Diversity of Some Aquatic Macroinvertebrates in Kanthonesint Lake of Pathein Township, Ayeyawady Region

Mu Mu Aung Soe [1], Naw Mae May Phaw[2], Kaythi Moe[3]

Abstract

Kanthonesint Lake in Pathein Township, Ayeyarwady Region was investigated to study the species composition and occurrence of some aquatic macroinvertebrates during December, 2018 to July, 2019. Four study sites were chosen in the study area. A number of 12 aquatic macroinvertebrate species belonging to the 12 genera, 12 families, seven orders, four classes and two phyla were recorded and identified. The highest number of species was found in order Decapoda and Caenogastropoda (25%), Hygrophila (16.66%) and Araneae, Amphipoda, Hemiptera and Coleoptera(8.33%). Among them Decapoda was the dominant group in all study sites. Among the collected specimens, *Macrobranchium palaemonides* was the highest number of individual. The individual number in Site III and Site IV were higher than that of other two sites. It may be due to the shallow water zone and many aquatic plants and decaying vegetative matter. According to Shannon index the highest value (2.12) was in Site IV while the lowest value (1.87) was in Site I.

Keywords: species composition, diversity

Introduction

Aquatic environments cover 72% of the Earth's surface and support a significant proportion of global invertebrate biodiversity (Strayer and Dudgeon, 2010). Animals that live in aquatic ecosystems are divided into two types: freshwater and marine. Aquatic ecosystems make over 90% of the entire ecosystems on earth; it contains an enormous amount of animals with extraordinary species diversity (Yash, 2015).

Aquatic invertebrates are found in the sediments of the pond bed as well as underneath floatingplants, among emergent aquatic plants and around their roots. Insects are the most diverse and abundant group of animals in a pond. Macroinvertebrates living in ponds consist primarily of shrimps, snails, worms and insects. Insects with incomplete life-cycle include dragonflies, mayflies and true bugs (Quek *et al*., 2014).

Benthic macroinvertebrates are animals without a backbone that can be seen with naked eye, and have to the ability to cling to bottom surfaces such as rocks, leaves or roots (Odum, 1971). Some aquatic macroinvertebrates spend their entire lives living in water, although many just live in the water when they are immature. As they reach maturity, larvae metamorphose and leave the water, spending their adult life on land.

Freshwater macroinvertebrates are commonly used as biological indicators for aquatic ecosystems health, serving as indirect measure for water quality (Stark *et al*., 2001). Freshwater macroinvertebrates serve as good stream health indicators because they have great diversity at both species level and at functional groups and abundance. They have a relative long life cycle of at least 6 months providing a good snap shot of the dominant physical and chemical conditions of the water body (Boothroyd and Stark, 2000; Mandaville, 2002).

[1] Associate Professor, Dr., Department of Zoology, Hinthada University
[2] Associate Professor, Dr., Department of Zoology, Hinthada University
[3] Demonstrator, Department of Zoology, Pathein University

Macroinvertebrates living in ponds consist primarily of shrimps, snails, worms and insects. Macroinvertebrates are basically big in size (0.5-50mm) spineless creatures (Quek *et al*., 2014). Macroinvertebrates play an important role in the ecosystem of which they are a part (Voshell, 2002).

Macroinvertebrates are part of all aquatic food webs, representing every major feeding type, including predators, scrapers, collectors, shredders, and filters (Rana, 2003). Therefore the present study was conducted with the following objectives:

- to identify and record the aquatic macroinvertebrates
- to observe the habitat type of aquatic macroinvertebrates species
- to calculate the diversity of aquatic macroinvertebrates species between the four sites

Materials and Methods

Study sites

The specimens were collected from four study sites in Kanthonesint Lake in Pathein Township, Ayeyawady Region. Kanthonesint Lake is natural freshwater lake. The total area of Kanthonesint Lake is 0.175843 square miles. Four study sites were randomly selected. Site I is located at 16° 47´ 51.026" N and 94° 45´ 19.259" E, Site II is at 16° 47´ 41.19" N and 94° 45´ 18.46" E, Site III is at 16° 47´ 55.91" N and 94° 45´ 07.58" E and Site IV is at 16° 47´ 48.51"N and 94° 44´ 51.64" E (Figure 1).

