Sains Malaysiana 44(1)(2015): 61–66

Length-weight Relationship and Condition Factor of Fish Populations in Temengor Reservoir: Indication of Environmental Health

(Hubungan Panjang-berat dan Faktor Keadaan Populasi Ikan di Empangan Temengor: Penunjuk Kesihatan Alam Sekitar)

MUZZALIFAH ABD HAMID*, MASHHOR MANSOR & SITI AZIZAH MOHD NOR

ABSTRACT

Length-weight relationship (LWR) and condition factor of seven fish species from the Temengor Reservoir, Peninsular Malaysia were analyzed. A total of 1155 individuals belonging to two families namely Nandidae and Cyprinidae were measured and weighed. The most highly represented family was Cyprinidae which comprised six species. Among these seven species, three species generally showed positive allometric growth, two species showed isometric growth and the other two species showed negative allometric growth. The exponent b *value of LWR ranged between 2.601 (*Oxygaster anomalura*) and 3.157 (*Cyclocheilichthys apogon*) with a mean of 2.983. The lowest mean condition factor, K was recorded in* O. anomalura *(0.648 ± 0.131) while the highest value was observed in* Pristolepis fasciata *(2.194 ± 0.153). This study has contributed to the knowledge of fish populations in this economically important area that could assist fishery management scientists in carrying out future ecological studies in line with the strategies of conservation, restoration and management.*

Keywords: Allometric growth; condition factor; fish populations; length-weight relationship; Temengor Reservoir

ABSTRAK

Hubungan panjang-berat (LWR) dan faktor keadaan bagi tujuh spesies ikan dari Empangan Temengor, Semenanjung Malaysia telah dianalisis. Sejumlah 1155 individu daripada dua famili iaitu Nandidae dan Cyprinidae telah diukur dan ditimbang. Famili yang diwakili paling tinggi ialah Cyprinidae yang terdiri daripada enam spesies. Antara tujuh spesies ini, tiga spesies menunjukkan pertumbuhan alometrik positif, dua spesies menunjukkan pertumbuhan isometrik dan dua spesies lagi menunjukkan pertumbuhan alometrik negatif. Nilai eksponen b *daripada LWR berjulat antara 2.601 (*Oxygaster anomalura*) dan 3.157 (*Cyclocheilichthys apogon*) dengan purata 2.983. Purata faktor keadaan, K yang paling rendah direkodkan pada* O. anomalura *(0.648 ± 0.131) manakala nilai tertinggi direkodkan pada* Pristolepis fasciata *(2.194 ± 0.153). Kajian ini telah menyumbang kepada pengetahuan populasi ikan di kawasan yang penting daripada segi ekonomi yang dapat membantu saintis pengurusan perikanan dalam menjalankan kajian ekologi pada masa hadapan bersesuaian dengan strategi pemuliharaan, membaikpulih dan pengurusan.*

Kata kunci: Empangan Temengor; faktor keadaan; hubungan panjang-berat; pertumbuhan alometrik; populasi ikan

INTRODUCTION

The length-weight relationship study is an approach that is widely applied in fisheries management as it provides information on stock condition (Bagenal & Tesch 1978). This relationship is used by fishery researchers and managers for two main purposes; to predict the weight from the length of a fish and to compare the average associated parameters between fish groups spatially or temporally. From this relationship, weight could be computed from a given length and *vice versa* through a mathematical equation. The length-weight relationship can be extended for the estimation of fish condition assuming that a heavier fish of a given length is in a better condition.

Studies on the length-weight relationship and condition factor have been well documented in many tropical freshwater fishes including the golden mahseer, *Tor putitora,* striped dwarf catfish, *Mystus vittatus*, butter catfish, *Ompok pabda* and scissor-tail rasbora, *Rasbora tawarensis* (Gupta et al. 2011; Hossain et al. 2006; Muchlisin et al. 2010; Zafar et al. 2002). Several studies on freshwater fish species in Malaysia have also been conducted in Sungai Batu and Sungai Tua in Selangor, Chenderoh and Kerian River basin in Perak, Pedu Lake in Kedah and Kenyir Reservoir in Terengganu (Kamaruddin et al. 2012; Mansor et al. 2010). However, to date, there has been no evaluation on these important fish parameters featuring the Temengor Reservoir which is the second largest reservoir in Peninsular Malaysia after Kenyir Reservoir.

