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Growth and Population Parameters of Tade Mullet (*Liza tade* Forsskal, 1775) from Mawlamyine, Mon State, Myanmar

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ABSTRACT

The growth and population parameters of tade mullet, Liza tade collected from Mawlamyine, Mon State during June 2018 − May 2019 were studied using the length frequency data. The growth parameters calculated the asymptotic length (L_∞) and curvature parameter (K) as 31.50 cm and 0.99 per year, respectively. The 't_0' value obtained from the von Bertalanffy plot estimated for L. tade was 0.16 yr. The estimated growth performance index (Ø´) was 2.99 and the estimated life span, longevity (t_{max}) was 3.19 years respectively. The total mortality, natural mortality and fishing mortality were 1.97 yr^{-1}, 1.78 yr^{-1} and 0.19 yr^{-1} and exploitation rates was 0.10 respectively.

Keywords: *Liza tade, Growth, Population parameters, Mortality, Exploitation.*

INTRODUCTION

The Mugilidae or grey mullets is a speciose family of Teleostean fishes, which has representatives in various coastal aquatic habitats of the world's tropical, subtropical and temperate regions [1]. Mullets are generally considered to be ecologically important and forms major food resource for human populations in certain parts of the world [2]. *Liza* is the largest genus of the Mugilidae family and it contains 24 species [3].

Determination of age and growth by employing direct methods are perhaps the most complicated and controversial matter in fish biology and also very expensive [4]. A study on growth is done mainly to determine the amount of fish, which can be produced in terms of quantity (weight) in a water body in relation to time [5]. Information on biology and population dynamics is essential for monitoring the rational exploitation and management of the stock [6].

Growth is an important aspect of the biology and life history of fish, and quantification of growth is frequently a crucial part of fisheries research and management [7]. The structure of a population is determined by the equilibrium between life history characteristics of reproduction, growth and mortality [8]. Certain methods of fisheries assessment require the separation of total mortality into its components due to fishing and due to natural causes. A multiple regression model predicting natural mortality from growth parameters, and mean environmental temperature, which has been widely used to provide estimates of natural mortality in assessments of fish stocks [9].

Direct readings of hard structures (e.g., otoliths, spines, vertebrae) to estimate the age of fish, or indirect estimates based on length distribution data over time are traditional methods to determine growth parameters of fish populations [10]. Indirect stock assessment tools are relatively more useful in tropical and sub-tropical waters since hard structures in these relatively warm waters, where seasonal differences are subtle, often present unclear band marks. These methods were applied in recent decades to tests life-history hypothesis and provided empirical estimations of relevant biological and fishery parameters such as length at first maturity and longevity [11].

Thus, stock assessment becomes a basic management approach to help the understanding of growth (relative to the individual and the population) and death of fish [12]. It's also contributes to making predictions about the exploitation of fish populations, which may help for the selection of alternative management

choices [13]. The lack of growth and mortality estimates is widespread for coastal marine fish populations. These are essential parameters for modeling population dynamics of fish stocks and ecosystems [11]. The aims of the present study are to estimate the growth parameters by using length frequency data and to determine the mortality and exploitation rates of *Liza tade* species form Mawlamyine, Mon State.

Materials and Methods

Study Area

The specimens were collected from Mawlamyine (Kyauktan) (Lat. 16º 26´ N, long. 97º 37´ 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 3.5 cm) and collected from local fishermens along the study area.

