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Length-weight relationship, condition factor and sex ratio of tade mullet (*Liza tade* Forsskal, 1775) from Mawlamyine, Mon state, Myanmar

Abstract

The species of *Liza tade* were collected from Mawlamyine, Mon State, Myanmar during June 2018 to May 2019. The analysis of fishes was based on 1264 specimens ranging in size from 10 to 30cm and in weight from 15 to 190g. The length-weight relationship of *L. tade* was determined for males, females and combined sexes as $W=0.016L^{2.82}$, $W=0.016L^{2.84}$ and $W=0.016L^{2.83}$ respectively. The samples have been found to be negative allometric growth pattern (b<3). The results indicated that the value of correlation coefficient (r) for males, females and combined sexes were as 0.972, 0.975 and 0.973, which were closer to 1 indicating that the length-weight relationship was highly correlated. The condition factor (K) was recorded as 1.088 for males, 1.140 for females and 1.114 for all individuals respectively.

Keywords: *Liza tade*, length-weight relationship, condition factor, sex ratio

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Introduction

Fishes of the family Mugilidae are commonly known as "mullets" or "grey mullets". This family includes 18 genera and 81 species.[1] Commonly found in marine and brackish waters or estuaries at 20m depth. Mullets (Mugilidae) are among the most common species from tropical and temperate marine coastal water in the world and constitute a fundamental protein resource for a number of human populations living in coastal areas.[2]

Tade mullet (*Liza tade* Forsskal 1775) is one of most important mullet species widely cultured in both brackish and freshwater mono and poly-culture fish ponds.[3] Owing to its good consumer preference and market price, non-carnivorous food habit and abundant availability of seeds, tade mullet is a good candidate for poly-culture with other species including shrimp.[4] It has a high quality flesh, superior growth, large maximum size and wide salinity and temperature tolerance power.[5]

Length-weight relationship (LWR) indicates the average weight of fish at a given length by making use of the mathematical equation to show relationship between the two.[6] Fish can attain either isometric or allometric growth.[7] Isometric growth indicates that both length and weight of the fish are increasing at the same rate. Allometric growth can be either positive or negative. Positive allometric implies that the fish becomes stouter or deeper-bodies as its length increases. Negative allometric implies the fish becomes slender as its length increases.

Condition factor (K) is an estimation of general well-being of fish[8] and is based on the hypothesis or assumption that heavier fish are in better condition than the lighter ones.[9] The condition factor of one or greater than one indicates the good condition of fish while the one less than one show bad condition.[10] Condition factor can be influenced by season, sex, type of food organism consumed by fish, age of fish, amount of fat reserved, and environmental conditions.[11]

Length-weight relationship and condition factor are important to fishery industry as they help to predict the best length and weight and time suited to harvest a particular species of fish.[12] Sex ratio and size structure constitute some of the basic information required for assessing reproductive potential and estimating stock size.[13] The purposes of this study are to describe the length frequency distribution, to calculate length-weight relationship and condition factor of *Liza tade* species by observing their growth pattern between length and weight.

Materials and methods

Study area

The samples of fishes were collected from Mawlamyine (Kyauktan) (Lat. 16º26´N, long. 97º37´N), Mon State, Myanmar. The samples were caught by cast net, gill net and small beach seine (nylon net) of various mesh sizes (2.5, 3.0 and 3.5cm) and collected from local fishermens along the study area.

Collection of samples

The specimens of *L. tade* were purchased monthly from landing site in Mawlamyine, during the period of June 2018 to May 2019. The samples were preserved in an ice-chest with ice cubes in the field and transported to the laboratory of Department of Marine Science, Mawlamyine University, Myanmar using for detail investigations. Total length (TL) to the nearest 0.1cm from the tip of snout to the tip of caudal fin was measured by making use of measuring board and weight (W) to the nearest 0.1g were recorded. Male and female individuals were identified after examining the gonads.

