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DIVERSITY AND DISTRIBUTION OF FRESHWATER FISHES AT SUNGAI MUAR, KUALA PILAH, NEGERI SEMBILAN

Nur Hasyimah Ramli*, Wan Nur Atilla Antasha Megat Asrul Hazaman

School of Biology, Faculty of Applied Sciences
Universiti Teknologi MARA, Cawangan Negeri Sembilan, Kampus Kuala Pilah , 72000 Kuala Pilah, Negeri Sembilan, Malaysia

**Corresponding author: nurhasyimah@uitm.edu.my*

Abstract

Freshwater fishes are species that spend their entire live in either freshwater inland or brackish estuaries. The checklist of the fish species should be updated consistently to ensure their diversity is preserved. The study of diversity and distribution of freshwater fishes at Sungai Muar, Kuala Pilah, Negeri Sembilan was carried out on 14 and 15 March 2020 to identify the fish diversity and their development in Sg. Muar, Negeri Sembilan. Trawl (fish collections), weighing machine and ruler (morphometric observations) was used during experiment. Fish species found during this study include *Oreochromis mossambicus* (Family Cichlidae), *Hemibagrus nemurus* (Family Bagridae), *Homaloptera tweediei* (Family Balitoridae), *Notopterus notopterus* (Family Notopteridae), *Oxyeleotris marmorata* (family Eleotridae), and five species of Family Cyprinidae, which were *Mystacoleucus marginatus*, *Osteochilus haseltii*, *Cyclocheilichthys apogon*, *Barbonymus schwanenfeldii* and *Hampala microlepidota*. Fishes from family Cyprinidae was dominated the area with a total of 102 individuals found. The statistical analysis shows the diversity (H')=1.826, richness (R')=2.004 and evenness (E')= 0.5645 of freshwater fish at Sungai Muar, respectively. The most dominant species found was *Mystacoleucus marginatus* with 50 individuals and the least abundant species were *Barbonymus schwanenfeldii, Homaloptera tweediei* and *Oxyeleotris marmorata* with one individual only. The length-weight regression shows a positive allometric growth with 'b' value is higher than 3 at both stations; 3.0118 (Station 1) and 3.4409 (Station 2). It shows that the fish becomes heavier as its length increases. This data provides information about the fish habitat in Sungai Muar and can be used to update the checklist of fish species in Sg Muar. The data obtained provides information about the fish habitat in Sungai Muar which could be useful for the planning of fishing activities Other than that, it also important as a guideline for future research and conservation purposes especially in Negeri Sembilan.

Keywords: diversity, distribution, freshwater fish, length-weight, Sg Muar

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Introduction

Fish have the highest diversity of species in all vertebrate taxa and are distributed in a variety of aquatic environments (De Silva *et al.,* 2007). About 40% of all fish species can be found in freshwaters (Dudgeon *et al.*, 2005). Malaysia reports a total of 1951 freshwater and marine fish species belonging to 704 genera and 186 families (Chong *et al*., 2010). Most of the fish species live in freshwater such as rivers and lakes. The scientists found out there are more than 800 known freshwater fish species in the North America and over 10,000 species worldwide (National Geographic, 2015). According to Khairul (2002), there are more than 340 species of freshwater fish in Borneo and FishBase (2019) reported that there are 620 species of freshwater fishes found in Malaysia.

