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Length-weight Relationships of Some Important Estuarine Fish Species from Merbok Estuary, Kedah

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Abstract

Merbok estuary, located in the northern part of Peninsular Malaysia, was inhibited by 81 species that are representatives of 45 genera and 36 families of fish. The length-weight relationship of 23 fish species belonging to 18 families was presented. The *b* values varied between 2.7928 for *Butis gymnopomus* and 3.6001 for *Sillago sihama*. Nine species exhibited positive allometric growth, 10 species were negative allometric growth, 3 species had isometric growth and 1 species was Gompertz form of growth. The length-weight relationships for some species from the Merbok estuary are hereby publish for the first time, and most of the fish specimens were juveniles.

Keywords: Estuarine fishes, length, weight, fisheries management, Merbok estuary

1. Introduction

Fish is a cheap protein source that contains nutrients and plays an important role in the development of a nation. Length and weight data of fish are very important parameters in the estimation of the length and age structures, population dynamic (Krause et al. 1998), growth and mortality rates, and well-being of the fish (Kohlers *et al*. 1995). They are also used to obtain information such as biomass from length frequency distribution (Anderson & Gutreuter 1983, Gayanilo *et al*. 1997) and fish condition (Petrakis & Stergiou 1995, Abowei *et al*. 2009) for stock assessment and management of the population of fish (Garcia *et al*. 1989, Sparre & Venema 1998, Blackwell *et al*. 2000, Haimovici & Velasco 2000). The knowledge of the natural history of fish species (Odedeyi *et al*. 2007) and in fish stock assessment, the length-weight relationship, is very crucial in estimating the standing stock biomass and comparing the development history of fish population from different regions (Patrakis & Stergiou 1995).

The condition factor or well-being of fish is crucial in fisheries biology (Weatherly & Gill 1987). This factor is the quantitative parameter that represents the well-being of the fish (Le Cren 1951), which reflects the condition of the fish in its habitat; the heavier the fish species of a given length, the better the physiological condition, indicating the fish feeds more in that area (Bagenal & Tesch 1978). This condition factor is also an index to understand the lifecycle of fish by referring to the coefficient values derived from the length-weight relationship data (Schneider *et al*. 2000). In other words, the condition factor of fish is strongly affected by both biotic and abiotic environmental factors (Saliu 2001). This parameter could be used to determine the status of the aquatic ecosystem in which the fish live, whether the ecosystem is in good condition or polluted (Luff & Bailey 2000, Anene 2005).

Unfortunately, no work on the LWR has been done on the fish species distributed in the Merbok estuary. The exception is Mansor *et al*. (2001) who worked on 28 species of 10 families of fish collected from the coastal and deep waters of the West Coast of Peninsular Malaysia, 36 species of 10 families collected from the East Coast of Peninsular Malaysia, 16 species of 4 families from Sabah waters, and 27 species of 5 families in Sarawak waters. This present study is focused on the length-weight relationship of some commonly found fish species and classifies them based on the growth pattern, which could provide information about the well-being of fish species inhabiting the Merbok estuary.

2. Materials and Methods

2.1 Study Area

Merbok estuary is one of the representative mangrove reserves lying between 5°30′ N and 100°25′ E in the northern part of Peninsular Malaysia. The length of the main river is about 35 km, connecting many tributaries and most of the water body is high in salinity except for a few kilometers at the upper site associated with freshwater (Ong *et al*. 1991, Mansor *et al*. 2012). The depth varies from 3 m to 15 m, with a few deep holes about 20 m, where tributaries join the Sungai Merbok. The water of Sungai Merbok drains into the Straits of Malacca with input of freshwater into the estuary through several small streams along the river. This is a fishing area for artisanal fishery as well as mariculture activities on prawns/shrimps, finfish cage culture, and mollusk collection (FAO/BOBP 1984).

2.2. Sampling Procedures

Fish samples were collected monthly in 2010 by using barrier nets, locally known as "pukat kering" in a 2 km radius of the 6 physicochemical sampling stations. The nets were deployed by artisanal fishers with the dimensions of the net at 100 – 120 m long, 3 – 5 m deep, and with 2.5 cm mesh size and without bunt. The nets were normally set during the low tide by anchoring the bottom rope to the riverbed. Then the head rope was raised and secured to poles during the high water. The fish was harvested during the low-water period for about 12 h after the net was set (Mansor *et al*. 2012). The fish caught were kept in plastic bags, labeled accordingly, and stored in ice for further work in the laboratory.