Study period

The present study was carried out between December 2018 to July 2019.

Collection of specimen and preparation

Macroinvertebrates were collected twice per month from each site by using insect net. Morphological characters, coloration and measurements were taken immediately in fresh forms. Morphological characters of collected specimens were recorded and taken photograph. The specimens were brought to the laboratory, Department of Zoology, Pathein University. The specimens were preserved in 70% alcohol for further study.

Identification and Classification

The collected specimen were identified according to Borror and Delong (1964), Holthuis (1980) and Subramanian and Sivaramakrishnan (2007).

Habitat types

Open water, surface water, aquatic plant, bottom dweller were selected as specific habitat types. Open water type includes the portions of lakes and ponds that remain permanently flooded all year. Surface water type consist any body of water above ground, including streams, rivers and lakes. Aquatic plant type is the environmental area in which a specified living organism lives. Bottom dweller type involves marsh and swamp environs.

Data analysis

Occurrence percentage

Occurrence percentage and abundance were analyzed following after Bisht *et al.* (2004).

$$\text{Occurrence percentage} = \frac{\text{No. of individual species}}{\text{Total No. of all species in particular site}} \times 100$$

Estimation of species diversity

Three indices of species diversity, Richness index, Shannon index and its evenness were used to assess species diversity of macroinvertebrates. Index value of each macroinvertebrates species collected from different collection sites were compared (Krebs, 2001 and Stiling, 1999).

The formula of Richness index is as:

$$\text{Richness index} = n + (n-1)/n$$

Where n is the number of individuals in each species.

The formula of Shannon index of species diversity is as:

$$H' = - \Sigma P_i \, Ln \, P_i$$

P_i is the proportion of individuals found in the i^{th} species Ln is the natural logarithm. The actual diversity and the maximum possible can be compared by a measurement called the evenness value. The formula is

$$\text{Evenness} = H'/Ln \, S$$

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

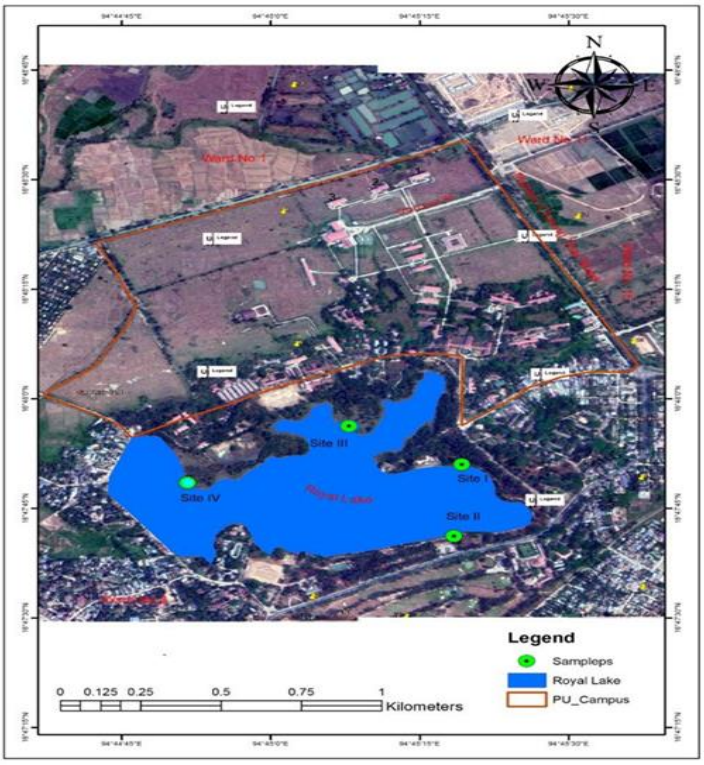


Figure 1. Location map of four study sites in Kanthonesint Lake (Base map - Setellite Image)

Results

A total of 12 macroinvertebrates species, comprising seven species of phylum Arthropoda and five species of phylum Mollusca were recorded from the four study sites. A total of nine species confined to nine families and six orders were recorded from Site I, eight species confined to eight families and five orders were recorded from Site II, 12 species confined to 12 families and seven orders were recorded from Site III and 12 species confined to 12 families and seven orders were recorded from Site IV (Table 1 and 2).

