squatters who previously lived in city suburban area also received land plots. The industries in the city area were moved to four Myothit townships. Low cost housing and residential buildings were constructed. Additionally, the land plots for departmental offices and training schools were given systematically. The area development of four Myothit townships in East Yangon District was assessed in this paper. Which factors controls the different type of areal development? In this paper, the physical factor, socio-economic factor and infrastructure factors are to be considered. In this paper, areal development is a term used to describe when population increases along with the establishment of many industrial zones in the specific study area. Furthermore, local people have increasing job opportunities in their respective townships.

I would like to use as "Dagon (East), Dagon (North), Dagon (South), and Dagon (Seikkan)", instead of Dagon Myothit (East) Township, Dagon Myothit (North) Township, Dagon Myothit (South) Township and Dagon Myothit (Seikkan) Township.

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Research Questions

-what are the spatial patterns of four Dagon Myothit townships within East Yangon District?

-when did the change of areal development conditions occur in four Dagon Myothit townships

-why are there different development types?

-which factors control the four Dagon Myothit Townships in East Yangon District?

in East Yangon District. To see the spatial pattern of the "Myothit townships" areal development, field observations were made. To know the spatial and functional changes, open talks and interviews with some residents, authority's person and private shops owners were made. Field observations support to get a clear overview of areal development in study area.

Research background

The previous study assessed the housing development, land use, socio economic conditions, water quality, water consumption, human endowment, and educational land use and distribution patterns of government schools in study area. But, most of the research paper was to study the only one township within East Yangon District. In terms of their physical factors, socio economic conditions, local people job opportunities, and infrastructure development among four townships are varied. Changes of areal development patterns depend on the various factors during 2004 and 2018.There was no research for the change in areal development pattern of the four Dagon Myothit townships. Therefore, this paper conducted the comparative study of areal development in four Dagon Myothit Townships within East Yangon District.

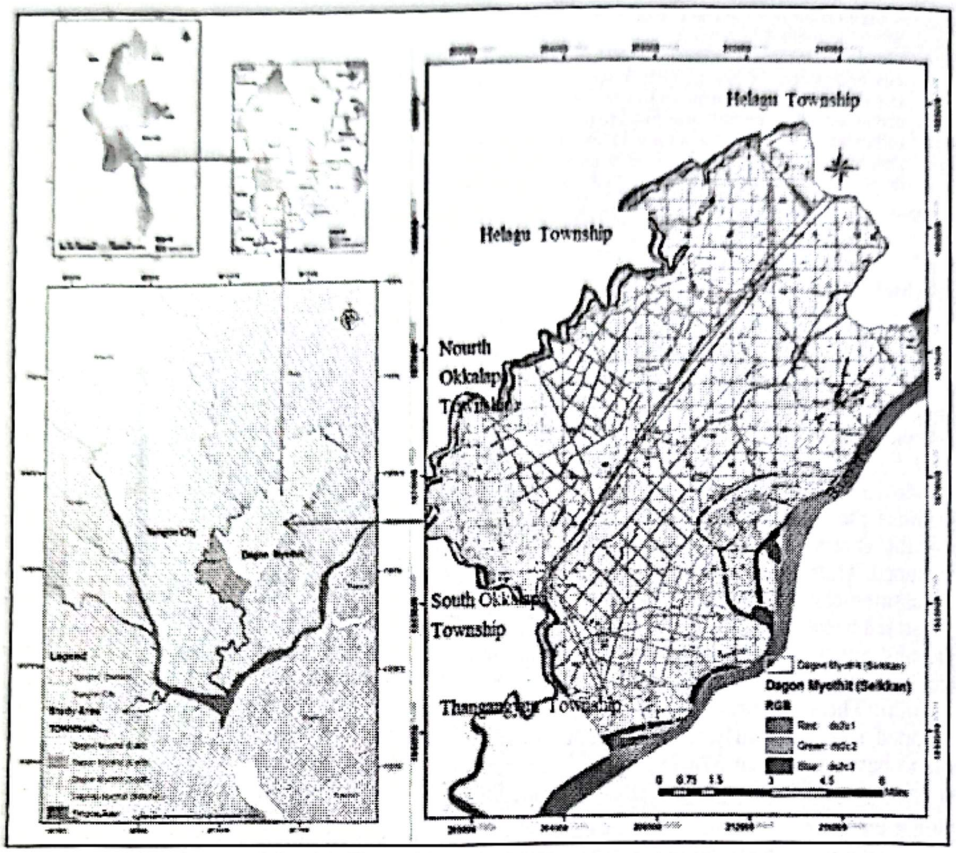

Figure (1): Location of Dagon Myothit Township in Yangon Region (Sources: Topographic map)

Study area

Dagon Myothit Township is located at the eastern part of Yangon City. It has an area of (282) square kilometer and comprised of four Dagon Myothit townships. It lies between 16°48' N and 16° 56' N and also between 96° 10' E and 96°21' E. It is included in East Yangon District which is about 17.7 kilometers from the downtown of Yangon City. Generally, it occupies the area between the Ngamoeyeik Chaung and Bago River. It is bounded by Hlegu Township on the north, North Okkalapa Township on the east, South Okkalapa Township and Thingangyun Township on the south and Bago River on the west. The climatic types of the study area are Tropical Monsoon Climate (Am) with well-defined wet and dry seasons. The soils of Dagon Myothit Township are diverse in physical characteristics and fertility (see figure 1).

Material and Methods

Primary data and secondary data are used to present areal development of Myothit townships

Results

Physical factors

In terms of physical factors, the drainage quality and the proximity between each township and the city centre were considered. Dagon (North) and Dagon (South) have relatively good locations as they are not too far from the city centre. However, Dagon (Seikkan) and Dagon (East) are located very far from the city centre with poor

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drainage conditions as it is situated relatively closer to rivers and creeks especially Ngamoyeik Creek.

Yangon City came to have an area of 792.95 square kilometers with an East Yangon District of 365.18 square kilometers (see figure 2a & 2b).

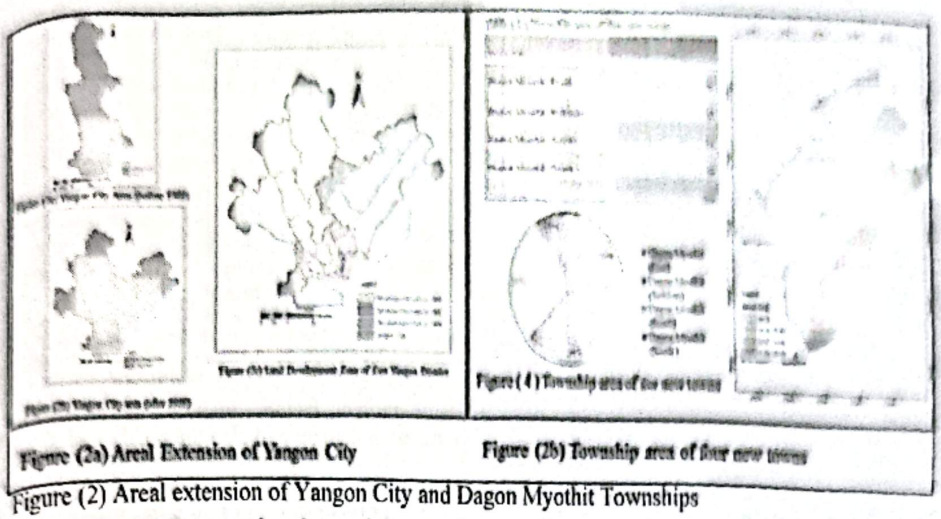

Figure (2a) Areal Extension of Yangon City

Figure (2b) Township area of four new towns

Figure (2) Areal extension of Yangon City and Dagon Myothit Townships

Sources: Land record department

Table (1) Physical condition of study area

Township	Area	Township Shape	No. of Ward	No. of Village	Length		Drainage and Climate				Soil Type
	km²				East To west	North To South	River/ Creek	Sea Level (ft)	Tempe rature	Rainfall (mm)	
Dagon Myothit (East)	91.03	Elongated	46	3	4.5 mils	9.5 mils	Nagemoe yeik Creek	30	22 °C - 36 °C	2671.8	meadow grey & swampy meadow
Dagon Myothit (North)	26.28	distorted rectangular shape	26	–	2.5 miles	4 miles	Nagemoe yeik Creek	18	22 °C- 30 °C	2616.2	Meadow grey
Dagon Myothit (South)	79.09	Elongated	26	6	3 miles	12	Nagemoe yeik Creek Maau Laydauk kan Creek	14.4	23 °C- 31 °C	2574.5	clay
Dagon Myothit (Seikkan)	85.40	Elongated	35	4	4 miles	13.25	Bago River	14.4	20 °C- 42 °C	2603.5	meadow gray & meadow alluvial

Sources: Administrative Department

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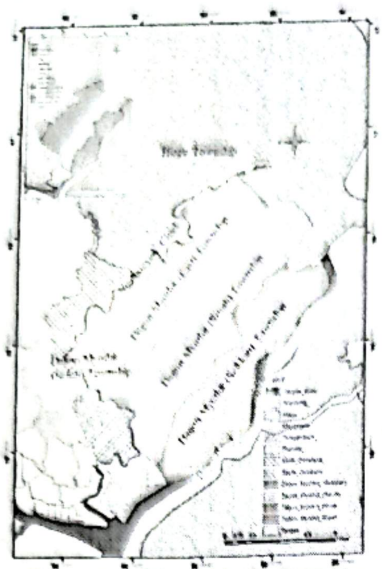

Figure (3) Location of Dagon Myothit Townships in East Yangon District

Sources: Topographic map

Among these Myothit townships, Dagon (East) is the largest area of 90.649 square kilometers, and Dagon (North) is the smallest area of 25.899 square kilometers (see figure 2b).Most of the townships have elongated shapes. In the study area, the northwest and northeastern part is bounded by Hlegu Township, Ngamoeyeik Creek and Bago River. There are floods during rainy seasons, and most of the agriculture lands are found in the northern part of the study area. The middle and southern parts are bounded by North Okkalapa, South Okkalapa, Thingangyun and Thaketa Township. Thus, residential area and multi economic activities are found.

Socio-economic factors

In terms of the socio-economic factors, the following factors were considered: population, multi econosic activities, land value, rental value, agriculture development, and job opportunities. According to the results, almost all townships have similar socio-economic characteristics except for Dagon (East): it has low land value with moderate agricultural development. However, Dagon (North) has high land value with multi-function economic activities. On the other hand, Dagon (South) and Dagon (Seikkan) have fair price of rental and land value. The two townships also have many job opportunities. Since, many industrial sectors are existed.

In this factor we will consider the demographic factor and economic activities. Demographic factors include the population, population density and also the residential density. Economic activities have also been included in the number of industrial zones, number of markets and number of retail shops in four townships.

In 2004, the highest number of populations, houses and households were found in Dagon (South). The lowest number of populations, houses and households were found in Dagon (Seikkan). In 2018, the highest number of populations, houses and households were also found in Dagon (South). And also, the lowest number of populations, houses and households were found in Dagon (Seikkan) (see figure 4).

Table (2) Socio economic condition of study area between 2004 and 2017

Township	2004		2018	
	Population Density	Residential Density	Population Density	Residential Density
Dagon Myothit (East)	1058.36	380.17	1708.1	469.50
Dagon Myothit (North)	6071..38	1714.44	7397.7	1796.79
Dagon Myothit (South)	3103.01	962.22	4025.8	1214.35
Dagon Myothit (Seikkan)	688,23	564,26	1959.0	778.77

Sources: Administrative Department

In the study of economic activities in Myothit townships area, Dagon (South) and Dagon (North) were more developed in economic activities. Less developed economic activities were found in Dagon (East) and Dagon (Seikkan).In Dagon (South) three industrial zones and nine markets were established. Moreover, the highest number of retail shops are found in Dagon (North). Land value varies depending on multi economic functions and locations. Highest land values are found in Dagon (North), second higest land value in Dagon (South), third highest land value in Dagon (East) and the lowest land value in Dagon Myothit (Seikkan) in study area.

