International Journal of Agricultural Technology 2017 Vol. 13(7.2): 1567-1577
Available online http://www.ijat-aatsea.com
ISSN 1686-9141

Spatial and Sexual Variation on Morphometrics, Length and Weight, and Condition Factor Dynamics of Endemic Silver Therapon (*Leiopotherapon plumbeus*, Kner)

Karl Jay A. De Leon, Adrian Deil C. Manliclic, and Mark Nell C. Corpuz*

Institute of Fisheries, College of Agriculture, Bataan Peninsula State University Orani Campus, Bayan, Orani, Bataan 2112, Philippines.

De Leon, K.J.A., Manliclic, A.D.C., and Corpuz, M.N.C. (2017). Spatial and sexual variation on morphometrics, length and weight, and condition factor dynamics of endemic silver therapon (*Leiopotherapon plumbeus*, Kner). International Journal of Agricultural Technology 13(7.2): 1567-1577.

Despite of the ecological and economic importance of silver therapon (*Leiopotherapon plumbeus*), biological information of this endemic terapontid is very scarce. Two geographically separated population of silver therapon were characterized which based on their morphometrics, length-and-weight relationship, ($W = aL^b$) and condition factor (K) dynamics to assess the present status of the stocks in two different aquatic habitats. Fish samples were collected from the selected fishpond in Orani, Bataan (n=96, 66 females and 30 males), and in Laguna de Bay in Los Baños, Laguna (n=78, 46 females and 32 males). The morphometrics of *L. plumbeus* were highly affected by genders, with females being significantly larger than male in all sampling sites (P<0.05). Significant difference in mean length and weight were observed between populations from Bataan and Laguna (P<0.05). Negative allometric growth was observed in Bataan population (b= 2.66), whilst Laguna showed positive allometric growth (b= 3.18) (P<0.1). Condition factor (K= 1.0) showed sexual dimorphism, with significanlty higher K obtained from females in all sites (P<0.05), albeit site variation was not observed (P<0.05). All observations in body condition factors achieved higher than 1.0 (range= 1.06–1.30). This study could provide information to fisheries biology and environmental management towards stock enhancement of the fish as well as for artificial breeding and production. This is the first time that these three biological parameters have been studied in this fish species in the said sites.

Keywords: Bataan, condition factor, length-and-weight, silver therapon

Introduction

The silver therapon (*Leiopotherapon plumbeus*, Kner), locally known as *ayungin*, *alukaok*, or *lukaok* is one of the endemic freshwater fishes of the Philippines (Herre, 1927; Mane, 1934) and the only known freshwater terapontid in the Philippines (Froese and Pauly 2012). It is indigenous to Laguna de Bay, but has been translocated in different inland water bodies in

* **Coressponding Author:** Mark Nell C. Corpuz; **Email:** markcorpuz.120785@gmail.com

Luzon, Philippines (Quilang *et al*., 2007). It is a mid-water omnivore and is mostly associated in rocky, vegetated lacustrine waters. The largest specimen documented attained 170 mm in total length (Quilang, *et al*., 2007), although fish with 60–85 mm are commonly observed. The species comprises a considerable portion of artisanal and subsistence fisheries in Laguna de Bay (Mane, 1934; Palma *et al*., 2002), and is regarded as a good candidate for aquaculture due to its readiness to spawn in captivity and high reproductive capacity (Ocampo *et al*., 2012). Unbeknownst to many, *L. plumbeus* also exists in the brackishwaters particularly in Bulacan and Bataan (Corpuz, personal observation.). When available in local market, it costs as much as ₱200 to ₱300 per kilo ($1= ₱50). Their natural populations have declined during the last several decades (PSA, 2015), mainly because of threats from environmental degradation (Palma *et al*., 2002), and alien species invasion (Guerrero, 2014).