Species Composition

A total of 12 species, 12 genera, 12 families and seven orders under four classes belonging to two phyla were recorded in all study sites.

The highest numbers of species were found in phylum Arthropoda (58.33%) followed by phylum Mollusca (41.67%) in all study sites during the study period. The monthly highest population (148 individuals, 25.04%) was attained in July and the lowest (18 individuals, 3.04 %) in May (Fig. 3).

According to monthly occurrence percentage, *Macrobrachium palaemonoides* revealed the highest number of individual (60) and occurrence percentage attained was (39.22%) while *Notonecta* sp. and *Thermonectus nigrofasciatus* revealed the lowest with four individuals (2.61%) each in Site I (Table 3).

In Site II, occurrence percentage of *Macrobrachium palaemonoides* was similarly highest with (40) individuals (43.01%) while *Bellamy bengalensis*, *Brotia herculean* and *Pseudosuccinea columella* appeared the lowest with one individual each and the occurrence percentage of (1.07%) (Table 4).

In Site III, occurrence percentage of *Macrobrachium palaemonoides* revealed the highest number of individual (41) and occurrence percentage attained was (33.61%) while *Pseudosesarma brehieri,Varuna litterata* and *Bellamy bengalensis* appeared the lowest with three individual (2.46%) each in Site III (Table 5).

In Site IV, occurrence percentage of *Macrobrachium palaemonoides* was similarly highest with (60) individuals (26.9%) while *Thermonectus nigrofasciatus* appeared the lowest with six individual and the occurrence percentage of (2.69%) (Table 6).

Distribution of recorded macroinvertebrates in different habitat types

In the present study, a total of 12 species were recorded in all designated four different habitat types. Among them, three species were observed in the open water, two species were recorded in the surface water and six species attached to the aquatic plant and only one species were recorded from the bottom dweller (Table 7 and Fig. 2).

Species diversity in all sites

The value of two parameters of species diversity such as species richness and Shannon index were compared for all sites.

The highest value of species richness index (233.79) was observed in Site IV and the least value (97.91) in Site II for some macroinvertebrate species. Shannon index expressed the highest value of (2.12) were observed in some macroinvertebrate in Site IV. The least value of Shannon index (1.49) was observed in Site II (Table 8).

Table 1. Systematic position of the recorded species during the study period

No	Phylum	Class	Order	Family	Genus	Species	Common Name
1	Arthropoda	Arachnida	Araneae	Tetragnathidae	*Tetragnatha*	*T. extensa*	Strength spider
2		Crustacea	Amphipoda	Hyalellidae	*Hyalella*	*H. azteca*	Side swimmers
3			Decapoda	Palaemonoidae	*Macrobrachium*	*M .palaemonoides*	Freshwater shrimp
4				Sesarmidae	*Pseudosesarma*	*P. brehieri*	Mud crab
5				Varunidae	*Varuna*	*V. litterata*	Swimming crab
6		Insecta	Hemiptera	Notonectidae	*Notonecta*	*Notonecta* sp.	Back swimmer
7			Coleoptera	Dytiscidae	*Thermonectus*	*T. nigrofasciatus*	Predaceous dividing beetle
8	Mollusca	Gastropoda	Caenogastropoda	Ampullariidae	*Pomacea*	*P. paludosa*	Apple snail
9				Viviparidae	*Bellamy*	*B. bengalensis*	Freshwater snail
10				Pachychilidae	*Brotia*	*B. herculea*	Mud snail
11			Hygrophila	Lymnaeidae	*Pseudosuccinea*	*P. columella*	Pond snail
12				Planorbidae	*Indoplanorbis*	*I. exustus*	Ramshorn snail

