Length-weight Relationship and Condition Factor of the Mystusnigriceps from Sungai Batang River, Indonesia

Ahmadi*

Faculty of Marine and Fisheries, Lambung Mangkurat University Banjarbaru 70714, South Kalimantan, Indonesia

***Corresponding Author:** **Ahmadi**, Faculty of Marine and Fisheries, Lambung Mangkurat University Banjarbaru 70714, South Kalimantan, Indonesia*

Abstract: *The Mystus nigriceps in Sungai Batang River, Indonesia are commercially exploited and they are vulnerable to destructive fishing methods, while morphometric characteristic of the fish is poorly studied. The fish were obtained from local fishermen. A total of188individualsof M. nigriceps consisted of 68 males and 120 females (103-195 mm total length and 15-72g weight) were investigated. Female had total length, body weight and body depth greater than male (P<0.001). Dealing with the catches, more than 22% of male falls within the range of 130 and 149 mm TL, and 30.00% of female found between 260 and 279 mm TL. The heaviest male (19.12%) and female (23.33%) weighed between 30 and 49 g. The ratio of body weight to total length of M. nigriceps in the present study was higher than other Mystus species from different geographical regions. The mean condition factor of female was significantly higher than male (P<0.05) with the respective values of 1.28±0.13 and 1.21±0.12. The fish samples were in moderate condition and grew negatively allometric (b=2.5010-2.7154). Outcomes of this study could be useful for fisheries management and conservation measures in this river.*

Keywords: *Allometric, Condition Factor, Length-Weight, M. Nigriceps and Sungai Batang.*

1. INTRODUCTION

Various Mystus species of family Bagridae have been widely studied and verified, including Mystusgulio (Hamilton, 1822),M. tengra (Hamilton, 1822) and M. vittatus (Bloch, 1794) from Bangladesh[1,2], M. wolfii (Bleeker, 1851) from Singapore[3] M.bleekeri (Day, 1877)from Pakistan[4], M.cavasius (Hamilton, 1822) and M.carcio (Hamilton, 1822) from India[5,6],M. micracanthus (Bleeker, 1846),M. nemurus (Valenciennes, 1840) and M. nigricheps (Valenciennes, 1840) from Indonesia[7,8,9]or M. castaneus from Malaysia[10].The Mystus species is served as food[11,12]and it has also good demand in fish market due to its taste and nutritional value[4,13]. The Mystus species can be found in the rivers, reservoirs, lakes and estuarine [14, 15, 16].

Several works on mystus species have been devoted in recent years such as morphometric characteristics [1, 2], proximate composition of body[4], identity of species[5] (Chakrabarty and Ng, 2005), redescription of species[17], as well as overview of aquaculture technology for this species[9,18].Each species of the family Bagridae has own its characteristic and they may have different performance and behavior even in the same habitat. To manage the mystus fishery resource rationally, it is therefore needed in-depth knowledge of its biology, feeding habit and ecology[4,7,8].The length-weight relationship is the most common scientific approach that used for analyzing growth or morphometric for an individual species of fish[1,2,19], as well as for understanding survival, maturity and reproduction[20,21]of various species from different geographical regions. It is also useful in local and interregional, morphological and life historical comparisons in species and populations [22, 23, 24]. Lawson [22] stated that fecundity may increase with increased body size in fish, while Ghorbani et al.[25]suggested that the fish length is the best indicator of production efficiency.

Fishing activity in Sungai Batang waters is open throughout the year regardless of seasonal periods, which is done by both villagers and beyond. The use of unfriendly fishing method (e.g. electro fishing and poisoning) is still happening beyond the control particularly during night time. In addition, pollution in wetlands and environmental degradation may also threaten this species [26, 27]. If it is

allowed without forbidden, it will adverse to fish habitat and socio-economic as the whole. On the other side, scientific information on morphometric characteristic of fish captured is still lacking. The main purpose of this study is to investigate length-weight relationship and condition factor of *M. nigriceps* to provide some fundamental suggestions for better fisheries management.

2. MATERIALS AND METHODS

2.1. Study Site

The research was conducted in Sungai Batang River, Martapura of South Kalimantan Province (Figure 1), located on 03°25'32" S and 114°43'21" E, determined by GPS-60 Garmin, Taiwan. The M.nigriceps, locally called lundu (Figure 2), were collected from the river using different types of fishing gears such as lukah (fish pot) and tempirai (stage-trap).The fish are quite difficult to catch during rainy season (October-April) but very easy to collect them during dry season (May-September) because they are concentrated on the sludge holes backwater or shallow water. The village consists mostly of wetland area with water level fluctuation between 0.5 and 2 m.
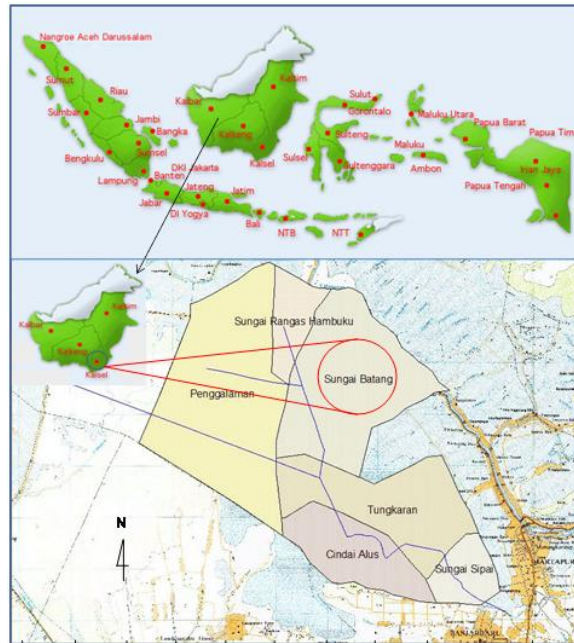