There are about 522 native species of freshwater fishes recorded in Malaysia. Native species are a species, subspecies, or lower taxon, that occur within its natural range and dispersal potential. It also called an indigenous species (IUCN 2000). Some of the native species of freshwater fishes are *Amblypharyngodon atkinsonii* (bombin Burma), *Barbodes binotatus* (common barb), *Boesemania microlepis* (gelama), *Boleopthalmus boddarti* (tembakul) and *Carcharhinus leucas* (bull shark) (FishBase, 2019). Oppositely, non-native species or alien species is a subspecies or lower taxon that appears outside its natural environment and dispersal potential and includes any component, gametes or proliferation of such species that may survive and potentially reproduce (IUCN, 2000). Cyprinidae family was believed to be the first species introduced outside their native ranges (Simon *et al.*, 2011). While, the introductions of freshwater fishes were initially started with Cyprinidae family including *Cyprinus carpio* (common carp) for food, followed by *Carassius auratus* (goldfish) for ornamental purposes and *Carassius gibelio* (Gibel carp) to increase the composition of fish population (Copp *et al.,* 2005). Gibel carp has accidentally been introduced through common carp stockings in Turkish inlands (Aydin *et al*., 2011) and produced more successful populations in reservoirs, lakes and ponds than in natural water (Tarkan *et al.,* 2012).

Scientists believe that fish species and habitat characteristics are correlated either with biotic or abiotic variables or the combination of the two (Guisan and Thuiller, 2005). Very few ecosystem models, however, specifically provide biotic factors that can be used to infer or provide proof of interactions between species (Elith and Leathwick, 2009). In fact, the human disturbances can also reduce the abundance of native species, offering future invaders an opportunity (Havel *et al*., 2005). As well as the ranges of affected fish could be decreased or relocated to higher latitude and elevation in response to climate change (Comte *et al.*, 2013). The warming of the climate can inhibit native species, making aquatic ecosystems more vulnerable to invasions (Sorte *et al*., 2013). Other abiotic factors include the environmental chemical and physical factors such as sunlight, temperature, water or moisture, and soil. For example, eextremes pH can directly kill adult fish and harm juvenile fish development. Its alkalinity can strip a fish of its slime coat and high pH level corrodes the fish's skin (Lenntech, 2020).

Additionally. the population of freshwater fish decline yearly in Malaysia. This is due to many threats faced by the species of freshwater fishes. It is believed that human activity is the biggest threat to freshwater fish populations (Benstead, 2019). Habitat destruction caused by agriculture activity and water pollution may also occur as the pesticide chemicals are washed into nearest water sources (Ronca, 2008). Other than that, lack of human awareness on the importance of fish conservation and the ignorance in the importance of fish ecology contributes to the declining number of fish species. Finally, overfishing by the villagers also caused a decline in the number of freshwater fishes, including top predators and migratory fishes (Allan *et al*., 2005).

Freshwater are presents in the form of lakes, wetlands, rivers, and streams (Debashree, 2019). Freshwater habitats show the highest percentages of endangered fish species (87%) and followed by estuarine habitats (66%) (Chong *et al*., 2010). More than half of Japan's native freshwater fish and more than one-third of Mexico's freshwater fish are at risk of extinction. The main drivers of this decline are the depletion of free-flowing streams and increased pollution from farming and urban areas (IUCN, 2019). Biodiversity behaviours of aquatic organisms are mostly determined by the spatial structure of the ecosystem, which is the dendritic structure of the river and river networks (Fausch *et al.,* 2002). This shows that conservation projects in small isolated streams are more needed than in larger and well-connected downstream streams (Swan and Brown, 2017). Upstream effects seem to predict better distribution of fish than local effects on anthropogenic and land cover factors, particularly for species that are sensitive to pollution (Markovic *et al*., 2019).

The research conducted will be beneficial in providing the knowledge and update checklist on the diversity and distribution of freshwater fishes at different sites at Sungai Muar, Negeri Sembilan. Other than that, the data collections on morphometric of fish can be used to determine either the anthropogenic activities conducted near both study sites affect the development of fish. The objectives of the study are to identify the diversity and abundance of freshwater fish and to determine the length-weight relationship of freshwater fishes at Sg Muar. The result of this research will help to increase the community awareness on the importance of fish as a source of protein and a significant help for the authority to plan the conservation programs. It can also increase the data record for Malaysia’s Department of Fisheries and this data can be used as future guideline for the studies of diversity and distribution of freshwater fishes in Sungai Muar, Negeri Sembilan.

