American Journal of Pure and Applied Biosciences, 3(6), 135-144, 2021

UniversePG

Publisher homepage: www.universepg.com, ISSN: 2663-6913 (Online) & 2663-6905 (Print)

https://doi.org/10.34104/ajpab.021.01350144

American Journal of Pure and Applied Biosciences

Journal homepage: www.universepg.com/journal/ajpab

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

May Thu Win*

Department of Zoology, Pathein University, Pathein 10014, Myanmar.

*Correspondence: maythiwin.sees19@nalandauniv.edu.in (May Thu Win, Assistant Lecturer, Department of Zoology, Pathein University, Pathein 10014, Myanmar).

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%), Coeleoptera 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).

Freshwater bodies contain diverse habitats which support myriads species of both plants and animals and support important ecosystem services for human well-being (Adeogun, 2011). Aquatic environments are important habitats for a multitude of species, complex food web and the predominant source of the essential requisite for all life in the biosphere. The aquatic habitats are the most important ecosystem in the whole of the biosphere, which are greatly influenced by water pollution (Gunnarsson *et al.*, 2004). Because of water pollution, many important species especially predators which control many pest are swiped off. Insects contribute to several levels of the food web in aquatic systems and a multitude of terrestrial organisms that in turn, depend on them. Kay Thi Moe, (2019) recorded that species composition, occurrence, and relative 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˚ 55́ 30̋ N & 94˚ 37́ 0̋ 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, hydrilla, 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 Hydrology, 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:

$$H' = -\Sigma \text{ Pi Ln Pi} \text{ ………………… (1)}$$

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 –

$$\textbf{Evenness} = H'/\text{LnS} \text{ ……………….. (2)}$$

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	Nepidae	*Nepa*	*N. cinerea*	Water Scorpion
				Ranatra	*R. linerea*	Water Stick Insect
			Gerridae	*Gerris Belostoma*	*G. argentatus*	Common pond skater Giant
			Belostomatidae	*Diplonychus*	*B. flumineum*	Water Bug
				Arocatus Corizus	*D. rusticus*	Water Bug
			Lygaeidae		*A. rusticus*	Swan Plant Seed bug
					C. hyoscyami	
					A. nigridosum	Black and red squash bug
		Coeleoptera	Hydrophilidae	*Hydrophilus*	*H. piceus*	Great Silver Water Beetle
			Dytiscidae	*Dytiscus Rhantus*	*D. verticalis*	Predaceous Diving Beetle
				Poecilus	*R. suturellus*	Predaceous Diving Beetle
			Carabidae		*P. lucublandus*	Ground Beetle
		Orthoptera	Acrididae	*Metaleptea*	*M. brevicornis*	Clipped-Wing Grasshopper
				Melanopus	*M. femurrubrum*	Red Legged Grasshopper
			Gryllotalpidae	*Gryllotapa*	*G. gryllotalpa*	Mole Cricket
		Hymenoptera	Apidae	*Bombus*	*B. vagans*	The Half Black Bumble bee
		Lepidoptera	Nymphalidae	*Agraulis*	*A. vanilla*	Gulf fritillary

			Pieridae	*Gonepteryx*	*G. rhamni*	Common brimstone
		Odonata	Coenagrionidae	*Ceriagrion*	*C. coromandelianum*	Yellow Waxtail
				Ischnura	*I. elegans*	The Blue-tailed Damselfly
			Libellulidae	*Sympetrum*	*S. fonscolombii*	Red veined Dartar
			Libellulidae			Four-Spotted Pennant
	Arachnida	Araneae	Dictynidae	*Argyroneta*	*A. aquatica*	Diving Bell Spider
Annelida	Clitellata	Opisthopora	Lumbricidae	*Lumbricus*	*L. rubellus*	Red Earthworm
Mollusca	Gastropoda	Architaenio	Ampullariidae	*Pomacea*	*P. maculata*	Florida apple snail
					P. lineata	The apple snail
					P. diffusca	Spike-topped apple snail
		Sorbeoconcha	Thiaridae	*Melanoides*	*M. tuberculate*	The red-rimmed melania
				Stenomelania	*S. plicaria*	The yellow chopstick snail
				Tarebia	*T. granifera*	The quilted melania

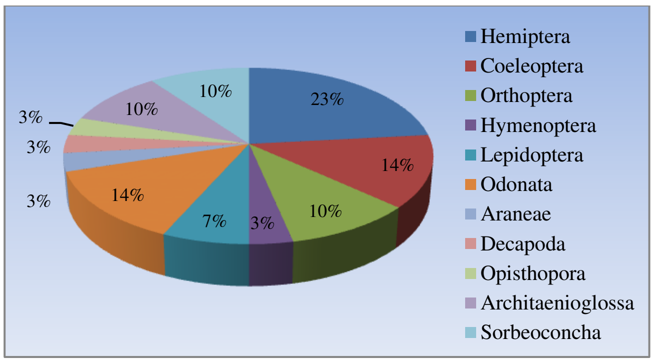

Fig 2: Composition of macro in vertebrate species belonging to different Order in study wetland.