The fish samples were separated according to the species (Mansor *et al.* 1998, Ambak *et al.* 2010). The length and weight measurement were conducted in the field (for commercial size fish), while the trash fishes (small fish and commercial fish with smaller sizes) were taken back to the laboratory for identification, measurement, and weighing. The total length (TL), body length (BL), standard length (SL), and whole body weight (BW) for each individual fish were taken and recorded.

The relationship between the TL and BW of the fish was estimated by fitting the data to a potential relationship in the form of $W = aL^b$ (Le Cren 1951, Benedict *et al*. 2009), where W is the BW of fish in grams, L is the TL of fish in centimeters, a is a constant or intercept, and b is the length exponent or slope. The parabolic equation ($W = aL^b$) was then transformed into a linear equation using a logarithmic method: $\text{Ln } W = \text{Ln } a + b \text{ Ln } L$. Based on the equation, the estimated values of a and b were obtained using least-squares regression (Zar 1984). The determination coefficient (r^2) was used as an indicator of the quality of the linear regression (Zar 1984). The t-test analysis was carried out for the length and weight data of each species to confirm the significance of the relationship at $P < 0.001$ (Zar 1984).

The growth patterns of fish determined by the exponent b values were calculated from the linear equation of the length-weight relationship. The fish were considered to have negative allometric growth when the b values were lower than 3, positive allometric growth if the b values were greater than 3, and isometric form of growth when $b = 3$. These growth patterns indicate the group of the fish either they are heavy, light, or isometric. Light fish can be categorized when the value of b is <3, as heavy when the value of b is >3, whereas the value of $b = 3$ indicates isometric growth (Smith 1996, Salam *et al*. 2005, Froese 2006, King 1995, Mansor *et al.* 2010). The mean condition factor (K) for each fish species were calculated using the formula of $K = (W/L^3*100)/n$ (Le Cren 1951, Froese 2006); where W is BW, L is TL and n is the number of individual of the fish species.

3. Results and Discussion

The Merbok estuary could be occupied by 69 species, representatives of 45 genera and from 36 families of fish and 2 families, 3 genera, and 8 species of shrimps. The average CPUE of fishes and shrimps captured by barrier net amounted to 1,248.6 g per boat per trip (g/b/t), of which 72.06% (897.9 g/b/t) were contributed by fish species, and 27.94% (350.7 g/b/t) were marine and giant freshwater prawns. The percentage rankings of important fish species are as shown in Fig. 2. *Arius argyropleuron* was the most common in terms of abundance due to the fact that these catfish are schooling in nature (Fischer & Bianchi 1984; Kailola 1999) and easily entangled in the net in a group. Mansor *et al*. (2012) reported that this fish matured throughout the year with major spawning peak for females occurred in April and minor peak in July, whereas males recorded a higher peak in November. Absolute fecundity of mature ovary was ranged from 19 to 87 eggs.

Overall, more than 61 fish species were measured and weighed, but only 23 species, belonging to 18 families were chosen in this study which had the regression (r^2) values greater than 0.85. The number of individuals varied from 9 in the case of *Grammatobothus polyophthalmus* to 539 for *A. argyropleuron*. The total length

