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Abstract. Overall, small holder of fish farmers in Kelantan in particular does not monitor their pond water quality to maintain fish health due to tedious and expensive work. Hence, this study was proposed to identify the assemblages of benthic macroinvertebrates at the fish pond for potential as a tool for water quality assessment via biological indicator. The study area was in one of the small holder fish pond at Gua Musang, Kelantan, Malaysia. Benthic macroinvertebrates were collected monthly from March to August 2021. Benthic macroinvertebrates were collected by using a heavy-duty D-frame dip net combined with a bag-shaped. The ecological indices were calculated (Shannon diversity index, Margelef's richness index, Pielou's evenness index, and Simpson's dominance index). Results showed a total of 356 individuals from 27 taxa of aquatic insects were collected. Corixidea (Hemiptera) recorded high abundance in July 2021. Even though there were differences in the abundance of benthos for monthly sampling, the season was only a part of the factors that might contribute, however the other factors cannot be neglected such as food availability, water quality and substrates composition conditions. Hopefully the findings could be used by the small holders to assess their pond water quality effectively with minimum cost.

1. Introduction

In the state of Kelantan, there are many fish farmers among villagers operating small ponds with small capital. These operators are usually not able to establish a systematic farming system including control and monitoring of the water quality of the pond itself. With limited knowledge and small capital, they can only afford to buy feed without focusing on other elements, especially assessment of pond health in the area due to inadequate capital, awareness and knowledge about the pond's sustainability [1]. By right, an existent of insect larvae and other aquatic life known as macroinvertebrates [2] in the pond itself which can be seen by naked eyes [3] can be a feed for the fish, can also act as organic waste decomposer and at the same time can also be used as bioindicator to assess fish pond health [4]. Benthic macroinvertebrates were becoming more widely used as biological indicators of water quality and ecosystem wellness due to their functional importance like relatively long-life spans, physically inactive existence, and ease for sampling, as well as a growing body of knowledge about their ecology and habitat needs [5]. Numerous researchers published extensive research reports on the use of macroinvertebrates to evaluate water quality in aquatic ecosystems. For instance, the ecological index and the macroinvertebrate biotic index, have been frequently used in America and Europe [6]. In an aquatic ecosystem, the structure of benthic communities reflects the ecological conditions, such as

habitat heterogeneity and water quality. The distribution of benthic macroinvertebrate communities was influenced by abiotic factors like temperature, pH, electrical conductivity, dissolved oxygen in the water column, granulometric composition, organic matter content in sediment, and many others [7]. Benthic macroinvertebrates belong to the following classes namely turbellaria, bivalve, hirudinea, gastropods, polychaetes, oligocheata, insects, and decapods. But, normally aquatic insects were the most prevalent benthic macroinvertebrates spotted in upstream freshwaters like Plecoptera, Hemiptera, Odonata, Coleoptera, Ephemeroptera, Dipteral, and Trichoptera [8].

The total number of invertebrates (abundance) and the number of different kinds of invertebrates (richness) can both be used to assess the health of aquatic ecosystems. In general, high benthic macroinvertebrates richness indicates the healthier the aquatic system [9]. An aquatic system could imply as under stress with less richness of benthic macroinvertebrates. Likewise, a low abundance (that was, a small number of animals) often indicates that an aquatic system has been impacted, whereas a large abundance may imply a healthier system [10]. The distribution, abundance, dominance, and diversity of benthic macroinvertebrates, as well as their relationships to environmental conditions, were crucial parts of understanding the structure and function of fish pond ecosystems [11]. Therefore, this study was conducted by conducting a survey of macroinvertebrate benthics assemblages which then calculate the ecological index that will be used as a tool to assess the quality and health of fish ponds.

2. Materials and Methods

2.1 Study Area

This study was carried out on a fish pond own by smallholder fish farmer, located at Kampung Baru Jeram Tekoh in the Gua Musang, Kelantan, Malaysia (5° 4' 30.5646", 102° 4' 19.9668").

2.2 Sample Collection and Analysis

Sampling was performed once a month for a six months period, starting from March to August 2021. Heavy-duty D-frame dip net was used to randomly collect three replicates sample in the fish pond at three points for each edge of the pond and pooled in zipper bag. Sieve, sorting pan, forceps, universal bottle, and plastics zipper bag was used to sieve and sort benthos. Sample was then preserved with 75% ethanol to avoid sample damages before it reach the laboratory for identification. Stereomicroscope and compound microscope was used for identification process up to family level [12,13]. Upon arriving to the lab, sample was poured into special tray (white colour) and wash several times with tap water to remove ethanol prior to sorting process. Sorting process is actually the process of eliminating debris which was attached with sample during sampling and the process of picking up macroinvertebrates benthic sample and place in universal bottle with 75% ethanol before performing identification.