Table 2. Species occurrence in four study sites

No	Scientific Name	Site I	Site II	Site III	Site IV
1	*Tetragnatha extensa*	√	√	√	√
2	*Hyalella azteca*	√	-	√	√
3	*Macrobrachium palaemonoides*	√	√	√	√
4	*Pseudosesarma brehieri*	-	-	√	√
5	*Varuna litterata*	-	-	√	√
6	*Notonecta* sp.	√	√	√	√
7	*Thermonectus nigrofasciatus*	√	√	√	√
8	*Pomacea paludosa*	√	√	√	√
9	*Bellamy bengalensis*	√	√	√	√
10	*Brotia herculea*	√	√	√	√
11	*Pseudosuccinea columella*	-	-	√	√
12	*Indoplanorbis exustus*	√	√	√	√
	Total	9	8	12	12

√ = present - = Absent

Table 3. Monthly occurrence of individual number and percentage from site I

Sientific Name	Dec	Jan	Feb	March	April	May	June	July	Total	Occurrence (%)
Tetragnatha extensa	2	2	5	1	-	-	-	2	12	7.84
Hyalella azteca	1	2	1	-	-	-	2	3	9	5.89
Macrobrachium palaemonoides	4	15	7	6	6	3	6	13	60	39.22
Pseudosesarma brehieri	-	-	-	-	-	-	-	-	-	-
Varuna litterata	-	-	-	-	-	-	-	-	-	-
Notonecta sp.	-	1	-	-	-	-	1	2	4	2.61
Thermonectus nigrofasciatus	1	1	1	-	-	-	1	-	4	2.61
Pomacea paludosa	2	2	1	2	1	1	4	5	18	11.77
Bellamy bengalensis	-	1	1	-	1	-	2	3	8	5.23
Brotia herculea	1	1	1	-	-	-	1	2	6	3.92
Pseudosuccinea columella	-	-	1	-	-	-	2	2	5	3.26
Indoplanorbis exustus	3	6	10	2	1	1	2	2	27	17.65
Total	14	31	28	11	9	5	21	34	153	100

Table 4. Monthly occurrence of individual number and percentage from site II

Sientific Name	Dec	Jan	Feb	March	April	May	June	July	Total	Occurrence (%)
Tetragnatha extensa	1	3	2	1	-	-	-	2	9	9.69
Hyalella azteca	-	-	-	-	-	-	-	-	-	-
Macrobrachium palaemonoides	3	5	9	4	2	3	5	9	40	43.01
Pseudosesarma brehieri	-	-	-	-	-	-	-	-	-	-
Varuna litterata	-	-	-	-	-	-	-	-	-	-
Notonecta sp.	-	-	1	-	-	-	-	1	2	2.15
Thermonectus nigrofasciatus	1	1	1	-	-	-	1	-	4	4.30
Pomacea paludosa	1	-	-	-	1	1	1	2	6	6.45
Bellamy bengalensis	-	-	-	-	-	-	-	1	1	1.07
Brotia herculea	-	1	-	-	-	-	-	-	1	1.07
Pseudosuccinea columella	-	-	-	-	-	-	1	-	1	1.07
Indoplanorbis exustus	3	5	10	3	1	-	3	4	29	31.19
Total	9	15	23	8	4	4	11	19	93	100

Table 5. Monthly occurrence of individual number and percentage from site III

Sientific Name			Feb	March	April	May	June	July	Total	Occurrence (%)
Tetragnatha extensa	1	1	2	2	-	-	1	5	12	9.84
Hyalella azteca	-	-	-	-	-	-	1	1	2	1.64
Macrobrachium palaemonoides	3	5	10	5	3	2	5	8	41	33.61
Pseudosesarma brehieri	-	-	-	-	-	-	2	1	3	2.46
Varuna litterata	-	-	-	-	-	-	1	2	3	2.46
Notonecta sp.	1	1	1	-	-	-	1	2	6	4.91
Thermonectus nigrofasciatus	1	1	1	1	-	-	-	1	5	4.09
Pomacea paludosa	1	2	3	2	2	1	3	4	18	14.75
Bellamy bengalensis	-	-	1	-	-	-	1	1	3	2.46
Brotia herculea	-	1	-	-	-	-	1	2	4	3.28
Pseudosuccinea columella	-	-	1	-	-	-	1	2	4	3.28
Indoplanorbis exustus	1	4	2	3	1	1	4	5	21	17.22
Total	8	15	21	13	6	4	21	34	122	100