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Figure (4) total numbers of population, houses and households in Dagon Myothit Townships

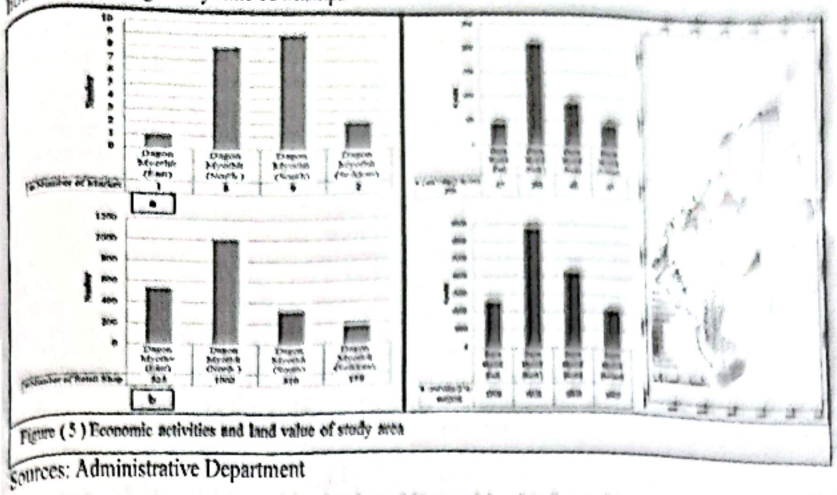


Figure (5) Economic activities and land value of study area

Sources: Administrative Department

Figure (5) Economic activities and land value of Dagon Myothit Townships

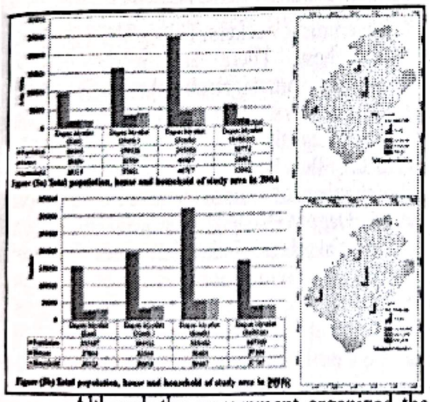
Sources: Administrative Department

Institutional factors

In terms of institutional factors, there were also many factors considered for each township especially government policy. Dagon (East) has a university and a mental hospital which really upholds the institutional characteristic of the township. Similarly, there is also a hospital in Dagon (South) as well as very good transport links. The government policies in each township differ from one another. In Dagon (North), the government policy offers land plots to government workers. The government also shifted all industrial works from the city center to Dagon (South). In Dagon (Seikkan), the government policy upholds the establishment of housing estates in this township.

Discussion

Dagon Myothit (East) Township



Although the government organized the land of Dagon (East), the township possessed low development in the early years. In 2004, only a small part of the township had reasonable development with residential areas and retail centers. After 2018, the residential area extended from the small parts in the early years to other parts of the township.

Dagon (East) also has great infrastructure facilities which have led to the betterment of electricity and transport links. The existence of Dagon University also plays an important role in the betterment of transportation. The dormitories of Dagon University, the mental hospital and railway station are also inclusive in the development progress of the township. Due to such progress, it is indeed a fact that the population has been increasing since the early years.

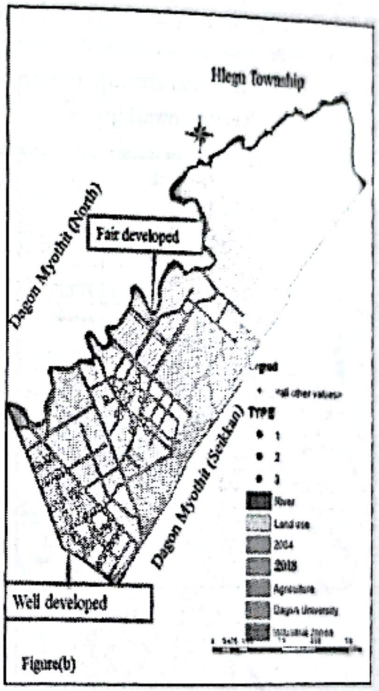


Figure (6) Areal development pattern of Dagon Myothit (East) Township

Sources: Topographic map and field survey

In the figure (4), it illustrates the number of populations, houses and households in the years 2004 and 2018. According to the records, it shows that the three factors: increased overall population from 78,472 in 2004 to 15548 in 2018, number of houses increased from 16412 in 2004 to 27804 in 2018, and households increased from 16565 in 2004 to 30123 in 2018. In the figure (5), it illustrates the number of different factories in

Dagon (East): cloth, paper, grocery, timer, electronics, drinking water and others. In Dagon (East), the highest number belongs to grocery producing factories with a total of 11. Overall, the variety of factories in this township is very well recognized. It also means that these factories create job opportunities for the local civilians. The highest populated wards in Dagon (East) are ward 1, 2, 3,4,5,6,7,8,9 and 10. The highest important economic activities are trading, agriculture and commerce. Government workers are assigned to reside in ward 133 and 156. On the right of No.7 highway road, there are agricultural activities, fish farms and chicken ranches. Flower plantation (Thapyae plants) is also observed in ward 39. Less developed wards are ward 134, 135 and 138. Bakeries and traditional medicine manufacturers are located in ward 118 and 119. Although Dagon (East) is not that economically developed, one could see the gradual development. Due to the location of Dagon University and Industrial zone, transportation and communication is decent and there are job opportunities. No.2 highway and Yangon Mandalay railroad exist in eastern part of the township. A railroad to Dagon University was made in the Southeast to the Northwestern direction in the township. There are some squatter huts on both sides of the Yangon-Dagon University railroad in the north eastern part of the township. In Dagon (East), major factors of area development are government land use such as education and health care places, industrial zones and retail shops.

Dagon Myothit (North) Township

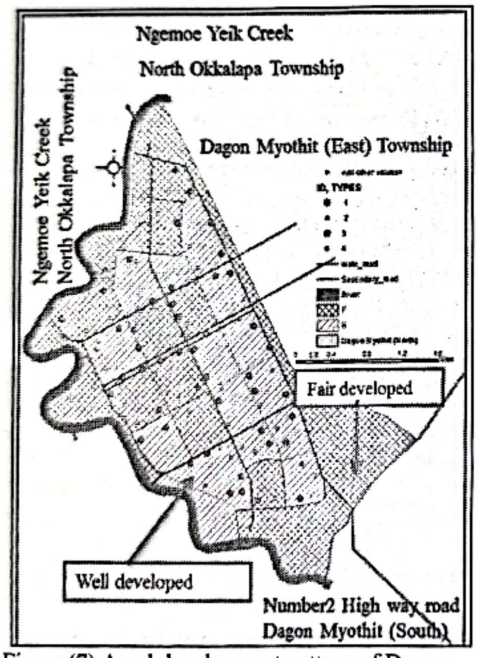


Figure (7) Areal development pattern of Dagon Myothit (North) Township

Sources: Topographic map and field survey

Generally, it occupies the area between the Ngamoeyeik Creek and No (2) Yangon Mandalay Highway. The township is connected with some other townships by creek crossing bridges. It connects with Thingangyun Township by Ngamoryeik bridge (Thingangyun). It also connects with South Okkalapa Township by Ngamoeyeik bridge (Parami) and with North Okkalapa Township by Dagon bridge and Dagon suspension bridge. It is bordering with Dagon (East), Thingangyun Township, Mayangone Township Township, South Okkalapa Township and North Okkalapa Township.

In 2004, the entire township was not developed. In 2018, development spread throughout the township with an increase in retail shops selling wood, construction materials, printing services and many more especially in the centre of the township. Nowadays, it is well-known that Dagon (North) is the most developed out of all the Myothit townships. Importantly, Dagon (North) has relatively more bridges as compared to other Myothit townships. These bridges serve as a root for good transport link and connections to other townships. In this township, ward No. 34, 35, 36, 37 and 48 are economically developed. An industrial zone, Pinlone housing, Rose garden housing and government housings existed in these townships. Low cost housings of YCDC are situated in ward 43 and 44. Minye Kyawswar housing is in ward 35. Cement industries are in ward 27. Sand trades are found in ward 41 and ward 51. Ward No.16, 49, 51 and 50 are least developed in the township. Foot-wear works are found in 31 Ward. A social association (Kyaw Thu Association) and car driving training sides are found in ward 48. The squatters live in ward 16 which is a railroad side and least developed. Ward 40 and 41 are least extended wards and government housings are found in this area. The area of the township near the river possesses sand works and shoe works. And, this area is not developed as compared to other parts of the township. The township has a huge variety of factories producing useful goods such as iron. These factories create employment opportunities for the people of this township (see figure 7).

Dagon (North) has the second largest population, housing and households. In terms of socio-economic factors, there are economic zones and industries. As an institutional factor, this particular area consists of land and residence given to government workers. This is where land value is the highest. There are neither educational institutions nor agricultural areas, and all is residential area. Dagon (North) has the smallest area among the Myothit townships In Dagon (North), the land plots of the township are systematic, and most of the township is residential area. Dagon (North) is a good location with residential areas, industrial zones and various economic activities.

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Dagon Myothit (South) Township

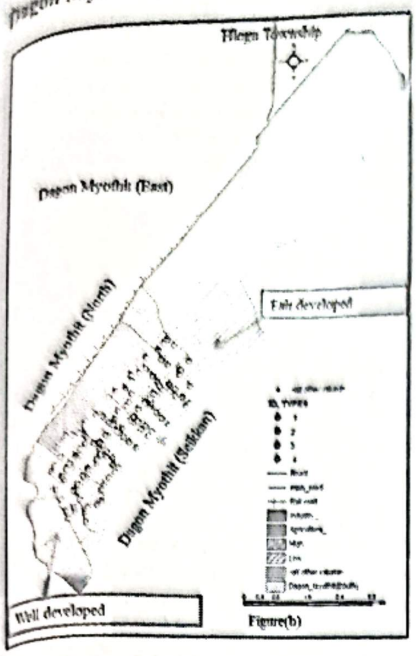


Figure (8) Areal development pattern of Dagon Myothit (South) Township

Sources: Topographic map and field survey

In Dagon (South) Township, Ngamoeyeik Creek exists in its southern part, and Yangon –Mandalay railroad and No.2 Highway is situated in its eastern and northeastern part. In 2004, the region's residential development was in the southern part of the region. There are several factors which resulted in the development. Although it was an industrial zone near to other new town areas, it still had poor road quality and wooden houses. By 2018, the area has been expanded to the northward. This is due to the area's good security reasons, good communication and transportation. The public housings have lower rent prices. It is also an industrial and economic zone with accessible health and education services.

