Diversity of Macro Invertebrates and Their Habitat Characteristics in Lan-Kuu Freshwater Wetland, Myanmar

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ABSTRACT

Lan-Kuu freshwater wetland of Auk SaThar in Mingin Township, Sagaing Region was investigated for its species composition, relative abundance, and diversity of aquatic macro-invertebrates from June 2020 to January 2021. This wetland has water throughout the year and is used by many local people for fishing and trapping birds. Thirty macro invertebrates’ species belonging to 28 genera, 19 families, 11 orders, 5 classes, and 3 Phyla were identified and recorded. These species belonged to the orders Hemiptera (23%), Coleoptera and Odonata (14% each), Orthoptera, Architaenioglossa and Sorbeoconcha (10% each), Lepidoptera (7%), and Hymenoptera, Araneae, Decapoda, and Opithopora (3%). Among the collected specimens Dytiscus verticalis accounted for the highest number of individuals while the least number of individuals were Arocatus rusticus. Average relative abundance indicated 9 species as ‘uncommon’, 14 species as ‘common’ and 7 species as very common in the studied wetland. According to the Shannon index, the diversity of macro invertebrates recorded in Lan-Kuu freshwater wetland, Myanmar, was high, (2.746-3.016), and so was the evenness (0.888-0.956).

Keywords: Freshwater wetland, Macro invertebrates, Habitat types, Diversity, and Species richness.

INTRODUCTION:

Invertebrates are common throughout the water columns (plankton and nekton), on plants, litter, and rocks (periphyton) and in the soil (benthos). Most invertebrates have complex life cycles with multiple life stages that may be found in different parts of a wetland, or even entirely outside the wetland. The distribution of aquatic invertebrates within and among wetlands are affected by its hydrological characteristics, including depth, frequency and duration of flooding, and physical-chemical characteristics, including pH, salinity, temperature and oxygen levels. As with other animals in wetlands, wetland invertebrates need to adapt to low level or even periodic absence of oxygen in the water column and especially in the soil (Chapman et al., 2004).
abundance of some aquatic macro invertebrates in Kan Thone Sint Lake of Pathein Township, Ayeyarwady Region in Myanmar (Ahmad et al., 2018). She recorded eight species of order Hemiptera, three species of order Decapoda and Caenogastropoda, two species of order Odonata, Diptera and Coleoptera, and one species each of Araneae, Amphipoda and Hygrophila under phylum Arthropoda. Among them, nine species were observed in the open water, six species were recorded in the surface water and attached to the aquatic plants and only three species were recorded from the bottom dweller.

The highest number of species Gerris remigis was recorded. The highest value of species richness index was (741.596) in site IV and Shannon index (2.522) in site III were observed in Kanthonesint Lake. The objectives of the present research were to -

1) Identify and record the occurrences of macro invertebrate species in freshwater wetland,
2) Evaluate the diversity and other related features of the macro invertebrates community in the wetland and
3) Document habitat characteristics and comment on the opportunities for their conservation.

MATERIALS AND METHODS:

Study area
The selected study area was the Lan-Kuu freshwater wetland in Mingin Township, Sagaing Region in Myanmar. Mingin is a town on the Southern side of the Chindwin River in Kale District in Sagaing Division of Burma (Myanmar). Mingin Township is situated between Latitude 22° 55’ 30” N & 94° 37’ 0” E. Lan-Kuu wetland is about 2 miles from the Mingin Township, near Auk Satha village (Fig 1). The wetland came into existence in 2008-2009 after the flooding of paddy fields and is called Lan-Kuu Htoo. Presently, it covers about 0.8 ha (i.e. 2 acres), surrounded by three villages – Auk Satha, Atet Satha & Pwetnyet. Water is available in this wetland all year round, with a depth of about 3.05-3.66 meters during the rainy season and about 1.22-1.52 meters during the summer and winter seasons. The farmers, unable to cultivate paddy anymore, now use the water from this wetland for their plantations and cattle. Local villagers are often involved in catching fish & birds from this wetland.

Fig 1: Map of the study freshwater wetland of Mingin Township, Sagaing Region in Myanmar (Source: From Google map)

Wetland Plants
There are many macrophytes such as water hyacinths, cattails, hydriilla, duckweed, willow trees and grasses in LanKuu freshwater wetland. The depth of water is a primary determinant of their distribution. As water levels in many wetlands change seasonally and from year to year, most wetland plants grow in varying water depths, including no standing water at all (Cook et al., 1974; Cook 1990, 1999). There are also paddy fields, and farms cultivating sesame, groundnut, and beans are near the LanKuu freshwater wetland.

