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Aquatic macroinvertebrate diversity and conservation management of Taungthaman lake, Amarapura Township, Mandalay region, Myanmar

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Abstract
Diversity of aquatic macroinvertebrate and conservation management was studied in Taungthaman Lake, during November 2018- February 2019. In order to bioassay water quality and aquatic health analysis using diversity indices. Species richness values of 15, 15, 18 and 31, evenness values of 0.78, 0.82, 0.78, and 0.71, Shannon-Wiener Index values of 3.06, 3.04, 3.25 and 5.63, and Simpson's index values of 0.133, 0.117, 0.100, and 0.074 were determined for macroinvertebrates. In the present study, low diversity indices, like the Shannon-Wiener Index, demonstrated that the lake is polluted and poor health status. Taungthaman Lake supports a highly productive freshwater capture/culture fishery and also an important tourist attraction. Although the lake is highly valuable in its natural state, it is also highly vulnerable to the impact of external factors. Therefore, it is necessary to prevent and conservation management of aquatic environment of lake health.

Keywords: macroinvertebrates, diversity, management, Taungthaman lake

1. Introduction
Wetland management systems need up to date knowledge of their biological composition and water quality. Assessment and monitoring of the ecological condition of wetland is an important tool used to, guide protective and restorative measure [1]. Ecosystem managers regularly turn to measures of richness, endemism and biodiversity to guide conservation efforts [2]. This type of information helps to determine where investment of time and money can achieve the greatest conservation outcome. With water quality monitoring, invertebrate surveys can fine out of the state or condition of a wetland and highlight areas of concern that need to be addressed by management [1].
Macroinvertebrats are a primary food for high level animals. They process organic matter by breaking down leaves and woody material that fall into water. Macroinvertebrates are part of all aquatic food webs and major feeding type, including predators, scrapers, collectors, shredders, and filterers [3]. Freshwater macroinvertebrates are very important indicators of the health of streams, lakes, ponds and rivers reflecting water quality and habitat conditions [4].
Taungthaman Lake is a natural flood plain with the main inflow of water from the Ayeyarwady bringing river fishes for spawning in the lake. It also serves as a large nursery for river fish. A local fishery industry also utilizes for breeding fishes. The latter gains much popularity as its productivity is highly prolific. The fresh water state of the lake is now much disturbed by the urban and the industrial development around the nearby new settlements discharging waste water in the lake. Contamination and pollution of these freshwater bodies can badly affect the hygiene of aquatic organisms as well as the people nearby. Therefore, water quality assessment for the Taungthaman Lake has to be done by using the various suitable measures. Macroinvertebrates are an important role to play in wetland ecosystems and widely used as bioindicators for water quality assessments. Thus, the objectives of this study were to investigate for the development of environmental concepts being beneficial to the national economy and conserving the natural beauty of Taungthaman Lake.

2. Materials and Methods
2.1 Study area and study sites
Taungthaman Lake is situated in Amarapura Township, Mandalay Region on the eastern bank of the Ayeyawady River. It lies between 21° 52′ 55″ N to 21° 54′ N latitude and 96° 03′ E to 96° 05′ E longitude. Three study sites were allocated as Site I and II. Site I lies at 21°54'1.88"N and 96° 3'57.17"E. Site II lines at 21°52'59.38"N and Site III at 96° 3'39.97"E.

2.2 Data Collection
Aquatic macroinvertebrates were recorded from each study site within fourth months study period from November 2018 to February 2019 in the cold season. A D-framed net was used to collect the macroinvertebrates.

2.3 Data analysis
Diversity index of macroinvertebrate species were calculated according to the Shannon-Weiner and Simpson methods. Species richness was calculated by the formula of Margalafs Index (d).

Shannon-Weiner's diversity index (1949);

$$H' = \sum_{i=1}^{s} (p_i \ln p_i)$$

Simpson's index (1949)

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

Margalef's species Richness Index (1958);

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

Hill's ratio (1973)

$$E = \frac{(1/D)-1}{e^{H'}-1} = \frac{N2-1}{N1-1}$$

2.4 Water quality parameter

Water quality parameters such as depth, temperature, pH and Dissolved Oxygen (DO) concentrations were measured to relationship among measured parameters by Water Laboratory, Water and Sanitation Department, Mandalay City Development Committee for analysis. Water temperature and water depth were recorded immediately at study sites.

2.5 Identification

Macroinvertebrates belonging to class Pelecypoda and Gastropoda were recorded identified with the keys of Frest and Johannes [5], and Class insects were identified with the keys of Easton *et al*. [6].

2.6 Information interview

The information interviews were recorded as follows

i) Biophysical assessment;
ii) Livestock;
iii) Assessing degradation & management.