Temengor Reservoir, which is a sustainable ecotourism hotspot among local and tourists, is very rich in flora and fauna biodiversity and supports a diverse number of fish species including the toman *Channa micropeltes*, carp *Hampala macrolepidota*, barb *Puntius bulu*, river catfish

Mystus nemurus, mahseer *Tor tambroides* and Malaysian carp *Probarbus jullieni* (Muzzalifah & Mashhor 2013; Zarul et al. 2012). While *T. tambroides* is considered as a highly threatened fish in Peninsular Malaysia, *P. jullieni* has a more critical status and is listed in CITES 1 (Chong et al. 2010). Therefore, it is vital that a strategic conservation and management plan be formulated in Temengor Reservoir for sustainable fishery resources to support the indigenous people living in that area as well as other stakeholders.

The objective of the present study was to provide baseline data on length-weight relationship and condition factor for seven major species (Figure 1) sampled from this lake: *Pristolepis fasciata* (patung), *Cyclocheilichthys apogon* (temperas), *Hampala macrolepidota* (sebarau), *Labiobarbus leptocheilus* (kawan), *Mystacoleucus marginatus* (sia), *Osteochilus hasseltii* (terbul) and *Oxygaster anomalura* (lalang). To the best of our knowledge this is the first report of length-weight relationships among