Length-weight relationship

The length weight relationship (LWR) was calculated as: $W=aL^b$ Ricker[14] and also expressed by taking the logarithms or natural

logarithms transformation: LnW=Lna+bLnL (or) y=a+b*x. Where W is body wieght of fish (g), L is total length of fish (cm), a is constant/ intercept and b is isometric exponent or regression slope which usually ranges from 2 to 4. In this equation, parameters a and b were estimated by the least squares method Sparre and Venema[15] after logarithmic transformation of the non-linear equation into linear form. A value 'b' can exhibit isometric growth, negative allometric growth or positive allometric growth pattern. The correlation coefficient 'r' was computed to determine the relationship between length and weight.

Condition factor

Fulton's condition factor (K) equation was used to determine the biological changes for individual fish as: $K=100*W/L^3$ Ricker[14] where W was the average weight (g) and L was the average total length (cm) to estimate how robust, healthy or well being state of the fish.

Sex ratio

Sex ratio of species was used to determined from the ratio tends to be of 1:1 male to female in the total population by chi-square analysis as:=$\sum (O-E)^2/E$, where O was the observed frequency of males or females and E was the expected frequency of males or females. Descriptive statistics were obtained using Excel (Microsoft Excel 2013) (Figure 1-3).

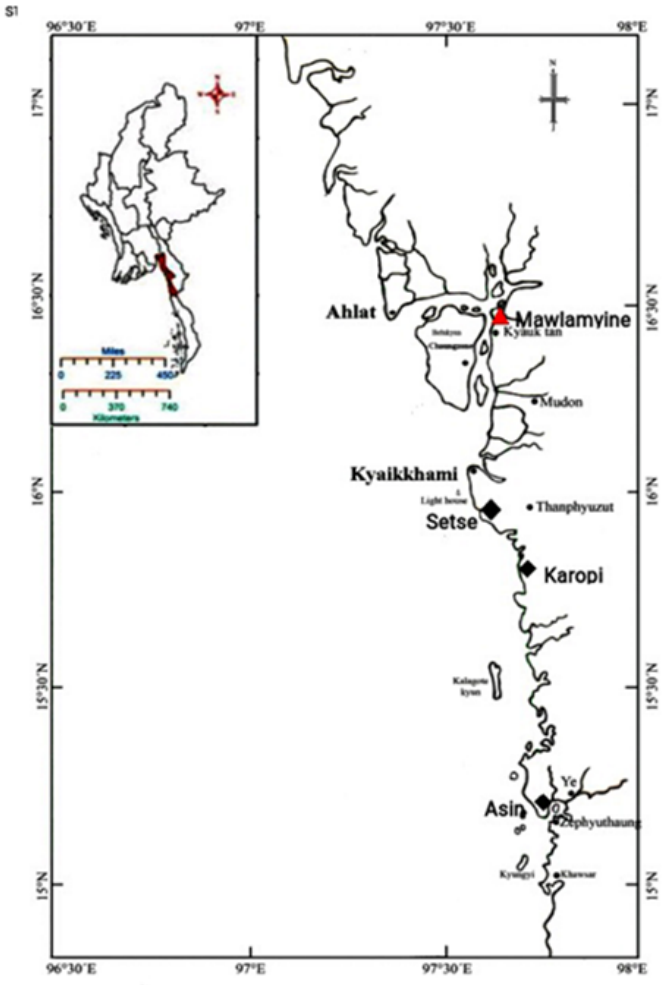

Figure 1 Map showing the study area of sample collection.

Figure 2 Picture of *Liza tade* in Mawlamyine.

Figure 3 Sketch of *Liza tade*.

Results

Length frequency distribution

The length frequency distribution of *L. tade*, a total of 1264 samples (623 males, 641 females) was found in the present study. The total length of individuals ranged from 10-30cm and the weight ranged from 15-190g. The most dominant total length size class being 20-22cm and the second abundance total length size class was 18-20cm (Figure 4). The largest number of the species belonging to the size class 20-22cm occurred in June, July and August. In view of this observation, *L. tade* was dominant and peak in June, July and August that the maximum length was found to be 28-30cm in these months. The minimum total length size of 10cm and smaller samples were extremely few in June and November.