Table 6. Monthly occurrence of individual number and percentage from site IV

Sientific Name	Dec	Jan	Feb	March	April	May	June	July	Total	Occurrence (%)
Tetragnatha extensa	2	4	4	2	-	-	1	3	16	7.18
Hyalella azteca	1	1	-	-	-	1	3	2	8	3.58
Macrobrachium palaemonoides	5	5	13	5	4	2	9	17	60	26.9
Pseudosesarma brehieri	-	1	-	-	-	-	3	3	7	3.13
Varuna litterata	1	-	-	-	-	-	2	2	5	2.24
Notonecta sp.	1	1	-	-	-	-	1	2	5	2.24
Thermonectus nigrofasciatus	2	-	1	1	-	-	1	1	6	2.69
Pomacea paludosa	3	4	5	3	2	1	5	9	32	14.4
Bellamy bengalensis	1	1	3	2	1	-	3	4	15	6.72
Brotia herculea	2	1	2	1	-	-	2	4	12	5.3
Pseudosuccinea columella	-	2	4	1	-	-	1	3	11	4.93
Indoplanorbis exustus	3	9	10	4	2	1	6	11	46	20.7
Total	21	29	42	19	9	5	37	61	223	100

Table 7. Distribution of recorded macroinvertebrates species in different habitat types

No	Name of the species	Open water	Surface water	Aquatic plant	Bottom dweller
1	*Tetragnatha extensa*	-	-	√	-
2	*Hyalella azteca*	√	-	-	-
3	*Macrobrachium palaemonoides*	√	-	-	-
4	*Pseudosesarma brehieri*	-	-	-	√
5	*Varuna litterata*	√	-	-	-
6	*Notonecta* sp.	-	√	-	-
7	*Thermonectus nigrofasciatus*	-	√	-	-
8	*Pomacea paludosa*	-	-	√	-
9	*Bellamy bengalensis*	-	-	√	-
10	*Brotia herculea*	-	-	√	-
11	*Pseudosuccinea columella*	-	-	√	-
12	*Indoplanorbis exustus*	-	-	√	-
	Total	3	2	6	1

Table 8. Comparison of diversity indices of macroinverebrates species in all sites

Sites	Species	Population	Species richness	Shannon index	Shannon eveness
I	10	153	161.70	1.87	0.812
II	9	93	97.91	1.49	0.67
III	12	122	131.42	2.02	0.81
IV	12	223	233.79	2.12	0.85