Methods

Sampling Site Determination

Sungai Muar was chosen as the sampling sites in this study (Figure 1). The river was divided into two stations for fish collections including at the both side of riverbank and at the centre of the river. The Geographical Positioning System (GPS) Garmin GPSMap 62s model was used to determine the accurate geographical coordinates and the elevation levels of the river. Based on the coordinates obtained, the location was plotted on Google Map (Station 1: 2°93’44.8”N, 102°85’14.8”E; Station 2: 2°58’45.3”N, 102°29’15.2”E).

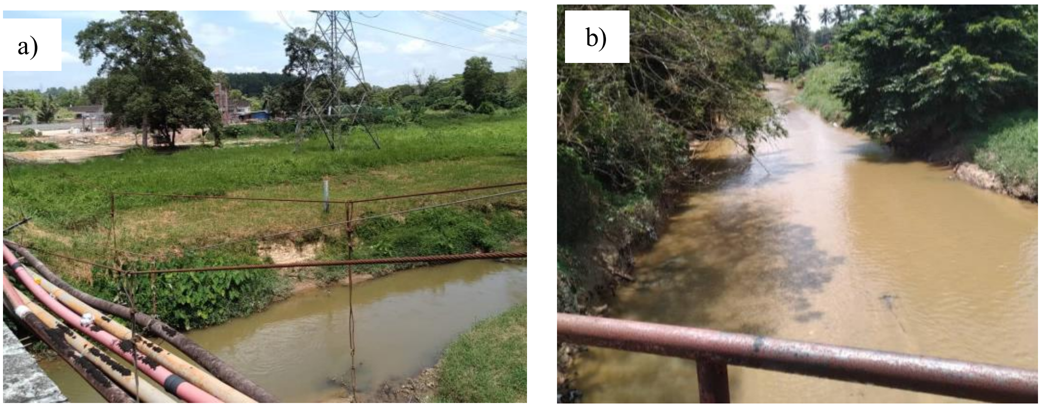

Figure 1. Sampling area of Sg Muar; a) Station 1 and b) Station 2

Physical Parameter Observation

The river length and width were measured at both stations using measuring tape. The measuring tape was hold one end at one point across the river near the riverbank to measure the width (Geography Fieldwork, 2016). The width was measured from inside riverbank side to the far bank edge and one meter above water’s surface (BBC, 2019). While the length of river (about 300 meters) was measured to determine the initial to the final checkpoint of sampling area.

Three readings were taken for the width measurement only for each station. For Station 1, the width measurement was 10.8 m (first check point), 8.5 m (middle check point) and 9.3 m (last check point). For Station 2, the width measurement was 11.22 m (first check point), 13.9 m (second check point) and 13.1 m (last check point). The width measurement was taken within 300 meters.

Fish Collection and Identification

This method is a modification from Nur Hasyimah *et al.* (2013). The sampling activities are carried out in sunny weather condition on 14 and 15 March 2020. The fish samples were captured by using trawl (3 x 4 meters – 10ft). The fish samples were collected from two different stations. The fish were used in identification process. The identification process was conducted to classify the fishes based on their morphological characteristics such as fin, color, mouth and eye. The scientific website of FishBase (List of Freshwater Fishes, 2019), List of Freshwater Fishes (Fish Mongabay, 2007), and the books entitled Freshwater Fishes of Western Indonesia and Sulawesi were used for process of identification. Key identification method such as having paired fins, a jaw and a single gill opening, help in determining the fish belong to one of several families were used to make the identification easier (Murthy, 2009). Second replications were conducted by following the same method.