Despite of the ecological and economic implication of this fish species, few science-based conservation efforts for its management has been conducted (Ocampo *et al*., 2012; Aya *et al*., 2014). At present, it is a target fish species for stock enhancement and aquaculture program of the national government, albeit reliable studies concerning its fisheries and ecological status in Bataan waters are yet available in scientific peer-reviewed literature.

Fish length and weight relationship is a fundamental indicator for fish stock assessment and estimating fish weight from a given length (Froese, 1998). The growth parameter, e.g., regression coefficient or slope value (*b*), obtained from LWR contributes to knowledge of fish growth pattern estimation (Froese, 2006). Furthermore, fish well-being variations between regions and species are examined by using fish body condition (K) (Abdoli *et al*., 2009) as the condition factor is largely influenced by habitat factors (Froese 2006) and reproductive parameters (Mahmood *et al*., 2012; Dinh, 2017). Because the LWR reliably predicts weight from length, it has become a useful tool to estimate standing stock biomass and yield in many fishery assessment studies (Martin-Smith, 1996; Goncalves *et al*., 1997; Das and Bordoloi, 2013).

The main goal of this study is to characterize the two populations of *L. plumbeus* based on their morphometrics, length and weight relationship (LWR) and condition factor. Information from this study will be useful to support fishery management and the conservation of both the fish species in question and the aquatic environment.

Materials and methods

Study areas

Fish samples were collected from two geographic populations. Ninety six (*n* = 96) samples of *L. plumbues* were collected from fishponds in Orani, Bataan (14°48.5'N, 120°32.6' E) on February 2017 with bag nets and seine net. Samples from Laguna de Bay (*n*= 78) in Los Baños, Laguna (14°12' N, 121°17' E) were collected on January 2016 with cast net and gill net. Fish samples were frozen and transported to laboratory for analysis.

Fish analyses

Sexes of *L. plumbues* were determined based on their internal genitalia, i.e., ovaries for female and testes for male. Total lengths (L) of fish specimen were measured using a vernier caliper (mm) was measured to the nearest millimeter (mm) from the tip of the snout to the tip of the longest caudal fin ray of the lower lobe. Wet weight of fish (W) was determined using a digital balance (g).

The allometric relationship between L and W was calculated by the formula following Ricker (1973):

$$W = a\ L^{b}$$

where, W = weight of an individual fish (g) ; L= length of an individual fish (mm); a and b are constants.

The data of L and W were analyzed by the least square method using the equation of Le Cren (1951) given as: Log W= Log a + b Log L

where a and b are constants estimated by linear regression of the log transformed variates. The fish body condition factor was calculated using the function:

$$k = \frac{w}{a\ x\ TL^{b}}$$

where, w is fish weight (g), TL is total length (mm), a is the regression intercept and b is the slope as described by (Le Cren, 1951).

Data analyses

Chi-square test was used to determine the extent of deviation of female and male ration to the theoretical 1:1 ratio (P<0.05). Descriptive statistics and normality (Shapiro-Wilk test) of data was also tested. All data followed the

assumption for normality. Length and weight data of males and females in each population as well as the two populations (combined sex) were compared using *t*-test ($P<0.05$).

Variation on morphometric measurement between sexes and sites were compared using *t*-test, and the effect of sexes and site interaction on the changes of TLs and Ws was tested using ANOVA. The variations in LWRs and growth pattern between females and males in different sampling sites were examined using ANCOVA, and *t*-test respectively

The growth patterns of this species e.g. allometric or isometric growth, was tested using t-test as describe by (Froese, 2006). The value of *b* was tested for theoretical value for isometry i.e., when *b* was significantly equal to 3, growth was regarded as isometric ($P<0.05$), $b<3$, negatively allometric ($P<0.05$), and $b>3$, positively allometric ($P<0.05$). Significance of deviation from $b = 1$ was tested using *t*-test of Clarke (1980) (Camacho *et al*., 2004). Analysis of covariance (ANCOVA) was performed to test for any difference between regression models which displayed L-W relationship. PaST v 2.17 and SigmaPlot v 10 were used for statistical analyses.