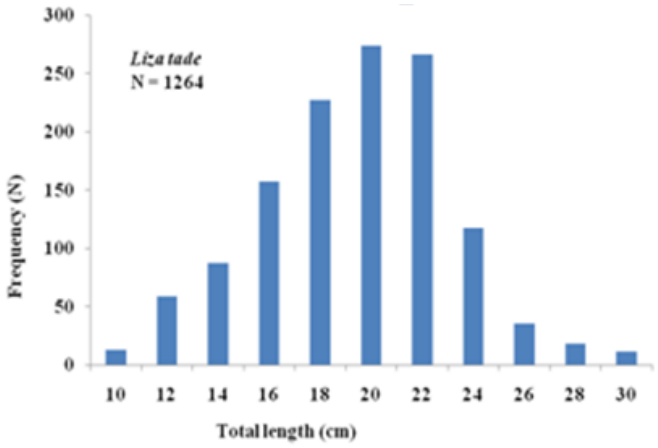

Figure 4 Total length frequency distribution of *Liza tade* form June 2018 to May 2019 Mawlamyine.

Length-weight relationship

The results of the length-weight relationship for *L. tade* species were calculated by using the equation of $W=aL^b$. In this study, the mean values for males were obtained to be 18.77±3.49 for length and

body weight of 71.99±34.43. The mean total length of females was 18.49±3.75 and the mean weight of 72.20±36.65. The means values for combined sexes of *L. tade* were recorded 18.63±3.63 for length and 72.10±35.56 for body weight (Table 1). The regression statistics for length-weight relationship of species recorded the regression slopes or growth coefficients, b values of *L. tade* was found to be 2.82 in males, 2.84 in females and 2.83 in total respectively. The length-weight relationship was represented by the equation for *L. tade* species: $W=0.016L^{2.82}$, r=0.972 (in male), $W=0.016L^{2.84}$, r=0.975 (in female) and $W=0.016L^{2.83}$, r=0.973 (in combined sexes). (Table 2).

Table 1 Length-weight relationship and condition factor of *L. tade* from the study area

Sex	N	Length (cm) Mean±S.D	Weight (g) Mean±S.D	a	b	SE(b)	r	K
Combine	1264	18.63±3.63	72.10±35.56	0.016	2.83	0.013	0.973	1.114
Male	623	18.77±3.49	71.99±34.43	0.016	2.82	0.018	0.972	1.088
Female	641	18.49±3.75	72.20±36.65	0.016	2.84	0.017	0.975	1.140

N, number of samples; a, constant; b, the exponent; SE, standard error of b; r^2, the correlation coefficient of length-weight relationship; K, condition factor

Table 2 Monthly sex ratio (Males: Females) of *Liza tade* from study area

Months	*Liza tade*				
	No of male	No of female	Ratio (M:F)	χ^2	P-value
June 2018	49	78	1:1.4	6.62	0.01
July 2018	58	72	1:1.2	1.51	0.22
Aug 2018	55	61	1:1.1	0.31	0.58
Sep 2018	58	47	1:0.8	1.15	0.28
Oct 2018	57	41	1:0.6	2.61	0.11
Nov 2018	47	43	1:0.9	0.18	0.67
Dec 2018	35	53	1:1.3	3.68	0.05
Jan 2019	52	40	1:0.7	1.57	0.21
Feb 2019	60	42	1:0.6	3.18	0.07
Mar 2019	62	50	1:0.8	1.28	0.26
Apr 2019	44	51	1:1.1	0.52	0.47
May 2019	46	63	1:1.3	2.65	0.10
Combined	623	641	1:1.0	0.26	0.61

The Ln transform data of length-weight relationship was determined that the growth was positive or negative allometric for male and female, as shown in figure 5. It was observed in the present study that the exponent b-values were also found varied from an isometric value (b=3). In general, the b-values reported for combine sexes, male and female of *L. tade* species ranged from 2.82-2.84. From this study, the exponent b-values of *L. tade* were less than 3.0.

Condition factor (K)

The mean K values of *L. tade* for the sampling period in the study area were found to be 1.08±0.037 for males, 1.14±0.031 for females and 1.11±0.024 for combined sexes respectively. The range of condition factor for *Liza tade* was 1.08 in males, 1.14 in females and 1.11 in total respectively. In this study, the females of *L. tade* had better condition factor of growth pattern than males.