of the fish species ranged from 2.2 cm to 82.0 cm, and the body weights were between 0.5 g and 6,600 g with the smallest fish represented by *Scatophagus argus* and the biggest fish, by *Lates calcarifer*.
Estimates of *a* and *b* for the length-weight relationship, the coefficient of the regression (r^2), and 95% confidence limits for *b* are tabulated in Table 1. The exponent *b* values varied between 2.793 for *Butis gymnopomu*s and 3.600 for *Sillago sihama*. Nine fish species showed positive allometric growth, which were considered as heavy groups with the *b* values ranged from 3.144 to 3.600, including *B. butis, G. polyophthalmus, Gerres filamentosus, Gerres oyena, Acentrogobius audax, Pomadasys kaakan, Platycephalus indicus, S. sihama, Terapon jarbua,* and *Tetraodon nigroviridis.* Ten species showed negative allometric species and were categorized as light fish at *b* ranged between 2.793 and 2.942, including *O. mossambicus*, *B. gymnopomus, L. calcarifer, Leiognathus nuchalis, Leiognathus smithursti, Lutjanus johnii, Lutjanus russelli, Liza subviridis, S. argus, and Terapon jarbua.* Three species had isometric growth (*b* = 3.045–3.089): *A. argyropleuron*, *Johnius belangerii, and Siganus javus.* There was 1 species, i.e., *Oxyeleotris marmorata* (Fig. 3)*,* in the Gompertz growth equation (Jørgensen 1994, Gamito 1998). The expected range of 2.79 < *b* < 3.60 was within the values confirmed by Froese (2006) and Froese & Pauly (2007). This variability might have been caused by seasonal fluctuations that reflected in the change of weight over the course of a year or by variability in sampling sites (Safran 1992) and might be also affected by habitat differences as shown by *O. marmorata,* which is a freshwater fish species, being plump approaching larger size.
The mean condition factors ranged from 0.5769 (SD, 0.1143) for *P. indicus* to 3.4994 (SD, 0.5619) for *S. argus*. Higher values of *K* were shown by *S. argus* most probably due to the truncation of body forms. The values obtained from this study showed that most of the species were in good condition. The factors affecting the variation values of *K* may include sex, stages of maturity, and state of stomach contents (Gayanilo & Pauly 1997, Abowei *et al*. 2009).
Length-weight relationships for 23 species from the study area are hereby published for the first time. Most of the fish specimens were juveniles. Nine species exhibited positive allometric growth, 10 species were negative allometric growth, 3 species had isometric growth and 1 species was Gompertz form of growth. Our study shows that the length weight of juvenile fishes are useful indicators for determining the importance of Merbok estuary as nursery areas. However further study on the fish condition in relation to the physicochemical parameters in the area would provide better understanding on the healthiness of the ecosystem for the betterment of conservation and management of the fishery resources.

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Table 1: The length-weight relationships of 21 fish species collected from Merbok estuary. n, number of individuals; TL, Total length; BW, Body weight; *a*, intercept; *b*, slope; fitted parameters with 95% confidence interval (CI); r^2, regression coefficient; *K*, mean condition factor and SD, standard deviation.

Family: species	n	TL (cm)		BW (g)		95% CI of b	r^2	BW $= a$ TL ^{b}	*K*	SD of *K*
		Min	Max	Min	Max					
Ariidae; *Arius argyropleuron* (Valeciannes, 1840)	539	7.7	32.0	4.8	334.8	3.049–3.129	0.9760	W = 0.0070 $L^{3.0890}$	1.0196	0.1396
Bothidae; *Grammatobothus polyophthalmus* (Bleeker, 1865)	9	5.9	15.3	1.2	34.5	2.734–3.934	0.9610	W = 0.0043 $L^{3.3339}$	0.8931	0.1611
Cichlidae; *Oreochromis mossambicus* (Peters, 1852)	14	6.2	24.5	4.8	308.7	2.796–3.060	0.9949	W = 0.0227 $L^{2.9280}$	1.8925	0.1751
Eleotridae; *Butis butis* (Hamilton, 1822)	102	7.9	14.0	4.1	33.7	3.275–3.806	0.8747	W = 0.0028 $L^{3.5402}$	1.0308	0.1688
" *Butis gymnopomus* (Bleeker, 1853)	440	8.2	29.9	6.0	224.9	2.753–2.830	0.9777	W = 0.0155 $L^{2.7928}$	0.8403	0.0856
" *Oxyeleotris marmorata* (Bleeker, 1852)	15	3.0	15.0	1.4	74.6	1.863–3.236	0.9226	W = 0.393 exp $^{0.3444 L}$	1.8469	0.1835
Gerridae; *Gerres filamentosus* (Cuvier, 1829)	273	5.8	17.9	2.4	85.5	3.164–3.305	0.9695	W = 0.0086 $L^{3.2441}$	1.5889	1.3159
Gerres oyena (Forsskal, 1775)	28	5.5	9.6	2.1	14.8	2.859–3.723	0.9040	W = 0.0086 $L^{3.2907}$	1.5821	0.2774
Gobiidae; *Acentrogobius audax* (Smith, 1959)	72	5.5	18.2	2.7	58.9	3.068–3.523	0.9226	W = 0.0049 $L^{3.2952}$	1.0407	0.2373
Haemulidae; *Pomadasys kaakan* (Cuvier, 1830)	259	5.6	15.6	1.7	67.6	3.151–3.238	0.9787	W = 0.0104 $L^{3.1949}$	1.6597	0.1403
Latidae; *Lates calcarifer* (Bloch, 1790)	47	15.5	82.0	50.0	6600.0	2.886–3.092	0.9869	W = 0.0123	1.1909	0.1359