2.3 Data Analysis

Identified macroinvertebrates benthic sample was then, used to calculate ecological indices to determine species diversity, species richness, evenness, and dominance. The indices used were Shannon Index to determine species diversity, Margelef's Index to determine the species richness, Pielou's Index to determine the species evenness, and Simpson's Index to determine dominance of the species according to formula in Table 1 by using Microsoft excel calculating function.

Table 1. Ecological Index Formula

No.	Index	Formula	Description
1	Shannon Diversity Index	$H' = -\sum_{i=1}^{s} \quad pi$ $ln\ ln\ pi$	H' = Shannon Diversity Index, p*i* = proportion of individuals belong to species *i* s = total number of species

2	Margalef's Richness Index	$d = \frac{(S-1)}{In(N)}$	d = Margalef's Richness Index S = Total number of Species N = Total Number of Individuals in the Sample
3	Pielou's Evenness Index	$J' = \frac{H'}{In\ S}$	J' = Pielou's Evenness Index H' = Shannon Diversity Index S = total number of individual in a sample
4	Simpson's Index	$D = \frac{\sum\ n_i(n_i-1)}{N(N-1)}$	D = Simpson's Index n_i = Number of individuals in belong to i species N = total number of individuals

3. Results and Discussion

3.1 Composition and Distribution of Benthic Macroinvertebrates

This study successfully recorded a total of 356 individuals which consist of 20 taxa (family) belonging to nine orders of insects which were Ephemeroptera, Coleoptera, Hemiptera, Odonata, Diptera, Decapoda, Orthoptera, Lumbriculida, and Tubificida (Table 2). The highest abundance of species (149 individuals) was found in July, with 7 families namely Caenidae, Corixidae, Nepidae, Notonectidae, Libellulidae, Chironomidae, and Acrididae. In comparison, the lowest abundance and taxa numbers were recorded in March, with 9 individuals and 4 families of insects. Besides that, 38, 51, 34, and 75 individuals were collected in April, May, June, and August, respectively. Benthic macroinvertebrates found in this area were mostly dominated by aquatic insects. The most abundant families were Corixidae (74% of total individuals) followed by the Chironomidae (6%), Notonectidae (4%), and Libellulidae (4%). Corixidea was found most abundant with 264 individuals, followed by Chironomidae (23), Notonectidae (14) and Libellulidae (13). Then, the most abundant order of Ephemeroptera found were Ephemerellidae and Caenidae (2% of total individuals) followed by Baetidae (1% of total individuals). On the other hand, Corixidae or water boatman was the most abundant and adaptive to this area due to the habitat of the area which was stagnant water or slow flowing water and small ponds as they dwell. It was also enabled and easy for Corixidea to swim right side up to feed on aquatic plants and algae. According to [14], Corixidea was commonly and widely distributed in most stagnant or nearly stagnant aquatic habitats with a bottom of relatively fine soil particles and a depth of water of less than one meter and functions as collector-gatherers due to they usually eat tiny organic particles that fall to the pond bottom and spend a lot of time swimming with their heads down to find them [15]. This findings was supported by [16], who reported that Corixidae eat living material found during agitating the sediment of water on the bottom of bodies of water such as nematodes, tiny insects, protozoa, and algae. Then, a few of Corixidae suck algae juices. In addition, family of Odonata which was found in this fish pond are Libellulidae (13 individuals), Coenagrionidae (2 individuals), and Corduliidea (1 individual). Normally, Libellulidae family or dragonfly larvae which belong to order Odonata indicating good water quality and healthy pond [17].

