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A comparative study of fish population in Temengor Reservoir and Bersia Reservoir, Perak, Malaysia

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ABSTRACT:

A study on fish diversity and community of two reservoirs in Hulu Gerik was carried out from August 2009 to December 2009. The two selected reservoirs were Temengor Reservoir and Bersia Reservoir. The aim of this study is to compare the community structures of freshwater fish population between these two reservoirs. A total of 15 species which comprise of six families were recorded in this study. Twelve species were recorded in Temengor Reservoir whereas 13 species were recorded in Bersia Reservoir. The best represented family in both reservoirs was Cyprinidae with eight species in Temengor Reservoir and seven species in Bersia Reservoir. *Cyclocheilichthys apogon* was selected for the length-weight relationship and condition factor analysis. *C. apogon* showed a better growth in Bersia Reservoir in comparison to Temengor Reservoir.

Keywords:
Fish diversity, reservoir, length-weight relationship, condition factor, *Cyclocheilichthys apogon.*

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INTRODUCTION

Fish is one of the most obvious and crucial inhabitants of a reservoir ecosystem. Fish are sensitive indicators of the relative health of aquatic ecosystems and their surrounding watersheds (Fausch *et al*., 1990). Their size, community composition and structure often reflect nutrient status of a water body. In addition, fish has a direct effect on other trophic levels, including phytoplankton and zooplankton. Generally, many fish species can be considered as top consumers in aquatic ecosystems (Dallinger *et al*., 1987). Some fish consume phytoplankton, whereas others consume zooplankton, fish or fish larvae. Pollutants that were discharged into aquatic environment are likely to accumulate in fish and represent a potential risk (Adams *et al*., 1992).

Hashim *et al*., (2012) recorded that there were 21 species of freshwater fish found in Temengor Reservoir in 2006. This finding indicated some missing species in comparison with the previous study done by Md. Akhir (1999) who found 37 species of fish in the same reservoir. Unfortunately, to date, there are no documented studies on fish species featuring Bersia Reservoir. Therefore, this study is believed to be the first report on fish population comparison between these two reservoirs and will thus further contribute to the development of comprehensive baseline data for freshwater fishes in these regions.

Fish species have been used as biological indicators to show the level of environmental quality towards the threats of aquatic pollution since early 1900s. The concept of using fish communities as biological indicator has been historically followed by several authors (Ortmann, 1909; Karr, 1981; Fausch *et al.,* 1990; Schiemer, 2000). Therefore, this study was conducted in order to detect changes in two consecutive reservoirs by using fish community as an indicator. In addition, this study compares the current status of fisheries between these two reservoirs within the context of conservation and management of fisheries.

MATERIALS AND METHODS

Sampling Area

A monthly study on fish diversity and community in two reservoirs in Hulu Gerik district, Perak, was carried out from August 2009 to December 2009. The two selected reservoirs were Temengor Reservoir and Bersia Reservoir (Figure 1). These sites were chosen due to their location at upper part of Sungai Perak basin which serves as the first two consecutive man-made lakes. Temengor Reservoir and Bersia Reservoir are separated by a dam named Temengor Dam (completed in 1977). Temengor Reservoir and Bersia Reservoir cover an area of 152km^2 and 5.7km^2 respectively.

Sampling of Fish

Six sets of experimental gill nets (250 cm vertical length x 2976 cm total width) with five different stretch mesh sizes (3.7 cm, 5 cm, 6.5 cm, 7.5 cm, 10 cm) were soaked randomly overnight in each reservoir. A total of 692 individuals were captured in Temengor Reservoir whereas 214 individuals were captured in Bersia Reservoir. All captured fish were identified and measured (total length and weight). Species identification was based on taxonomic keys by Mohsin