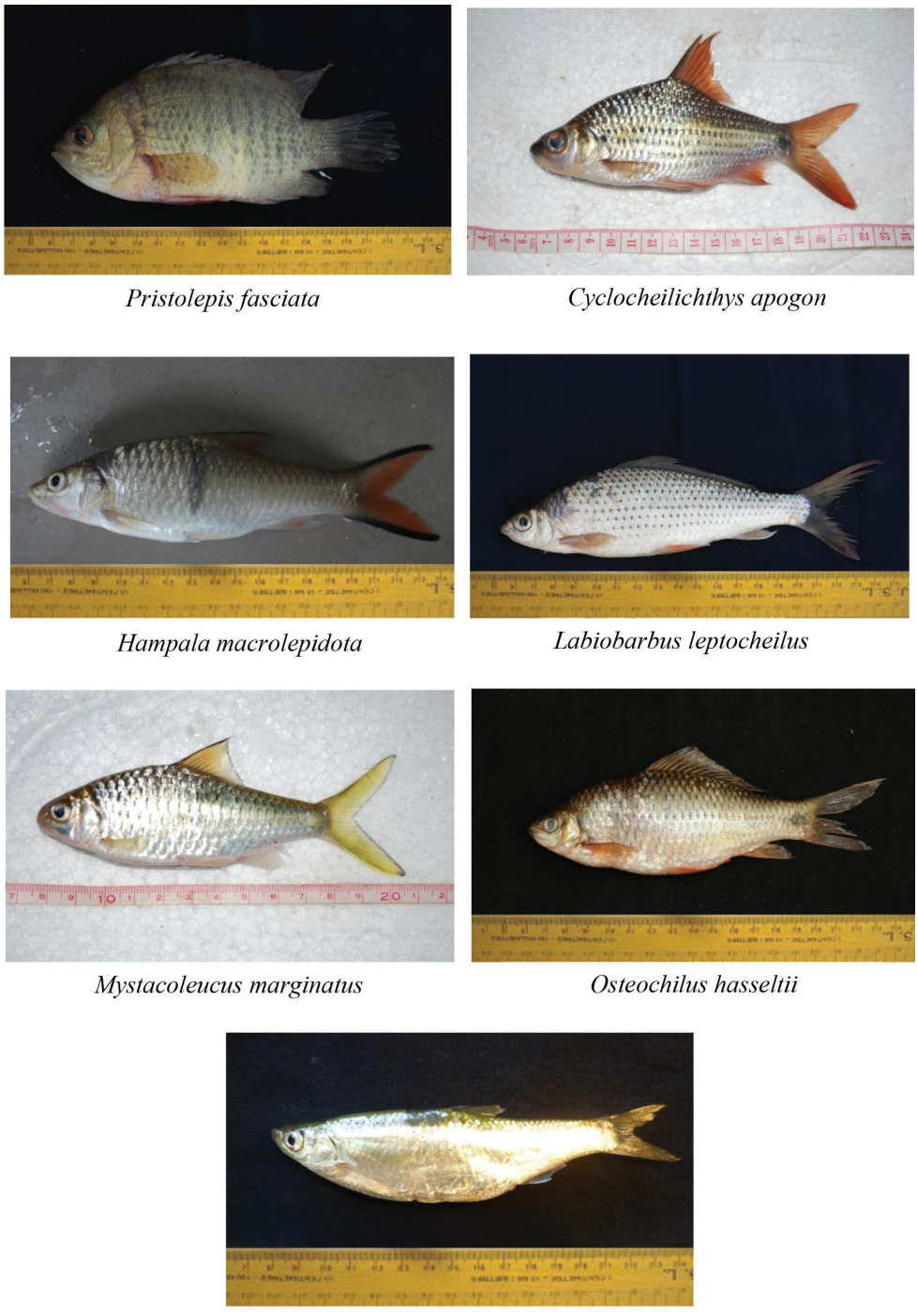

FIGURE 1. The seven fish species analyzed in this study

fish populations in Temengor Reservoir and will thus contribute to the development of a comprehensive baseline data of freshwater fishes in this region.

Materials and Methods

This study was conducted in Temengor Reservoir which is the most upper part of Sungai Perak basin in the Hulu Gerik district in northern Peninsular Malaysia (Figure 2). It is located between 101° 17' 67'' E to 101° 30' 90'' E and 05° 48' 43'' N to 05° 13' 77'' N. Temengor Reservoir covers an area of 15200 ha with an average water level of 239 m above sea level and serves as an important hydroelectricity source. A monthly study was conducted for 10 months from August 2009 to December 2010 covering the dry season (August 2009, December 2009, January 2010, February 2010 and December 2010) and wet season (September to November 2009, September to October 2010).

During each sampling excursion, six sets of experimental gill nets (250 cm vertical length × 2976 cm total width) with five different stretch mesh sizes (3.7, 5, 6.5, 7.5 and 10 cm) were deployed randomly in Temengor Reservoir and left overnight. All captured fishes were kept in an ice-chest and taken back to the Aquatic Laboratory at Universiti Sains Malaysia for further identification and measurement. All samples were weighed and total lengths were measured to the nearest 0.1 g and 0.1 cm, respectively. Species identification was based on taxonomic keys by Ambak et al. (2010) and Rainboth (1996).

The relationship between length and weight (LWR) of the fish samples were calculated using the equation $W=aL^b$. The values of constant a and b were estimated using the least-square method applied to the log transformed data as $log\ W= log\ a + b\ log\ L$ (Ricker 1973), where W (g) is the body weight of the fish, L (cm) is the total length, a is the intercept of the regression curve and b is the regression coefficient. Fulton's condition factor (K) was estimated from the relationship $K=100W/L^3$ to assess the fish condition in Temengor Reservoir.

Statistical analysis was conducted by combining the data from the wet and dry seasons due to the limited number of sample sizes (<30) in certain months. Mean values of length-weight relationship and condition factor were thus considered to be representative of the study area regardless the sampling locations. Moreover, in this study, factors such as habitat, seasonal effect, stomach fullness, preservation techniques, maturity stage, age and sex which also affect the length-weight relationship (Cherif et al. 2008; Ozaydin et al. 2007) were not taken into consideration. For these reasons, the estimated length-weight relationship and the values of a and b should be considered as mean annual values, as proposed by several authors (Andreu-Soler et al. 2006; Borges et al. 2003; Veiga et al. 2009).