Table 2. Composition and distribution of benthic macroinvertebrates in fish pond

ORDER	FAMILY	MONTH						TOTAL
		Mar	Apr	May	Jun	Jul	Aug	

Ephemeroptera	Ephemerellidae	0	2	5	0	0	0	7
	Baetidae	0	0	2	2	0	0	4
	Leptophlebiidae	0	0	1	0	0	0	1
	Caenidae	0	0	2	0	3	1	6
Coleoptera	Hydrophilidae	1	0	0	0	0	0	1
	Elmidae	0	0	1	0	0	0	1
Hemiptera	Corixidae	4	26	28	17	120	69	264
	Nepidea	0	0	0	1	1	0	2
	Notonectidae	0	4	0	2	8	0	14
	Hydrometridae	0	1	0	0	0	0	1
	Pleidae	3	0	0	0	0	0	3
Odonata	Libellulidae	0	1	3	0	7	2	13
	Coenagrionidae	0	0	0	2	0	0	2
	Corduliidae	0	0	0	0	0	1	1
Diptera	Chironomidae (Midges)	0	3	6	5	8	1	23
Decapoda	Atyidae	1	0	2	2	0	1	6
Orthoptera	Acrididae	0	0	0	1	2	0	3
	Tridactylidae	0	0	1	0	0	0	1
Lumbriculida	Lumbriculidae	0	1	0	0	0	0	1
Turbificida	Turbificidae	0	0	0	2	0	0	2
NUMBER OF ABUNDANCE		9	38	51	34	149	75	356
NUMBER OF TAXA		4	7	10	9	7	6	20

3.2 Ecological Indices of Benthic Macroinvertebrates

Diversity index provides information about community composition by taking into account not only species richness but also relative abundances of different species. Diversity index can also help to reflect information on the rareness and commonness of species in a community. Figure 1 showed the results of Shannon-Weiner index or diversity index in the fish pond for 6 months period which were from March until August 2021. The value of diversity index changed every month and the highest was

recorded in May (1.74) and the lowest in August (0.40). In addition, biodiversity indices value recorded in July and August were less than 1.0, this indicated certain number of species dominated the area, uneven distribution of species represent unhealthy of the pond where habitat structure was disturbed [18]. On the other hand, biodiversity indices value recorded in March, April, May, and June were greater than 1.0, this indicated the ecosystem remains stable and able to support numerous species of benthos. According to [19], pond or river which has diversity index between 1 to 3, can be categorise as moderate and its able to support aquatic life, especially fish. On the other hand, the possible reasons of low diversity index in July and August, most probably due to the beginning of the rainy season which brings together pollution through surface runoff into ponds.

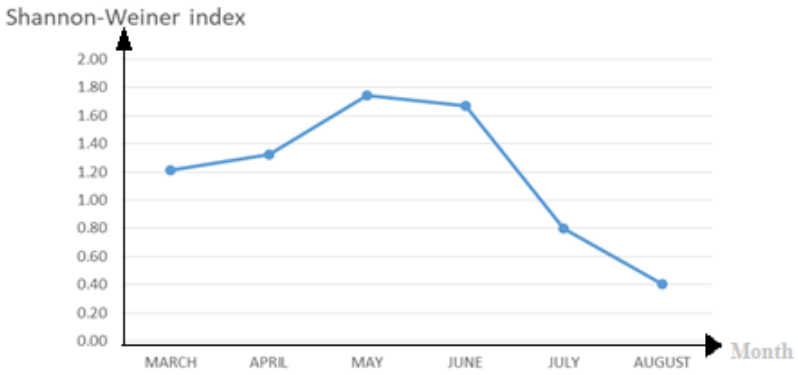

Figure 1. Shannon-Weiner indices of fish pond benthic macroinvertebrates

The trend of species diversity and species richness are the same where its recorded highest value in May and June and the lowest in July and August. The highest richness index value which was recorded in May is 2.29 and the lowest richness index value was recorded in August is 1.16. While in March, April, June, and July the richness index value were 1.37, 1.65, 2.27, and 1.20 (Figure 2). The results indicated the quality of fish pond is good and it was in healthy conditions during May and June but it was the other way round in July and August and the possible reasons would be non-point source pollution attached with run off.

Figure 2. Margalef's Indices of fish pond benthic macroinvertebrates

Figure 3 showed results of the evenness index based on Pielou's index. The highest value of evenness index was recorded in March followed by June, May, April, July and August. Based on the results, evenness index can be classified into two cluster, which is high and low evenness index classes. High evenness index was recorded in March (0.88), April (0.68), May (0.76) and June (0.76), while low evenness index was recorded in July and August (0.23). Evenness index value recorded was inline with biodiversity and richness indices recorded where it was high in May and June and low in July and August. The index value near 1 indicates that the species distribution is more even where the number of individual for each species almost the same or not much different. On the other hand, evenness index value close to 0 indicates certain species dominated the area. For example Corixidae species is dominated the area in the month of July and August. This indicated, Corixidae is kind of robust species, pollution tolerant species and can be used to indicated low quality of fish pond water and unhealthy fish pond conditions.