Figure1. *Map showing the location of sampling site in Sungai Batang River, Indonesia*

Figure2. *A fish sample of M. nigriceps from Sungai Batang River*

2.2. Data Collection

A total of 188individuals of *M. nigriceps* comprising 68 males and 120 females were obtained from local fishermen during Mei 2017.Fishwere identified for sex, and measured for total length (TL) and body depth (BDD) and weight(W).Total length was taken from the tip of the snout to the extended tip of the caudal fin. Body depth was measured from the dorsal fin origin vertically to the ventral midline of the body. The total length and body depth of each individual were measured with a ruler to the nearest mm, while whole body weight was determined with a digital balance to an accuracy of 0.01 g (Dretec KS-233, Japan). The size distribution of fish sampled was set at 10-interval class for total length and 5-interval class for weight group. The length-weight relationship of fish can be expressed in either the allometric form [28]:

$$W = aL^b \tag{1}$$

Where: W is the total weight (g), L is the total length (mm), *a* is the constant showing the initial growth index and *b* is the slope showing growth coefficient. The *b* exponent with a value between 2.5 and 3.5 is used to describe typical growth dimensions of relative wellbeing of fish population [29].This *b* value has an important biological meaning; if fish retains the same shape and grows increase isometrically (*b*=3). When weight increases more than length (*b*>3), it shows positively allometric. When the length increases more than weight (*b*<3), it indicates negatively allometric [30] (Hossain et al., 2006). Isometric growth indicates that the body increases in all dimension in the same proportion of growth whereas the negative allometry indicates that the body become more rotund as it increases in length and a slimmer body [31].Determination coefficient (R^2) and regression coefficient (r) of morphological variables between male and female were also computed.The condition factor of fish was estimated using the following formula [32]:

K = 100(W/L3)   (2)

where K is the Fulton's condition factor, L is total length (cm) and W is weight (g).The factor of 100 is used to bring K close to a value of one. The K value is used in assessing the health condition of fish of different sex and in different seasons.

2.3. Statistical Analysis

The Mann-Whitney test was employed to compare the body sizes and condition factor of male and female. All tests were analysed at the 0.05 level of significance using SPSS-16 software.

3. RESULTS

All estimated length-weight relationship and the ratio of body sizes of *M. nigriceps* from Sungai Batang River are presented in Table 1 and Table 2. The body size of male (n=68) ranged from 103to195mm (132.93±16.53 mm) total length and from 16to 66 g(29.10±9.91 g) weight. While the body size of female(n=120) varied from 105 to 175 mm (141.33±14.70mm) total length and from 15 to 72 g (37.08±11.61 g) weight, with the ratio of male to female was 0.6 : 1.0.

Table1. *Total length, weight and condition factor of male and female of M. nigriceps taken from Sungai Batang River*

Sex	n	Total length (mm)			Weight (g)			a	b	R^2	r	Allometric	K
		Min	Max	Mean ± SD	Min	Max	Mean ± SD					pattern	Mean ± SD
Male	68	103	195	132.93±16.53	16	66	29.10±9.91	0.00010	2.5010	0.8806	0.9384	A-	1.21±0.12
Female	120	105	175	141.33±14.70	15	72	37.08±11.61	0.00005	2.7154	0.7805	0.8835	A-	1.28±0.13

n = Number of fish samples, SD = standard deviation, a = constant, b = exponent, R^2 = determination coefficient, r = regression coefficient, A- = negative allometric, K = condition factor

Table2. *The ratio of body sizes of M. nigriceps sampled from Sungai Batang River*

Sex	n	BDD/TL	a	b	R^2	r	W/TL	a	b	R^2	r
Female	120	0.21±0.02	0.6203	-0.2170	0.0505	0.2247	0.26±0.06	0.00005	1.7154	0.5866	0.7659
Female	120	0.21±0.02	0.6203	-0.2170	0.0505	0.2247	0.26±0.06	0.00005	1.7154	0.5866	0.7659

n = Number of fish samples, a = constant, b = exponent, R^2 = determination coefficient, r = regression coefficient, BDD = body depth, W = body weight, and TL = total length