Results and Discussion

A total of 19 fish species from eight families namely Bagridae, Channidae, Cichlidae, Cyprinidae, Eleotridae, Nandidae, Notopteridae and Osphronomidae were sampled in this study. However, length-weight relationship was not calculated for twelve species where the number of individuals was below 30 including for the predatory species, *Channa micropeltes*. The lower number of individuals captured might be due to the use of only gill

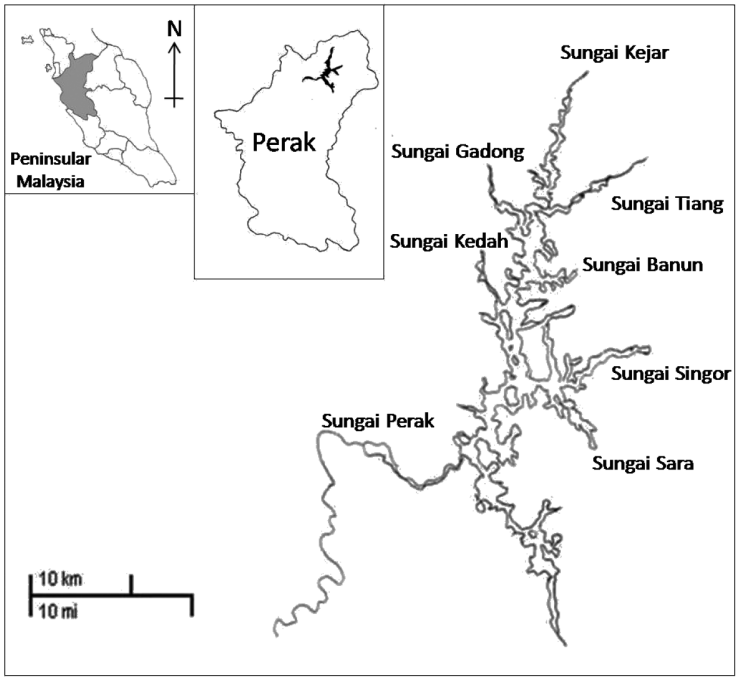

FIGURE 2. Map of the Temengor Reservoir showing the inflows from different rivers. Inset: map of Peninsular Malaysia and Perak state

nets. Thus, only seven species were analyzed in this study with a total of 1155 individuals belonging to two families; Nandidae and Cyprinidae. The age sizes of fish in this study varied considerably from young to adult stages with different growth rates. This high variability was due to the collection of fish using several mesh sizes. Mansor et al. (2010) stated that the selection of mesh sizes of net could contribute to the various sizes of fish caught and hence resulting in different growth. All the age sizes were used to determine the length-weight relationship for each species. The most abundant species sampled were *Osteochilus hasseltii, Cyclocheilichthys apogon, Hampala macrolepidota* and *Oxygaster anomalura* which belong to Cyprinidae. The length-weight relationship parameters for the seven fish species in Temengor Reservoir are presented in Table 1.

Linear regressions were significant for all species (p<0.05), with five of seven R^2 values (71%) >0.95. The group and growth pattern of each fish are summarised in Table 2. The b values of LWR for *H. macrolepidota* and *O. hasseltii* were close to 3.0, hence indicating isometric growth and representing the ideal shape of fish. *P. fasciata, M. marginatus* and *C. apogon* had positive allometric growth with b>3.0. Two fish species namely *O. anomalura* and *L. leptocheilus* had negative allometric growth of b<3.0.