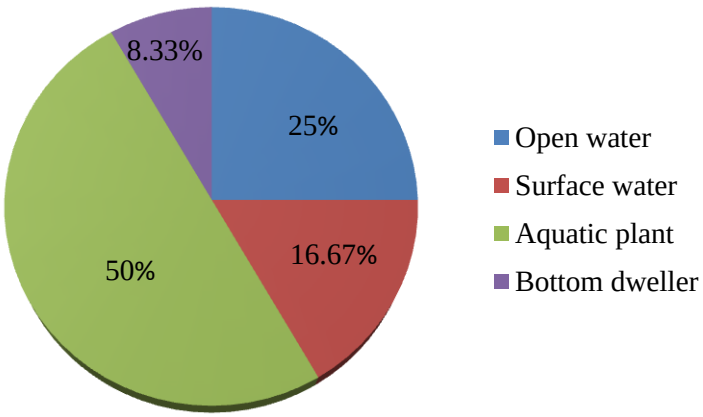


Figure 2. Percentage of macroinvertebrate species in different habitats

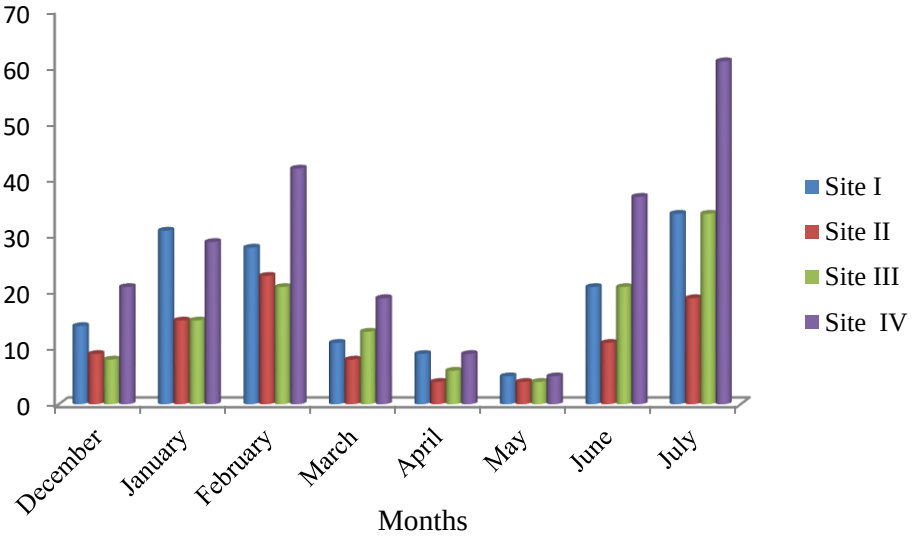
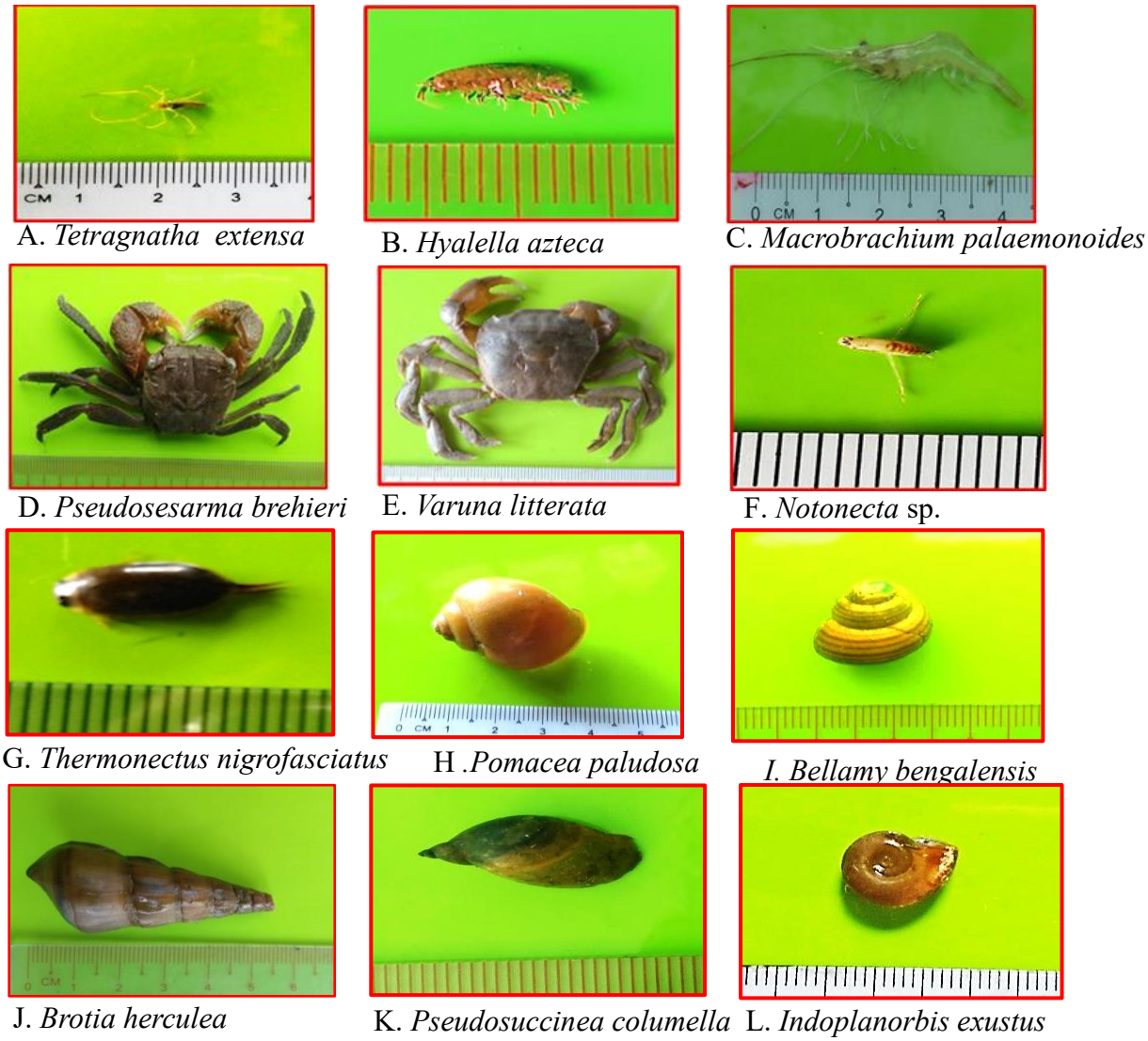