Abundance of macro invertebrates

The total number of macro-invertebrates collected from the studied wetland was 1779 individuals. Hemiptera (with 467 individuals) were predominant, followed by Odonata (with 330 individuals), Coleoptera (214 individuals), Decapoda (170 individuals), Lepidoptera (151 individuals), Architaenioglossa (142 individuals), Orthoptera (133 individuals), Araneae (91 individuals), Sorbeoconcha (83 individuals), Hymenoptera (five individuals) and Opisthopora (three individuals) (**Table 2**).

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	*Belostomaflumineum*	3	5	5	7	9	11	15	10	65	3.65	0.036	C

5	*Diplonychusrusticus*	-	-	7	5	13	5	10	30	70	3.93	0.039	C
6	*Arocatusrusticus*	-	-	-	-	-	-	2	-	2	0.11	0.001	uC
7	*Corizushyoscyaminigridosum*	-	-		-		-	3		3	0.17	0.002	uC
8	*HydrophilusPiceus*	-	-	-	-	-	-	3	-	3	0.17	0.002	uC
9	*Dytiscusverticalis*	10	15	20	25	20	15	30	50	185	10.40	0.104	vC
10	*Rhantussuturellus*	-	-	-	-	-	-	3	5	8	0.45	0.004	uC
11	*Poeciluslucublandus*	3	5	2	3	3	-	2	-	18	1.01	0.010	C
12	*Metalepteabrevicornis*	-	-	-	-	5	12	10	5	32	1.80	0.018	C
13	*Melanopusfemurrubrum*	10	15	10	12	12	7	10	5	91	5.12	0.051	vC
14	*Gryllotapagryllotapa*	3	2	3	2	-	-	-	-	10	0.56	0.006	uC
15	*Bombusvagans*	5	-	-	-	-	-	-	-	5	0.28	0.003	uC
16	*Agraulis vanilla*	15	10	15	10	7	7	7	8	79	4.44	0.044	C
17	*Gonepteryxrhamni*	10	10	15	10	9	7	6	5	72	4.05	0.040	C
18	*Ceriagrioncoromandeliamum*	10	10	5	10	5	5	3	5	53	2.98	0.030	C
19	*Ischnuraelegans*	5	8	10	8	5	4	5	5	50	2.81	0.028	C
20	*Sympetrumfonscolmsonii*	10	7	10	7	5	5	3	3	50	2.81	0.028	C
21	*Nymphs of Libellulidae*	15	20	22	25	30	20	25	20	177	9.95	0.099	vC
22	*Argyronetaaquatica*	10	10	12	14	10	15	10	10	91	5.12	0.051	vC
23	*Palaemonmalcolmsonii*	25	20	15	20	25	25	20	20	170	9.56	0.095	vC
24	*Lumbricusrubellus*	3	-	-	-	-	-	-	-	3	0.17	0.002	uC
25	*Pomaceamaculata*	5	5	7	5	3	8	10	10	53	2.97	0.030	C
26	*Pomacealineata*	5	7	5	5	7	8	5	8	50	2.81	0.028	C
27	*Pomaceadiffusca*	3	5	5	7	8	8	3	-	39	2.19	0.022	C
28	*Melanoidestuberculate*	3	5	7	5	8	10	10	15	63	3.54	0.035	C
29	*Stenomelaniaplicaria*	-	-	-	-	3	2	2	1	8	0.45	0.004	uC
30	*Tarebiagranifera*	-	-	-	-	2	2	5	3	12	0.67	0.007	uC
	Total= 30 Species	**178**	**191**	**218**	**211**	**236**	**218**	**262**	**265**	**1779**	**100**		