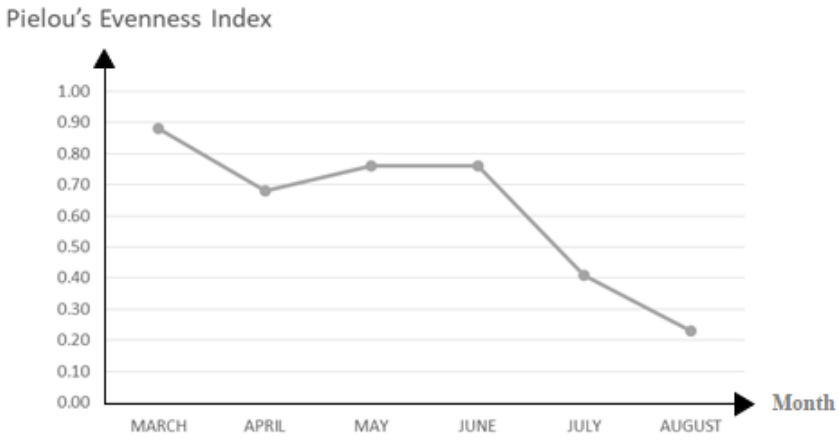

Figure 3. Pielou's Indices of fish pond benthic macroinvertebrates

The results and trend of dominance index was opposite of diversity, richness and evenness indices as shown in Figure 4 below where it was highest in July and August and lowest in March, April, May and June. The greater the diversity value, the lower the dominance index, and vice versa, the greater the dominance value, the lower the diversity. In March, the dominance index value was 0.25, in April the dominance index was 0.48, in May was 0.32, in June was 0.27, in July was 0.65 and in August was 0.85. The lowest dominance value was recorded in March and the highest in August. Higher dominance index is basically an indication of unhealthy ecosystem, unhealthy surrounding environment and unable to support living things well.

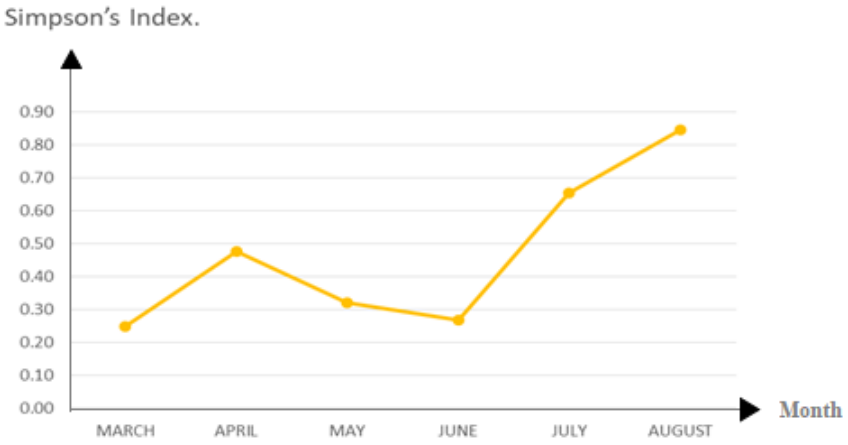

Figure 4. Simpson's Indices of fish pond benthic macroinvertebrates

Based on the results, healthy pond conditions occurred during dry and low raining seasons from March until June. Unhealthy pond conditions occurred during rainy seasons from July until August. Diversity index is positive correlated with richness, evenness and dominance indices, the higher the richness and evenness, the higher the diversity index. On the other hand, dominance index was negatively correlated with diversity, richness and evenness indices. The higher the dominance index the lower the diversity, richness and evenness.

4. Conclusion

As a conclusion, studied fish pond was dominated by (Hemiptera) followed by Chironomidae (Diptera) and the diversity, richness, evenness and dominance of benthic macoinvertebrate benthics species varied monthly. This was believed to be due to non-point souce pollution entered to the pond via run off during raining day. Therefore, it is sufficient to used these organisms as bioindicator as the ecological indices is carried monthly shows any changes condition at the pond will effecting the distribution and abundance of these organisms. However, a details research on how to used it to assess need to be done so a standard policy and guideline can be introduce and implemented by farmer to assess their pond quality.

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