Sampling of macro invertebrates
Macro invertebrate samples were collected once a month from the study site during the study period from June (2020) to January (2021). A net made of bamboo and wood, and insect nets, were used to collect samples from four different habitat types – surface water, water column, macrophytes, and the bottom. The external morphological characters and coloration of each specimen were noted immediately, morph metric measurements were conducted, and photographs were taken. The collected specimens were then counted and preserved in plastic boxes for identification and detailed studies. The collected species were identified using keys of Subramanian and (Sivaranakrishnan, 2007; IOWATER 2005; Epler, 2006; Easton et al., 2012).

Physico chemical parameters
Monthly data on ambient temperature and rainfall were obtained from Department of Meteorology and Hy-
drology, Mingin Township, Sagaing Region in Myanmar. The water temperature and pH were measured in Lan-Kuu freshwater wetland by the thermometer and pH Test Kit and dissolved oxygen (DO) Test Kit once per month (Rubel et al., 2019).

**Data Analysis**

Relative abundance

Relative abundance was analyzed following Bisht et al. (2004).

\[
\text{Relative abundance} = \frac{\text{Number of individual species}}{\text{Total number of all species in a particular site}}
\]

- uC = Uncommon (having relative abundance less than 0.0100)
- C = Common (having relative abundance of 0.0100 and above but less than 0.0500)
- vC = Very common (having relative abundance of 0.0500 and above).

**Estimation of species diversities**

Three indices – species richness, Shannon index, and evenness – were used to assess the species diversity of macro invertebrates (Krebs, 2001; Stiling, 1999). Species richness (S) is indicated by the number of species in a sample. The formula of Shannon index of species diversity is as:

\[
H' = -\Sigma Pi \ln Pi \dots \dots \dots (1)
\]

Where, Pi is the proportion of individuals found in the ith species Ln is the natural logarithm. A high number of species a more even distribution both increase diversity as measured by the Shannon index (Stilling, 1999). The Shannon index has a minus sign in the calculation so the index actually becomes positive. The higher number of species and a more even distribution both increase diversity as measured by the Shannon index. The actual diversity and the maximum possible can be compared by a measurement called the evenness value. The formula is –

\[
\text{Evenness} = \frac{H'}{\ln S} \dots \dots \dots (2)
\]

Where, S is total number of species. Evenness is usually range between 0 and 1.0.

**RESULTS:**

**Species Composition**

A total number of 30 species of 27 genera belonging to nineteen families and eleven orders under five classes of three phyla of freshwater invertebrates were recorded in Lan-Kuu wetland. The highest number of species was found in phylum Arthropoda (77%) followed by phylum Mollusca (20%) and phylum Annelida (3%) in study site during study period. The highest numbers of orders were found in Hemiptera (23%) and lowest numbers of Hymenoptera, Araneae, Decapoda and Opisthopora (3%, each) in Lan-Kuu wetland (Table 1, and Fig 2).

**Table 1:** Systematic position of some macro invertebrate’s species recorded (June 2020-January 2021).

| Phylum         | Class       | Order       | Family                  | Genus         | Species                | Common-name               |
|----------------|-------------|-------------|-------------------------|---------------|------------------------|---------------------------|
| Arthropoda     | Insecta     | Hemiptera   | Nepida                  | Nepa          | N. cinerea             | Water Scorpion            |
|                |             |             | Gerridae                | Ranatra       | R. linerea             | Water Stick Insect        |
|                |             |             | Belostomatidae          | Gerris Belostoma | G. argentatus       | Common pond skater Giant |
|                |             |             | Lygaeida                | Diplonychus   | B. flumineum           | Water Bug                 |
|                |             |             |                         | Arocutus Corizus | D. rusticus           | Water Bug                 |
|                |             |             |                         |               | A. rusticus            | Swan Plant Seed bug       |
|                |             |             |                         |               | C. hyoscyami           | Black and red squash bug  |
|                |             |             |                         |               | A. nigrudosum          | Great Silver Water Beetle |
| Coeleoptera    | Hydrophilida| Dytiscidae   | Hydrophilus             | H. piceus     | R. verticalis          | Predaceous Diving Beetle  |
|                |             |             | Dytiscus Rhantus        |               | R. suturellus          | Predaceous Diving Beetle  |
|                |             |             | Poecilus                |               | P. lucublandus         | Ground Beetle             |
| Orthoptera     | Acrididae   |             | Metaleptea              | M. brevicornis| M. femurrubrum         | Clipped-Wing Grasshopper  |
|                |             |             | Melanopus               |               | G. gryllotalpa         | Red Legged Grasshopper    |
|                |             |             | Gryllotalpida           |               |                        | Mole Cricket              |
| Hymenoptera    | Apidae      |             | Bombus                  | B. vagans     |                        | The Half Black Bumble bee |
| Lepidoptera    | Nymphalidae |             | Agraulis                | A. vanilla    |                        | Gulf fritillary           |
Occurrence of macro invertebrates
The highest population of macro invertebrates (265 individuals) was recorded in January, closely followed by December (262 individuals), while the lowest (178 individuals) was recorded in June. *Dytiscus verticalis* was the predominant species (with total 185 individuals), 50 of which were recorded during December-January, while *Arocatus rusticus* was the rarest (with only two individuals) (Table 2).