								$L^{2.9893}$		
Leiognathidae; *Leiognathus nuchalis* (Temminck & Schlegel, 1845)	61	3.7	7.5	0.7	5.7	2.692–3.278	0.8757	$W = 0.0125 L^{2.9852}$	1.2385	0.1483
" *Leiognathus smithursti* (Ramsay and Ogilby, 1886)	31	6.0	17.1	3.0	53.0	2.733–3.148	0.9867	$W = 0.0173 L^{2.9405}$	1.5372	0.2164
Lutjanidae; *Lutjanus johnii* (Bloch, 1792)	111	6.4	17.3	4.6	97.6	2.823–3.016	0.9706	$W = 0.0218 L^{2.9195}$	1.8139	0.2554
" *Lutjanus russelli* (Bleeker, 1849)	130	4.4	18.6	0.7	97.6	2.806–2.972	0.9739	$W = 0.0206 L^{2.8890}$	1.6116	0.2405
Mugilidae; *Liza subviridis* (Valenciennes, 1836)	193	10.4	21.6	11.8	113.3	2.801–2.971	0.9590	$W = 0.0150 L^{2.8863}$	1.1038	0.0959
Platycephalidae; *Platycephalus indicus* (Linnaeus, 1758)	33	11.1	27.6	5.9	156.2	3.341–3.661	0.9847	$W = 0.0013 L^{3.5011}$	0.5769	0.1143
Scatophagidae; *Scatophagus argus* (Linnaeus, 1766)	314	2.2	14.0	0.5	85.5	2.896–2.989	0.9808	$W = 0.0388 L^{2.9423}$	3.4994	0.5618
Sciaenidae; *Johnius belangerii* (Cuvier, 1830)	52	4.9	14.3	0.8	28.3	2.748–3.343	0.8938	$W = 0.0102 L^{3.0447}$	1.1660	0.3304
Siganidae; *Siganus javus* (Linnaeus,1766)	92	3.0	15.0	0.8	56.7	2.918–3.182	0.9591	$W = 0.0140 L^{3.0503}$	1.5935	0.3256
Sillaginidae; *Sillago sihama* (Forsskal, 1755)	31	7.8	15.0	2.8	30.7	3.411–3.789	0.9813	$W = 0.0018 L^{3.6001}$	0.7157	0.0848
Terapontidae; *Terapon jarbua* (Forsskal, 1775)	37	5.7	11.4	3.3	30.8	2.723–3.153	0.9565	$W = 0.0197 L^{2.9379}$	1.7238	0.1503
Tetraodontidae; *Tetraodon nigroviridis* (Marion de Proce, 1822)	25	3.0	17.5	0.4	169.6	2.790–3.498	0.9334	$W = 0.0228 L^{3.1441}$	3.2201	1.0443

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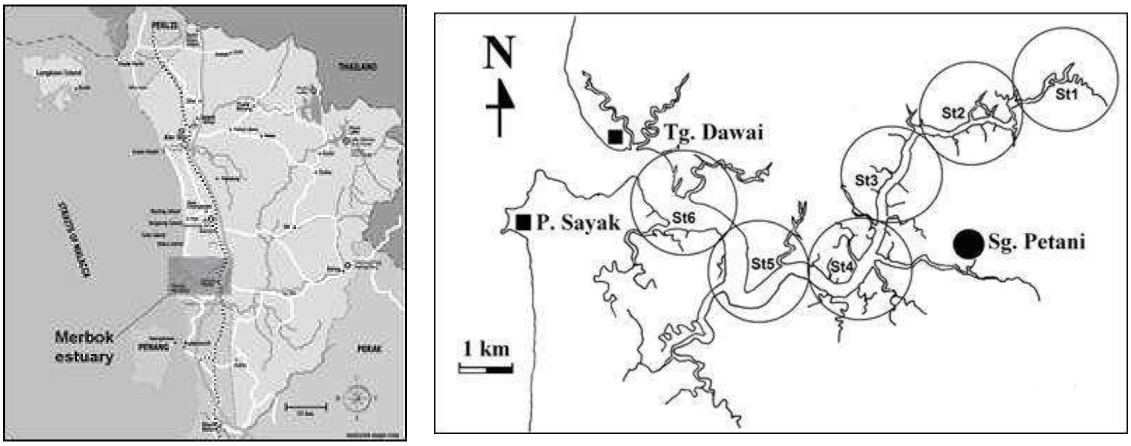