Results

Morphometrics

Number of specimens collected from the two sites was dominated by female (Bataan = 68.75%; Laguna= 58.97%). The overall ratio of males to females was 1:1.81, which did not significantly deviate from expected ratio of 1:1 ($\chi 2= 79.76$, df= 1, $P<0.01$).

The mean length of females from Bataan (100.33 ± 12.23 mm, $n= 66$) was significantly longer than males (92.89 ± 10.16 mm, $n= 30$, t = 4.11, $P<0.01$). In Laguna specimens, the mean length of females (91.87 ± 13.21 mm, $n= 46$) was not significantly longer than males (86.36 ± 10.49 mm, $n= 32$, $t= 2.78$, $P>0.05$). Mean length of females between Bataan and Laguna were highly statistically different ($t= 4.93$, $P<0.01$), but males were significantly similar ($t= 1.01$, $P>0.05$). Overall, significant difference in mean length was observed between the populations of Bataan (98.00 ± 12.08 mm, n= 96) and Laguna (91.42 ± 13.01mm, $n= 78$, $t= 4.88$, $P<0.01$).

In Bataan, sexual difference was observed between mean weight of females (26.70 ± 9.32g, $n= 66$) and males (20.47 ± 6.98g, $n= 30$, $t= 4.61$, $P<0.01$). Likewise, mean weight of females (25.11 ± 11.79g, $n= 46$) and males from Laguna (19.02 ± 7.13mm, $n= 32$, $t= 3.68$, $P>0.05$) was statistically different. Inter-site comparison of weight of females from Bataan and Laguna

showed no significantly difference (t= 1.01, P>0.05), and so as with males (t= 1.14, P>0.05). Overall, the mean weight of Bataan populations were statistically similar (24.75 ±9.10g, n= 96) to Laguna (22.61 ±10.53g, n= 78, t= 2.03, P>0.05).

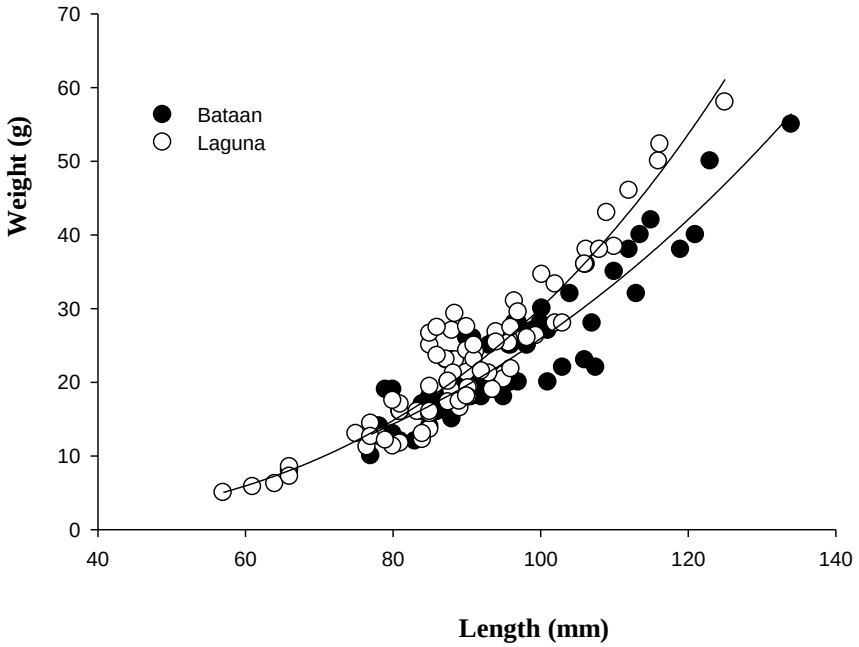

Figure 1. Relationship of *L. plumbues* total length (mm) with weight (g). Bataan b= 2.66, r^2= 0.85; Laguna b= 3.18, r^2 =0.89