3. Results and discussion

3.1 Species diversity of macroinvertebrate

Water quality is evaluated by comparing the number of tolerant organisms to the number of intolerant organisms. A large number of pollution-tolerant organisms and few intolerant organisms ma indicate poor water/or habitat quality [7]. A total of 34 aquatic macroinvertebrate species, 34 genera belonging to 25 families, 24 orders were recorded. The most dominant recorded was found in study Site III (18 species, 251 individuals), followed by Site II (15 species, 137 individuals) and the lowest invertebrate was found in Site I (15 species, 133 individual) (Figure 3.1); it is because of Site III is sound habitat for macroinvertebrates and more favorable condition than others sites.

In the monthly recorded, the highest number of 31 species was recorded in February 2019 and 18 species in January 2019. The lowest number of 15 species was in December 2018 (Table 3.1, Figure 3.1). Species richness is generally measured to determine the overall health of an aquatic habitat [8]. In the present study, the highest species richness values of 5.45 was found in February and the lowest species richness was found in November and December (2.86) each. It is clearly showed; the health of Taungthaman Lake is good habitat condition in February because of February is more suitable habitat for aquatic invertebrate species.

One of the major components of species diversity is species richness and the species richness index commonly varied between l and 5, and the larger the index indicates a more healthy body of water and when tends towards 1, pollution is through to increase [9]. In the present study, diversity index, the highest values 2.91 was found in February, followed by January 2.51, December 2.31. The lowest value of Shannon-Wiener Index was 2.22. Simpson's index values of November, December, January and February were 0.133, 0.117, 0.100, and 0.074 restively which were determined for macroinvertebrates (Figure 3.2). Thus, Taungthaman Lake's the healthy body of water was found in February than in January and December.