Figure 3. Monthly abundance of the recorded aquatic macroinvertebrates



A. *Tetragnatha extensa* B. *Hyalella azteca* C. *Macrobrachium palaemonoides*

D. *Pseudosesarma brehieri* E. *Varuna litterata* F. *Notonecta* sp.

G. *Thermonectus nigrofasciatus* H .*Pomacea paludosa* *I. Bellamy bengalensis*

J. *Brotia herculea* K. *Pseudosuccinea columella* L. *Indoplanorbis exustus*

Plate 1. Recorded macroinvertebrates species

Discussion

At the present study, a total of 12 species of 12 genera of 12 families and nine orders were recorded. Thida Aung (2016) stated 19 species of aquatic invertebrates from Shwe Paunk Pin In.

In the present work, *Macrobrachium palaemonoides*, was found throughout the study period in all study sites. Than Nyunt Swe (2017) stated *Tetragnatha extensa*, *Macrobrachium palaemonoides, Lestes sponsa*, *Gerris remigis*, *Gerris lacustris* and *Hydrometra martini*, *Gyrinus* sp. and *Gillia altilis* were encountered in every month of the study period in Be Gyi In in Pakokku Township.

In the present study, 10 species in Site I, nine species in Site II, 12 species in Site III and 12 species in Site IV were recorded in Kanthonesint Lake. Among the 12 species the highest number of species was found in order Decapoda and Caenogastropoda (three species, 25%) followed by Hygrophila (two species, 16.66 %), and Araneae, Amphipoda, Hemiptera and Coleoptera (one species each, 8.33%) respectively. Ei Ei Khaing Nyein (2015) recorded four orders of insects Odonata, Hemiptera, Coleoptera and Diptera in Meiktila Lake.

In the present study, four different habitats were observed the distribution of recorded macroinvertebrates. Among 12 species, three species were found in the open water, two species were found on the surface water, six species were found in aquatic plant and one species bottom dweller. Differences in abundance of macroinvertebrates were probably related to the habitat and environmental condition of the Kanthonesint Lake.

Between these four study sites, the highest (223) individual in Site IV and the lowest (93) individual in Site II was observed in study period. This may be because Site IV is shallow water zone and that has many aquatic plants and decaying vegetative matter than those of the Site II. The species and population of macroinvertebrates varies with months. The highest population was found in July at Site I, II, III and IV. The lowest population was found in May at all study sites.

In the present study Shannon index ranges from 1.49 to 2.12 in all sites. Khan *et al.* (2007) showed the diversity index ranging from 1.20 to 1.49 in their study and Anbalagan *et al*. (2004) observed values ranged 1.883 to 2.493 from four sampling station in their observation. Value of Shannon diversity index for real community is between1.5 to 3.5 (Krebs, 2001).The diversity of macroinvertebrates in Kanthonesint lake area revealed as the real community for the macroinvertebrates species. Species diversity index is in fact a combination of species richness and evenness indices into a single quantity Yazdian *et al.* (2014).

Conclusion

From the findings of this study, it is concluded that macroinvertebrates are good candidates to be used as bio-monitoring of water quality and environmental conditions of freshwater bodies. Kanthonesint Lake has been observed that high abundance and diversity of macroinvertebrates, so this indicates that balance of ecosystem.