Morphometric Measurement

The morphometric study on the characters of fish were conducted to distinguish taxonomic units and to observe the detect differences between fish populations (Mojekwu, 2015). The length and width of the fish were measured in cm using ruler (30 cm), while weighing machine (5000g Camry electronic balance – Model EK9270/EK9270H) were used to determine the weight of fish (in grams (g)). The data were recorded. The morphometric data were the primary source of information for taxonomy and evolutionary study (Shobha *et al*., 2017). Based on Pandey (2017), the total length was measured from tip of snout to tip of caudal fin, while head length was measured from tip of snout to the most distant point on opercular membrane.

Statistical Analysis

PAST software version 3.26 was used to analyze the fish diversity (H'), richness (R') and evenness (E'). MINITAB 19 software was used to analyze the length-weight relationship.

i. **Shannon-Wiener Index**

Shannon-Wiener Index was used to determine the fish species abundance based on the number of species and the number of individuals in each species (Muchlisin and Siti Azizah, 2009).

$$H' = -\sum p_i \ln (p_i)$$

Where;

H' = Shannon-Wiener Index, $p_i = \frac{n_i}{N}$
p_i = Proportional abundance of species i
n_i = Total number of individuals of species i
N = Total number of individuals of all species

ii. **Margalef Index**

The Margalef diversity index appears to be a good indicator of diversity and a valuable parameter for evaluating the time series of data (Iglesias-Rios and Mazzoni, 2014). The Margalef diversity index (Margalef, 1958) (d) was calculated using the following formula:

$$d = \frac{S - 1}{\ln N}$$

Where;

S = number of species
N = total number of individuals in the sample

iii. **Evenness Index**

Evenness index was used to compare the numbers of individuals in the same study site for each species (Gaunle, 2018).

$$J = \frac{H/Hmax}{H/\log_e S}$$

Where;

J = evenness index
S = total number of species present in the sample
H' = Shannon-Wiener index

iv. **Length-Weight Regression Analysis**

Length-Weight Regression analysis was used to study the relationship between total length and weight of fish (Morato *et al*., 2001).

$$W = aL^b$$

Where;

W	=	weight in gram
L	=	standard length in centimeter
a	=	intercept of y-axis
b	=	regression coefficient

Result and Discussion

Total Fish Diversity and Abundance at Sungai Muar

Table 1 shows the diversity and abundance of fish caught in Sungai Muar. Total numbers of fish caught were 147 individuals from 6 families. From these 10 species of fishes, the most abundant species was *Mystacoleucus marginatus* from family Cyprinidae with 50 individuals (34%),followed by *Osteochilus haseltii* with 22 individuals (15%),*Hemibagrus nemurus* with 21 individuals (14%), *Cyclocheilichthys apogon* with 16 individuals (10.9%), *Oreochromis mossambicus* with 20 individuals (13.6%) and *Hampala microlepidota* with 13 individuals (8.8%) The least abundant species are *Notopterus notopterus* with 2 individuals (1.4%), while *Barbonymus schwanenfeldii, Homaloptera tweediei* and *Oxyeleotris marmorata* with 1 individual (0.7%) only.

Table 1. The diversity and abundance of fish at Sungai Muar, Negeri Sembilan

Family	Common Name	Scientific Name	Individual No
Cyprinidae	Sia	*Mystacoleucus marginatus*	50
	Terbul	*Osteochilus haseltii*	22
	Cemperas	*Cyclocheilichthys apogon*	16
	Lampam	*Barbonymus schwanenfeldii*	1
	Sebarau	*Hampala microlepidota*	13
Cichlidae	Tilapia Hitam	*Oreochromis mossambicus*	20
Bagridae	Baung	*Hemibagrus nemurus*	21
Notopteridae	Belida	*Notopterus notopterus*	2
Balitoridae	Ikan Pasir	*Homaloptera tweediei*	1
Eleotridae	Ikan Ubi	*Oxyeleotris marmorata*	1
6	**10**	**10**	**147**