Distribution of macro invertebrates
In the present study, a total of 30 species were recorded in different habitat types of the wetland. Among them, three species each were observed in the surface waters and in the water column, while 17 species were attached to the macrophytes and seven species were recorded from the bottom zone. (Plate 2 and Table 3)

Relative abundance of macro invertebrates
The relative abundance of specimens revealed that nine species were uncommon, 14 were common, and seven were very common in the studied wetland (Table 2).

Table 2: Monthly number of individuals recorded and percentage species occurrence from study wetland (From June 2020 to January 2021).

| Sr. No. | Species                  | June | July | August | September | October | November | December | January | Total | Occurrence (%) | Relative abundance | Status |
|---------|--------------------------|------|------|--------|-----------|---------|----------|----------|---------|-------|----------------|-------------------|--------|
| 1       | Nepacinerea              | 10   | 7    | 15     | 10        | 15      | 17       | 25       | 20      | 119   | 6.69           | 0.067             | vC     |
| 2       | Ranatralinerea           | 10   | 15   | 20     | 11        | 17      | 15       | 20       | 15      | 123   | 6.91           | 0.069             | vC     |
| 3       | Gerrisargentatus         | 5    | 10   | 8      | 10        | 15      | 10       | 15       | 12      | 85    | 4.78           | 0.048             | C      |
| 4       | Belostomatoflumineum     | 3    | 5    | 5      | 7         | 9       | 11       | 15       | 10      | 65    | 3.65           | 0.036             | C      |
| Species                          | (A) | (B) | (C) | (D) |
|--------------------------------|-----|-----|-----|-----|
| Diplonychusrusticus            | -   | -   | 7   | 5   |
| Arocatusrusticus               | -   | -   | -   | -   |
| Corizushyoscyaminigridosum     | -   | -   | -   | -   |
| HydrophilusPiceus              | -   | -   | -   | -   |
| Dytiscusverticalis             | 10  | 15  | 20  | 25  |
| Rhantussuturellus              | -   | -   | -   | -   |
| Poeciluslucublandus            | 3   | 5   | 2   | 3   |
| Metallepteabrevicornis          | -   | -   | -   | -   |
| Melanopusfemurrubrum           | 10  | 15  | 10  | 12  |
| Gryllotapagryllotapa           | 3   | 2   | 3   | 2   |
| Bombusvagans                   | 5   | -   | -   | -   |
| Agraulis vanilla               | 15  | 10  | 15  | 10  |
| Gonnepteryxhammi               | 10  | 10  | 10  | 9   |
| Ceriagrioncoromandeliamum      | 10  | 10  | 5   | 10  |
| Ischnuraelegans                | 5   | 8   | 10  | 8   |
| Sympertrumfonscolmsonii        | 10  | 7   | 10  | 7   |
| Nymphs of Libellulidae         | 15  | 20  | 22  | 25  |
| Argyronetaaquatica            | 10  | 10  | 12  | 14  |
| Palaemonmalcolmsonii           | 25  | 20  | 15  | 20  |
| Lumbricusrubellus              | 3   | -   | -   | -   |
| Pomaceamaculata                | 5   | 5   | 7   | 5   |
| Pomacealineata                 | 5   | 7   | 5   | 7   |
| Pomaceadiffusca                | 3   | 5   | 7   | 8   |
| Melanoidestuberculate          | 3   | 5   | 7   | 5   |
| Stenomelaniaplicaria           | -   | -   | -   | -   |
| Tarebiagranifera               | -   | -   | -   | -   |