Length-Weight Relationships and Growth Rate

Estimated L-W relationship parameters of *L. plumbues* collected from Bataan and Laguna are summarized in Table 1. The L-W relationship in Bataan population revealed negative allometric growth rate (b= 2.66, r^2= 0.85, P<0.05) (Figure 1); the females populations growth rate also showed negative allometric coefficients (b= 2.51, r^2= 0.80, P<0.05); male populations' growth rate however was isometric (b= 2.85, r^2= 0.91, P>0.05). The growth parameter of females was still significantly similar to that of males (ANCOVA F= 1.98, P>0.05) (Figure 2A).

The L-W relationship in Laguna population revealed isometric growth rate (b= 3.17, r^2= 0.89, P>0.05) (Figure 1); the growth rate of females (b= 3.13, r^2= 0.92, P>0.05) and males (b= 2.85, r^2= 0.91, P<0.05) were both isometric

(Figure 2B). Female growth parameter was not significantly different from the male (ANCOVA F= 3.79, P>0.05).

Growth coefficient between females of Bataan and Laguna was observed to be statistically different (ANCOVA F= 29.24, P<0.01). Furthermore, significant spatial variation between males from different population was also observed (ANCOVA F= 10.17, P<0.01). Using combined sexes, Bataan and Laguna populations exhibited highly significant variation on growth rate (ANCOVA F= 37.42, P<0.01).

Table 1. Descriptive statistics and estimated L-R relationship parameters for both sexes of *Leiopotherapon plumbeus*

	n	Length	Weight	Regression Parameters		r^2
		Mean ± SD	Mean ± SD	*b*	*a*	
Bataan	96	98.01 ± 12.08	24.75 ± 9.10	2.66	0.0001	0.85
Female	66	100.38 ± 12.23	26.70 ± 9.32	2.51	0.0003	0.80
Male	30	92.89 ±13.21	20.47 ± 6.98	2.85	0.00005	0.91
Laguna	78	91.42 ± 13.01	22.61 ±10.53	3.18	0.00001	0.89
Female	46	91.87 ± 13.21	25.11 ± 11.79	3.14	0.00002	0.92
Male	32	90.77 ± 12.90	19.01 ± 7.14	2.85	0.00006	0.76

n= number of individuals; SD= standard deviation; a= intercept; b= slope; r^2= coefficient correlation.

Condition Factor

The mean condition factors of females (Bataan= 1.29 ± 0.31; Laguna= 1.30 ± 0.44) and males (Bataan= 1.07 ± 0.25; Laguna= 1.06 ± 0.31) from the two sites were higher than the standard threshold of 1.0. The computed values for females was statistically deviated from K= 1.0 (t-test, P<0.05), but the males were not significantly different from the value of 1.0. The computed parameters in Bataan (1.22 ± 0.32) and Laguna (1.20 ± 0.41) were significantly different from parameter K= 1.0 (P<0.05, Figure 3).