From the data obtained, the most dominant fish recorded was classified into family Cyprinidae with 102 individuals from 5 species in Sungai Muar, Negeri Sembilan. This was followed by fish from family Bagridae (21 individuals; 1 species) and family Cichlidae (20 individuals; 1 species). Family Notopteridae with 2 individuals from 1 species, while Balitoridae and Eleotridae recorded only 1 individual for each single species. The fish from family cyprinidae such as *Cyclocheilichthys apogon, M. marginatus, N. stracheyi, R. caudimaculata, S. binotatus and S. orphoides* mostly abundance in the area of moderately higher than the overall averages for the width discharge of habitat, dissolved oxygen and alkalinity (Beamish *et al.,* 2006). So that, the higher abundance of cyprinidae in Sg Muar maybe due to the moderate width discharge of the river and low water velocity.

The morphological characteristics and diet preferences also become another factor that contribute to the presence of Cyprinidae in this river. The morphological characteristics and diet preferences also become another factor that contribute to the presence of Cyprinidae in this river. Sg Muar is filled with grass and large trees on its banks. There are also creeping plants floating on the surface of the water. Therefore, it becomes a good breeding ground for zooplankton, phytoplankton larvae and pupae of insects, aquatic invertebrates and detritus to reproduce and in turn becomes a food source for cyprinidae (Lammens and Hoogenboezem, 1991; Muchlisin *et al*., 2015). The diet must also consider the fish's size and the food's availability depends on its density and size distribution (Lammens and Hoogenboezem, 1991).

Based on a study done by Nur Hasyimah *et al.* (2013), *C.s apogon, O. haseltii, H. microlepidota* and *O. mossambicus* are the species that can still be found in recent study. While *Puntius gonionotus, Hyposarcus pardalis* and *Prophagorus nieuhofi* is no longer found during sampling activities. Recently, a greater number of *M. marginatus* was recorded compared to Nur Hasyimah *et al*. (2013) and it shows that the species has abundantly multiply at Sungai Muar, Negeri Sembilan after seven years. *O. haseltii* was also found in a study at Cameron Highlands, Pahang by Nur Hasyimah (2008) as this species occurs in all types of habitats but usually occur in large streams with slow currents (FishBase, 2019). In my opinion, when there is an additional abundance of the same fish in the same area, it shows that the fish species is able to adapt to changes in its environment without affecting its growth and ability to reproduce.

There were two individuals of *Notopterus notopterus* and only one individual of *B.s schwanenfeldii, H. tweediei,* and *O. marmorata* were recorded in this study, as they may be recently introduced to the habitat. Other than that, only one individual of *H. tweediei* (ray-finned) species was caught even though the riverbed of the river is sandy. According to Rainboth (1996), *H. tweediei* preferred to live among patches of live or dead vegetation in clear area with moderately flowing and oxygen-rich streams. The most abundant species comes from Cyprinidae family with a total of 102 individuals, which is equivalent to 69.4% of the total catches. These results indicate that the rate of species abundance from the family Cyprinidae in Sg Muar is the highest compared to other families. Similar results were obtained by Chow *et al.* (2016) and Khairul Adha *et al.* (2009).

Fish Diversity and Abundance at Sungai Muar (Station 1 and Station 2)

Table 2 shows the diversity and abundance of freshwater fish at Station 1 (S1) and Station 2 (S2) at Sg. Muar. A total of 50 individuals of fishes from five families was recorded at S1. The most dominant species found at this station is *Mystacoleucus marginatus* from family Cyprinidae with 19 individuals, followed by *Hampala microlepidota* with 10 individuals from the same family. Other species found is in single digit number which are *Oreochromis mossambicus* (8 individuals), *Osteochilus haseltii* (5 individuals), *Cyclocheilichthys apogon* (3 individuals) and *Hemibagrus nemurus* (2 individuals). While *Barbonymus schwanenfeldii, Homaloptera tweediei* and *Notopterus notopterus* recorded with one individual only for each species. Some species were shown in Figure 2.