Significant differences were observed at length-weight relationship of male and female, while *b* values implied that the body shape displays a negative allometric growth pattern (*b*<3), which means that the length increases more than weight (Figure 3A).The estimated *b* values in the WLR equations were 2.5014(R^2= 0.8806) for male and 2.7154(R^2= 0.7805) for female, indicating that more than 78% of variability of the weight is elucidated by the length. The index of correlation(r) of male and female were 0.9384 and 0.8835, found to be higher than 0.5, showing the length-weight relationship is positively correlated. Statistically female had total length, body weight and body depth greater than male (P<0.001). The mean ratio of body weight to total length of female was significantly higher than that of male (P<0.001) (Figure 3B).The ratio of W/TL for male ranged from 0.8901 to 1.7388 (1.21±0.12), while for female varied from 0.7289 to 1.7314 (1.28±0.13). As revealed in Table 2, the R^2 values were found between 0.5866 and 0.7265 indicating that more than 58% of variability of the

ratio is explained by the length. The 'r' values of male and female were 0.8523and 0.7659, found to be higher than 0.5, showing the ratio relationship is highly correlated. The increased of body depth was corresponding to the total length (Figure 4A). The exponent values obtained from the equation curve were $0.633(R^2= 0.3209)$ for male and $0.7834(R^2= 0.4104)$ for female. There was no significance difference in the mean ratio of body depth to total length between male and female (P>0.05) (Figure 4B). The ratio of BDD/TL for male ranged from 0.1615 to 0.2869(0.21 ± 0.03), while for female varied from 0.1724 to 0.3120 (0.21 ± 0.02) (Table 2).
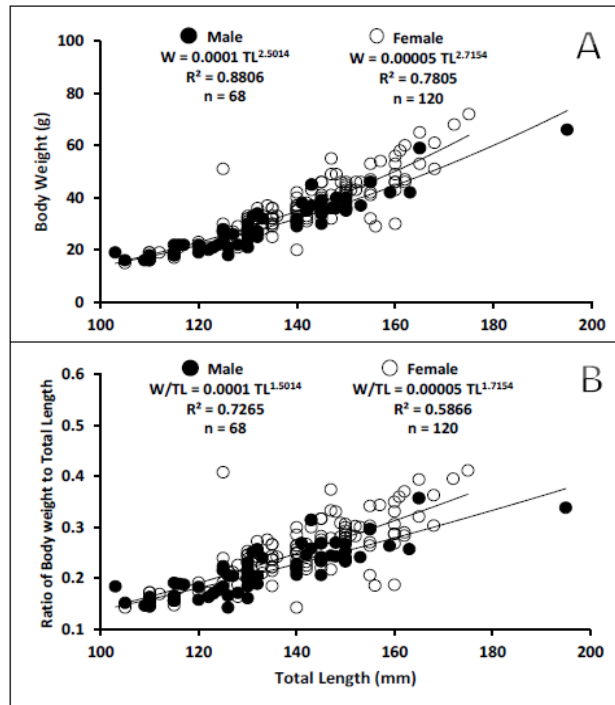

Figure3*A. The relationship between body weight and total length of M. nigriceps from Sungai Batang River. Fish grew negatively allometric. **B**. The relationship between the mean ratios of body weight to total length of M. nigriceps. Female had the ratio (W/TL) value greater than male.*
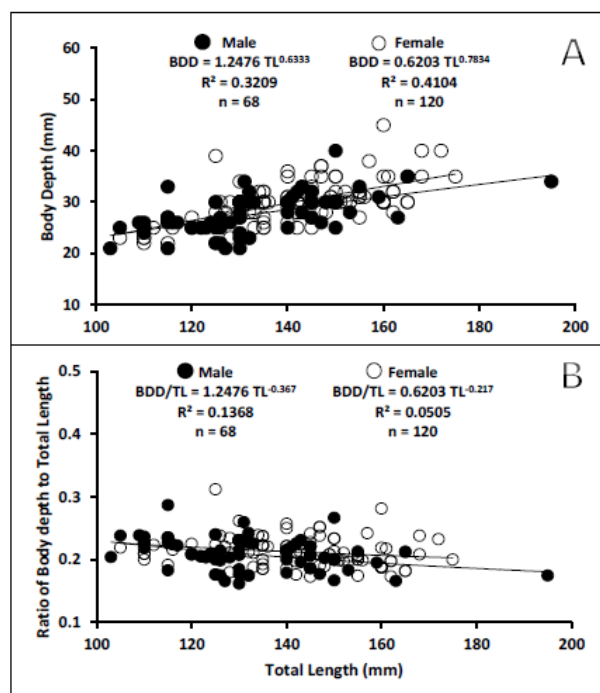

Figure4*A. The relationship between body weight and total length of M. nigriceps from Sungai Batang River. Fish grew negatively allometric. **B**. The relationship between the mean ratios of body weight to total length of M. nigriceps. Female had the ratio (W/TL) value greater than male.*