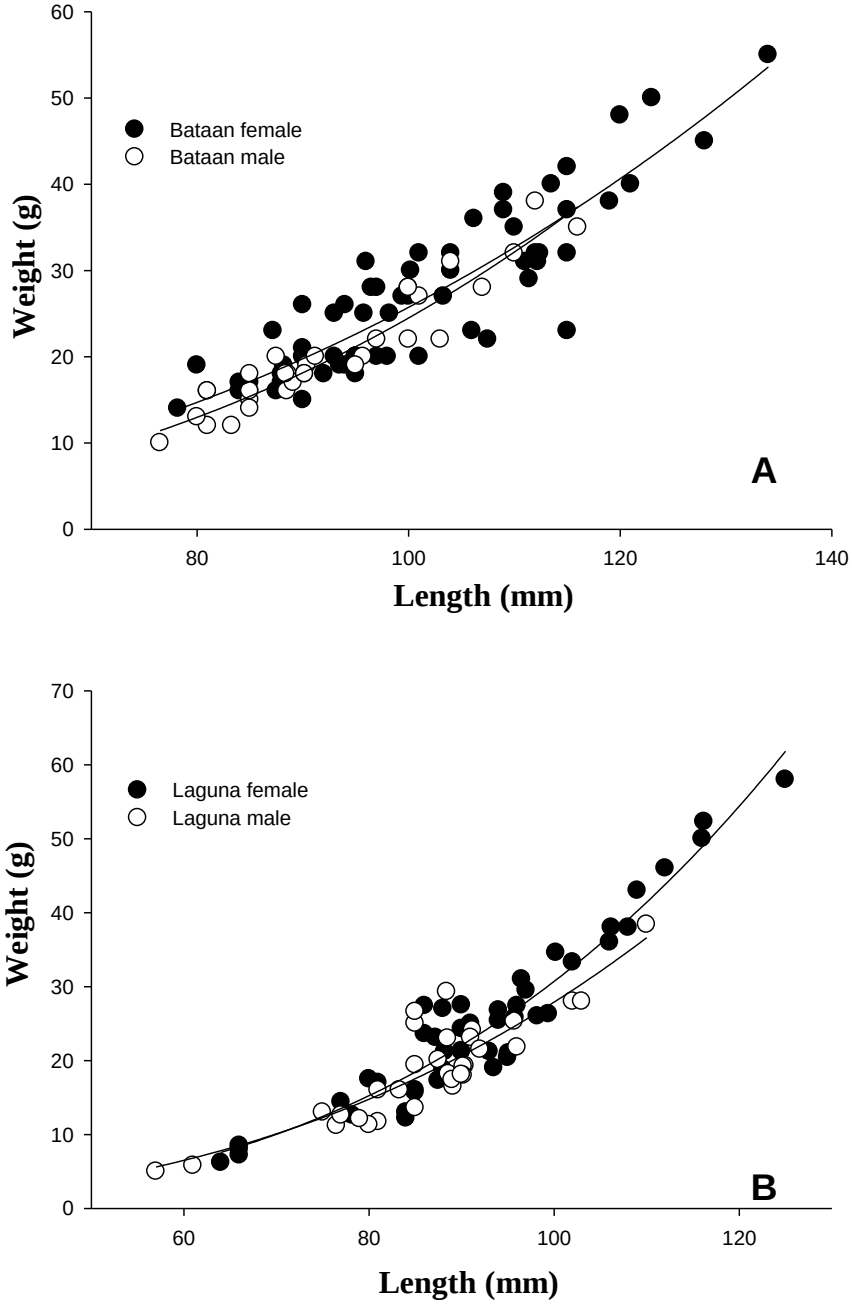

Figure 2. Relationship of *L. plumbeus* total length with weight. (Bataan♀= 2.51, r^2= 0.80; Bataan ♂= 2.85, r^2= 0.91) (**A**). (Laguna♀= 3.14, r^2= 0.92; Laguna♂= 2.85, r^2= 0.76) (**B**)

The condition factor of *L. plumbeus* was significantly different between sexes and sites (ANOVA F= 3.47, P<0.01, Figure 3). Intra-site variation between sexes was observed (Bataan: t= 4.10, P<0.05; Laguna: **t**= 4.32, P<0.05), indicating changes of the body condition of the species did not depend on genders. As depicted in Figure 3, there were no inter-site variation between sexes of the same species (P>0.05). In the combined sexes, the mean condition factors K were not significant different between Bataan (1.22 ± 0.32), and Laguna (t= 0.689, P>0.05).