**Total= 30 Species**

(-) = Absent, uC = Uncommon, C = Common, vC = Very common

**Plate 1:** Different habitat types of macro invertebrates; (A) Surface water, (B) Water column, C) Macropytes, and (D) Bottom dweller.
Table 3: Distribution of recorded macro invertebrates in different habitat types.

| Sr. No | Species Name                | Water Surface | Water Column | Macrophytes | Bottom dweller |
|--------|-----------------------------|---------------|--------------|-------------|----------------|
| 1      | Nepacinerea                 | √             |              |             |                |
| 2      | Ranatralinerea              |               | √            |             |                |
| 3      | Gerrisargentatus            | √             |              |             |                |
| 4      | Belostomaflumineum          |               |              | √           |                |
| 5      | Diplonychusrusticus         |               |              | √           |                |
| 6      | Arocatusrusticus            |               |              | √           |                |
| 7      | Cortzushyoscymbiminigridosum|               |              | √           |                |
| 8      | HydrophilusPiceus           |               |              | √           |                |
| 9      | Dytiscusverticalis          |               |              | √           |                |
| 10     | Rhantussaturellus           |               |              | √           |                |
| 11     | Poeciluslucublandus         |               |              | √           |                |
| 12     | Metalepteabrevicorns        |               |              | √           |                |
| 13     | Melanopusfemurrubrum        |               |              | √           |                |
| 14     | Gryllotapagryllotapa        |               |              | √           |                |
| 15     | Bombusvagans                |               |              | √           |                |
| 16     | Agrabulis vanilla           |               |              | √           |                |
| 17     | Gonepteryxrrhamni           |               |              | √           |                |
| 18     | Ceriagrimoncoromandelianum  |               |              | √           |                |
| 19     | Ischnuraelegans             |               |              | √           |                |
| 20     | Sympetrumscolomsonii        |               |              | √           |                |
| 21     | Nymphs of Libellulidae      |               |              | √           |                |
| 22     | Argyroneta aquatic          |               |              | √           |                |
| 23     | Palaemonmalcolmsonii        |               |              | √           |                |
| 24     | Lumbricusrubellus           |               |              | √           |                |
| 25     | Pomacea maculate            |               |              | √           |                |
| 26     | Pomacealineata              |               |              | √           |                |
| 27     | Pomaceadiffusca             |               |              | √           |                |
| 28     | Melanoidestaberculata       |               |              | √           |                |
| 29     | Stenomelaniaplicaria        |               |              | √           |                |
| 30     | Tarebiagranifera            |               |              | √           |                |

Table 4: Diversity of macro invertebrates.

|                | June  | July  | August | September | October | November | December | January |
|----------------|-------|-------|--------|-----------|---------|----------|----------|--------|
| Total Number (N) | 178   | 191   | 218    | 211       | 236     | 218      | 262      | 265    |
| Species richness (S) | 22    | 20    | 21     | 21        | 23      | 22       | 27       | 22     |
| Shannon Diversity Index (H) | 2.901 | 2.865 | 2.891  | 2.871     | 2.915   | 2.926    | 3.016    | 2.746  |
| Evenness         | 0.939 | 0.956 | 0.950  | 0.943     | 0.930   | 0.947    | 0.915    | 0.888  |

Species diversity of macro invertebrates

Minimum 20 species were observed in July, while the maximum numbers of species (27 species) were observed in December. The Shannon diversity index was minimum (2.746) in January and maximum (3.016) in December (Table 4 and Fig 3 to 5). It is interesting to note that while both the species richness and the diversity peaked in December, the evenness peaked in July (0.956) when the diversity was low, and the species richness was the lowest. Both the diversity and the evenness are lowest in January.
Climatic variations at the study site

The monthly temperature (°C) and rainfall (mm) were obtained from the Department of Meteorology, Mingen, for all the months between June 2020 and January 2021. The ambient temperature (maximum) ranged between 30.5°C-39.0°C and ambient temperature (minimum) between 8.7°C-22.0°C. The maximum and minimum temperatures, otherwise reasonably stable over the summer months, declined between November 2020 and January 2021, the winter season. Rainfall was recorded every month, except December 2020, with a maximum of 167 mm in July (Table 5 & Fig 6).