There are a few residential quarters in its southern most northern and eastern part. The township has industrial zones such as iron melting works, steel structure works, and water pipe works as the main business works in the township. Mills and factories also exist in its southern most part. Ready-mix concrete industries and sand trades are found beside the Ngamoeyeik Creek especially. One third of the township area is residential quarters, and village tracts are found in the northern most part of the township. Iron works are found in ward 28 of Dagon (South). Services such as hotels, motels, furniture, beauty salons and fashion boutiques are found in ward 20. Building materials are also found in ward 54, 55 and 56. Ward 70 and 71 are less developed. Old houses have been renovated into shops. Ward 105, 106 and 107 are sparsely populated. The housing department has established low cost houses in these areas, and water accumulates during rainy seasons. Main commercial activities are old wood supplies, drinking water shops and domestic good trading services. There are also industrial zones. Due to the presence of industries and iron works in Dagon (South), there are also job opportunities. In addition, there are military battalions and nursing institutes on government lands. Due to good transportation, communication and existences of industries, population is gradually increasing. In Dagon (South), physical factors such as location are favourable, but in rainy seasons, there are also poor drainage systems in some wards. Although it has smaller area in comparison to Dagon (East), it has a greater number of populations, households and houses. There are also three industrial zones. This is due to higher job opportunities created from iron works and construction material manufacturing. As a socioeconomic factor these aspects were present. As an institutional factor in the past, it was a government relocated area, which was given to squatters. Land blocks were 1500 square feet in general. Dagon (South), major factors of area development is also government land use such as education, other industrial zones and developing residential areas. In Dagon (South), major factors of area development are also government land use such as education, other industrial zones and developing residential areas.

Dagon Myothit (Seikkan) Township

It is located in the eastern part of the East Yangon District. It occupies part of the lower valley of the Bago River. It is bounded by Hlegu Township in the north, the Bago River in the east and southeast, Thanlyin Township in the south, Thaketa Township in the southwest, and Dagon (South) Township in the west.

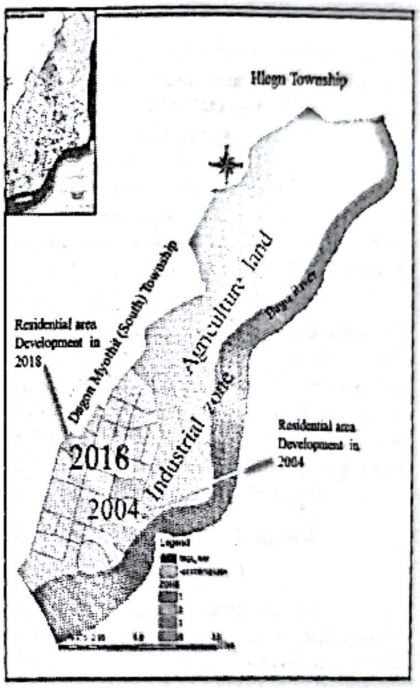
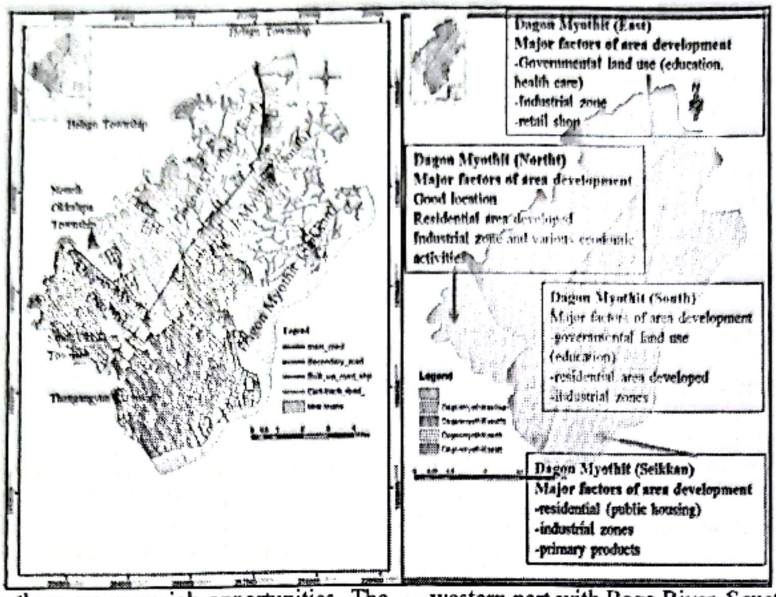


Figure (9) Areal development pattern of Dagon Myothit (Seikkan) Township

Sources: Topographic map and field survey

In 2004, there were observations of public housing projects including village settlements in the southeastern part of the region as shown in figure (9). It was expanded to northwest and southwest by 2018. This is mainly due to the increase of population. According to figure (4&5), population grew from 50611 to 167300 by 2018. Industrial zones and integrated factories within these zones resulted in the population growth. Therefore, there are more job opportunities. The industrial zones include factories for manufacturing timber, traditional medicines, oil storage and water treatment plants, etc. In 2004, the settlement area consisted of villages and ward No. 92 and 94, especially Yuzana Garden City. Ngamoeyeik water storage tank is in No.92 ward and the given water supply to the whole Yuzana Garden City Housing. This is due to presence of agricultural land and industrial zones. However, there were also poor road conditions, which hindered the growth.

In 2018, the zone expends larger towards the north and expanded around Yuzana Garden City. This is due to good security and road accessibility. There are also more abundant industrial zones and economic activities in addition to lower cost housing opportunities. In recent years, there is also observation of high cost housing projects, such as Yardanar Hnin Si housing project. Yadarna Hnisi housing project is found in No.73, 74, 75, 76, 77 and 78 quarter of the township. Dala bank village track, Nyan-bin village tract, Thayat chaung village track and Kyi su (east) village track exist in the northern most part of the township. Fish and fishery product industries are found in the Dagon (Seikan). Dagon bridge and No.1 Thanlyin bridge are found in its western part with Bago River. Squatters are found in the No.148, 149, 50 and 151ward. The industrial zones in the township have fuel oil storage works, timber works, garment factories and traditional medicine works. The villagers living in the neighboring area of the zones are working in the works mentioned above.



Dagon (Seikkan) has the third highest population, houses and households. It is situated near the Bago River, which is an area prone to floods. The river allows fish and prawn farming, which form many job opportunities. This is a typical socio-economic factor. Residential housing, industrial zones and primary products contribute towards the major factors of area development in Dagon (Seikkan). The area has relatively low population, but the ongoing government housing projects have led to rise in population.

Figure (10) Major factors of areal development pattern in Dagon Myothit Townships

Sources: Topographic map and field survey

Conclusion

This research consists of four Dagon Myothit townships: Dagon (East), Dagon (North), Dagon (South) and Dagon (Seikkan). Before 1994, there were only South and North Dagon Myothit, but after 1994, South Dagon created Seikkan Dagon, and North Dagon created East Dagon. These four Myothit townships are situated between Bago River and Ngamoeyeik creek. Therefore, these areas near the water bodies experience flood plains during rainy seasons.

In each of these areas, settlements began in regions which were close to former suburban areas such as Thingangyun, South Okkalapa, North Okkalapa and Thaketa Township. Later, these areas expanded northwards and westwards. However, in the northern most parts, there is a presence of agricultural lands and village tracks.

If we divide the entire region by half, the northern most part is mainly agricultural land. The other half consists of residential areas, industrial zones, multi economic activities including retail shops, and governmental land use in study areas. Therefore, that particular half is a Myothit area and land value or rental housings are cheaper in comparison to central business districts. This has also resulted in higher immigration rates. These residents also work in CBDs, but they work mostly within their areas. Observations show that area development pattern is different from one place to another. This is due to physical factors such as location, bounded areas, proximity to river and floods in rainy seasons. Socio economic factors

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such as population increases, houses, households, marketplaces, retail function and establishment of industrial zones also play a role.

This paper considered the three aspect of physical, socio-economic and institutional factor of the areal development of Dagon Myothit Townships in East Yangon District. Most of the Myothit Townships were established on the former agriculture land. Therefore, its area is flat plain and sometimes flooded in the rainy season. Topographic feature and connected to the other townships are also important for the areal development of Myothit Townships.

In a Myothit township, number of populations, houses and household are the important factor of area development. Moreover, local economy and urban functions are considering the major factor of areal development. Because, within Myothit township local people job opportunities are vital role of areal development.

There are also institutional factors such as government policies, education, health care and infrastructure developments. Each factor has advantages and disadvantages. These conditions created differences in areal development patterns. Most main roads and secondary roads are situated in the centre and southern part of Myothit township (see figure 10) Government policy and infrastructure development is also the essential factor of Myothit township areal development. Since, education, health care and transport accessibility is also to be considered as the other factors of Myothit townships development. Hence, the factors mentioned above should be considered in areal development.

After assessing the research paper, the order of area development is as follows: Dagon (South) is the first, Dagon South is the second, Dagon (Seikkan) is the third, and Dagon (East) is the fourth. The only developed area in 2001 was the southern part of the township area. The township possessed poor development statistics due to security issues, poor road conditions, and low population. However, positive changes gradually took place in the preceding years. These changes included good security conditions, increased population, good transport links and healthcare. In 2018, development of the township spread to the middle part of the township as well. Among the four Myothit townships, Dagon Myothit (East) has the largest area, and Dagon Myothit (Seikkan) has the smallest area. I will to change some agriculture are to residential area and places of other economic activities in Myothit townships.

Acknowledgements

I would like to express my special gratitude to Dr. Aung Win Rector, University of Myitkyina and Dr. Soe Myint Aye and Dr. Aye Aye Ko, Pro-rectors University of Myitkyina, for allowing me to do this research paper.

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GEOG 002

Production of Laung Zum (Dendrobium Species) for Making Lhaovo Ethnic Traditional Costume in Chipwe Township, Kachin State

Zaung Nyoi, Lecture, Geography Department, University of Myitkyina
Kyu Kyu Zin, Professor, Geography Department, University of Myitkyina

Abstract

"Chiphwi Township is located at the northeastern Kachin State, Myanmar. Most of the Lhaovo ethnic lived in Chiphwi Township and Sawlaw Township. The name of LaungZum orchid came from Tibetian Highlands where Lhaovo ethnic wonder around. This orchid is called "KautHninThitkwa(Glutinous Rice Orchid) by the local people. LaungZum orchid fibres are the main item in making Lhaovo traditional costumes and the original idea of the ethnic. Fibre producing process are mainly done in Chiphwi and Sawlaw, Wai Maw and Myitkyina Townships. This research presents the costumes, traditional arts of the ethnic groups that has been living in Myanmar since ancient times. And also, to preserve from the extinction of Lhaovo ethnic's art of thread making from the LaungZum orchid fibres. Finally, the art of thread making from orchid fibres is not only the treasure of the Lhaovo ethnic but it's also for Myanmar races. Therefore, both the Lhaovo ethnic and all the people living in Myanmar has the responsibility to preverse the handicraft material.

Keywords: costumes, Lhaovo ethnic

Introduction

Long stalk orchid, LaungZum orchid, plays an important role in making traditional costumes of the Kachin residing in the Northern region of Myanmar. It is said that orchids are considered worldwide as 'Queen of Flowers'. They are also called *'Lady of Canopy'* by the poets having a parasitic nature of growing on trees and cliffs.

According to the Botanical researchers, there are around 18,000 varieties of orchids on Earth. They can be classified as long stalk and of short ones and also divided in colors of red, yellow, brown, purple, blue and many more. The Lhaovo use long stalk orchids in decorating traditional garments.

Some variety of orchids could not be used for traditional costume making as they have brittle stalks unlike LaungZum orchids which have flexible stalks. Inside, there is some sticky substance, like beeswax and it is used as glue.

Adorning traditional costumes using LaungZum orchid fibre is an inheritance from Mother Nature to the Lhaovo tribe. It can be considered that the traditional clothing making process and final products are part and parcel of national treasure.

The threads made from orchid fibres can be found on Lhaovo maiden's sleeves, as well as on the head piece, skirts and bags.

The threading process from the orchid fibres are mainly done in Chiphwi, SawLaw, WainMaw and Myitkyina areas.

LaungZum orchid fibres are the main item in making Lhaovo traditional costumes and the original idea of the tribe. It is the important part of their lives and therefore detailed researches on the history of the people itself and the garments will be presented on this paper.