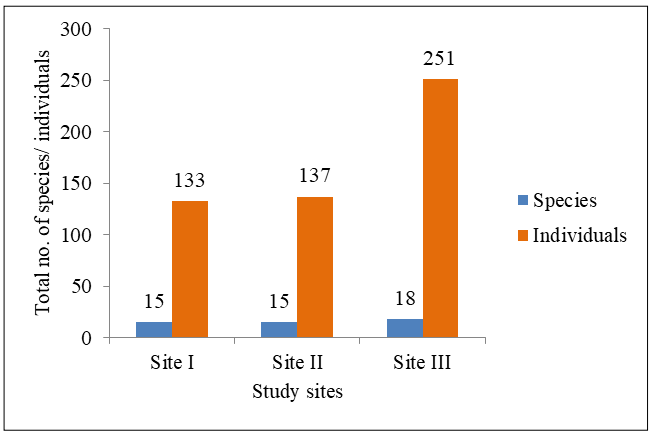

Fig 3.1: Species and individuals recorded at three study sites

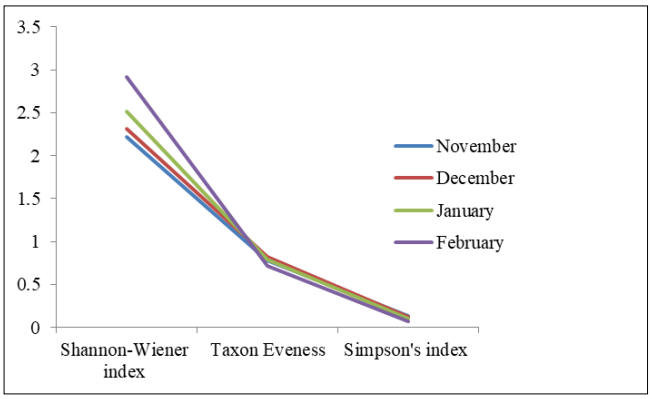

Fig 3.2: Monthly species diversity recorded at three study sites

Table 3.1: Monthly occurrence of aquatic macroinvertebrate at Taungthaman Lake

Sr. No.	Species	Nov	Dec	Jan	Feb	Total
1	*Ranatra linearis*	4	6	23	9	42
2	*Ranatra chinensis*	2	7	5	3	17
3	*Corixa punctata*	9	11	5	0	25
4	*Dolomedes triton*	0	0	7	0	7
5	*Tetragnatha montana*	3	3	3	2	11
6	*Gerris lacustris*	33	30	35	24	122
7	*Agriocnemis femina*	9	10	30	31	80
8	*Paederus fuscipes*	4	2	6	10	22
9	*Palaemonetes paludosus*	20	18	16	11	65
10	*Notonecta sp.*	3	2	5	0	10
11	*Tetrix subulata*	2	3	5	2	12
12	*Gerris remigis*	1	2	11	10	24
13	*Abedes heberti*	3	2	15	11	31
14	*Ischnura senegalnesis*	17	18	24	34	93
15	*Ischnura pumilio*	22	21	50	35	128
16	*Pardosa amentata*	0	0	3	3	6
17	*Anax junius*	0	0	3	1	4
18	*Paracecion malayanum*	0	0	0	3	3
19	*Acrida acuminata*	0	0	0	3	3
20	*Acrida conica*	0	0	0	3	3
21	*Trithemis pallidinervis*	0	0	0	2	2
22	*Acrida ungarica*	0	0	0	6	6
23	*Belostoma sp.*	1	2	5	1	9
24	*Limnogonous fossarum*	0	0	0	8	8
25	*Limnogonous aduncus*	0	0	0	4	4
26	*Limnogonous luctuosus*	0	0	0	4	4
27	*Hydrobasileus croceus*	0	0	0	6	6
28	*Orachelium gladiator*	0	0	0	2	2
29	*Argiope catenulata*	0	0	0	2	2
30	*Crocothemis servillia*	0	0	0	3	3
31	*Rhyothemis phyllis*	0	0	0	3	3
32	*Rhytothemis variagata*	0	0	0	3	3
33	*Acisoma inflatum*	0	0	0	5	5
34	*Pardosa sp.*	0	0	0	2	2
Total number of individuals		133	137	251	246	767

3.2 Physico-chemical parameters

Considerable monthly variations in respect of certain physico-chemical parameters were observed. Gaikwad [10] reported that water temperature in the range of 31.5°C and 32°C is appropriates for the growth of planktonic organisms. In the present study, the lowest mean temperature was recorded in December while the highest mean value was also recorded in the month of February. The average depth of water found maximum 24.32 m in November while it was found minimum 0.487 m in February. pH is classed as one of the most important water quality parameters. Measurement of pH relates to the acidity or alkalinity of the water. The pH value of the water is important as different fish species prefer different conditions. Most fish can be kept within the range of pH 6.5- 8.0 [11]. Optimum pH for fish growth and health is between 6 and 9. If pH is outside this range, fish growth will be reduced. Mortalities will occur when pH values are less than 4.5 or greater than 10 [12]. The highest pH recorded was in February (7.5) while the lowest was in November and December (7.1) each (Figure 3.3). It is may be due to different temperature, dissolved oxygen and also different pH value were (7.5).

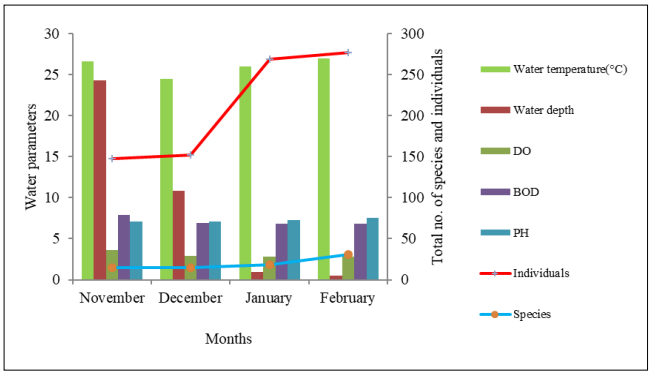

Fig 3.3: Relationship between total no. of species/individuals and water parameter

3.3 Information interview

The key informations were recorded from five persons who are members of the community and knowledgeable of the water resources in the local area.

Water quality: The level of phytoplankton is too high. When the weather is too hot, the level of the water and the dissolved oxygen falls. When water levels drop, the chemical reaction of the sediment at the bottom of the lake leads to the emission of ammonia and nitrogen. That's what kills the fish.

Water level: When the water level is high during the rainy season the walkway isn't that far out of the water. But during the winter dry season, when the water level drops markedly, the bridge stands high above the ground and the remaining water of the lake.

Conservation of the lake: Wastewater and rubbish should be prevented from entering the lake, a water treatment plant should be built, sediment should be removed and a propeller system should be introduced to circulate the water.

Company developing the lake: A company that is developing a resort and culture park on Taungthaman Lake has guaranteed its eco-friendliness amid local concern over the environmental impact of the project. The Myanmar Investment Commission gave the green light to the project in March.

4. Conclusion

This study have revealed that Taungthaman Lake in Mandalay are a good habitat for Macroinvertebrates and there is a little variation in their distribution in the like surveyed. According to information interview, the lake is leading to conserve, but the lake is highly valuable in its natural state, it is also highly vulnerable to the impact of external factors especially pollution and a variety of contamination. The fresh water state of the lake is now much disturbed by the urban and the industrial development around the nearby new settlements discharging waste water through Payandaw Creek into the lake. The load and quality of the waste polluting the lake is not exactly known. Thus, more researches are required in order to do conservation and prevent the health of Taungthaman Lake.

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