The size distribution of M. nigriceps samples in the present study is shown in Figure 5. It can be seen that more than 22% of male falls within the range of 130 and 149 mm TL, and 30.00% of female found between140 and 149 mm TL. The heaviest catches of male (19.12%) and female (23.33%) weighted between 25 and 34 g. Regardless the sex, we observed that there was a difference in the exponent for smaller length class as compared to larger one indicating that the species has two growth levels (Figure 6). The smaller individuals (< 122mm TL) grew with the exponent significantly lower than the cubic value (W = 0.0006 TL$^{2.1680}$ with R^2 = 0.9104). While the larger specimens (≥122 mm TL) grew with exponents significantly higher than the cubic value (W = 0.0001 TL$^{2.5123}$ with R^2 = 0.9640). It indicates that more than 91% of variability of the fish growth is explained by the length. A positive correlation between length and weight was indicated by the higher correlation coefficient (r=0.9540 - 0.9818). Dealing with the condition factor (K), it is clearly demonstrated in Figure 7that the condition factor (K) of female was significantly higher than male (P<0.05). The mean K values obtained ranging from 0.8901 to 1.7388 (1.21±0.12) for male and from 0.7289 to 1.7314 (1.28±0.13) for female.
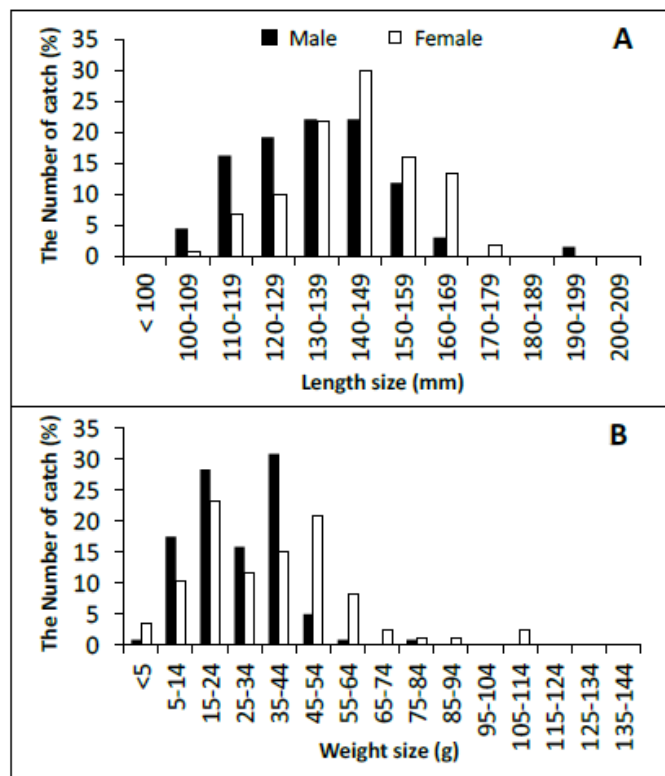

Figure5. *The percentages of length size (A) and weight size (B) distribution between male and female of M. nigriceps taken from Sungai Batang River*
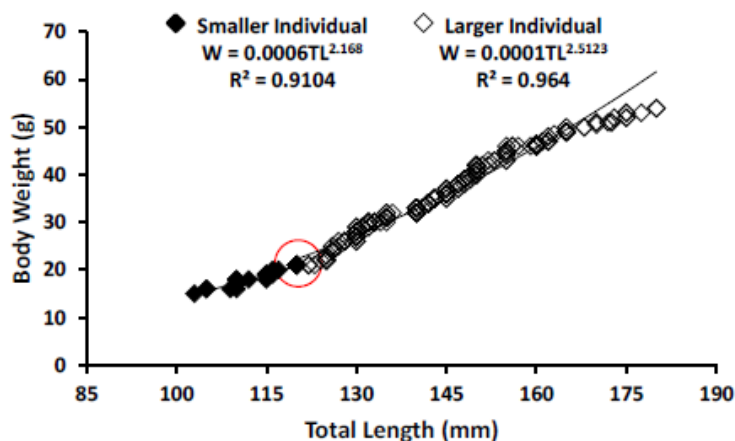

Figure6. *The relationship between the body weight and total length of M. nigriceps. The circle mark indicates the intersection points of smaller individuals (< 122 mm TL) and larger individuals (≥ 122 mm TL) of the fish samples.*
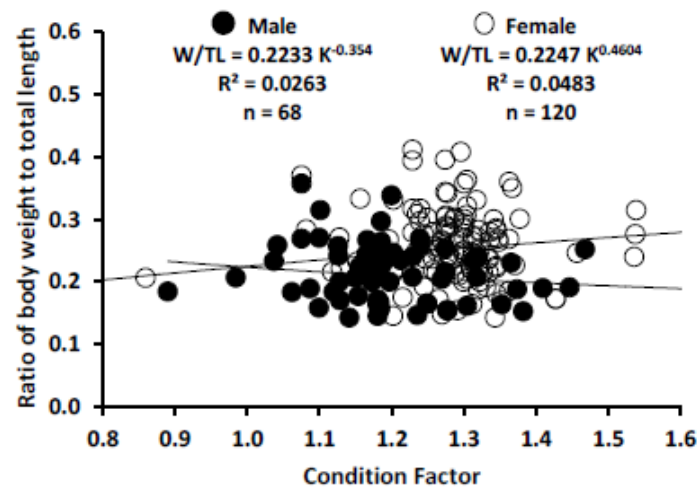
Figure7. *The relationship between the ratio of body weight to total length and the condition factor of M. nigriceps. The female's condition factor was considerably higher than male.*