Location, Size, Shape and Boundary of Chipwe Township

Chiphwi Township is situated in the northeastern part of Myanmar and it comprises in Myitkyina District of Kachin state. It lies between 25°25' and 26°35' North latitudes, and 97°55' and 98° 45' East latitudes. Chipwe Township comprises Chiphwi and Panwa towns and 40 village tracks. It has an area of 1324.09 square miles(847420 acres).

Chiphwi Township is bounded by Sawlaw Township on the north, the People's Republic of China on the east, Waimaw Township on the south, and Injanyang Township on the west. (Map 1.1) . The orchid species grown in Chiphwi, Myitkyina district, Kachin state is epiphytes. It has been divided in two categories; trees of colder climates and trees of warmer climates. There are three species of orchids grown in the colder regions. All of these trees have thick barks which orchids love and therefore makes them grow easily on the trees. These three types of trees are found growing 400 to 500 metres above the sea level and can grow up to 100 to 150 feet. The orchids grow around 70 to 80 metres on the trees. All of these trees have thicker barks as they gain in age.

It is found that orchids grown in warmer climate mostly grow on hilly regions. Some species can be grown in the Central and lower parts of the country. There are also three types of orchids grown in this warmer climate. They are orchids grown on every tree.
These trees have real thick barks where many orchids grow on. The trees are 150 metres high and orchids grow around 70 metres to 300 metres above sea level.

Habitats and Characteristics of LaungZum Orchid

LaungZum orchids grown around Chiphwi, Kachin State are varied and also have different colours. Usually orchids bloom during spring but some species do bloom in rainy seasons and winter as well. Some stalks are long, and some have shorter stems. The colours are in such red, yellow, brown, purple, ivory, and many more.

Among those variants, orchids with long stalk are used to extract fibres for traditional costumes. LaungZum orchids have 16 to 24 inches long thin stalk that hang downs. The leaves are elliptical shape and at least three inches long.

These long stalk orchids are called 'KautHninThitKwa' (Glutinous Rice Orchids) by the Lhaovo. This type of orchid has distinctive quality in comparison with others. Some of the orchid species have brittle stalks and the fibres are easily broken when used. 'KautHnin' orchid of the Lhaovo are like glutinous rice; not easily broken, flexible and easy to use for decoration. Inside, there are some sticky substance like beeswax and are used as glue.

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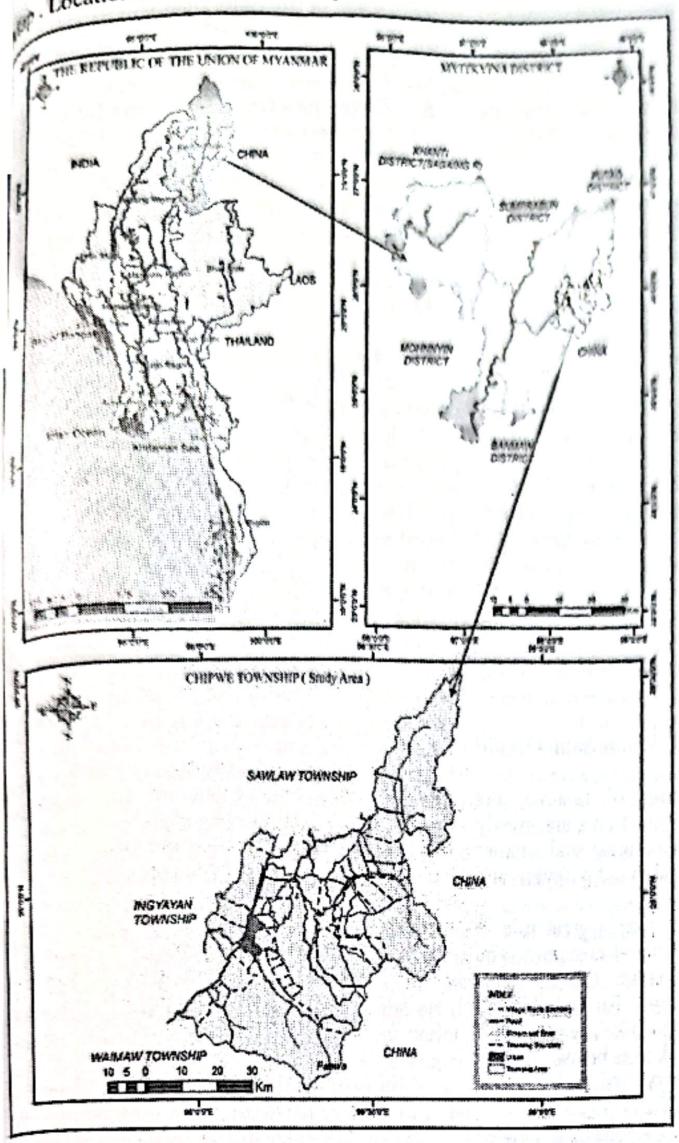
Location of Chipwe Township



Source: UTM map no 2796, 2797,2696, 2697 & 2698

Production of Laung Zum (Dendrobium Species) for Making Lhaovo Ethnic Traditional Costumes

Characteristics of LaungZum Orchid Fibre

Plate. LaungZum Orchid Plant

LaungZum orchids are harvested at two to four years of age. They are harvested when flowers are blooming and also when stalk bends down. When they are harvested beyond the above said age, the fibres become brittle and the colour of the fibre turns could turn reddish. If harvested before the time, the fibres become white.

Natural Properties of LaungZum Orchid Fibres

Among 18000 varieties of orchids, only long-stalk orchids can be used to extract orchid fibre. Even among the long stalk orchids the properties differ from one species to another.

As mentioned above, LaungZum orchids are found in two different areas; on the highland of Chiphwi and Trawled, and flatland areas of Myitkyina and WainMaw. The highland LaungZum orchids give brighter colour and better quality compared to that of flatland areas. Although different, the distinctive natural properties of LaungZum orchids are as of below.

1. Able to pollinate across one rocky cliff, one tall tree to another without falling down to the ground
2. Become richer in colour after times
3. No decolorizing over time like the dyed threads
4. Lasting colour and quality and not easily deteriorating

Processing Procedures of LaungZum Orchid Fibres

The traditional handicraft of Lhaovo; the making of thread out of orchid fibres are mainly done in Chiphwi and Trawled areas and smaller amount are made in Sumprabum, Myitkyina and Wainmaw townships.

LaungZum orchid fibres play a great role in making Lhaovo tribe's traditional costumes. The orchid that is used to extract the fibres is 'KautHninThitKwa' (Glutinous Rice Orchid), a yellow petal orchid with long stalk. The process of extracting fibre from the stalk is as below.

1. Firstly, the stalks are harvested, and they
2. are vertically cut in half
3. The beeswax like substance inside is scraped with a blade
4. The stalk shell is soaked in water till it swell and the remaining substance of the core is again scraped off.
5. The shells are dried under sunlight or heat for a day. The colour changes into yellow.
6. Upon using, the dry shells are soaked in water for half an hour and then placed on a bamboo or a cylindrical shape wood. A sharp blade is used to cut the
7. yellowish gold shell piece into required length and size.
8. The yellowish gold piece is now ready to use for weaving and decoration.

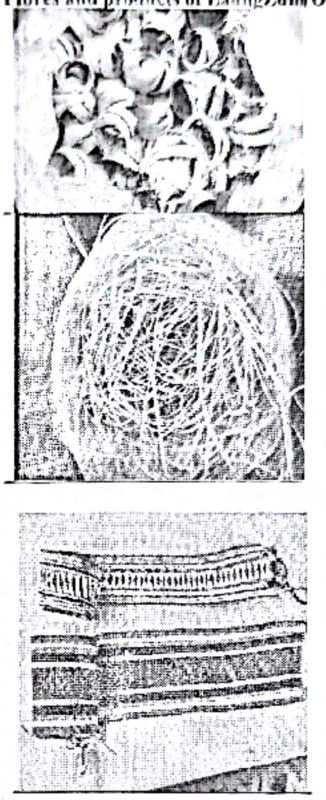
Porcupine quills are used as decorative tools. Design and patterns are sewed and weaved using the golden orchid threads on an inch black cloth using porcupine quills.

Types of Design and Patterns

The process of designing fabrics with LuangZum orchid fibres is called 'KhuKae'' in Lhaovo language and many designs and patterns could be done using the fibre. Below is the list of designs and patterns used by the Lhaovo people.

1. Bin: bu - Three string knitting pattern
2. Jh-kag" - Binding Edge pattern
3. Npyan: - Snail Trail pattern
4. Baokho' - Two string pigtail pattern
5. ZeimZhain - Three string cross pattern
6. Zhaungqid - HpaukSait (Detailed pattern)
7. Kyinghoe: - Hook knitting pattern
8. Kyihaung: - Star pattern
9. Zo: ce' - Rice grain pattern
10. Bao lam: - Four string Pigtail pattern
11. Kham pyi - ChyaHkat pattern
12. Ce' Zhao" - Layering pattern
13. Zeim Koi - Single string pattern
14. Ce' Mo" - Big Flower design pattern

Plate. Fibres and products of LaungZum Orchid



Finding

LaungZum orchids of the Lhaovo are epiphytes found growing on trees of tropical climate located just above the sea level of 400 metres. It is found that the orchids mainly grow on large trees such as Bai Chang, Mann, and Nyuk. These trees have thick barks which make it easier for the orchids to cling on. The flowers can also grow on cliffs of the Rocky Mountains.

Lhaovo traditional costumes are of black cotton cloth embellished with colorful threads. The yellow color threads on the cloths are made out of orchid fibres and the Lhaovo love the yellow stripes. Yellow is the colour of the Lhaovo and denotes three symbolic meanings to it.

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First of all, just like the golden orchids being used a noble flower that grows in certain height, humans should also be proud yet pure at heart. Secondly, one should cherish oneself like gold, and one should also stand proud for their beliefs and ideas like the unchanging value of gold.

Lastly, it represents a ray of hope to all beings just like the golden ray of sunlight. The threading process of the LaungZum orchids fibres are mainly done in Chiphwi, Trawled, Waimaw and Myitkyina townships. It is important to preserve this orchid kind that produces the main ingredients for the traditional garments.

Results

Orchid plant is growing in Chiphwi Township, Myitkyina District, Kachin State which has various colour such as white, red, yellow and purple. The orchid is valuable, and it is the traditional heritage of ethnic and region. According to the survey, most of the LaungZum orchid grown a little in Wai Maw Township and Myitkyina Township. In the past, Lhaovo ethnic are lived in the native area, Chiphwi and most of the LaungZumfibre weaving work is done as a group work in Wai Maw Town and also done at Myitkyina Town and also found at the wards in Kyun Pin Tha, Zeelun and Alegon. Moreover, according to the field survey, the native local people want to conserve the orchid tree which produce the raw material, it is learnt. By studying the traditional costume of Lhaovo ethnic, the traditional dress is varied with the period by period. But the traditional costume is become changed with the period. At the present, the modern period of ZaiWah ethnic traditional costume is similar to the Lhaovo ethnic dress. It is concluded. And later, LaungZum orchid fibreproducing tree is very rare in the study area and the native ethnic understand the value of orchid. Afterwards, they are contributing to the local people about the art of weaving fibre from orchid. At the current period, fibre from orchid weaving design is changing differently and to preserve the ethnic pride, the native pride and traditional heritage and not to be disappear the handicraft work. Therefore, it must be preserved the traditional heritage and fibre produced orchid tree to preserve the art of thread making from the LaungZum orchid tree.

Suggestion and Future Prospect

It can be seen from the researches that Lhaovo take pride and love the garments and accessories make from LaungZum orchid fibres. They also wear them to be easily distinguished from other tribes, to prevent themselves from extreme weathers and even just for beautifying themselves.

There are classes for this traditional handicraft given at the Kachin Women's Association and in other areas and the younger generations should put much effort to not just learn and master but also preserve it to prevent this art of making threads from orchid fibres from disappearing.