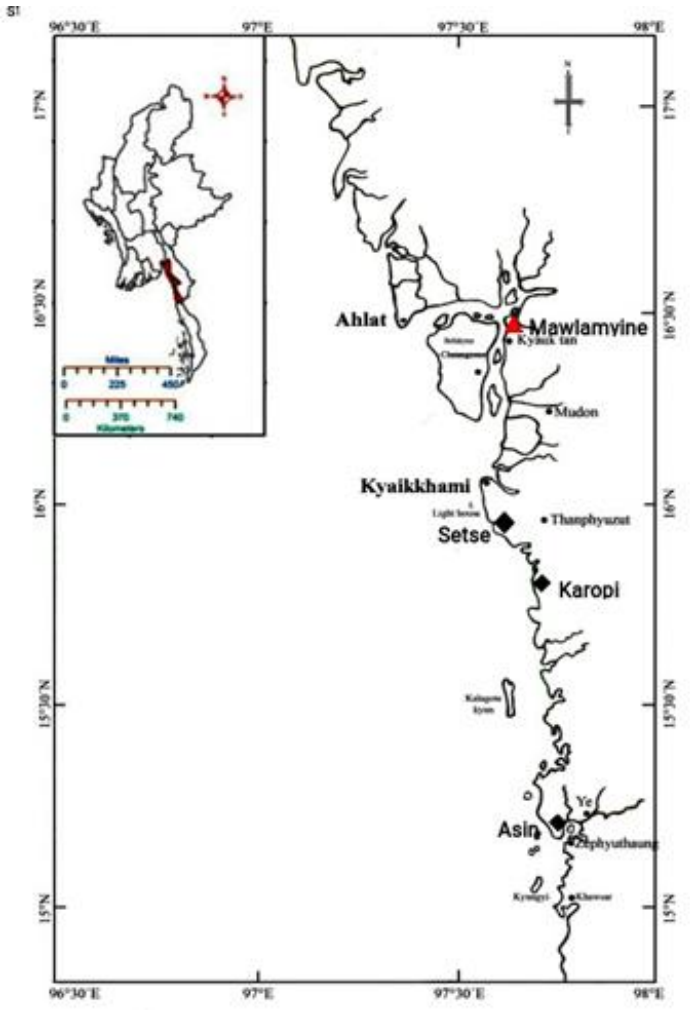

Figure1. *Map Showing the study area of sample collection*

Collection of Samples

The specimens of *L. tade* were collected 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.

Growth Parameters

The monthly collected length based data were analysed using FISAT II (FAO-ICLARM Stock Assessment Tools) (version 1.2.2) as explained in detail by Gayanilo (1997) [14]. The parameters of the von Bertalanffy Growth function (VBGF), asymptotic length (L_∞) and growth coefficient (K) were estimated by means of ELEFAN-1 method (Pauly and David 1981) [15].

Pauly's (1979) [16] empirical equation for the theoretical age at length zero (t_0) was used to

obtain this parameter as: Log $(-t_0)$ = -0.392-0.275Log L_∞ - 1.038LogK

Estimates of growth parameters follow the von Bertalanffy's growth equation (1938) [17]:

$L_t = L_\infty (1- e^{-K(t-t_0)})$

Where L_t is the length at age t, L_∞ is the asymptotic length that is the mean length of fish would reach if they were to grow indefinitely, K is the growth coefficient and t_0 is the age of the fish at zero length.

The growth performance index was computed from the equation:

$ø' = 2 \log L_\infty + \log K$ (Pauly and Munro 1984) [18]

The longevity of each species was estimated using the equation:

$t_{max} = 3/K+t_0$ (Taylor 1960) [19]

where t_{max} is the approximate maximum age of fish would reach or the time the individual takes to reach 95% of the asymptotic length. The recruitment pattern was described from recruitment curves obtained by the reverse projection of the length frequency data onto the time axis using the estimated values of L_∞, K and t_0.

Mortality Parameters

Total mortality (Z) was calculated by Pauly's linearized length-concerted catch curve method from the equation: $\ln (N_i/\Delta t) = a + bt$

Where N_i = number of fish in length class (i), Δt = the time needed for the fish to grow through length class (i) and t = age corresponding to the mid-length of class i, and where b, with sign changed, was an estimate of Z.

The natural mortality (M) was calculated by Pauly's empirical equation (Pauly 1980) [20], where the mean habitat temperature was 29 °C.

$\text{LogM} = - 0.0066 – 0.279 \log L_\infty + 0.6543 \log K + 0.4634 \log T$

where M = natural mortality, L_∞ = asymptotic length, K = growth curvature of VBGF and T = the mean habitat water temperature °C.

The fishing mortality rate (F) was computed using the relationship: F = Z – M

Where, Z = total mortality and M = the natural mortality.

The exploitation rate (E) was evaluated from the equation: E = F/Z (Sparre & Venema, 1992)[11].

Probability of capture was estimated directly from the length-converted catch curve analysis (Pauly 1984a) [21]. Relative yield-per-recruit (Y/R) and relative biomass per-recruit (B/R) values were carried out using the FISAT software.