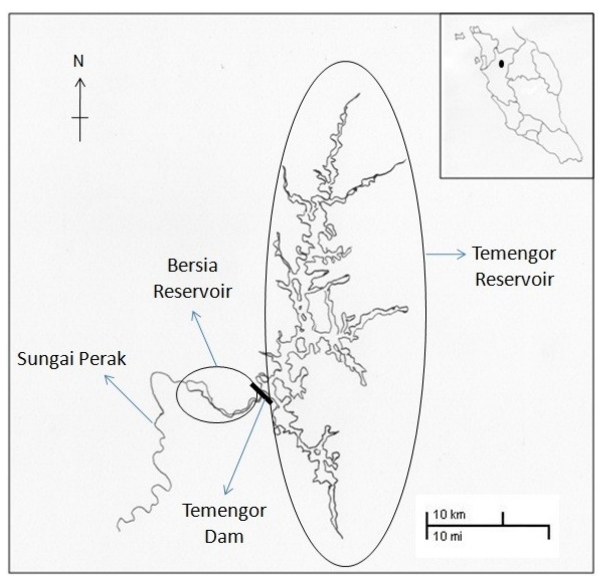

Figure 1: Location of Temengor Reservoir and Bersia Reservoir at upper part of Sungai Perak basin (Inset: Map of Peninsular Malaysia)

and Ambak (1983) and Rainboth (1996).

Shannon Wiener Diversity and Evenness Indices

These indices were applied to fish diversity study and were computed for each system. The diversity and evenness indices were done by using Multi-Variate Statistical Package (MVSP) version 3.13 d.

Length-Weight Relationship (LWR)

In general, the change in weight of the fish can be described by the relationship $W=aL^b$, where *W*=observed fish weight (g) and *L*=observed fish length (cm). Value of *a* is estimated by using antilogarithm of *ln* in the linear regression; $\ln W = \ln a + b \ln L$, where *ln* = regression intercept and *b* = regression slope.

Condition Factor (K)

Condition factor refers to the factor of well being and the degree of fatness of fish (Fafioye and Oluajo, 2005). Condition factor (*K*) is presented by the equation $K= 100W/L^3$, where *W*=weight (g) and *L*=total length (cm). *Cyclocheilichthys apogon* was selected for this purpose.

Independent-samples t test

Independent-samples t test was computed by using SPSS version 11.5 for comparing two parameters; total fish catch and total catch of *C.apogon* between Temengor Reservoir and Bersia Reservoir.

RESULT

Fish Community Structure

Fifteen species, which comprised of six families, were recorded during this study. Cyprinidae was the most dominant family with nine species while the other families were only represented by one or two species (**Table 1**). Twelve species were recorded in Temengor Reservoir with four families while 13 species were recorded in Bersia Reservoir with six families. Total catch in both reservoirs showed that *Osteochilus hasseltii* and *C.apogon* were two species that dominated the catches during this study, which represented 30% and 18% of the total catch, respectively. In Temengor Reservoir, *O.hasseltii* and *Chela anomalura* represented 35% and 20% each of the catches followed by *C.apogon*. However in Bersia Reservoir, *C.anomalura* was absent and *Labiobarbus leptochilus* and *C.apogon* represent the two highest abundance with 24% and 23% each followed by *O.hasseltii* (16%) and the other seven species (17%). A total of four families were recorded in Temengor Reservoir while six families were recorded in Bersia Reservoir. The highest abundance of family composition is Cyprinidae in both Temengor and Bersia reservoirs. In Temengor Reservoir, Cyprinidae comprised of eight fish species whereas in Bersia Reservoir, Cyprinidae comprised of seven fish species.

Shannon Wiener Diversity and Evenness Indices:

Result showed that diversity index in Bersia Reservoir (2.108) was higher than Temengor Reservoir (1.783) during the study. Evenness index of fish species in Bersia Reservoir is also higher than Temengor Reservoir which represents 0.822 and 0.718, respectively. Bersia Reservoir recorded a higher number of species present, but the individuals in the community were distributed more equally among the species. In Temengor Reservoir, there is one less species compared to Bersia Reservoir and most of the individuals belong to *O.hasseltii*. *O.hasseltii* is the most common species in Temengor Reservoir that makes up about 35% of the community.

Length-Weight Relationship (LWR)* of *C.apogon

The example form of parabolic equation of *C.apogon* in Temengor Reservoir and Bersia Reservoir was shown in **Table 2**. The estimation for the length-weight relationship in Temengor Reservoir is taken by the formula, $W=0.004L^{3.363}$. From the relationship, the values of *a* and *b* are 0.004 and 3.363, respectively. For length-weight relationship of *C.apogon* in Bersia Reservoir, the parabolic equation is represented by $W=0.004\ L^{3.414}$. Based on this formula, the values of *a* and *b* were 0.004 and 3.414, respectively. The regression coefficient in Bersia Reservoir (R^2=0.965) is slightly