The art of thread making from orchid fibres is not only treasure of the Lhaovo but it's also of Myanmar citizens. Therefore, both the Lhaovo tribe and all the people residing in Myanmar have the responsibility to preserve the handicraft. The craftsman should also be encouraged not just to maintain the tradition but also to spread the art to be known worldwide. The handicraft which was once just an embellishment and ornaments of the traditional costumes should be encouraged to develop an export commodity.

The raw material is needed for the handicraft could be got from the naturally grown orchids and therefore preservation and prevention of deforestation in those forest areas should be done as well. Gardens, natural reserves and plantations should also be preserved to prevent from endangerment and extinction of the species.

The government should take part in providing law and order for the reserves, should also encourage the locals to participate in the caring and developing processes. With this being carried out, unemployment among the locals could be lessened and therefore will also increase the country's revenue.

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First of all, I would like to acknowledge to my thesis supervisor Dr. Ja Kham, Professor and Head, Department of Geography, University of Myitkyina for giving me permission to carry out this research work and to publish it paper.

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I am also grateful to the officers and service personnel from the Meteorology Department, Myitkyina, Immigration and Manpower Department of Myitkyina town and Lhaovo Cultural and Literature Convention in Chiphwi and Waimaw.

I would like to tender my thanks to all my friends (teachers) of Geography Department of Myitkyina University. I also want to express my respect and gratitude to U Nabuk Dau Lum, U Lagang Dau Hawng who had been accompanying with me in field work. Finally, I really want to say thank to my family who have been supporting me mentally, physically and financial aid through the journey of preparing this paper.

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1. မြတ်ထေးဦး(ပညာရေးတက္ကသိုလ်)
မြန်မြင်ပြင်ရောက်ရာကလော်ဝေါသွေးနှင်းများ၁၉၉၉-ရန်ကုန်
၂. အိအိမော်၊ မ (ယဉ်ကျေးမှု)ကချင်ဒေသ အဆင်တန်ဆာဆိုင်းများ၊ တအပ်ဖန်တီးမှုနှင့် မြန်မာ့ယဉ်ကျေးမှုနှင့်အနုပညာဆိုင်ရာစာစဉ်တိုးဆု
၃. မြတ်ထေးဦး(ပညာရေးတက္ကသိုလ်) လော်ဝေါ်ချုပ်ယဉ်ကျေးမှု ဓလေ့များ ၂၀၁၀ ရန်ကုန်၊ စာပေဗိမာန်ဆုရမြန်မာ့ယဉ်ကျေးမှုနှင့် အနုပညာဆိုင်ရာစာစဉ် ပထမတွဲ ၂၀၁၃ ရန်ကုန်၊ ပထမအကြိမ်စာပေဗိမာန်ထုတ်၊ပြည်သူလက်စွဲစာစောင်
၄. ဦးဝင်လွင်း၊ဦး လော်ဝေါ်စာပေဇာတိတော်တော်
လောင်ဖွဲ့သစ်ခွဲချုပ်ဆုံးနှုံးလာခဲ့ပုံနောက်ခံဝိုင်းဝန်းမှု
သမိုင်း၁၉၁၁_၂၀၁၃မြစ်ကြီးနာမြို့
၅. လှန်းအိုင်ဟောင်း၊ဦးလော်ဝေါ်စာပေဥပဒ္ဒ
လော်ဝေါ်လူမျိုးများ နေထိုင်ဆင်းတတ်လာပုံနှင့်သိသောင်းစရာ များ (၂၀၁၅ ရန်ကုန်) စာ ၁၀
၆. လော်ဝေါ်စာပေနှင့် ယဉ်ကျေးမှုအရှဲ့ ဆောင်းဆောင်းဆက်လော်ဝေါ်ဒေါ်ဖိုးရာတစ်စုံတဲ့ဖွဲ့ဖွဲ့နှင့် ဝိုင်းဝန်းမှုရှဲ့ သမ်ဖွဲ့(ဆောင်ဖွဲ့) အမြဲတြိုင် လော်ဝေါ်အလှူဆေမီးများ၏ ဝတ်စုံတွင်းဆလျဆင်မှုနောက်ခံသမိုင်း စာစောင် ၂၀၁၅ ရန်ကုန်ဝင်ဘာ ၁၈
၇. ကချင်ပြည်နယ်ပြစ်ကြီးများရှိနိုင်ငြိုနယ်ဆေးထုဆုပ်ရှင်းရေး ဦးမိုးသူး နိုင်ငြိုနယ်ဒေသဆိုင်ရာအချက်အလက်များ ၂၀၁၅ရန်ကုန်၊ ကက်တင်ကာလ ၂၅

Seasonal Diseases of Rural Health Centers in Myitkyina Township

Aye Aye Moe, Associate Professor, Dr, Department of Geography, University of Myitkyina

Abstract

Myitkyina Township has favorable geographical conditions for the development of seasonal diseases. The study area is located between North Latitudes 24° 35' 9" and 26° 10' 3" and East Longitudes 96° 40' 58" and 97° 32' 58". It is composed of 28 Wards and 17 village tracts with an area of 1188544 acres or 1857.1 square miles. The Ayeyarwady and its tributaries drain dominantly in Myitkyina Township. According to Koppen's classification, Myitkyina has a generally humid subtropical climate (Caw). The study area has a total population of 241395 persons and a population density of 130 persons per square mile. From 0.96% to8 8% of the population of rural health centers are recorded to have suffered mainly from the seasonal diseases of Diarrhea, Dysentery, Tuberculosis (TB) , and Acute Respiratory Infection (ARI) during the recent year. In this research, the researcher identifies that regarding epidemic seasons: diarrhea and dysentery cases occur mostly in the rainy season: tuberculosis cases occur mostly in the rainy season (August) and ARI cases occur mostly in the pre-monsoon and post-monsoon. As epidemic areas: diarrhea occurrence prevails yearly or periodically in water-logged settlement areas and in the wards of poor sanitation and human environment and tuberculosis and ARI occur in the wards where indoor and surrounding areas where the air is polluted. Finally, a conceived model showing the factors influencing upon seasonal diseases in Myitkyina Township is produced.

Keywords: diarrhea, dysentery, TB, ARI.

Introduction

Myitkyina Township is one of the six townships in Myitkyina District of Kachin State of Myanmar Naing Ngan in Southeast Asia. First of all, data are collected by obtaining analog data from publications, articles, departmental records, and library. Simultaneously field observation is also made by delivery of questionnaires, and personal interviewing. Detailed records on seasonal diseases are obtained from Township Health Department, Myitkyina. Secondly, collected data are processed into suitable forms with the help of GIS (Geographic Information System) and manual work. Finally, the processed data are examined by means of statistical methods and graphical methods.

Aim

The main aim of this research is to investigate the epidemic condition of seasonal diseases which is a risk to public health in Myitkyina Township.

Objectives

The major objectives of this research are

- to identify the disease-distributed areas
- to describe disease frequency by proportion ratios and rates
- to find seasonal disease determinants by means of geographical factors
- to produce an aetiological generalization on seasonal diseases.

The Study Area

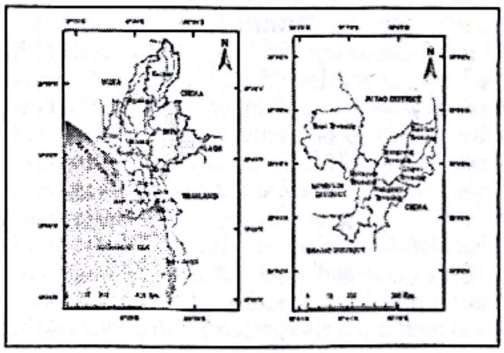
Myitkyina Township is located in the northern part of Myanmar. It is situated between North Latitudes 24° 35' 9" and 26° 10' 3" and East Longitudes 96° 40' 58" and 97° 32' 58". It is composed of 28 Wards and 17 village tracts with an area of 1188544 acres or 1857.1 square miles (Figure 1). Myitkyina is the capital of Kachin State as well as the headquarters of Myitkyina District.

Myitkyina Township is bounded by Sumprabum Township on the north, Injangyan and Waingmaw Townships on the east, Sinbo and Doghphoneyan Subtownships on the south and Mogaung, Phakant and Tanaing Townships on the west.

Myitkyina Township is long in the north-south and narrow in the east-west. Generally, it takes an elongated shape.

Generally seasonal diseases are closely connected to relief and to urban and rural residents of Myitkyina Township living here adaptable with its relief. Some of topographical locations such as water-logged areas favour the incidence of seasonal diseases in the study area. Myitkyina Township is generally mountainous in its northern part, hilly in the southern portion, and has a lowland plain in the central part. Therefore, it can be subdivided into three topographic regions: (1) southern hilly region, (2) central lowland, and (3) northern hilly and mountainous region (Figure 2).

The Southern Hilly Region is in the southernmost part of the township, particularly between the Ayeyarwady River in the east and Kaukkwe Creek in the west or in the south of the central lowland area. In this region, mountains extend parallel from north to south.



(1) Location of Myitkyina Township

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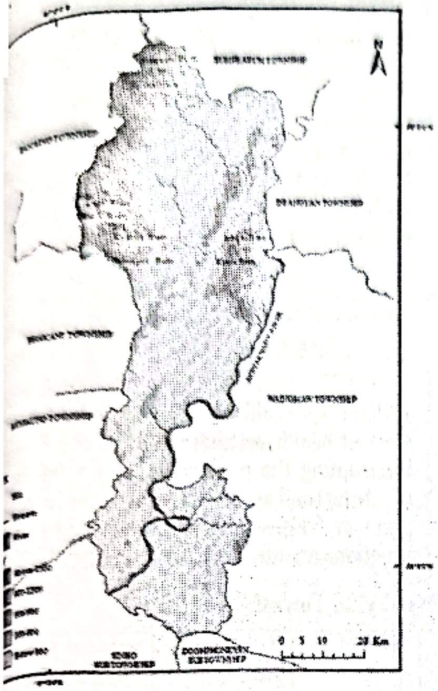


ure (2) Relief and Drainage of Myitkyina wnship

rce: Topographic Map No.92B, 92C, 92D and

The Central Lowland area lies between southern hilly region and the northern ountainous region. From north to south yitkyina plain, and Talawgyi plain are important the lowland area.

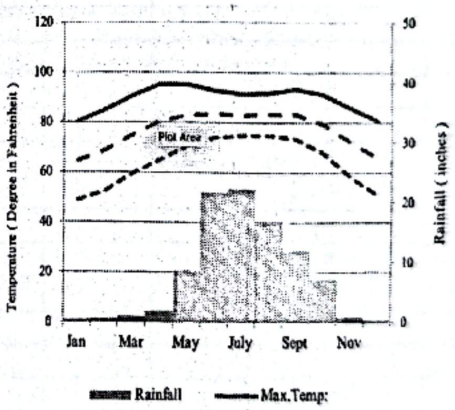
The Northern Hilly and Mountainous egion occupies the northern part of

yitkyina Township, lying at an altitude between ,000' (610m), and 7,500 feet (2,286m) above sea evel. The Ayeyarwady River and its tributaries rain dominantly in Myitkyina Township. The iver emerges from the Nmai Hka – Mali Hka river ...mence, 28.5 miles north of Myitkyina, then flows southwards for 108 miles through the township.

Climate plays an important role in the health of urban and rural residents. According to the location, the township falls in the Temperate Zone and close to the Tropic of Cancer. Due to this condition, it receives the Subtropical climate. As it is bounded by the Ayeyarwady River on the east and mountains on the west and north, the climate of all the villages resembles that of the town of Myitkyina. Lying in the Subtropical Zone of Myanmar and far from the sea, Myitkyina Township is fairly hot throughout the year, particularly in April and May. Besides, the study is situated about (600) miles north from the Gulf of Moattama (Martaban) Andaman Sea, and the climate resembles as continental climate. As Myitkyina is surrounded by high mountains, it receives more monsoon rain than Central Myanmar. Therefore, Myitkyina has a warm and a wet climate.