Acknowledgements

I would like to express my deepest thanks to Dr. Theingi Shwe, Acting Rector and Dr. Yee Yee Than and Dr. Aye Lwin, Pro-Rectors, Hinthada University for this research. We would like to express our sciences gratitude, extend my sincere gratitude to Dr. Aye Aye Than, Professor and Head, Dr. Moe Moe Kyaw and Dr. Sa Soe Shwe, Professors, Department of Zoology, Hinthada University for their permission to do this research.

References

Anbalagan S., B. Kaleeswaran and Balasubramanian, C., (2004). Diversity and tropic categorization of aquatic insects of courtallam hills of Western ghats. Entomon 29(3): 215-220.

Bisht, M. S., Kukretu, M. and Shanibhisan, (2004). Relative abubdance anddistribution of bird fauna of Garhwal Himalaya.*Eco. Enu*.&*Cons.*, 10(4); 451-460 Ferraris, C. 1996. Commercial inland fishes of central Myanmar.

Boothroyd, I.K.G., Stark, J.D., (2000). Use of invertebrates in Monitoring In: New Zeland Stream Invertebrates: Ecology and implications for management. *In* K. Collier & M. J. Winterbourn. (eds.) New Zealand Limnological Society, Hamilton. pp. 344-373.

Borror, D.J., and Delong D.M., (1964). An introduction to the Study of Insect, Revised Edition,

Ei Ei Khaing Nyein, (2015). Seasonal variation, abundance and diversity of fish and macroinvertebrate fauna in Meiktila Lake, Meiktila Township. *Ph D Dissertation*, Meiktila University.

Holthuis, L.B., (1980). Shrimps and prawns of the world. Annotated catalogue of species of interest to fisheries F.A.O species catalogue. *F.A.O Fresheries Synopsis*, No.125, Vol.1.

Khan A.N., Kamal D., Mahmud M.M., Ragman M.A. and Hossain, M.A., (2007). Diversity, distribution and Abundance of Benthos in Mouri River, Khulna, Banglades., int j. Sustain, Crop Prod, 2 (5):19-23.

Krebs, C.J., (2001). The experimental analysis of distribution and abundance. Ecology.

Mandaville, S.M., (2002). Benthic Macroinvertebrates in Freshwater-Taxa Tolerance Values, Metrics, and Protocols, Project H-1. (Nova Scotia: Soil & Water Conservation Society of Metro Halifax).

Odum. E.P., Fundamentals of ecology, 3rd W.B. Saunders Company. Philadelphia, (1971). pp: 574.

Quek, A.,Tan, L.Y.,Wang, L.K. and Clews, E., (2014). A Guide to Freshwater Fauna of Ponds, In Singapore Tropical Marine Science Institute, National University of Singapore.

Rana, S.V.S., (2003). Essentialis of Ecology and Environmental Science. Asoke K. Ghosh, Prentice- Hall of India Private Limited. New Delhi. 368 pp.

Stilling, P., (1999). Ecology: theories and application. Prentice Hall Inc. Upper Saddle River, NJ 07485.

Strayer, D.L., Dudgeon, D., (2010). Freshwater biodiversity conservation: recent progress and future challenges. *Journal of the North American Benthological Society* 29: 344-358.

Subramanian, K.A and Sivaramakrishnan, K.G (2007). A Field Guide of Aquatic Insects of India.

Than Nyunt Swe, (2017). Relative occurrence and abundance of some aquatic invertebrates between Be Gyi In and Shwe Pauk Pin In, Pakokku Distinct. *M. Res Thesis*. Department of Zoology, Pakokku University.

Thida Aung, (2016). Some Aquatic Invertebrates of Shwe Pauk In (Lake), Pakokku Township, *M.Res Thesis*. Department of Zoology, Pakokku University.

Voshell, J.R., (2002). A Guide to Common Freshwater Invertebrates of NorthAmerica. McDoland and Woodward Publishing Company, Granville, Ohio. 442pp.

Yash, (2015). Difference between Freshwater and marine Water Animals. Availablefrom: https://googleads.g.doublecklick.net/paged/ads?client=ca-pub-

Yazdian Hamed, Nematollah Jaafarzadeh and Banafsheh Zahrale, (2014). Relationship between benthic macroinvertebrate bio-indices and physicochemical parameters of water: a tool for water resources managers.