Table 1: Species checklist and total individual catch recorded in Temengor Reservoir and Bersia Reservoir during this study

Bil	Family	Species	Total individual catch	
			Temengor	Bersia
1	Bagridae	*Mystus nemurus*	8	12
2	Bagridae	*Mystus wyckii*	-	6
3	Channidae	*Channa micropeltes*	1	9
4	Cyprinidae	*Labiobarbus leptochilus*	31	52
5	Cyprinidae	*Chela anomalura*	141	-
6	Cyprinidae	*Puntius gonionotus*	-	5
7	Cyprinidae	*Puntius schwanenfeldii*	1	5
8	Cyprinidae	*Hampala macrolepidota*	88	18
9	Cyprinidae	*Mystacoleucus marginatus*	33	1
10	Cyprinidae	*Cyclocheilichthys apogon*	117	48
11	Cyprinidae	*Osteochilus hasseltii*	241	35
12	Cyprinidae	*Tor tambroides*	1	-
13	Eleotridae	*Oxyeleotris marmoratus*	-	1
14	Nandidae	*Pristolepis fasciatus*	19	9
15	Notopteridae	*Notopterus notopterus*	11	13
	Total Catch		**692**	**214**
	Total Species		**12**	**13**

higher than Temengor Reservoir (R^2=0.920). **Figure 2** and **Figure 3** showed the examples of the length-weight relationship of *C.apogon* in Temengor and Bersia reservoirs, respectively.

Condition factor (K) of C. apogon

The condition factor of *C.apogon* (**Figure 4**) in Temengor Reservoir for October and December were higher than in Bersia Reservoir. There was no catch of *C.apogon* in Temengor and Bersia reservoirs for September and August, respectively. For September in Bersia Reservoir, the condition factor was 1.3197 ± 0.118. The value then decrease to 1.0825 ± 0.061 in October. Then the value was increased in November (1.2664 ± 0.206). A little decrease was then recorded in December (1.2427 ± 0.172). In Temengor Reservoir, the condition factor recorded is 1.2090 in August and 1.3227 ± 0.425 in October. The figure shows the decrease in November (1.1592 ± 0.206). A slight increase recorded in December (1.3181 ± 0.172).

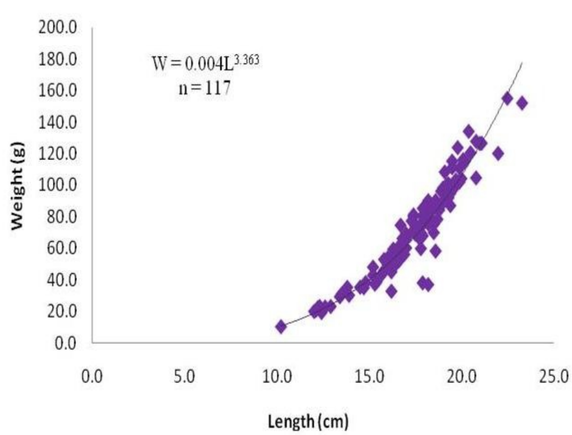

Figure 2: The length-weight relationship of *C. apogon* from Temengor Reservoir

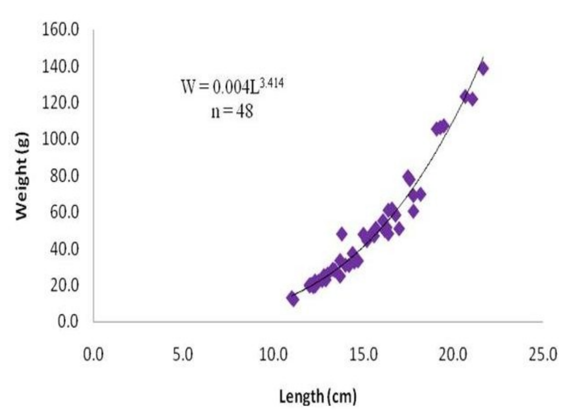

Figure 3: The length-weight relationship of *C. apogon* from Bersia Reservoir

Table 2: Parameter estimates and parabolic equations for *C.apogon* in Temengor Reservoir and Bersia Reservoir in the study. n= total number of samples, min=minimum value, max= maximum value, a= intercept of regression line, b= slope of regression line, R^2 = regression coefficient.