RESULTS

Length Frequency Distribution and Growth Parameter

A total of 1264 specimens of *Liza tade* ranging from 10 to 30 cm were estimated the growth parameters using length frequency data. The mean length of samples was 18.63 ± 3.63 cm. The asymptotic length (L_∞) and growth coefficient (K) value were recorded as 31.50 cm and 0.99 $year^{-1}$. The restructured length frequency distribution diagram and growth curves produced by ELEFAN I method and displayed in Fig 2. A and B. Powell-Wetherall plots for the estimation of L_∞ and Z/K of *L. tade* was given in Fig 2. E. The L_∞ values obtained for *L. tade* was 29.64 cm [r=-0.925; regression equation, Y= 9.04 + (-0.305)*X]. The obtained growth parameters for *L. tade* by three methods were given in Table 1. The value of growth performance index (Ø´) was 2.99 and estimated t_0 value was 0.16 yr. The growth of *Liza tade* can be described by von Bertalanffy growth equation as:

$L_t = 31.50 (1-e^{-0.99(t-0.16)})$

Longevity estimated to be 3.19 year. The estimated observed extreme length was 30 cm and predicted extreme length was 32.37 cm (Fig 2. C). Two recruitment peaks were found in the present investigation- one during June, July and another during October (Fig 2. D). The value of L_{max}/ L_∞ was 0.927.

Table1. *Growth parameters of Liza tade obtained from different methods from length frequency data.*

Liza tade	Method	L_∞(cm)	Z/K	K(yr^{-1})	Rn/Score
	Powell Wetherall	29.64	2.279	-	-
	ELEFAN 1 Automatic scan	31.40	-	1.00	0.144
	K-scan	31.50	-	0.99	0.177

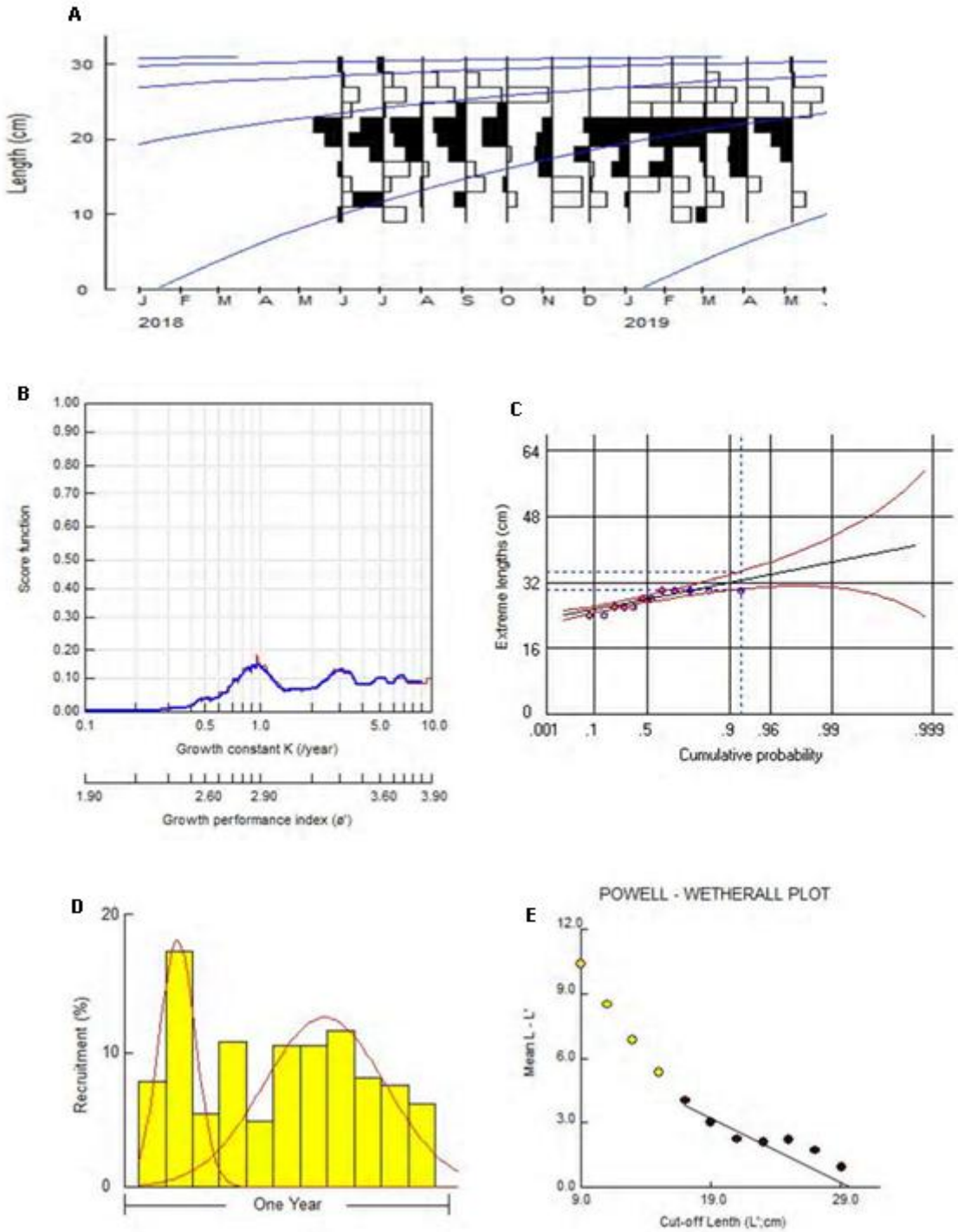

Figure2. *Estimated growth parameter of Liza tade: A) Restructured Von Bertalanffy growth curve and length frequency plot; B) K estimation; C) Maximum length estimation; D) Recruitment pattern; E) Powell-wetherall plot.*