Table 2. The diversity and abundance of fish at Station 1 and Station 2

Family	**Common Name**	**Scientific Name**	**S1 Individual No.**	**S2 Individual No.**
Cyprinidae	Sia	*Mystacoleucus marginatus*	19	31
	Terbul	*Osteochilus haseltii*	5	17
	Cemperas	*Cyclocheilichthys apogon*	3	13
	Lampam	*Barbonymus schwanenfeldii*	1	0
	Sebarau	*Hampala microlepidota*	10	3
Cichlidae	Tilapia Hitam	*Oreochromis mossambicus*	8	12
Bagridae	Baung	*Hemibagrus nemurus*	2	19
Balitoridae	Ikan Pasir	*Homaloptera tweediei*	1	0
Notopteridae	Belida	*Notopterus notopterus*	1	1
Eleotridae	Ikan Ubi	*Oxyeleotris marmorata*	0	1
6	**10**	**10**	**50**	**97**

*S1=Station 1; S2=Station 2

A total of 97 individuals have been found at Station 2. *Mystacoleucus marginatus* from family Cyprinidae with 31 individuals is the most abundant species, followed by *Hemibagrus nemurus* with 19 individuals from family Bagridae. Other species recorded were *Osteochilus haseltii*, *Cyclocheilichthys apogon* and *Oreochromis mossambicus* with 17 individuals, 13 individuals and 12 individuals respectively. While only 3 individuals from *Hampala microlepidota,* and an individual from *Notopterus notopterus, Oxyeleotris marmorata* were recorded.

Mystacoleucus marginatus was found most abundant at both stations as it prefers living in flowing water with substrates of sand and also inhabits lakes and reservoirs as a result of damming and other human interferences (FishBase, 2019). This study sites are water dam, thus explaining the abundant of this species. *Notopterus notopterus* can only be found in single digit as it prefers brackish water; mixing of freshwater with seawater more compared to freshwater (Yanwirsal *et al.*, 2017).

Osteochilus haseltii (Terbul)

Cyclocheilichthys apogon (Cemperas)

Oreochromis mossambicus (Tilapia Hitam)

Notopterus notopterus (Belida)

Mystacoleucus marginatus (Sia)

Figure 2. The examples of freshwater fish collected at Sg Muar

Analysis of Fish Diversity by Shannon-Weiner Index, Margalef Index and Evenness Index

The data obtained were analysed using PAST software version 3.26. As a result, the diversity (H') = 1.826, Richness; (R') = 2.004 and Evenness (E') = 0.5645 from both stations were analyzed. Shannon-Wiener Index shows that Sungai Muar have high diversity of fish. Margalef Index shows that Sungai Muar have high species richness and Evenness Index shows that Sungai Muar have partial evenness of fish species.

The analysis of diversity was conducted and as a result, the diversity (H') = 1.745, Richness; (R') = 2.045 and Evenness (E') = 0.6364 was recorded for Station 1. While in Station 2, the diversity (H') = 1.719, Richness; (R') = 1.530 and Evenness (E') = 0.6974 was obtained. Based on these results, the diversity and richness at Station 1 is higher than Station 2 because the abundance of species was evenly distributed among all the species in the community. While the evenness is higher in Station 2 compare to Station 1 due to more equitable species in proportion to each other (Table 3).

Table 3. Statistical data analysis of fish sample from Sungai Muar, Negeri Sembilan

Sampling Site	**Shannon-Wiener Index**	**Margalef Index**	**Evenness Index**
Station 1	1.745	2.045	0.6364
Station 2	1.719	1.530	0.6972
Both Stations	1.826	2.004	0.5645

From the analysis obtained, it is possible to consider that the diversity of freshwater fish in Sungai Muar as slightly diverse. This is due to Sungai Muar environment that make it suitable for freshwater fish species habitat (Nur Hasyimah *et al*., 2013). However, there are also environmental disturbance that affects the diversity and distribution of freshwater fishes at Sungai Muar, such as human disturbance consists of bridge, water dam and houses. Construction leftover were also thrown into the river.