The condition factor, K for seven fish species in Temengor Reservoir is presented in Table 3. The fish species sampled in this study showed K >1.0 except *O. anomalura* and *L. leptocheilus*. The K value is strongly correlated to LWR and therefore the exponent b is very crucial in assessing the well-being of fish. This study provides new information on the length-weight relationship of seven major species from Temengor Reservoir since there is no previous data on the LWR of fishes from this biodiversity rich area.

The majority of fish species from the Temengor Reservoir conformed to the typical b values of 2.5 to 3.5 although this parameter varied significantly within this range (Froese 2006). Thus, the higher b values of regression slope showed that the LWR of a particular species followed the cube law. High b values are a reflection of the general condition of appetite and gonad content of the fish (Pervin & Mortuza 2008). The weight of fish increased when they utilize the food items that are available for growth and energy (Kamaruddin et al. 2012; Offem et al. 2007). The values may also vary significantly according to other factors featuring sex, growth phase, stomach contents and gonad development (Hossain et al. 2006; Leunda et al. 2006; Pervin & Mortuza 2008).

Apart from these factors which are directly related to the fish, ecosystem health associated to the effects of human activities such as logging and aquaculture encompassing the detrimental water quality could be another cause and if true, it would be a very worrying trend for this area as it would affect all the biota its supports. In addition, b values are also reliant on biological and environmental conditions and geographical, temporal and sampling factors (Bagenal & Tesch 1978; Froese 2006). However, these factors were not taken into consideration due to time and budget constraints.

The higher b value of *C. apogon* in Pedu Lake (Mansor et al. 2010) showed that it provided a more favourable environment for this species which has better growth as compared to Temengor Reservoir. In addition, *H. macrolepidota* had a better growth in Kenyir Reservoir (Kamaruddin et al. 2012). Our preliminary study seemed to indicate that Temengor Reservoir might be a relatively less healthy environment for certain fish species since the life span of this reservoir is closely dependant on its forest catchment areas. Sedimentation might be high due to poorly managed logging activities that may affect the water quality especially dissolved oxygen (Mashhor 2010). This would provide an unfavourable environment for the sampled fish species as compared to Pedu Lake and Kenyir Reservoir. More comprehensive studies need to be conducted which would involve the standardisation of the sampling sizes, sampling depths and sampling season as well as understanding the biology of the fishes before further inferences could be made on comparisons among these various sites.

Since Fulton's condition factor, K is a measurement involving the length and weight for a particular fish, therefore it could be influenced by the same factors as LWR. Barnham and Baxter (1998) proposed that if the K value is 1.00, the condition of the fish is poor, long and thin. A 1.20 value of K indicates that the fish is of moderate condition and acceptable to many anglers. A

TABLE 1. The number of specimens, n and estimated parameters of the length-weight relationship for seven species in Temengor Reservoir. a = intercept of regression line, b = slope of regression line, C.L. = Confidence Level, R^2 = Regression Coefficient

Family	Species	n	a	95% C.L. of a	b	95% C.L. of b	R^2
Nandidae	*Pristolepis fasciata*	31	0.018	-2.018 to -1.472	3.072	2.841 - 3.303	0.962
Cyprinidae	*Cyclocheilichthys apogon*	233	0.008	-2.155 to -1.985	3.157	3.087 - 3.227	0.971
	Hampala macrolepidota	207	0.010	-2.073 to -1.886	3.019	2.950 - 3.088	0.973
	Labiobarbus leptocheilus	73	0.015	-2.002 to -1.617	2.845	2.701 - 2.991	0.955
	Mystacoleucus marginatus	83	0.007	-2.274 to -1.945	3.147	3.000 - 3.295	0.957
	Osteochilus hasseltii	357	0.010	-2.075 to -1.862	3.038	2.956 - 3.122	0.937
	Oxygaster anomalura	171	0.020	-1.824 to -1.562	2.601	2.498 - 2.705	0.935

TABLE 2. Fish grouping in Temengor Reservoir based on the value of *b*, slope of the linear regression. NA= Negative Allometric (*b*<3), IS= Isometric (b=3), PA= Positive Allometric (*b* >3)