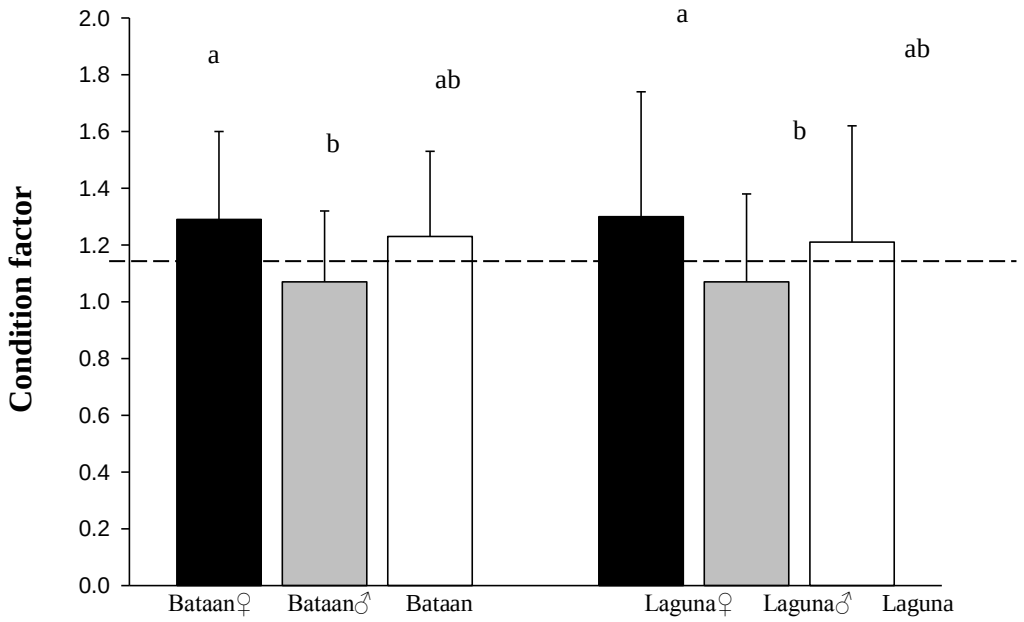

Figure 3. The variation of condition factors between sexes and sites of *L. plumbeus*. Dashed line represents ideal condition factor value.

Discussion

The presence of *L. plumbeus* in different water bodies signifies the capacity of the populations to adapt in wide-array of environmental conditions (Ocampo *et al.*, 2012). This paper revealed that *L. plumbeus* is euryhaline and a secondary freshwater fish. Their adaptation can be reflected to their body morphometry, LWR, and condition factor. In this study, it seems that sites' environmental condition and sex did affect the length of the two populations. Bataan populations are relatively larger than in Laguna. This variation may

occur due to variability between the two aquatic ecosystems. It is noteworthy to mention that Bataan population was seined in brackishwater fishponds, thus the environment is semi-controlled with provision of fertilizer, feeds and other inputs for aquaculture. On the other hand, Laguna population is obtained from wild stock, and the nutrition and well-being of the population is dependent on natural food resources. Variation of sizes of the populations is also attributed to different gears used to capture the samples. Bataan populations were collected using seine netting, which is more selective in fish size than in cast net and gill net that were used in Laguna. Significant difference in L and W between sexes of co-occurring population is mainly attributed to the reproductive capacity and recruitment/ maturation event of the species. Similar to observation of Mallen-Cooper and Stuart (2003), females of silver perch are larger than males in cohort. Females can divert their energy resources into somatic growth as their maturation occurred later than males.

In contrary to morphometrics, Laguna populations were found to have better LWRs than in Bataan as inferred to the higher body weight of the former. Bataan populations exhibited negative allometric growth pa indicating that the fish tends to become "thin and slender". On the other hand, Laguna populations exhibited positive allometry, signifying the tendency of populations to become "plump" (Wooton, 1979). This differential growth rate and phenotypic plasticity suggest that *L. plumbeus* population has better adaptation in natural, freshwater habitat. Specifically, the results have implications on food assimilation and condition of the species and the water quality prior to sampling. The data on LWR of conspecifics from Candaba marsh (Philippines) revealed almost similar parameters with LWR of Laguna populations (Garcia, 2010). Other fish species caught from the wild are usually showed positive LWRs, a similar observation that was also documented by King and Udo, 1998; Garcia, 2010; Dinh 2017.