Morphometric Measurement of Fish

Based on table 4, the standard length of fish samples collected ranged between 4 cm to 21.8 cm. The width of samples ranged from 1.5 cm to 13 cm and the weight ranged from 2 g to 770 g. There are three species collected with single individual only including *B. schwanenfeldii*, *H. tweediei* and *O. marmorata*. There is insufficient amount of data, thus the range of length, width and weight for these three species could not be presented.

Table 4. The data analysis of fish at Sungai Muar, Negeri Sembilan

Species Name	**Individual No.**	**Length (cm)**			**Width (cm)**			**Weight (g)**		
		Min	**Med**	**Max**	**Min**	**Med**	**Max**	**Min**	**Med**	**Max**
Mystacoleucus marginatus	50	4	8	12	1.5	3	4.5	2	11	44
Osteochilus haseltii	22	8.5	11.75	14	3	4.5	5.5	9	42.5	78
Cyclocheilichthys apogon	16	7	9	10.5	2.8	4	5	3	16	39
Hampala microlepidota	13	7.5	9	9.6	2.5	3	4	7	12	28
Oreochromis mossambicus	20	14	18	21	5.5	7	13	39	166.5	770
Hemibagrus nemurus	21	10.5	12	15.8	2.5	3	6.5	6	26	112
Notopterus notopterus	2	17		19.5	5		5.5	47		65
Barbonymus schwanenfeldii	1		21.8			8.8			291	
Homaloptera tweediei	1		18.2			2.5			14	
Oxyeleotris marmorata	1		11.5			2.5			35	

Length-Weight Regression Analysis of Caught Fish Sample

The relationship between length and weight is one of the standard methods which yield authentic biological information and become great importance in fishery assessments. This defines the statistical relationship between the two variables, length and weight and allows for the known length classes to determine the deviations from the predicted weight (Kuriakose, 2014).The length and weight relationship produced a non-linear graph shown in Figure 2. This can be explained by thinking length as linear measure and weight as volume. As a linear amount of length is added, a disk of volume with commensurate weight is also added (Ogle, 2009). Based on the figure, it shows that variability in weight increases with increasing fish length as the scatter points increases from left to right.

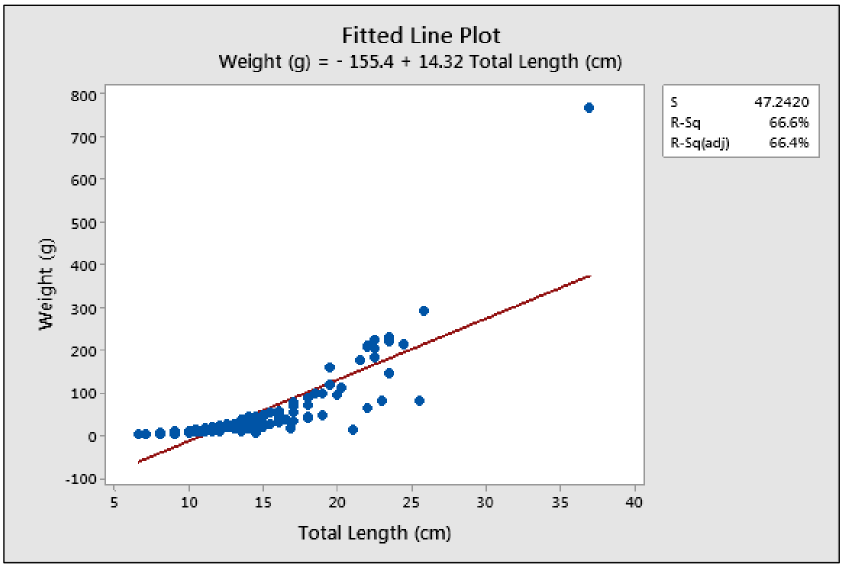

Figure 2. Length-weight regression pattern for species diversity at both stations