4. DISCUSSION

In the present study, the maximum size (195 mm TL) of *M. nigriceps* was larger than the six *mystus* species (i.e. *M. bleekeri, M. tengra, M. vittatus, M. cavasius*and *M. gulio*: 11.6-17.2 mm TL) collected from Ganges and Rupsha Rivers in Bangladesh [1, 2], but it was lower than maximum sizes of *M. vittatus* (210 mm TL) and *M. gulio* (460 mm) reported by Talwar and Jhingran [14]. During fishing season, it is very likely to collect *M. nigricheps* smaller than 103 mm TL (16 g weight) using the nets, but fishermen prefer release them back to the river rather than sold them with no or lower price, conversely the smaller fish might be untrappable because of fishing gear selectivity [33]. The other way, it is also possible for fishermen to collect fish with the size larger than 195 mm TL (66 g weight) in the study; however, it is beyond our investigation due to the transactional selling of fish is usually occurred in early mooring before the fish transported to the local market and it can be categorized as unreported fishing.

The length-weight relationship and its parameters (*a* and*b*) have a wide application in fish biology and fisheries management. In fish, the weight is considered to be a function of length [32], while the fish length, according to Ghorbani et al. [25], is the best indicator of production efficiency. It is clearly mentioned in Table3, a negative allometric growth pattern (*b*<3) for *M. nigriceps* in the present study is also agreed with other *Mystus* species such as *M. nigriceps* female from Pinang Luar Lake[34], *M. cavasius* from Betwa River [26], *M. tengra* from Gomti and Ganges Rivers [1,35], *M. cavasius* from Indus River[36], *M. vittatus* from Ganges River[30]or *M. gulio* from Narreri Lagoon[37].According to Vicentin et al.[38], fish with *b* value less than 3 consumed more of its energy in axial growth rather than weight. Our finding is contrary to *M. cavasius* from Cauvery River[39], *M. gulio* from Rupsha River and Chilika Lagoon[1,40]or *M. cavasius from* Jamuna River[27]in which displayed positive allometric growth patterns(*b*>3). Meanwhile, *M. nigriceps* male from Pinang Luar Lake[34]and *M. cavasius* collected from Ganges River[2]were reported to have isometric growth pattern (*b*=3).Variation in slope may be attributed to sample size variation, life stages, growth difference, seasonal fluctuations, change in physiological condition during spawning periods, gonad development, sex, physicochemical conditions of the environment and environmental factors such as food and space[1,31,41].Total weight of fish may also be altered by the weight of the stomach content depending on the food ingested just before weighing [42].

Table3. *Comparative length-weight relationship, condition factor and growth pattern of Mystus species from different geographical areas.*

Species	Sex	n	Ratio of W/TL	a	b	R²	Allometric pattern	Average K	Locations	Country	References
M. nigriceps	M	68	3.38	0.0001	2.50	0.8806	A-	1.21	Sungai Batang	Indonesia	Present study
M. nigriceps	F	120	4.11	0.0000	2.71	0.7805	A-	1.28	Sungai Batang	Indonesia	Present study

Length-weight Relationship and Condition Factor of the Mystusnigriceps from Sungai Batang River, Indonesia

Species	Sex	N	W/TL	a	b	R²	Type	K	River	Country	Reference
M. nigriceps	M	132	2.17	0.0004	3.09	0.7553	I	-	Pinang Luar	Indonesia	Ginting et al., 2014
M. nigriceps	F			0.0000	2.97	0.9539	A-	-	Pinang Luar	Indonesia	Ginting et al., 2014
M. bleekeri	P	47	1.35	0.0258	2.54	0.9800	A-	-	Ganges River	Bangladesh	Hossain et al., 2016
M. tengra	P	65	1.30	0.0158	2.80	0.9580	A-	-	Ganges River	Bangladesh	Hossain et al., 2016
M. tengra	P	48	1.85	0.0064	2.62	0.9400	A-	-	Gomti River	India	Kumar et al., 2014
M. tengra	P	100	0.76	-3.8300	2.36	0.9940	A-	0.97	Ganges River	Bangladesh	Akther et al., 2017
M. gulio	P	59	3.62	0.0091	3.11	0.9750	A+	-	Rupsha River	Bangladesh	Hossain et al., 2016
M. gulio	P	59	3.41	0.1100	2.204	0.9110	A-	1.04	Narreri Lagoon	Pakistan	Awan et al., 2017
M. gulio	P	341	5.02	0.0077	3.11	0.9200	A+	-	Chilika Lagoon	India	Panda et al., 2016
M. cavasius	P	171	2.03	0.0069	3.10	0.9690	A+	-	Ganges River	Bangladesh	Hossain et al., 2016
M. cavasius	P	100	1.36	-5.3300	3.07	0.9890	I	1.03	Ganges River	Bangladesh	Akther et al., 2017
M. cavasius	P	176	1.19	0.0053	3.21	0.9200	A+	-	Jamuna River	Bangladesh	Hossain et al., 2011
M. cavasius	P	…	…	…	3.29	…	A-	…	Betwa River	India	Sani et al., 2010
M. cavasius	P	391	0.40	0.0300	2.54	0.9400	A-	0.85	Indus River	Pakistan	Soomro et al., 2015
M. cavasius	P	…	…	…	2.91	…	A+	…	Cauvery River	India	Muralidharan et al., 2011
M. vittatus	P	56	1.56	0.0169	2.77	0.960	A-	-	Ganges River	Bangladesh	Hossain et al., 2016