Fig. 1. Merbok estuary located in Kedah State showing the physicochemical sampling stations. St1, Lalang River; St2, Semeling River; St3, Jerang Belanga; St4, Teluk Wang; St5, Gelam River, and St6, Lubuk Pusing.

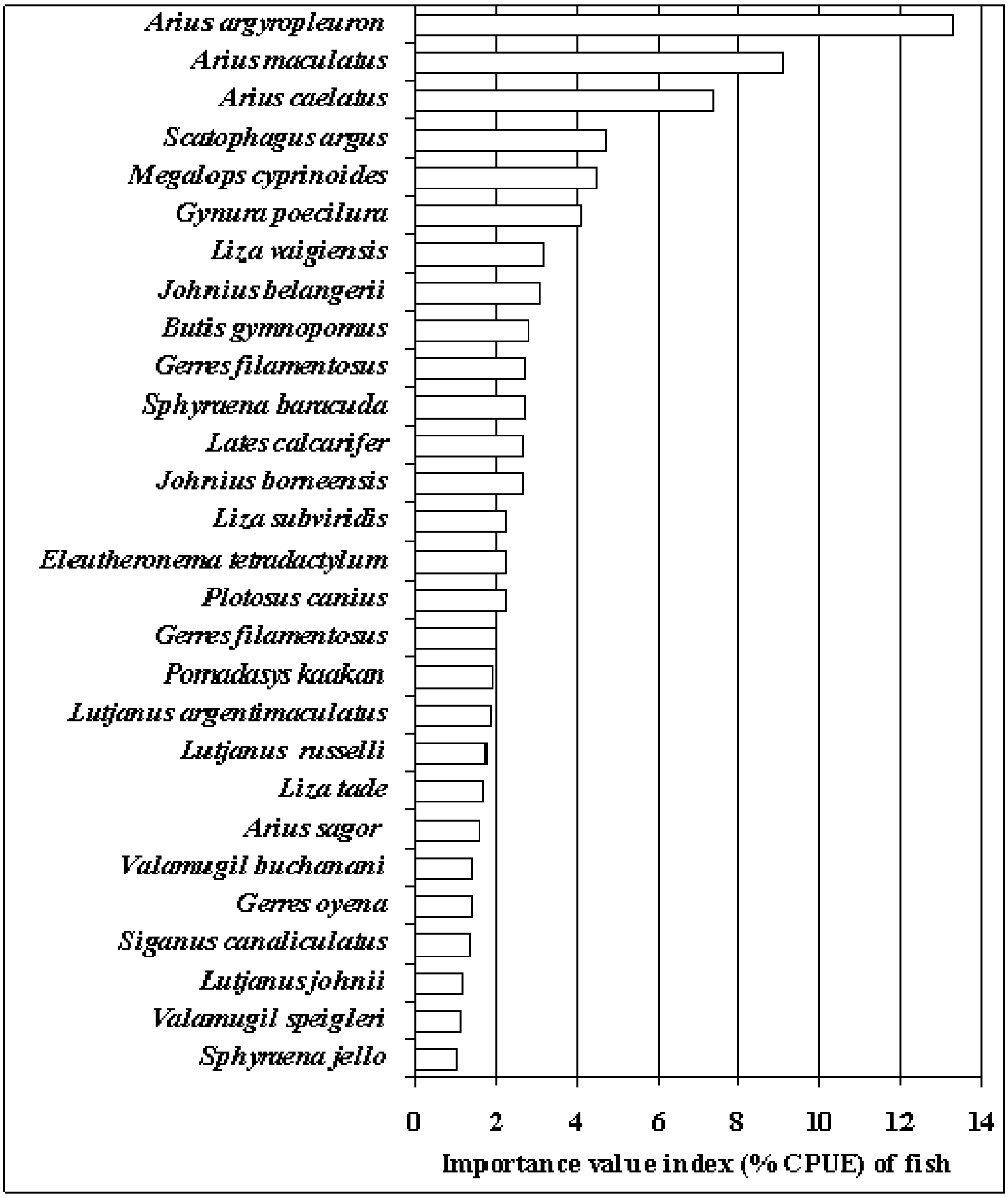

Fig. 2. Important value index of dominant fish species