Reservoir	n	Total Length (cm)		Weight (g)		a	b	R^2	$W = aL^b$
		Min	Max	Min	Max				
Temengor	117	10.2	23.3	10.0	155.0	0.004	3.363	0.920	$W = 0.004\ L^{3.363}$
Bersia	48	11.0	21.7	12.2	123.6	0.004	3.414	0.965	$W = 0.004\ L^{3.414}$

Independent-samples t test

Independent-sample t test was used to test if Bersia Reservoir was affected by Temengor Dam. Based on the **Table 3**, the two parameters were not differed significantly ($p>0.05$) between the Temengor and Bersia reservoirs. This means that total individual fish catch and condition factor of *C.apogon* at Bersia Reservoir were relatively similar to Temengor Reservoir.

DISCUSSION

A total of 906 individual fish comprised of six families were recorded in both Temengor and Bersia reservoirs. However, when compared to previous studies, the declining trend in species diversity in Temengor Reservoir was noted. A total of 37 species with 15 families were recorded in Temengor Reservoir by Md Akhir (1999) in comparison to this study which recorded only 12 species with five families.

The highest percentage of family composition in both Temengor and Bersia reservoirs is Cyprinidae. Zakaria-Ismail (1996) reported that the Cyprinidae was the most common family in Malaysian freshwater bodies. This largest family of all freshwater fishes occupies virtually all habitats throughout their distribution (Howes, 1991; Nelson, 1994). This family is highly adapted in any body forms and mouth structures (Ward-Campbell *et al.*, 2005). Taki (1978) highlighted that in Southeast Asia, the distributional summit of cyprinids may contribute to 40% or more of the species in a watershed. In addition, Rathod and Khedkar (2011) noted that Cyprinidae was the dominant family in Gangapur Dam, India as well.

Gue´Gan *et al.,* (1998) suggested that the components of reservoir size (surface area) and energy availability (net primary productivity) are the most important factors in predicting fish diversity. Nevertheless, the role of other possible factors such as current climate and history of the reservoir are merely marginal importance. The difference between species diversity in Temengor Reservoir and Bersia Reservoir may due to the environmental changes especially logging activities. According to Samat *et al*., (2002) logging activities will change the water body from being shaded with canopy cover to exposed water body with little cover. Logging activity also plays a major role in water body through the changes in hydrological regimes, water quality, amounts of organic debris, sediment transport and quantity, and primary and secondary production (Campbell and Doeg, 1989).

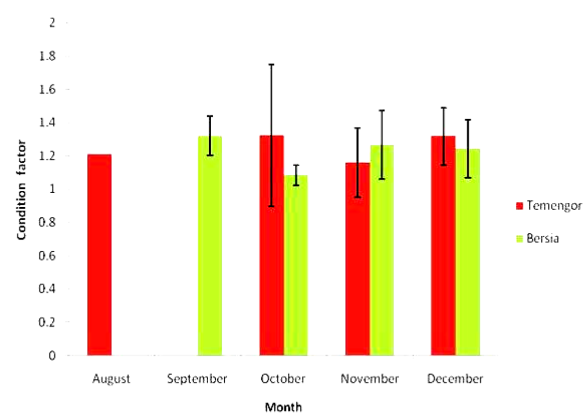

Figure 4: Condition factor (mean ± SD) of *C. apogon* in Temengor Reservoir and Bersia Reservoir

Table 3: Independent-sample t test

Parameter	p	Mean
Total individual fish catch	0.143, p>0.05	0.9563 ± 0.5786
Condition factor of *C.apogon*	0.721, p>0.05	0.0244 ± 0.0653

The fish community and distribution can be very diverse, and it depends on both biotic and abiotic conditions of reservoir such as food availability, size of the water body, oxygen content and the primary production of plants and algae (Gophen *et al.,* 1998). Factors such as increased fishing pressure, open access and unregulated fisheries, and biologically incompatible water level management of reservoir can affect the fisheries of reservoir, negatively (Petr, 1995).

Damming plays a significant role as external factor. The formation of reservoir initially boosts food availability and presents high water level variations (Agostinho *et al.,* 1999). Ambak and Jalal (1998) documented the changes occurred in fish fauna and the patterns of habitat use as the result of the inundation of the man-made Lake Kenyir. Moreover, factors such as water transparency, water velocity in fish habitats, and food availability should be considered to analyze the effects on fish composition.