### Table 5: Monthly variations of meteorological parameters in study area.

| Weather parameters | June | July | August | September | October | November | December | January |
|--------------------|------|------|--------|-----------|---------|----------|----------|---------|
| Ambient Temperature (°C) (max) | 39.0 | 38.2 | 39.0 | 38.7 | 37.0 | 32.5 | 30.5 | 32.5 |
| Ambient Temperature (°C) (min) | 21.0 | 22.0 | 21.7 | 20.0 | 20.0 | 11.6 | 8.7 | 11.6 |
| Rainfall (mm) | 111 | 167 | 68 | 115 | 113 | 49 | No | 49 |

Physicochemical parameters of water

The water temperature ranged from 30°C to 40°C, the pH values were between 7.4 and 9.0, while dissolved oxygen content ranged from 7.0 to 12.0 mg/l (Table 6 and Fig 7 to 9). The lowest pH value was recorded in August, whereas the highest value was recorded in September.

DISCUSSION:

Species richness, evenness, and the Shannon diversity remained relatively high throughout the study period in the Lan-Kuu freshwater wetland, with a slight increase in the richness and diversity exhibited during the winter months, particularly in December.
Table 6: Water parameters in study wetland.

| Water parameters          | Month (2020-2021) |
|---------------------------|------------------|
|                           | June  | July | August | September | October | November | December | January |
| pH                        | 8.2   | 7.8  | 7.4    | 9.0       | 8.2     | 8.2      | 8.6      | 8.2     |
| Dissolved oxygen (DO) (mg/L) | 7.0   | 8.0  | 7.0    | 10.0      | 12.0    | 12.0     | 11.0     | 11.0    |
| Water temperature (°C)    | 30.0  | 30.0 | 30.0   | 40.0       | 35      | 35       | 40       | 35      |

The total macro invertebrate population was also reasonably consistent throughout the study period but peaked in December-January. While the ambient temperature was lower during the winter months, perhaps the lack of rainfall in December 2020 accounts for the increase in total population, species richness, and diversity of macro invertebrates. Water regimes, particularly permanence and hydro periods, are the prime determinants for wetland macro invertebrate diversity (Gleason and Rooney, 2018). The distribution of aquatic macro invertebrates within and among wetlands is also affected by water chemistry, especially pH and salinity, temperature, and oxygen levels. Dissolved oxygen is one of the critical factors affecting invertebrate abundance and diversity (Thorpe et al., 1991). Temperature and pH also affect the abundance and diversity of invertebrates (Covich et al., 1999). Of the 30 species encountered, 17 were associated with macrophytes. However, none of these has the potential to become pests. While snails from the genus *Pomacea* are common in the Lan-Kuu wetland, the potential pests such as the golden apple snail (*Pomacea canaliculata*) or the island apple snail (*Pomacea insularum*) are notable by their absence. These pest species, initially introduced in Asia-Pacific from their native habitat in South America around the 1980s, can significantly reduce macrophytes and paddy biomass, shifting the wetlands towards an algal dominated system. It is not just the absence of pests but the presence of diverse species that draw special attention to this wetland. Even at the order level, the dominant group (Hemiptera) constitutes barely more than a quarter of the total macro invertebrate assemblage. The species diversity index combines species richness and evenness indices into a single quantity (Yazdian et al., 2014). The consistently high values of the macro invertebrate diversity are perhaps best explained by the permanence of the water body, supported by regular
rainfall in the Lan-Kuu freshwater wetland. The lack of rainfall in December supports this idea since there is a marked change in the diversity of macro invertebrates in January.

**CONCLUSION:**
The Lan-Kuu freshwater wetland has emerged as a mature habitat for diverse macro invertebrates, indicating robust ecosystem functions that merit conservation initiatives. As the base of the ecological food chain is diverse and productive, the possibility of Lan-Kuu freshwater wetland to attract waterfowl is high, opening up possibilities for ecotourism in the region. The introduction of tourism will benefit farmers in the region who may have lost their paddy fields to the wetlands and have shifted to fisheries and waterfowl capture. The key hydrologic driver of the Lan-Kuu freshwater wetland appears to be rainfall, which means that conservation efforts may be limited to protecting it from either over-extraction of biological material or introducing pest species into the system. However, there is a strong need to continue monitoring its biological diversity, particularly those of the macrophysics and the macro invertebrates.

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**CONFLICTS OF INTEREST:**
The author declares there is no conflict of interest to publish it.

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