A+ = positive allometric, A- = negative allometric, I = isometric, W = weight, TL = total length, K = condition factor, M = male, F= female, P = pooled

We computed the exponent of the fish growth for the larger individuals of *M. nigriceps* (122-180 mm TL) was 2.5123, which was lower than the exponent value (3.150) for *M. cavasius* from Indus River, Pakistan observed at the maximum size of 148 mm [43]. It meant that such ontogenic variations in the cubic law differ from other fish species; however, a more detailed analysis regarding the reasons contributing to such variations is necessary. Dealing with the growth dimensions of relative wellbeing of fish population, the exponent value for larger individuals in the present study falls within the range of 2.5 and 3.5 [29]. There were different ratios of body weight to total length among the *Mystus* species (Table 3). The ratio of body weight to total length of *M. nigriceps* male in the present study was similar to that of *M. Gulio* collected from Rupsha River in Bangladesh [1] and Narreri Lagoon in Pakistan [37]. However, the ratio (W/TL) value was higher as compared to other *Mystus* species from different geographical areas [2, 34, 35, 36,].

The mean K values obtained for male (1.21±0.12) and female (1.28±0.13) of *M. nigriceps* in the present study was slightly higher than those of *mystus* species reported by other researchers (see Table3). Barnham and Baxter [44] suggested 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 good and well-proportioned fish would have a K value that is approximately 1.40. Based on this criterion, the fish sampled in Sungai Batang River were in moderate condition and grew negatively allometric. Variation in the value of the mean K may be attributed to biological interaction involving intra specific competition for food and space between species including sex, stages of maturity, state of stomach contents and availability of food [8, 12, 38]. Information on condition factor of fish is considerably needed for aquaculture system management particularly to understand specific condition and healthy of fish being cultured. When the fish becomes leaner as the length increases, the manager or fish farmer should take management strategies, for example, by improving

the quality of feed contents and its feeding ratio, and rearranging fish density to reduce competition for food and space between them.

In the investigated area, *M. nigriceps* were mostly caught by *lukah* (fish pot) and *tempirai* (stage-trap), while in other regions, *mystus* species were collected using different types of fishing gears including gillnet, cast net, drag net, trawl net, or hand net[1,4,35,37].It is interestingly noted that during spawning period, the seeds of *M. nigriceps* might be unintentionally trapped in the fish cages along Sungai Batang River, they living together with the fish cultured (i.e. carp, nile tilapia, patin)and even grow faster than the wild fish, which provides marginal income for fish farmers. There are two main constraints being faced in this area of study: the first, there is no daily record for *M. nigriceps* catch in quantity (e.g. number, length and weight) because fishermen or their family members directly sold the fish to trader or consumer in some places; and secondly, fishing activity is on-going throughout the year regardless of seasonal periods, thus resulted in the ratio of the fish exploitation rate to the fish growth rate in this river is still unpredictable. It is a great challenge for Marine and Fisheries Services of Banjar District to improve the quality of inland fishery statistical data for commercially important freshwater fish species including *M. nigriceps* fishery, and our results provided the first reference on the length-weight relationship and condition factor of *M. nigriceps* species in this river. The scientist and manager can use this scientific information to initiate the stock assessments and conservation measures for this species.

REFERENCES

[1] Hossain, M.Y, Hossen, M.A, Pramanik, M.N.U, Sharmin, S., Nawer, F., Naser, S.M.A., Bahkali, A.H.and Elgorban, A.M.(2016). Length–weight and length–length relationships of five Mystus species from the Ganges and Rupsha rivers. Bangladesh Journal of Applied Ichthyology. 32: 994-997.

[2] Akther, S., Akhter, M. andHossain, M.(2017). Length-weight relationship and condition factor of two Gangetic Mystus species, *Mystustengra* (Hamilton, 1822) and *Mystuscavasius* (Hamilton, 1822). Journal of Entomology and Zoology Studies. 5(2): 979-982.

[3] Ng, H.H.(2012). The status of the catfish *Mystuswolffii*Bleeker, 1851 (Actinopterygii: Siluriformes: Bagride) in Singapore, with notes on its taxonomy. Nature in Singapore 5: 73-77.

[4] Naeem, M. andIshtiaq, A.(2011). Proximate composition of Mystusbleekeri in relation to body size and condition factor from Nala Daik, Sialkot, Pakistan. African Journal of Biotechnology. 10(52): 10765-10763.

[5] Chakrabarty,P. and Ng, H.H.(2005). The identity of catfishes identified as *Mystuscavasius* (Hamilton, 1822) (Teleostei: Bagridae), with a description of a new species from Myanmar. Zootaxa. 1093: 1-24.