collected from the Merbok estuary, ranked by percentage CPUE (g/boat/trip).

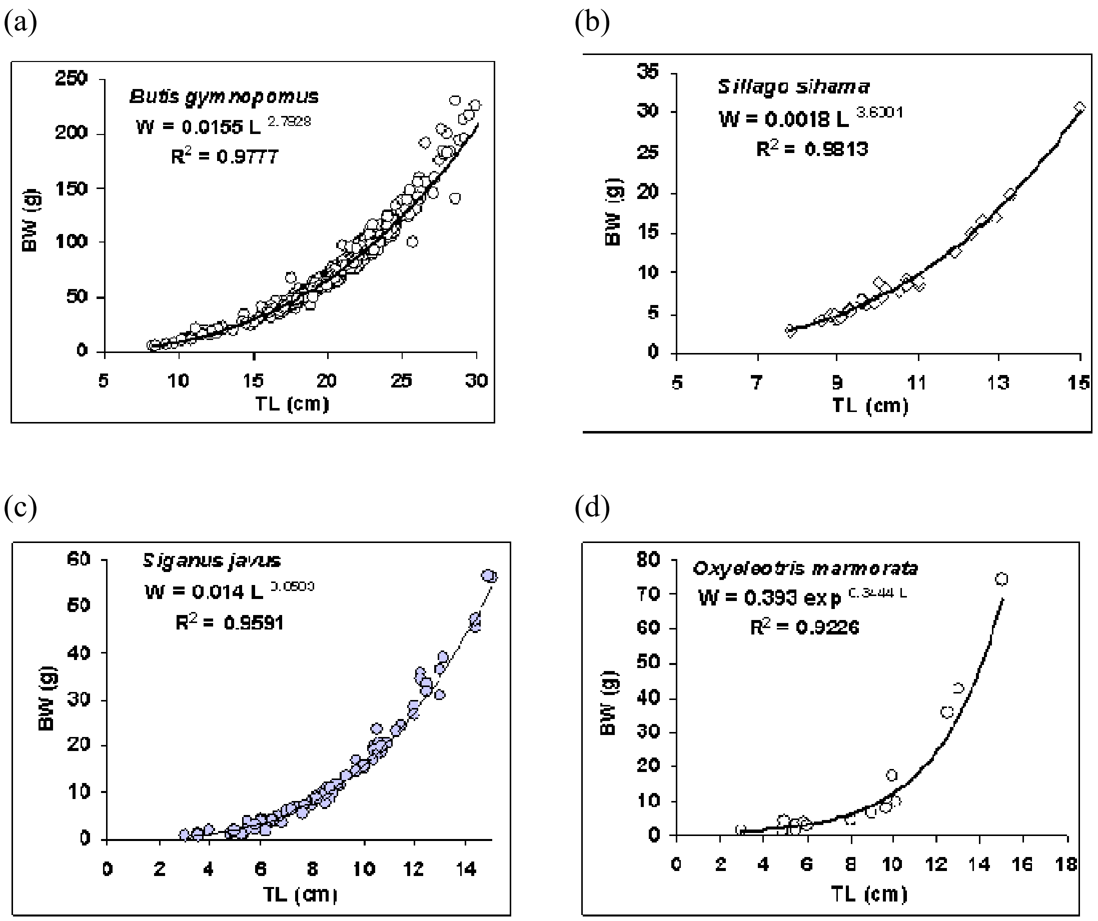

Fig. 3. Length-weight relationship of the negative allometric (a); ligther), positive allometric (b); heavier), isometric (c) and Gompertz growth equation (d) in fish from the Merbok estuary of Kedah.