(-) = 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	*Corizushyoscyaminigridosum*			√	
8	*HydrophilusPiceus*			√	
9	*Dytiscusverticalis*	√			
10	*Rhantussuturellus*			√	
11	*Poeciluslucublandus*			√	
12	*Metalepteabrevicornis*			√	
13	*Melanopusfemurrubrum*			√	
14	*Gryllotapagryllotapa*				√
15	*Bombusvagans*			√	
16	*Agraulis vanilla*			√	
17	*Gonepteryxrhamni*			√	
18	*Ceriagrioncoromandeliamum*			√	
19	*Ischnuraelegans*			√	
20	*Sympetrumfonscolmsonii*			√	
21	*Nymphs of Libellulidae*				√
22	*Argyroneta aquatic*			√	
23	*Palaemonmalcolmsonii*		√		
24	*Lumbricusrubellus*				√
25	*Pomacea maculate*			√	
26	*Pomacealineata*			√	
27	*Pomaceadiffusca*				√
28	*Melanoidestuberculate*				√
29	*Stenomelaniaplicaria*				√
30	*Tarebiagranifera*				√
	Total	**3**	**3**	**17**	**7**

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.

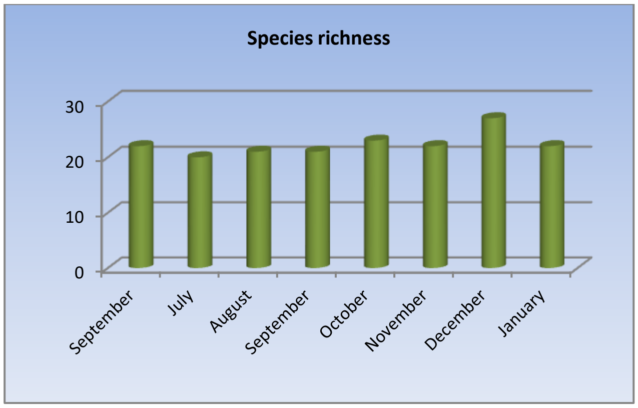

Fig 3: Species richness in study freshwater wetland.

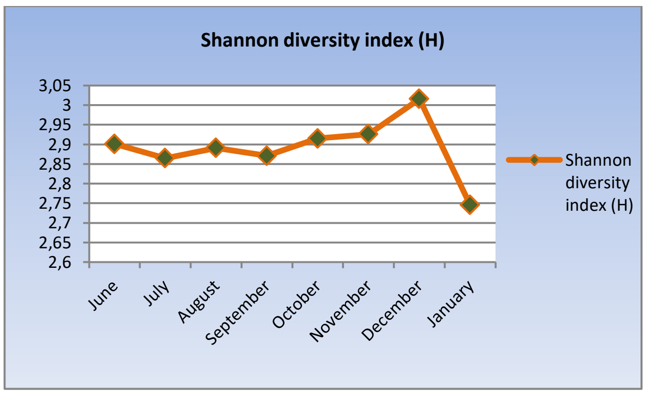

Fig 4: Shannon diversity index in study wetland.

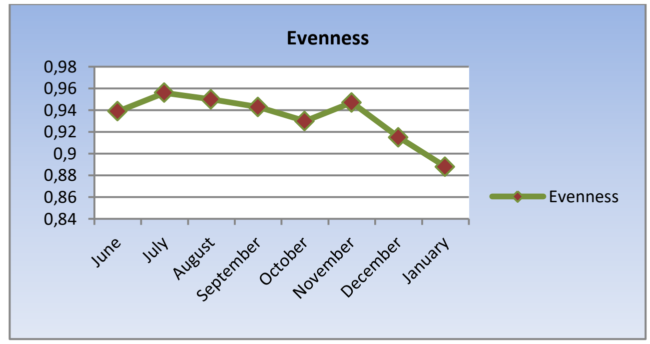

Fig 5: Evenness of macro invertebrate species in study wetland.

Climatic variations at the study site

The monthly temperature (°C) and rainfall (mm) were obtained from the Department of Meteorology, Min-gin, 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	Month (2020-2021)							
	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

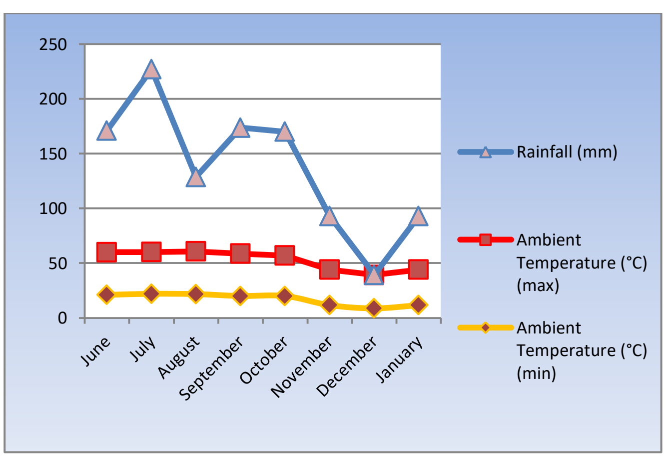

Fig 6: Monthly variations of meteorological parameters in study area.