[6] Buragohain, A.(2018). Study of absolute fecundity of *Mystuscarcio* (Hamilton, 1822) of Puthimari River (Hajo) of Kamrup (R) District of Assam, India. International Journal of Zoology Study.3(2): 268-270.

[7] Aryani, N.(2015). Native species in Kampar Kanan River, Riau Province Indonesia. International Journal of Fisheries Aquatic Studies.2(5): 213-217.

[8] Nugroho, R.A., Santoso, Y.G.G., Nur,F.M., Hariani,N. andSolikin,S.(2016). A preliminary study on the biodiversity of fish in the Suhui River, Muara Ancalong, East Kutai, Indonesia .AACL Bioflux. 9(2): 345-351.

[9] Rahman, M.A., Zaher, M., Azimudin, K.M.,Yeasmin, S., Khan, M.M. andArshad, A.(2012). Stocking density effects on growth and production of the threatened silurid catfish, *Mystuscavasius*(Hamilton) fingerlings in nursery ponds. Aquaculture Research. 44: 1132-1139.

[10] Fahmi-Ahmad, M., Rizal, S.A. and Amirrudin, B.A.(2015). Ichthyofaunal diversity of TasekBeraSamsar site, Pahang, Peninsular Malaysia. Journal of Wildlife and Parks. 30: 27-43

[11] Shinde, S.E., Pathan,T.S., Raut,K.S., Bhandare,R.Y. and Sonawane,D.(2009). Fish biodiversity of Pravara River at Pravara Sangam District Ahmednagar, (M.S.) India. World Journal of Zoology. 4: 176-179.

[12] Gupta, S.(2014). A review on *Mystuscavasius*, a popular food fish of Indian subcontinent. International Journal of Fauna and Biological Studies.1(6): 27-31

[13] Roos, N., Wahab,M.A., Hossain, M.A.R. and Thilsted, S.H.(2007). Linking human nutrition and fisheries: Incorporating micronutrient-dense, small indigenous fish species in carp poly culture production in Bangladesh. Food Nutrient Bulletin. 28: 280-293.

[14] Talwar, P.K. and Jhingran,A.G.(1991). Inland fishes of India and adjacent countries. Vol. 1. Rotterdam: A. A. Balkema.

[15] Jayaram, K.C. andSanyal,A.(2003). A taxonomic revision of the fishes of the genus Mystus Scopoli (Family: Bagridae): Records of the Zoological Survey of India. Occasional Paper No. 207.The Zoological Survey of India, Kolkata.

[16] Begum, M., Abdullah-Al Mamun, A., Islam, M.L. andAlam, M.J.(2008). Morphometric characters and their relationship in estuarine catfish.Journal of Bangladesh Agricultural University. 6(2): 349-353.

[17] Darshan, A., Mahanta, P.C., Barat,A. and Kumar, P.(2013). Redescription of the Striped Catfish *Mystus tengara* (Hamilton, 1822) (Siluriformes:Bagridae), India. Journal of Threatened Taxa. 5(1): 3536-3541.

[18] Sukendi, Putra, R.M. andEddiwan.(2017). Biodiversity of fish in the waters of lake village, China Reed, HuluSiak District, District Kampar.International Journal of Oceansand Oceanography. 11(2): 175-188.

[19] Khan, S., Khan, M.A.,Miyan, K. andMubark, M.(2011). Length-weight relationship for nine freshwater teleosts collected from River Ganga, India. International Journal ofZoological Research. 7(6): 401-405.

[20] Musa, A.S.M. and Bhuiyan, A.S.(2007). Fecundity on *Mystusbleekeri* (Day, 1877) from the River Padma Near Rajshahi City. Turkish Journal of Fisheries and Aquatic Science. 7: 161-162.

[21] Mou, M.H., Hasan, K.R. and Ahamed, S.(2018). Comparative efficacy of stocking density on growth and survival of fry of *Mystusvittatus* in nursery ponds. International Journal of Fisheries and Aquatic Research. 3(1): 22-26

[22] Lawson, E.O.(2011). Length-weight relationships and fecundity estimates in mudskipper *Periophthal muspapilio* (Bloch and Schneider, 1801) caught from the mangrove swamps of Lagos Lagoon, Nigeria. Canadian Journal of Fisheries and Aquatic Sciences. 6: 264-271.

[23] Khan, M.A., Khan, S. and Miyan, K.(2012). Studies on length-weight and length-length relationships of four freshwater fishes collected from River Ganga. Journal of Fisheries and Aquatic Sciences.7(6): 481-484.

[24] Hossain, M.Y., Rahman, M.M., Jewel,S., Hosssain, M.A., Ahamed,F.,Tumpa, A.S., Abdallah, E. and Ohtomi, J.(2013). Life history traits of the critically endangered catfish *Eutropiichthysvacha* (Hamilton 1822) in the Jamuna (Brahmaputra River distributary) River, northern Bangladesh. Sains Malaysia. 42(3): 265-277.