Sex ratio

The monthly sex ratio of *Liza tade* was computed for the expected ratio of 1:1 male to female by chi-square method. During the study period, a total of 623 males and 641 females were recorded with the ratio of 1male to 1.0 female (χ^2=0.26). The present study observed that there was no significant difference in number of males and females in all months from the expected 1:1 ratio (p>0.05).

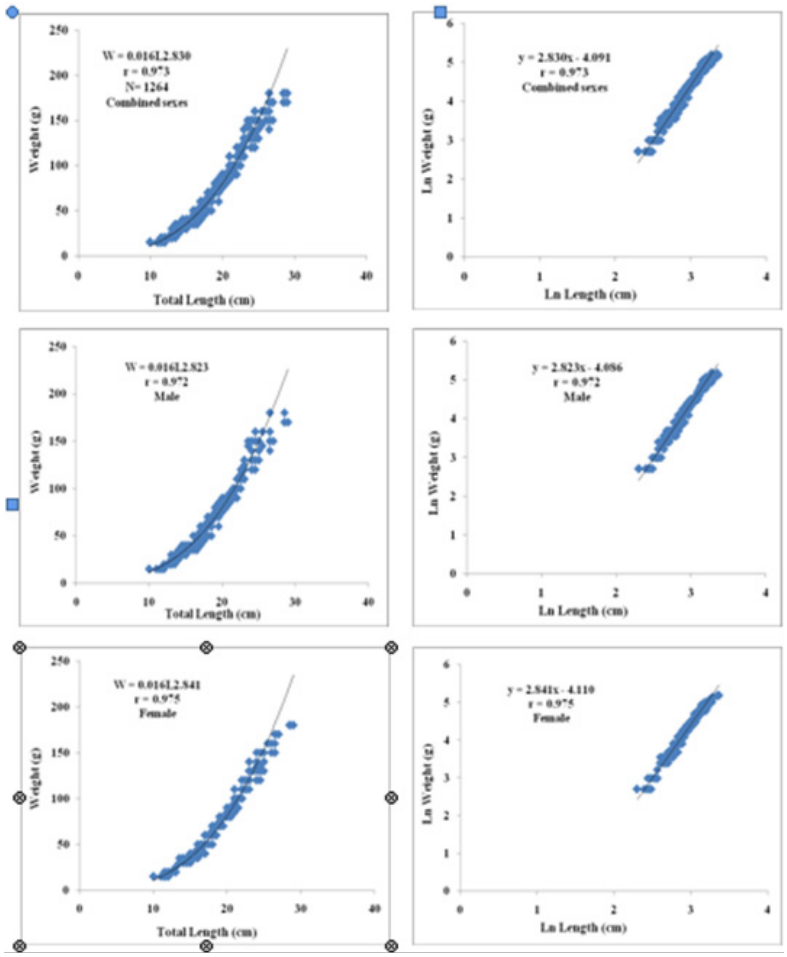

Figure 5 Length-weight relationship of Combined sexes, Male and Female of *L. tade*.

Discussion

The samples of tade mullets were calculated separately for males, females and combined sexes by using the length frequency data collected from June 2018 to May 2019. Fish can exhibit different growth patterns namely isometric growth (b=3) where there is no change in body shape with increase in length, negative allometric growth (b<3) where fishes become slender with increase in length indicative of not too good environment factors and positive allometric growth (b>3) where fishes become fatter with increase in length indicative of good environmental factors such as dissolved oxygen, optimum temperature, availability and/or abundance of food.

The parameter b may vary seasonally, even daily and between habitats. Thus, the length-weight relationship in fish is affected by a number of factors including gonad maturity, sex, diet, stomach fullness, health, and preservation techniques as well as season and habitat.[16] With regard to the b-value of the family Mugilidae, 3.069 in *Liza aurata* from the Adriatic Sea[17] 3.37-3.39 in *Mugil cephalus* from Parangipettai waters[18] 2.79-2.94 in *Liza aurata* from Homa Lagoon[19] 2.951 in *Liza tade* from extensive brackish water farming system[20] 2.63058 and 2.87606 in *Liza dussumieri* and *Valamugil seheli* from Myeil waters, Taninthayi region.[21] In the present study, the exponents b-value of the length-weight relationship (combined sexes: b=2.83; males: b=2.82 and females: b=2.84) of *L. tade* were estimated in Mawlamyine and showed negative allometric growth.