During this study, the gill nets were placed randomly at the tributary. Generally, tributaries were differed from the main water body with respect to environmental properties and the local heterogeneity (Benda *et al*., 2004). The fish density and community were higher in tributaries compared to main water body (Brown and Coon, 1994) because tributaries have become main habitats for early life stages of fish (Rice *et al*., 2001).

The length-weight relationship parameters allow calculation and estimation of fish condition. Among the fish from the same length, the heaviest will be in better condition (Bagenal and Tesch 1978). In this study, a square of regression coefficient (R^2) was used to estimate the parameters of the length-weight relationship. Based on the length-weight relationship of *C.apogon* in both reservoirs, every individual fish can influence the accuracy of regression coefficient (R^2). The length or other physical dimension including weight can be influenced by environmental factor (Shukor *et al*., 2008). Shamekhi *et al.,* (2012) reported that the inter-basin differences in length and weight of the fish were influenced by the availability of food resources and fish growth.

The coefficient of condition is also used to determine the suitability of the environment for particular species. The change of length-weight relationship of fish is influenced by environmental factors. If the environmental factor favours the fish's growth, the fish will show *b* value that close to 3.0 (Yousof *et al*., 1989). Results have shown that *C. apogon* in Bersia Reservoir has higher *b* value than Temengor Reservoir. This indicated that *C. apogon* has better growth in Bersia Reservoir as compared to Temengor Reservoir. However, the *b* value that was closer to 3 in Temengor Reservoir showed that *C apogon* in Temengor Reservoir has the ideal shape of fish growth.

The growths of fish depend on the availability of food and habitat. Usually, fish that have adequate food and suitable habitat occupation are heavier than normal weight at a certain length (Jobling, 2002). Regarding to the environmental factors that influence formation of growth pattern in tropical fishes, Santos and Barbieri (1993) highlighted that it can diverge in intensity within and between years.

Condition factors have been widely used to get the information about biological status of fish. The term 'condition' can be used to express the fish's general well being (Le Cren, 1951). Condition factor of *C.apogon* was measured based on the number of total catch of the species, in both Temengor and Bersia reservoirs. The higher *K* value of *C. apogon* in Bersia Reservoir indicated that this reservoir provided a more favourable environment for this species as compared to Temengor Reservoir.

The difference of *K* values are influenced by age of fish, sex, season, stage of maturation, fullness of gut, type of food consumed, amount of fat reserve and degree of muscular development (Ozaydin *et al.,* 2007; Cherif *et al.,* 2008). In some fish species, the gonads may weigh up to 15% or more of total body weight. The *K* value will decrease rapidly in females when the eggs are shed (Barnham and Baxter, 1998). The *K* value is greatly influenced by the development of stages in reproductive organs. During the study, there is a month that the *C.apogon* is spawning and some of them are in different stage of the reproductive cycle.

Generally, *C.apogon* moves to flooded forest and on forested floodplain. This species was found in the impoundment and seems to prosper here. As noted by Rainboth (1996), this species was known to breed late in the high-water season from September to October as water levels peak and begin to decline. This movement is basically to avoid predation by other species that move back to the rivers immediately at the onset of falling water. Moreover, this harmless species is rarely used in aquaculture or as bait (Chheng *et al.,* 2005).

The presence of dam in consecutive reservoirs will influence the environmental conditions in the latter reservoir. This is because the dam led to significant changes in the river's annual hydrographic due to the large storage reservoir it impounds (McAdam *et al*., 1999). However, the two parameters tested in this study which were the total of fish catch and the condition factor of *C.apogon* in Bersia Reservoir were relatively similar with Temengor Reservoir. Therefore, Temengor Dam has no effect on fisheries in Bersia Reservoir.

CONCLUSION

Twelve fish species were recorded in Temengor Reservoir whereas 13 species were recorded in Bersia Reservoir. The highest percentage of family composition in both Temengor and Bersia reservoirs is Cyprinidae. The higher *K* value of *C. apogon* in Bersia Reservoir indicated that this reservoir provided a more favourable environment for this species as compared to Temengor Reservoir. Results showed that the fish population found in Temengor Reservoir was relatively similar with Bersia Resevoir. Therefore, Temengor Dam has no effect on fisheries in Bersia Reservoir.

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