According to the temperature records for 30 years from 1989 to 2018, the average annual maximum, mean and minimum temperatures of the study area were 89.46° F, 76.8° F and 64.24° F, respectively. January was the coldest month with the average maximum temperature of 80.27°F and the average minimum temperature of 48.72°F. The average mean temperature was found to be 64.39° F. April was the hottest month of the year with the average maximum temperature of 95.34°F and the average minimum temperature of 65.2°F and the average mean temperature of 80.7° F (Figure 3).

The annual range of temperature was therefore, 30.14°F. During the 30-year period from 1989 to 2018, the average annual rainfall of Myitkyina was 94.36 inches. In these 30 years, the highest monthly rainfall occurred in the July with 22.27 inches and the least monthly rainfall in the month of December with 0.36 inches.



igure (3) Temperature and Rainfall Conditions of Myitkyina (1989-2018)

Months	Jan	Feb	Mar	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Avg/Total
Max.Temp:	80.27	84.94	90.70	95.34	95.04	92.57	91.37	92.00	93.40	91.29	86.05	80.57	89.46
Mean.Temp:	64.39	68.81	74.64	80.27	82.72	83.35	83.02	83.48	83.40	79.68	72.10	65.76	76.80
Min. Temp:	48.72	52.69	59.61	65.20	70.39	74.12	74.66	74.96	73.39	68.07	58.12	50.95	64.24
Rainfall	0.54	0.70	1.09	1.90	8.60	21.71	22.27	17.07	11.94	7.30	0.92	0.32	94.36

Source: Meteorology and Hydrology Department, Myitkyina.

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According to Koppen's classification, the 30-years data from 1989 to 2018 show that Myitkyina has a Cwa type of climate or Humid Subtropical.

Population plays an important factor in the development of an area. The total population and population growth of a region help greatly in the study of economic development.

According to 1973 census, the total population of Myitkyina Township was 104,156 and 153,061 in 1983. Thus, during the 10-year period from 1973 to 1983 the population of the study area increased by 48,905 with annual growth rate of 3.2 per cent per year (Table 1).

Table (1)Population and Population Growth of Myitkyina Township(1973-2018)

Year	Population	Increase	Growth Rate
1973*	104156		
1983*	153061	48905	3.92%
1993	181785	28524	1.73%
2018	241395	59610	1.30%

*Census

Source: Immigration and National Registration Department, Myitkyina.

In 1993, the total population of Myitkyina Township was 181,785 persons. When compared to 1983, the total population increased year by year. In 2018, the total population of Myitkyina Township was 241,395 persons. During the period from 1993 to 2018, the increase was 59,610 persons with an annual growth rate of 1.3 per cent per year.

Population distribution varies from one village to another. The variation in population distribution depends on topography, the availability of communication and economic activities. In Myitkyina Township, areas along the motor road and railroad in flat plain areas are densely populated whereas the mountainous and forested areas are found to be sparsely populated (Table 2 and Figure 4).

In 2018, the total population of Myitkyina Township was 241,395. 78 per cent live in the urban area of Myitkyina and the remaining 22 per cent are dispersed among the 17 village tracts. In that year; Rampu was the Ward with the largest population numbering 18,786, that is 7.78 per cent of the total population of Myitkyina Township. Sankin was the village tract with the least population with 545 persons which 0.23 per cent of the total population.

Seasonal Diseases Common of Rural Health Centers in Myitkyina Township

"Disease" is defined as "a condition in which body health is impaired, a departure from a state of health, an alternation of the human body interrupting the performance of vital functions" (Webster) and as "a condition of the body or some part or organ of the body in which its functions are disrupted or deranged"

Table (2) Population Distribution and Density of Myitkyina Township (2018)

No	Wards/ Village Tracts	Sq.miles	Area (Acres)	Household	Number of Population	Population Density (per square mile)
1	Ayer	0.49	314	727	3335	6806
2	Kachinsu	0.16	100	318	2667	16669
3	Shansu (North)	0.10	66	201	2419	24190
4	Shansu (South)	0.11	70	144	2395	21773
5	Myoma	0.10	62	163	2179	21790
6	Minyat	0.07	44	115	2123	30329
7	Myothit	0.09	56	249	2273	25256
8	Thida	0.38	240	422	3542	9321
9	Dukataung	0.55	352	882	6765	1230
10	Shwenyaungpin	0.32	203	1150	8302	25944
11	Khemarthiri	0.33	212	957	7071	21427
12	Yuzana	0.31	201	839	5523	17816
13	Myemyint	0.25	161	787	4980	19920
14	Yangyaung	0.24	154	833	5383	22429
15	Kyungpintha	0.25	157	928	5554	22216
16	Ayesedi	0.19	123	782	5888	30989
17	Aungnan	0.23	149	1176	5669	24648
18	Sitapru	2.63	1681	2540	15216	5786
19	Myothitkyi	1.82	1162	3196	16947	9312
20	Rampu	2.23	1430	3721	18786	8424
21	Lekone	3.95	2528	3157	17446	4417
22	Mankhein	4.26	2725	1112	5800	1362
23	Tatkone	7.21	4615	3087	17956	2490
24	Shwesat	2.52	1614	1242	6596	2617

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	Wards/ Village Tracts	sq m....	(Acres)	Household	Number of Population	Population Density (per square mile)
32	Kyetpaungchan	3.07	1965	669	4472	1457
33	Panmati	6.59	4220	1489	7156	1086
34	Shweaik	1.07	685	87	1144	1069
35	Shwepyitha	0.72	459	187	1262	1753
36	Tayaungzup	254.76	163044	122	737	3
37	Injit	328.79	210425	56	747	2
38	Tanghpre	403.41	258185	21	2124	5
39	Alam	84.45	54049	722	4254	50
40	Naungnan	11.50	7358	1239	6435	560
41	Palaw	46.89	30010	893	5103	109
42	Namjin	55.90	35777	216	1749	31
43	Nankwe	142.94	90839	1194	4988	35
44	Mawhpawng	30.52	19530	1077	5746	188
45	Shadaung	15.28	9780	306	2316	152
46	Akye	37.00	23678	495	2661	72
47	Loikhaw	38.93	24913	580	3185	82
48	Khaungphuywathit	36.59	23418	268	1332	36
49	Khaungphyywahaung	8.38	5366	197	1360	162
50	Hokat	117.60	75264	254	1370	12
51	Talawgyi	186.39	119287	1360	7894	42
52	Sankin	18.55	11873	130	545	29
	Total	1857.10	1188544	40290	241395	130

Source: Immigration and National Registration Department, Myitkyina.

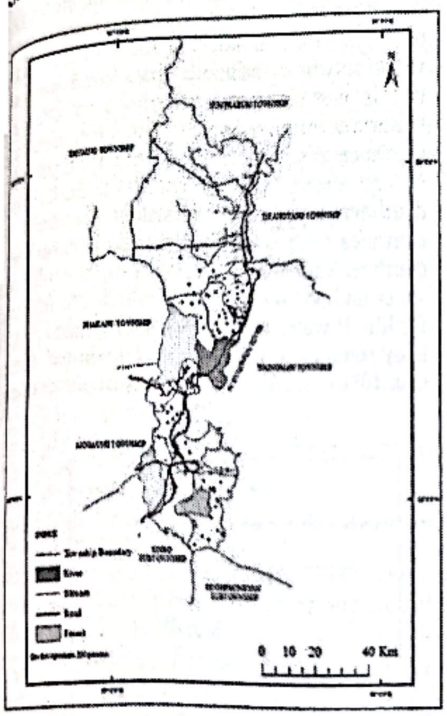

Figure (4) Population Distribution of Myitkyina Township (2018)

Source: Land Management and Registration Department, Myitkyina.

(The Oxford Dictionary). The simplest definition is, of course, that disease is just the opposite of health which is a state of complete physical, mental, and social wellbeing and not merely an absence of disease or infirmity (WHO, 1948). According to Susser (1983) (Page 105, Reference), disease is a physiological/ psychological dysfunction. Literally, the term disease means "without ease (uneasiness) or the opposite of ease – when something is wrong with bodily function." According to (Ayurvedic Standards), there are three different types of diseases: **seasonal diseases, natural diseases, and external diseases.**

Seasonal diseases are those that occur due to seasonal changes. The diseases are caused due to cold, heat, rain, snowfall, etc. Most of these diseases are epidemic in nature such as malaria, cholera, typhoid, pneumonia, gastroenteritis, etc. Sunstrokes are also climatic, so they are put in this category. Individual diseases such as dysentery, eczema, ringworms, common cold, etc. will be classified as seasonal diseases.

Natural diseases are the results of destructive natural occurrences such as disasters involving the earth, water, atmosphere, fire, etc. Even accidents and sudden deaths are included in natural diseases according to astrology.

External diseases are all caused by external agencies. Wounds, injury, and problems with spirits, hallucinations, etc. are external diseases.

Seasonal diseases to be studied in this research include the diseases that occur not only in summer, winter, and the rainy season but also in pre-monsoon and post-monsoon periods, i.e., in transitional periods between the seasons. Diseases which mostly occur in Myitkyina Township are diarrhoea, dysentery, tuberculosis, ARI, malaria, snake bite, measles, typhoid, pneumonia, influenza, whooping cough, rabies, food poisoning, trachoma, viral hepatitis, and chicken pox (Township Health Profile, 2016, 2017 and 2018). Of these seasonal diseases, the four former diseases are studied in emphasis.

Health Care Taking

In Myitkyina Township, healthcare-taking on various diseases is being carried out by healthcare staffs of various levels of Government and Private Health Centers. In the entire township, there are one 500-bedded General Hospital, one 100-bedded Narcotic Hospital, One Army

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Hospital, 5 Rural health Centres (RHC), 21 Sub-Rural Health Centres and six private hospitals,- Kyayzutaw, Santhawda, Malizug, Myatmon, Thidaku, and Ayethukha Hospitals (Table 3 and Figure 5).

Seasonal Diseases of Rural Health Centers in Myitkyina Township

A constant epidemiological surveillance of disease outbreak and control of communicable diseases is being undertaken nationwide. Activities for controlling communicable diseases that have regional importance are also to be tackled through activities encompassing surveillance and control. Central Epidemiology Unit (CEU) is responsible for the surveillance and control of communicable diseases classified in two broad categories viz principal epidemic diseases such as severe diarrhoea (Cholera), dengue haemorrhagic fever, plague, HIV/AIDA. Meningococcal disease is designated as epidemic prone disease and needs to be reported immediately.

Seventeen Diseases and conditions are put under national surveillance. Diarrhoea diseases such as diarrhoea, dysentery, food poisoning, typhoid and paratyphoid and vaccine preventable diseases such as measles, neonatal tetanus, other tetanus, diphtheria, and whooping cough are included in the list. Central Epidemiology Unit is also responsible for surveillance of new emerging diseases like avian influenza, acute flaccid paralysis (AFP) and Adverse Events Following Immunization (AEFI) surveillance as well as outbreak investigation, rapid response and control activities for all epidemic prone communicable diseases. Related to disease surveillance some of the major challenges are sporadic disease outbreaks which occur in some areas including highly pathogenic Avian Influenza Infection, probably causing human infection, outbreak among poultry farms. The skill of basic health staff in early detection, reporting and response activities for control of communicable diseases need to be further strengthened, including public awareness programs for communities.