Group	Fish species	*b*, slope of regression	Growth pattern	$W=aL^b$
Light	*Oxygaster anomalura*	2.601	NA	$W = 0.020\ L^{2.601}$
Light	*Labiobarbus leptocheilus*	2.845	NA	$W = 0.015\ L^{2.846}$
Isometric	*Hampala macrolepidota*	3.019	IS	$W = 0.010\ L^{3.019}$
Isometric	*Osteochilus hasseltii*	3.038	IS	$W = 0.010\ L^{3.038}$
Heavy	*Pristolepis fasciata*	3.072	PA	$W = 0.018\ L^{3.072}$
Heavy	*Mystacoleucus marginatus*	3.147	PA	$W = 0.007\ L^{3.147}$
Heavy	*Cyclocheilichthys apogon*	3.157	PA	$W = 0.008\ L^{3.157}$

TABLE 3. Statistical description obtained for seven fish species sampled in the Temengor Reservoir. Length (cm), Weight (g) and Condition Factor (*K*)

Species	Length (cm)		Weight (g)		*K*
	min - max	mean ± s.d.	min - max	mean ± s.d.	mean ± s.d.
Pristolepis fasciata	10.4 - 18.6	15.323±1.618	25.0 - 124.0	79.401±22.664	2.194±0.153
Cyclocheilichthys apogon	10.2 - 23.3	16.579±2.710	11.0 - 155.7	65.635±31.667	1.325±0.129
Hampala macrolepidota	11.2 - 40.1	22.962±5.154	18.0 - 802.0	156.631±110.110	1.120±0.140
Labiobarbus leptocheilus	14.6 - 28.4	21.248±2.809	32.0 - 179.0	95.985±30.828	0.974±0.083
Mystacoleucus marginatus	9.7 - 17.8	13.155±1.938	7.80 - 66.50	27.984±13.649	1.141±0.110
Osteochilus hasseltii	10.8 - 25.2	19.064±2.960	16.0 - 232.0	94.747±101.853	1.215±0.162
Oxygaster anomalura	9.2 - 27.0	18.674±3.630	6.0 - 92.60	45.342±22.936	0.648±0.131

good and well-proportioned fish would have a *K* value that is approximately 1.40. Based on this criterion, the sampled fishes in Temengor were in good condition except *O. anomalura* and *L. leptocheilus* that showed negative allometric growth. According to Gupta et al. (2011) the difference in condition factor could be due to the availability of food organisms at a particular time as well as the difference of gonad development. The present data could not clarify which factors among those described above could have led to these observations. In summary, the differences in LWR and condition factor of all species in this study could be due to the factors listed earlier or a combination of factors which require further investigation.

CONCLUSION

This study provides the first basic information on length-weight parameters for seven major species collected from Temengor Reservoir. Three species namely *P. fasciata, M. marginatus* and *C. apogon* exhibited a trend of positive growth whereas two species namely *H. macrolepidota* and *O. hasseltii* showed isometric growth. These growth trends denote that this reservoir could provide a favourable environment and suitable habitat for the growth of those fishes. The parameters as shown in this study could be employed to study the growth and population dynamics of the seven fish species exploited from this region. This study has contributed to the knowledge on sustainable fishery resources in Temengor Reservoir.

ACKNOWLEDGEMENTS

We would like to thank Universiti Sains Malaysia and Pulau Banding Rainforest Research Centre for providing physical facilities to carry out this study. Funding for this project was provided by Research Grant 1001/PBIOLOGI/815070.

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Muzzalifah Abd Hamid* & Mashhor Mansor
School of Biological Sciences
Universiti Sains Malaysia
11800 MINDEN, Penang
Malaysia

Siti Azizah Mohd. Nor
Centre for Marine and Coastal Studies
Universiti Sains Malaysia
11800 MINDEN, Penang
Malaysia

*Corresponding author; email: muzzalifah.abdhamid@gmail.com

Received: 12 December 2013
Accepted: 29 May 2014