[25] Ghorbani, Salamatdoustnobar, R., Ghaem, M.S.S. and Motallebi,V.(2012). The effect of different levels of prebiotic on the length of fingerling rainbow trout. African Journal of Biotechnology. 11(36): 8928-8931.

[26] Sani, R., Gupta, B.K., Sarkar, U.K., Pandey, A., Dubey, V.K. andLakra, W.S.(2010). Length–weight relationships of 14 Indian freshwater fish species from the Betwa (Yamuna River tributary) and Gomti (Ganga River tributary) rivers. Journal of Applied Ichthyology. 26(3): 456-459.

[27] Hossain, M.Y., Mosaddequr Rahman, M.M., Fulanda, B., Jewel, M.A.S., Ahamed, F. and Ohtomi, J.(2011). Length–weight and length–length relationships of five threatened fish species from the Jamuna (Brahmaputra River tributary) River, northern Bangladesh. Journal of Applied Ichthyology.2011: 1-3.

[28] Froese, R.(2006). Cube law, condition factor and weight-length relationships: history, meta-analysis and recommendations. Journal of Applied Ichthyology.22: 241-253.

[29] Bagenal, T.(1978). Methods for assessment of fish production in freshwaters. 3rd ed. London, Oxford: Blackwell Scientific Publication.

[30] Hossain, M.Y., Ahmed, Z.F., Leunda, P.M., Jasmine, S.,Oscoz, J., Miranda, R. and Ohtomi, J.(2006). Condition, length–weight and length–length relationships of the Asian striped catfish *Mystusvittatus* (Bloch, 1794) (Siluriformes: Bagridae) in the Mathabhanga River, southwestern Bangladesh. Journal of Applied Ichthyology. 22: 304-307.

[31] Jobling, M.(2008). Environmental factors and rates of development and growth. In: Hart PJ, Reynolds JD, editors. Fish Biology: Hand book of fish biology and fisheries.vol1. Oxford: Blackwell Publishing Ltd,pp. 97-122.

[32] Weatherley, A.H. and Gill,H.S.(1987). The biology of fish growth. London:Academic Press.

[33] Ahmadi and Rizani, A. (2013). Light traps fishing in Sungai Sipai Flood Swamp of Indonesia. Recommendations for future studies. Kasertsart University Fisheries Research Bulletin. 37(2): 17-30.

[34] Ginting, S.A., Putra, R.M. andEfizon, D. (2014). Study on morphometric, meristic and growth patterns of *Mystusnigriceps* in the Pinang Luar oxbow. JOM October 2014.pp 1-9. Available from: https://media.neliti.com/media/publications/201173-none.pdf [accessed 15Desember 2018]

[35] Kumar, R., Yadav, S.S. andTripathi, M.(2014). Studies on length-weight relationship of seven commercially important freshwater fish species of Gomti River Lucknow (U.P.) India. International Journal of Fisheries and Aquatic Studies. 1(3): 1-3

[36] Soomro, A.N., Baloch, W.A.,Laghari, Z.A.,Palh, Z.A.,Lashar, K.H.,Mastoi, G.M. andSaddozai, S.(2015). Length-weight relationship and condition of *Mystuscavasius* (Hamilton) from lower Indus River at Thatta District, Sindh, Southern Pakistan. International Journal of Emerging Trends in Sciences and Technology. 2(2): 1875-1879.

[37] Awan, K.P., Qamar, N., Farooq, N. andPanhwar, S.K.(2017). Sex ratio, length weight relationships and condition of eight fish species collected from NarreriLagoon, Badin, Sindh, Pakistan. Journal of Aquaculture and Marine Biology.5(4): 00130.

[38] Vicentin, W., Costa, F.E.D.S, Suarez, Y.R.(2012). Length-weight relationships and length at first maturity for fish species in the upper Miranda River, southern Pantanal wetland, Brazil. Journal of Applied Ichthyology. 28(1): 143-145.

[39] Muralidharan, M., Arunachalam, M. and Raja, M. (2011). Length–weight relationships for fish species from Cauvery River at Hogenakal in South India.Journal of Applied Ichthyology. 27(3): 968-969.

[40] Panda, D., Karna, S.K., Mukherjee, M., Manna, R.K., Suresh, V.R. et al.(2016). Length-weight relationships of six tropical fish species from Chilika Lagoon, India.Journal of Applied Ichthyology.32: 1286-1289.

[41] Prasad, G. andAli, P.H.A. (2007).Length-Weight relationship of a cyprinid fish *Puntiusfilamentosus* from Chalakkudy River, Kerala.Zoos' Print Journal. 22(3): 2637-2638.

[42] Muth, K. and Smith, L.L. (1978). The Burbut fishery in Lake of the Woods.Technical Bulletin. 296, p. 33

[43] Muhammad, H., Iqbal, Z., Bashir, Q. andHanif, M.A.(2017). Length weight relationship and condition factor of catfish species from Indus River, Pakistan. Punjab University Journal of Zoology. 32(1): 35-38.

[44] Barnham, C. and Baxter, A.(1998). Condition Factor, K, for Salmonid Fish. Fisheries Notes.1–3.