In Myitkyina Township, classified as disease under surveillance was seventeen in number. They are diarrhoea, dysentery, food poisoning, typhoid, measles, diphtheria, whooping cough, neonatal tetanus, tetanus (other), meningitis, acute respiratory infection (ARI), viral hepatitis, rabies, malaria, snake bite, tuberculosis (TB) new smear (+) (-) and extra (TB), and anthrax. All diseases or conditions that particularly affect large population groups leading to either death or disability are generally termed as "public health issues". Social expectations and awareness of the importance of development and its relationship with health had increased rapidly in the study area.

In Myitkyina Township, diarrhoea, dysentery, tuberculosis and ARI are more common seasonal diseases. These diseases occur at different time of the three seasons and differ from place to place. Although there are seventeen common diseases in the township, based on the data collected from the Township Health Department and observation in the Rural Health Centers (RHC), the major common diseases of diarrhoea, dysentery, tuberculosis and ARI are studied.

Table (3) Rural Health Centers and Sub-Rural Health Centers in Myitkyina Township

Sr.	Rural Health Centers	Sub-Rural Health Centers
1	Manhein	1. Sitarpu 1 2. Sitarpu 2 3. Western Lekhone 4. Shweset 5. Zeehat
2	Naungnan	1. Namjin 2. Tetkone 1 3. Tetkone 2 4. Palana 5. Yeinkhaw 6. Kyaryarpall
3	Talawgyi	1. Ywathit 2. Hokat 3. Hkaunghpu
4	Tanhpee	1. Alam 2. Hyanzhut
5	Mawhpawng	1. Lwekhaw 2. Namkol 3. Mollidu 4. Pamati 5. Ayemyatharyar

Source: Township Health Department, Myitkyina.

Diarrhoea

Diarrhoea is an infectious disease that is spread via contaminated water or food. The disease may occur after flood or during drought period (War Win Htike, 2007), and is both epidemic and endemic (WHO, 1999).

Diarrhoea is the passage of watery stools, usually at least three times in a 24-hour period. However, it is the consistency of the stools rather than the number that is most important. Frequent passing of formed stools is not diarrhoea. Babies fed on only breastmilk often pass loose, pasty stool; this is not diarrhoea. Diarrhoea is caused by bacteria or viruses. According to the clinical types, diarrhoea diseases can be classified into four: watery diarrhoea (cholera if acute), bloody diarrhoea (dysentery), persistent diarrhoea, and diarrhoea with severe malnutrition. Any type of diarrhoea causes dehydration or rapid depletion of water and sodium - both of which are necessary for life. If water and salt are not replaced fast, the body starts to "dry up" or get dehydrated. If more than 10% of the body's fluid is lost, death occurs.

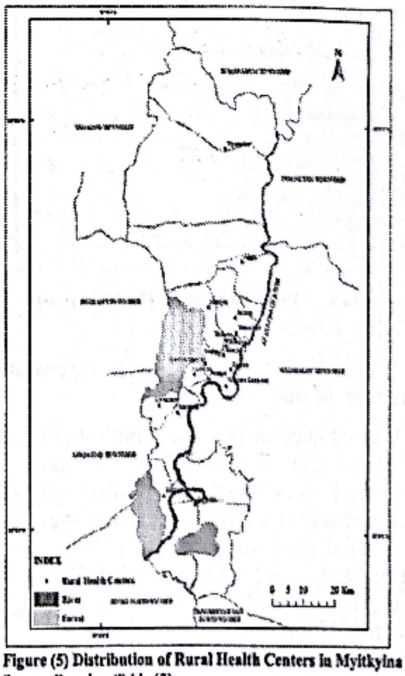

Figure (5) Distribution of Rural Health Centers in Myitkyina Township
Source: Based on Table (3)

As to the ...
...ntal data, it is found ...
...nually in Myitkyina Township (Table 4 ...
...ure 6).

...(4) Diarrhoea Cases Occurred in Myitkyina Township (2016~2018)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
[illegible]	91	115	96	156	140	352	301	145	121	78	101	74
[illegible]	101	96	96	57	90	185	141	104	83	78	64	51
[illegible]	114	100	88	128	141	191	206	162	90	70	56	50
[illegible]	306	311	280	341	371	728	648	411	294	226	221	175
[illegible]	102	104	93	114	124	243	216	137	98	75	74	58

...: Township Health Department, Myitkyina.

The figure shows that diarrhoea cases ... in not less than 50 patients every month of ...ears observed and that the cases have been ...sing year after year. In 2018, it prevailed in ... people, of which 830 were children in age ...er than 5 years. Of 830 patients, 47.47% ...red in Naungnan RHC area, 19.28% in ...khein RHC area, 13.01% in Mawhpawng ... area, 11.08% in Talawgyi RHC area, and ...% in Tanhpre RHC area.

Dysentery

Regarding dysentery cases, 332 dysentery cases occurred in 2016, 244 dysentery cases in 2017 and 221 dysentery cases in 2018. This dysentery case usually occurs in the places and in the season of diarrhoea of Rural Health Centers in Myitkyina Township. On monthly average (during the three observed years) it accounted for 22 dysentery patients (Table 5 and Figure 7).

...le (5) Dysentery Cases Occurred in Myitkyina Township (2016~2018)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2016	23	11	24	25	30	36	44	42	19	25	35	18
2017	18	19	28	12	29	22	37	34	16	17	5	14
2018	16	21	6	22	22	31	28	25	15	15	12	15
Total	57	51	58	59	81	89	109	101	50	57	52	47
Avg	19	17	19	20	27	30	36	34	17	19	17	16

...urce: Township Health Department, Myitkyina.

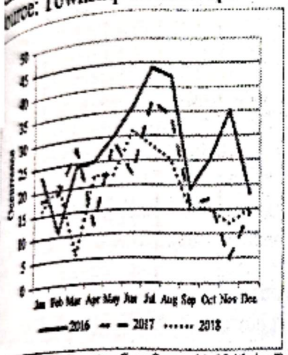

Figure (7) Monthly Dysentery Cases Occurred in Myitkyina Township (2016~2018)
Source: Based on Table (5)

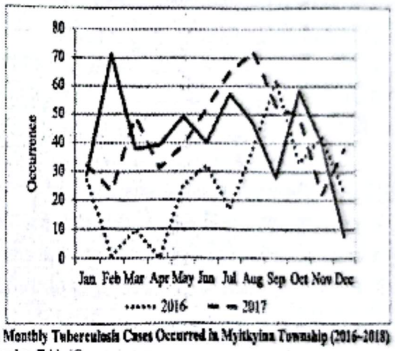

Figure (8) Monthly Tuberculosis Cases Occurred in Myitkyina Township (2016~2018)
Source: Based on Table (6)

than 446 people have suffered TB every year and about 37 people in every month during the 2016-2018 years Table (6) and fluctuating in the observed years, for instance, 310 cases in 2016, 525 cases in 2017 and 504 cases in 2018.

Table (6) Tuberculosis Cases Occurred in Myitkyina Township (2016~2018)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2016	27	1	10	0	25	32	17	38	62	33	42	23
2017	32	23	49	31	39	52	65	72	53	49	22	38
2018	29	71	38	39	49	40	57	47	28	58	40	8
Total	88	95	97	70	113	124	139	157	143	140	104	69
Avg	29	32	32	23	38	41	46	52	48	47	35	23

Source: Township Health Department, Myitkyina.

Regarding spatial distribution 65.48% of the total TB cases prevailed in Mankhein RHC area, 25.4% in Naungnan RHC area, 8.73% in Tanhpre RHC area, and 0.4% in Talawgyi RHC area.

Acute Respiratory Infection (ARI)

Acute respiratory infection (ARI) is the most common human ailment. Many of these

infections run their natural course in older children and in adults without specific treatment and without complications. ARI may cause inflammation of the respiratory tract anywhere from nose to alveoli with a wide range of combinations of symptoms and signs. ARI is often classified by clinical syndromes depending on the site of infection and is referred to as ARI of upper (AURI) or lower (ALRI) respiratory tract. The clinical features include runny nose, cough, sore throat, difficult breathing and ear problem. Fever is also common in ARI. According to the WHO estimates, every year ARI in young children is responsible for an estimated 4.1 million deaths worldwide. It is estimated that Bangladesh, India, Indonesia, and Nepal together account for 40 per cent of the global ARI mortality. About 90 per cent of the ARI deaths are due to pneumonia which is usually bacterial in origin. The incidence is due to high prevalence of malnutrition, low birth weight, and indoor air pollution in developing countries (Park, 2001). In general, rates tend to be high in infants and young children, and in the elderly in all countries. In this research, epidemic season, and age group suffering from ARI in the township are investigated.

As to the field data and the health departmental data, it is found that more than 94 people have suffered the ARI every year and about 8 people in every month during the 2016-2018 years Table (7) and Figure (9). According to the table and figure, it is found that the ARI cases have been lessening year after year, for example 167 cases in 2016, 62 cases in 2017 and 53 cases in 2018.

Spatially 45.28% of the total ARI cases prevailed in Talawgyi RHC area, 37.74% in Menhkein RHC area, 11.32% in Mawhpawng RHC area, and 5.66% in Tanhpre RHC area.

Table (7) ARI Cases Occurred in Myitkyina Township (2016~2018)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2016	9	10	32	5	8	5	24	31	15	47	6	4
2017	3	5	6	4	4	14	13	3	1	1	5	1
2018	3	1	3	6	7	4	15	3	1	1	8	1
Total	15	16	41	15	19	23	52	37	17	49	19	6
Avg	5	5	14	5	6	8	17	12	6	16	6	2

Source: Township Health Department, Myitkyina.

Analysis on Seasonal Diseases of Rural Health Centers in Myitkyina Township

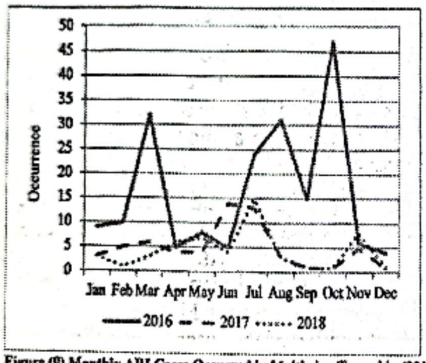

Figure (9) Monthly ARI Cases Occurred in Myitkyina Township (2016~2018)
Source: Based on Table (7)

Seasonal disease conditions of Myitkyina Township are studied by examining of four seasonal diseases commonly found in the township, using temporal and seasonal analyses.

Analysis on Epidemic Seasons of Seasonal Diseases

In this analysis, monthly change on each disease by season is examined by graphical method of drawing the season-dividing lines inserted in the graph showing average monthly cases of each disease and by calculating the figures of average total cases that occurred by season.