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

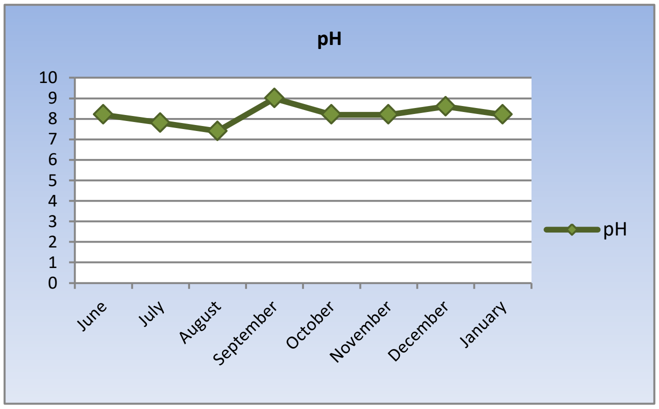

Fig 7: Monthly variations of pH parameters in study wetland.

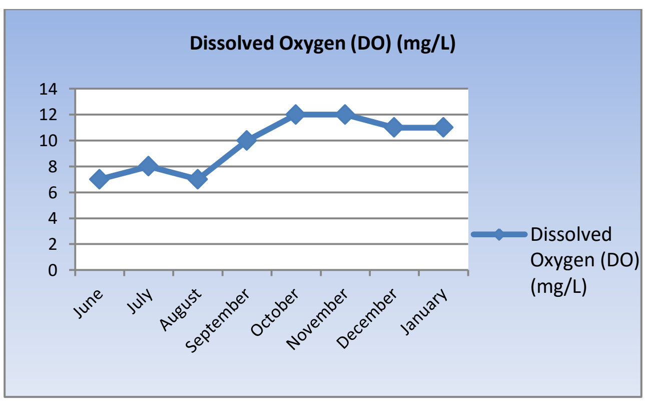

Fig 8: Dissolved oxygen in study wetland.

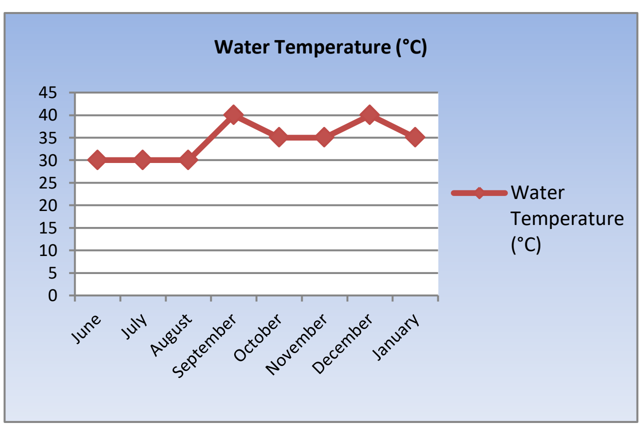

Fig 9: Water temperature in Lan-Kuu freshwater wetland.

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 (Thorp *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.

ACKNOWLEDGEMENT:

Firstly, I wish to greatly express my gratitude to my supervisor Dr. Somnath Bandyopadhyay, Associate professor, School of Ecology and Environmental Studies (EES), Nalanda University, India for his guidance, cooperation and advice throughout the study period. Secondly, I am grateful thank to my younger sisters and brothers for helping in collection of specimens. Last, I wish to express my deepest gratitude to my parents for their kindness and helping in collection of specimens throughout the period of this work.

CONFLICTS OF INTEREST:

The author declares there is no conflict of interest to publish it.

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Citation: Win MT. (2021). Diversity of macro invertebrates and their habitat characteristics in Lan-Kuu freshwater wetland, Myanmar. *Am. J. Pure Appl. Sci.*, **3**(6), 135-144. https://doi.org/10.34104/ajpab.021.01350144