Sexual dimorphism in LWR was also observed in this study. Males had similar growth parameters despite of geographical separation. Females however, displayed high LWR plasticity, with Laguna being plumper than in Bataan. In females, the allometric growth of abdomen can be influenced by spawning oocytes, resulting to bulge abdominal portion (positive allometry), or if not, a regressed ventral part due follicular atresia of females (negative allometry) (Tran 2008). Our finding was supported by Soni and Kathal (1979), Srisuwantach *et al.* (1980), and Ayo-Olalusi (2014) who observed that LWR and mean condition factors were higher in females than in males.

Despite of differences in morphometrics and LWR, the condition factors of the two populations were remained significantly homogeneous. Although, the body condition of *L. plumbeus* was highly affected by genders, in which the

K value of females is consistently higher than males. It is safe to assume that the two studied areas provides favorable ecological condition for *L. plumbeus* growth as reflected to K values that are close to threshold of 1.0. This suggests that the two habitats are endowed with resources (e.g., food availability, feeding and foraging grounds) that are necessary for the fish survival and reproduction. This information is vital to fisheries biology and environmental management towards stock enhancement of *L. plumbeus* as well as the need for diversification or exploration of other avenues for artificial breeding, and upscale rearing of this fish species.

For future study, the influence of factors such as body size range, seasonal abundance, and habitat characteristics in the wild or in culture is open to future studies. Likewise, LW and condition factor dynamics of riverine populations of *L. plumbues* can also be studied in future researches.

Acknowledgement

The authors are grateful to the funding of BPSU Research and Development Office. Sincerest gratitude is accorded to Mr. Jeremy Boncalos and Ms. Wetzel Enriquez for the assistance during sampling and fish analysis, and to our fisherfolk collaborators during collection.

References

Abdoli, A., Allahyari, S., Kiabi, BH., Patimar, R., Ghelichi, A., Mostafavi, H., Aghili SM. and Rasooli, P. (2009). Length-weight relationships for seven gobiid fish species in the southeastern Caspian Sea basin, Iran. Journal of Applied Ichthyology 25: 785-786.

Ayo-Olalusi, CI. (2014). Length-weight relationship, condition factor and sex ratio of African mud catfish (*Clarias gariepinus*) reared in flow-through system tanks. Journal of Fisheries and Aquatic Science 9: 430-434.

Aya, FA., Corpuz, MC., and Garcia, LMB. (2014). Diet composition, feed preferences and mouth morphology of early stage silver therapon (*Leiopotherapon plumbeus*, Kner 1864) larvae reared in outdoor tanks. Journal of Applied Ichthyology 30: 1-6.

[PSA] Philippine Statistics Authority – Department of Agriculture. 2015. https://psa.gov.ph.

Camacho, MV., Sakakura, Y. and Hagiwara, A. (2004). Early development of the self-fertilizing mangrove killifish *Rivulus marmoratus* reared in the laboratory. Ichthyological Research 51: 309-315.

Das, MK. and Bordoloi, S. (2013). Length-weigth relationship and condition factor of *Lepidosephalicthys Goalparensis* Pillai and Yazdani, 1976 in Assam, India. Journal of Applied Ichthyology 30(1): 246-247.

Dinh, QM. (2017). Morphometrics, growth pattern and condition factor and dynamics of the goby *Stigmatogobius pleurostigma* (Blecker 1949) during dry and wet seasons in the Mekong Delta, Vietnam. Asian Fisheries Science 30: 17-25.

Froese, R. (1998). Length-weight relationship of 18 less-studied fish species. Journal of Applied Ichthyology 14: 117-118.