The results of length weight relationship of tade mullets were compared with the available literature. For *L. tade*, negative allometric pattern (b<3) obtained in this study is similar to findings observed in Sunderban area[22] and in extensive brackishwater farming system.[20] The value of exponent 'b' of different size of *Liza tade* was 2.952 and 2.834 from Sunderban area. In the present study, the b-value of this species is slightly lower than the result of Sunderban area.[22] This negative allometric growth pattern could be attributed to low food items for this species in the ecosystem or reduction of their body size to escape predation or high fishing mortality or intensity and adverse effects of oil pollution on the growth.[23]

The overall result of this study revealed that *L. tade* showed negative allometric pattern of growth with the b-values less than ideal value (3.0) which indicates that as the length of the fish increased, it become lighter, thinner or less plumpy or simply put, it shows poor growth of length and weight.[24] The fish did not grow symmetrically as they became thinner with increase in length.[25]

The reason for the different result of b-value there may be ecological differences or variability such as temperature and food supply. Individuals in any fish population growing in the same areas during the growth of the individuals in different populations some differences can be observed.[26] If fish grow isometrically than it retains its body shape and its specific gravity will also remain unchanged during the life time, therefore, in such cases, its b-value must be equal

to 3.0. Hence, this growth pattern in fish will follow the cube law. But under natural condition, most fish do not show the cube law, because they change their body shape as they grow or increase in size and become heavier in one season and lighter in the other season.[27]

The value of coefficient of correlation (r) determined that the relationship between length and weight was significant or not which can take values ranging between -1 and +1. The value of (r) higher than 0.5 stated that length weight relationship was positively correlated.[28] In the present study, the correlation coefficient 'r' values indicated higher than 0.5 between length and weight relationships for combined sexes, males and females of *L. tade*. So the relation between the length and weight of tade mullets was positively correlated and highly significant. Differences in growth patterns exhibited by the different species in different environments could be due to differences in sample sizes, seasons and related environmental factors such as food availability and optimum temperature.

The condition factor of fish is a quantitative parameter of the well being state of the fish. When condition factor values are higher it means that fishes have attained a better condition and are better adapted to the environment. The variations in K values of grey mullet species might be due to the differences in the maturation of gonads, increases or decreases in feeding behavior, amounts of fats or population changes that may occurs due to the changes in food items.[29]

In the present study, the mean condition factor estimated from the equation $K=W*100/L^3$ was 1.08 in males, 1.14 in females and 1.11 in combined sexes for *L. tade*. Females of *L. tade* (1.14) showed the highest mean values of condition factor (K) than males, indicating that females of these mullet species at a given length were heavier than males of similar length. The highest K values recorded for *L. tade* was indicating that it can survive well even when environmental condition. These observations on condition factors have been influenced by a number of factors including sex, sexual activity, environmental stress, and season among others.[30]

Sex ratio studies provide information on the proportion of male to female fish in a population and are expected to be 1:1 in nature. Any deviation from this ratio may indicate the dominance of one sex over the other.[31] It is suited that dominance of one sex relative to the other can be due to different behaviours in the two sexes leading to an easier catch of one sex, differences in fishing methods and equipments, different fishing factors related to season and schooling in feeding and spawning ground and spatio-temporal segregation of the sexes.[32] Month wise analysis of sex ratio of present study showed that the overall sex ratio of males to females was 1: 1.0 in *Liza tade*. Chi square analysis χ^2 of *Liza tade* (0.26) showed that there was no significant different at 5% probability level. Sex ratio was reported on *Liza aurata*[19] who observed a predominance of females over males (1: 1.8) from Homa Lagoon. The sex ratio for *Mugil cephalus* was 1: 0.53 and this showed a statistically significant (<0.05) dominance of the males over the females for the size range.[33] However, more females than males of *Liza abu* in the Water of the Khozestan Province were recorded the ratio of 1: 2.7 male to female respectively. [34]

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Conflicts of interest

The author declares that there is no conflicts of interest.

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