Analysis on Epidemic Season of Diarrhoea

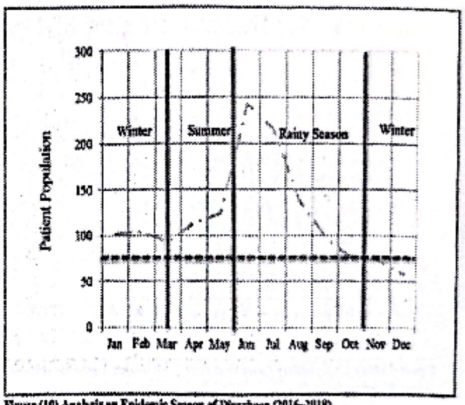

Figure (10) Analysis on Epidemic Season of Diarrhoea (2016~2018)
Source: Table (4)

Regarding analysis on *epidemic season* of diarrhoea case, firstly, based on the 2016-2018 data shown in table (4), seasonal cases of

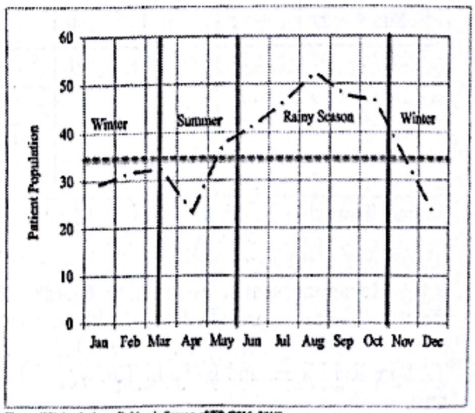

Figure (12) Analysis on Epidemic Season of TB (2016~2018)
Source: Table (6)

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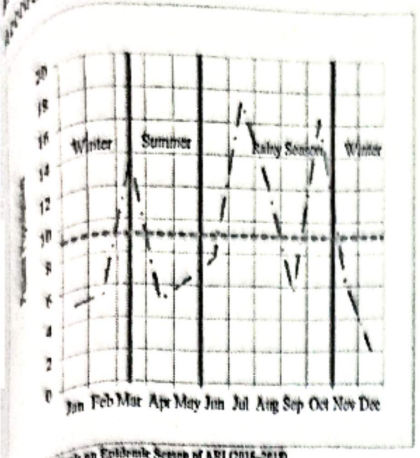
...rrhoea are calculated from the monthly cases ...analyzed by line graph as in Figure (10).

...according to the figure, annual diarrhoea is found



...(10) Analysis on Epidemic Season of ARI (2016-2018)
...Table (7)

...have prevailed in about 58 persons on average, ...above the average cases in the rainy season. In fact, ...although most of the diarrhoea cases are found in ...the rainy months, the largest number of the cases ...is found to have prevailed in June. It is shown by ...the peak found in the figure (10).

Besides the analysis by season-dividing

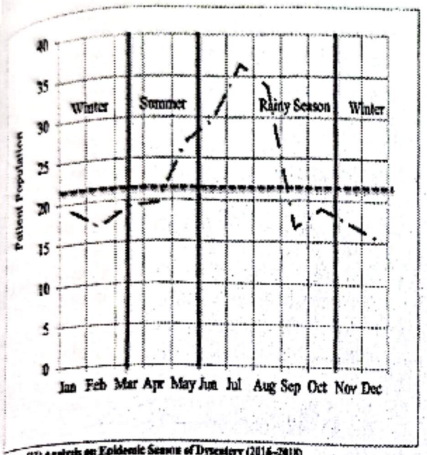


Figure (11) Analysis on Epidemic Season of Dysentery (2016-2018)
Source: Table (5)

lines, in order to clarify the epidemic season of diarrhoea mathematical calculation has been used. According to the calculation result, on average the diarrhoea cases prevail in 285 people in summer, in 769 people in the rainy season and in 460 people in winter and it is known that 114 patients suffer from diarrhoea in each of the summer months, 158 patients in each of the rainy months, and 84 patients in each of the winter months. Therefore, it can be ratified that diarrhoea is found and usually prevails commonly in the rainy season. Finally, based on the results of these two analyses, it is inferred that in Myitkyina Township diarrhoea is found and that it can be prevails commonly in the rainy season and the peak occurs in June.

Analysis on Epidemic Season of Dysentery

In this case, based on the 2016-2018 data shown in table (5), seasonal cases of dysentery are also calculated from the monthly cases and analyzed by line graph as in Figure (11).

According to the figure, annual dysentery case is found to have prevailed in about 23 persons as in average. Above the average cases are those of summer and the rainy season. In fact, although most of the dysentery cases are found in rainy months, the largest number of the cases occurs in July.

Apart from the analysis by season-dividing lines, in order to clarify the epidemic season of dysentery mathematical calculation has been used. According to the calculation result, in average the dysentery cases prevail in 57 people in

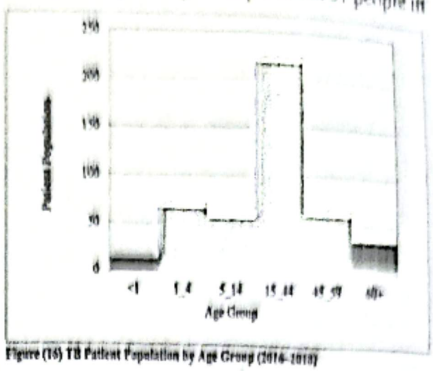


Figure (16) TB Patient Population by Age Group (2016-2018)

summer, in 136 people in the rainy season and 76 people in winter and thus it is found that 23 patients of dysentery suffer in each of the summer months, 27 patients in each of the rainy months, and 18 patients in each of the winter months. Therefore, it can be ratified that dysentery is found and that it usually prevails commonly in the rainy season. Finally, based on the results of these two analyses, it is inferred that in Myitkyina Township dysentery is found and that it usually prevails commonly in the rainy season and particularly peak in July or in the early rainy season.

Analysis on Epidemic Season of TB

In the analysis on epidemic season of TB, based on the 2016-2018 data shown in table (6), seasonal cases of TB are also calculated from the monthly cases and analyzed by line graph as in Figure (12).

In the figure it describes that annual TB cases are found to have occurred in about 37 persons as in average. Above the average cases are found in the rainy season. In fact, although most of the TB cases are found in the rainy months, the largest number of the cases is found in August. In addition the analysis by season-dividing lines, in order to identify the occurrence season of TB mathematical calculation has been used. According to the calculation result, on average the TB cases prevail in 77 people in summer, in 234 people in the rainy season and 135 people in winter and thus it is known that 31 patients suffer from TB in each of the summer months, 47 patients in each of rainy months, and 30 patients in each of winter months. Therefore, it can be identified that TB is found and that it usually occurs commonly in the rainy season. Finally, based on the results of these two analyses, it can be assumed that in Myitkyina Township TB is found that it usually occurs commonly in the rainy season, but the peak in August or in the late rainy season.

Analysis on Epidemic Season of ARI

In analysis on epidemic season of ARI, based on the 2016-2018 data shown in table (7),

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seasonal cases of ARI are also calculated from the monthly cases and analyzed by line graph as in Figure (13).

The figure reveals that annual ARI case is found to have prevailed in about 9 persons on average. Above the average cases are those of the rainy season. In fact, although most of the ARI cases are found in the rainy months, the largest number of the cases is found in July. Besides the analysis by season-dividing lines, in order to clarify the epidemic season of ARI mathematical calculation has been used. According to the calculation result, in average the ARI cases prevail in 18 people in summer, in 59 people in the rainy season and 25 people in winter and thus it is found that 7 patients suffer from ARI in each of the summer months, 12 patients in each of the rainy months, and 6 patients in each of the winter months. Therefore, it can be identified that ARI is found and that it usually prevails commonly in the rainy season. Finally, based on the results of these two analyses, it can be assumed that in Myitkyina Township ARI is found that it usually prevails commonly in the rainy season and particularly peak in July.

Analysis on Seasonal Diseases by Age Group

In this analysis, monthly change on each disease by season is examined by graphical method, particularly column graphs by age group. For this analysis monthly cases of the four seasonal diseases, which occurred in the years of 2016 to 2018 are averaged according to the age group.

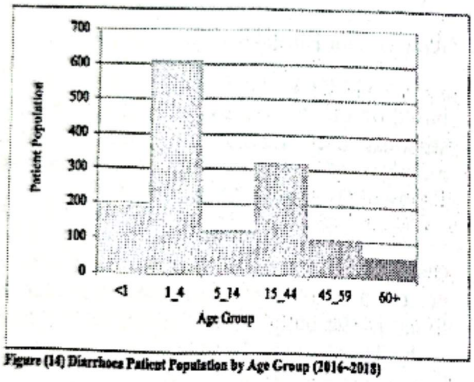

Figure (14) Diarrhoea Patient Population by Age Group (2016-2018)

According to the graphical method (Figure 14), in **diarrhoea case** it is found that 1~4 years aged group is most easily accessible to suffer from diarrhoea. Next is 15~44 years aged group. The least accessible is found to be the 60 years and >60 years aged group.

According to (Figure 15), in **dysentery case** it is found that 15~44 years aged group is most easily accessible to suffer from dysentery. Next is the 45~49 years aged group. The least accessible is found to be the younger than 1 year aged group.

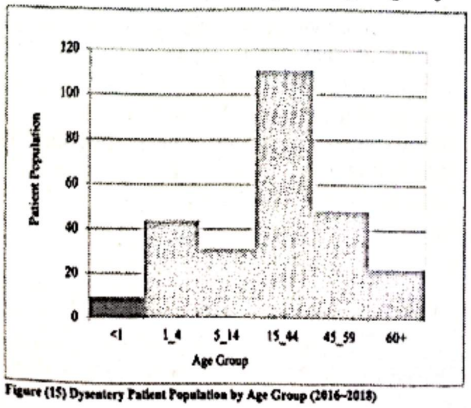

Figure (15) Dysentery Patient Population by Age Group (2016-2018)

In **TB case** (Figure 16) it is found that the 15~44 years aged group is most easily accessible to suffer from TB. Next is the 1~4 years aged group. The least accessible is found to be the < 1 year aged groups.

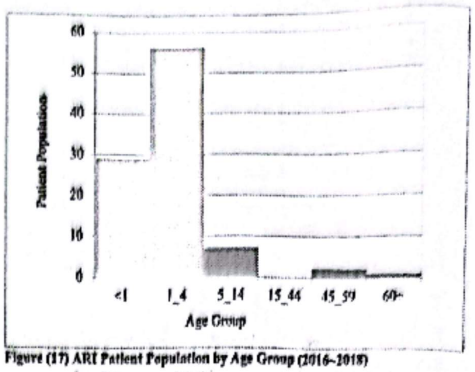

Figure (17) ARI Patient Population by Age Group (2016-2018)

In Figure (17), regarding **ARI case** it is found that the 1~4 years aged group is most easily accessible to suffer from ARI. Next is < 1 year aged group. ARI case is not found in the 15~44 aged group.

Results and Findings

This research emphasizes seasonal diseases particularly diarrhea, dysentery, tuberculosis (TB) and ARI. It has examined the epidemic seasons and the age groups suffering from those diseases. The results and findings are described below.

(1) **Diarrhoea** is found to prevail commonly in the **rainy season** and the peak occurs in **June**.
(2) **Dysentery** is found to occur commonly in the **rainy season** and the peak prevails in **July**.
(3) **TB** usually prevails in the **rainy season** and the peak occurs in **August**.
(4) **ARI** usually prevails commonly in the **rainy season** and the peak occurs in **July**.
(5) The occurrence of **diarrhoea** is found mostly in the age group of 1~4 years and secondly in the 15~44 years group.
(6) The occurrence of **dysentery** is found mostly in the age group of 15~44 years.
(7) The occurrence of **TB** is found mostly in the age group of 15~44 years.
(8) The occurrence of **ARI** is found mostly in the age group of 1~4 years.

Conclusion

In fact, in Myitkyina Township, all of the government-appointed health-care staffs are carrying out their duties but they need to work systematically and effectively, in cooperation with local non-governmental organizations. Particularly, except for the family healthcare program, malnutrition program, program keeping the environment clean, school healthcare program, and preventive vaccination program, the following tasks should be carried out by the healthcare staffs.

For diarrhoea and dysentery, it is necessary (i) to organize the public to use fly-free latrine at every house, (ii) to organize and educate the public to drink a lot of water and to consume food that is condusive to health, (iii) to keep up the practice of washing hands after use of the latrine.

For ARI, it needs to educate the children to stay be free from the danger of breathing in smoke from cigarettes and other sources, and to organize the people to come to the nearest healthcare centers and get treatment as soon as they contract this disease.

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If the healthcare persons organize the public and carry out the tasks as suggested and the public follow the instruction of healthcare personnel, it is certain that health conditions of the public of Myitkyina Township will improve more than before.

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