Goodness of fit test is used to measure the correlation of sample data fit the distribution from a population with a normal distribution (Kenton, 2019). The regression model's goodness of fit is indicated by the value 'R square' in the output. A good relationship fitted should have high value of 'R square' where the value is between zero to 1.0 (Kuriakose, 2013). The data for 'R square' for Both Station, Station 1 and Station 2 were 0.67, 0.63 and 0.73 respectively. Station 2 recorded a good fit as the value is the nearest to 1.0 (Table 5). The values obtained for length-weight regression analysis for each place differ. This is due to a number of factors, including season, habitat, gonad maturity, sex, diet, and stomach fullness, health and preservation techniques and differences in the length ranges of the caught specimen affects the length-weight relationship in fishes (Kuriakose, 2014). In this study, both habitat and differences in the length ranges of the fish contribute to the values. Station 1 is located in a more open area compared to Station 2 with the presence of more people along with ongoing construction activities. While, the number of specimens caught at Station 2 is greater with more variety of sizes compared to Station 1.

Table 5. The value of parameters; a, b and r^2

Sampling Site	**A**	**b**	**r^2**
Station 1	0.0078	3.0118	0.6250
Station 2	0.0034	3.4409	0.7320
Both Stations	0.0043	3.3104	0.6660

Length-weight regression analysis was used to study the relationship between total length and weight of fish (Morato *et al.*, 2001). The formula of $W = aL^b$ was log transformed to estimate the parameters of 'a' and 'b', where 'a' representing the intercept and 'b' representing the slope of the relationship. There is a positive allometric growth if 'b' is larger than 3, meaning that the fish becomes heavier as its length increases (Nehemia *et al.*, 2012). The data analysed shows 'b' value is larger than 3 at all stations

(Table 5), which indicating that the fishes become heavier as it increases in length. This is a positive allometric growth and it is an optimum condition for growth which is good for the fish development (Jisr *et al.*, 2018).

Most species collected in this study are endemic species in Malaysia such as *Mystacoleucus marginatus, Osteochilus haseltii* and *Cyclocheilichthys apogon.* According to Corse *et al.* (2015), habitat degradation induced similar ecomorphological trait changes in the two fish species from family cyprinidae including *Chondrostoma nasus* (invasive) and *Parachondrostoma toxostoma* (endemic), where the invasive species is more affected than the native species. Therefore, it shows that the environmental disturbances that occur in the area of Sg Muar have less effect on the abundance and growth of fish, especially cyprinids.

Other than that, the individual no. of *O. mossambicus* which is a non-native species captured is 20 individuals (13%) and considered high compared to other species such as *B. schwanenfeldii* and *H. tweediei,* with weight and length between 39 g to 770 g and 14 cm to 21 cm, respectively. According to Olurin and Aderibigbe (2006), Tilapias are plastic animals because the physical and biological composition of their ecosystem may have a significant impact on their growth and maximum size. So that, it shows that Sg Muar provides a suitable habitat for the development.of *O. mossambicus.*

Conclusion

In conclusion, Sungai Muar had been considered as highly diverse with abundant species. The total fish caught in Sungai Muar of Negeri Sembilan is 147 individuals from 7 families, 10 species found during the sampling activities. Sungai Muar was dominated by *M. marginatus* from family Cyprinidae. This was followed by *O.s haseltii* and *H.s nemurus*. From the analysis of length-weight regression, the individual fishes also show normal development and growth. Both diversity, abundance and length-weight result prove that Sungai Muar was not threatened by development pressure caused by anthropogenic activities. It is highly recommended to proceed the study on water quality parameters including physical and chemical in future to reinforce the accuracy in investigating the factors of fish diversity associated with the environment.

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