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

Froese, R. and Pauly, D. (2012). Fishbase. electronic database accessible at http://www.fishbase. org.search. Updated on 12 February 2012.

Garcia, LMB. (2010). Species composition and length-weight relationship of fishes in the Candaba, wetland on Luzon Island, Philippines. Journal of Applied Ichthyology 26: 946-948.

Gonçalves, JMS., Bentes, L., Lino, PG., Ribeiro, J., Canario, AV. and Erzini, K. (1997). Weight-length relationships for selected fish species of the small-scale demersal fisheries of the south and south-west coast of Portugal. Fisheries Research 30(3): 253-256.

Guerrero, RD. (2014). Impacts of introduced freshwater fishes in the Philippines (1905–2013): a review and recommendations. Philippine Journal of Science 143(1): 49-59.

Herre, AH. (1927). Gobies of the Philippines and the China Sea. Monograph of the Bureau of Science, Manila. 23: 1-352.

King, RP. and Udo MT. (1998). Dynamics in the length-weight parameters of the mudskipper *Periophthalmus brabarus* (Gobiidae), in Imo River estuary, Nigeria. Helgoländer Meeresuntersuchungen 52:179-186.

Le Cren, ED. (1951). The length–weight relationships and seasonal cycle in gonad weight and condition in the perch (*Perca fluviatilis*). Journal of Animal Ecology 20: 201–219.

Mahmood, K., Ayub, Z., Moazzam, M. and Siddiqui, G. (2012). Length-weight relationship and condition factor of *Ilisha melastoma* (Clupeiformes: Pristigasteridae) off Pakistan. Pakistan Journal of Zoology 44: 71-77.

Mallen-Cooper, M. and Stuart I.G. (2003). Age, growth and non-flood recruitment of two potamodromous fishes in a large semi-arid/temperate river system. River Research and Applications 19: 697-719.

Mane, AM. (1934). Spawning and feeding habits of *Mesopristes plumbea* (Kner), a common therapontid of Laguna de Bay. Philippine Agriculturists 6 (23): 502-515.

Martin-Smith, K.M. (1996). Length/weight relationships of fishes in a diverse tropical freshwater community, Sabah, Malaysia. Journal of Fish Biology 49: 731–734.

Ocampo, PP., Padalhin, A, and Camacho MVC. (2012). Induced spawning and larval rearing of ayungin (*Leiopotherapon plumbeus*, Kner.) Philippine Council for Agriculture, Aquatic and Natural Resources Research and Development, Department of Science and Technology. Los Baños, Laguna, Philippines. 14 p.

Palma, AL., Diamante, AS., and Pol, RM. (2002). An assessment of fishery resources of Laguna de Bay. Aquatic Ecosystem Health and Management 5: 121-128.

Quilang, JP., Basiao, ZU., Pagulayan, RC., Rodero, RR., and Barrios, EB. (2007). Meristic and morphometric variation in the silver perch, *Leiopotherapon plumbeus* (Kner, 1864), from three lakes in the Philippines. Journal of Applied Ichthyology 23: 561-567.

Ricker, WE. (1973). Linear regressions in fishery research. Journal of Fisheries Research Board of Canada 30: 409-434.

Soni, DD. and Kathal, KM. (1979). Length-weight relationship in *Cirrhinus mrigala* (Val.) and *Cyprinus carpio* (Ham.). Masya 5: 69-72.

Srisuwantach, VR., Soungchomphan, R. and Sea-Eng, P. (1980). Water quality conditions as disease related stressors in Clarias ponds. Ecology Technical Paper No 3. Ecology Unit National Inland Fisheries Institute, Bangkok, Thailand. 33 pp.

Wooton, RJ. (1979). The effect of size of food ration on egg production in the female three-spined stickleback, *Gasterosteus aculeatus*. Journal of Fish Biology 5: 89-96.

(Received 24 October 2017 ; accepted 25 November2017)