MORTALITY ESTIMATE

The computed total mortality (Z) value of *L. tade* was 1.97 year^{-1} and the length converted catch curves was illustrated in Fig 3. A. The fishing mortality (F) estimated was 0.19 year^{-1}. The natural mortality (M) was 1.78 year^{-1} resulted from Pauly's empirical formula at 29ºC sea surface temperature. The exploitation rate (E) obtained from F/Z was 0.1. The values obtained by probabilities of capture were L_{25}= 12.88 cm, L_{50}= 14.76 cm and L_{75}= 16.10 cm (Fig 3. B).

The relative yield per recruit (Y´/R) and biomass per recruit (B´/R) analysis of *L. tade* were estimated using knife edge selection method in FISAT II (Fig 3. C). This result was determined as a function of L_c/L_∞ and M/K, used for analysis of were 0.31 and 1.797

respectively. The yield/recruit reached a maximum at an exploitation rate of 0.40 in pooled and as the exploitation rate increased, the Y/R decreased. Exploitation rate (E) at different levels as E_{10}, E_{50} and E_{max} estimated by the analysis are 0.35, 0.278 and 0.42 respectively. The computed values of exploitation rate and the Y/R and B/R were given in Table 2 and 3.

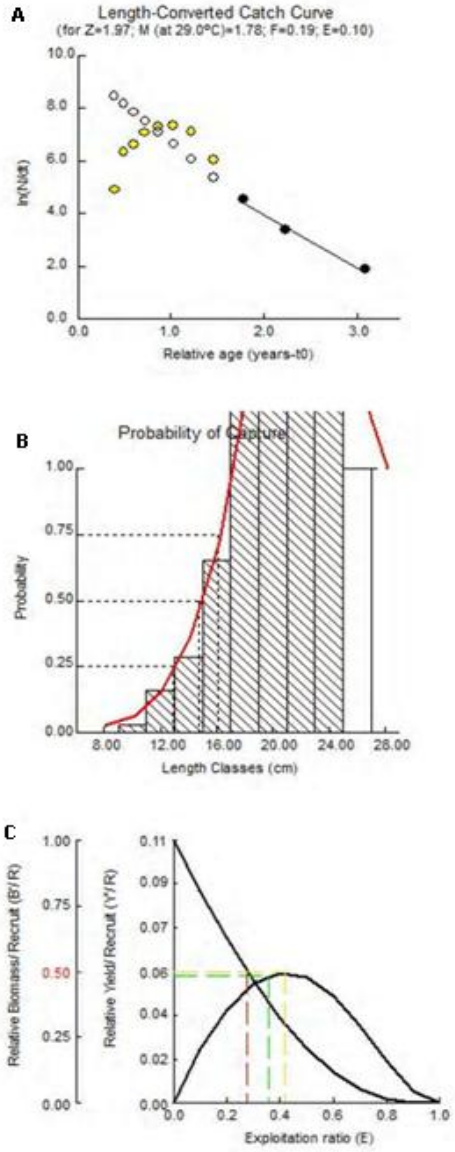

Figure3. *Estimated mortality parameters of Liza tade: A) Length converted catch curve; B) Probability of capture; C) Relative yield per recruit and biomass-per-recruit.*

Table2. *Exploitation rate of L. tade.*

Liza tade	**E(F/Z)**	**Lc/L∞(input)**	**M/K(output)**	**E10**	**E50**	**Emax**
	0.1	0.31	1.797	0.355	0.278	0.421

Table3. *The relative yield per recruit and relative biomass per recruit predicted at each exploitation rate for L. tade.*

E	***Liza tade***	
	(Y/R)	**(B/R)**
0.01	0.022	0.805
0.20	0.039	0.626
0.30	0.050	0.466
0.40	0.054	0.327
0.50	0.053	0.211
0.60	0.045	0.120

0.70	0.032	0.055
0.80	0.018	0.018
0.90	0.005	0.002
0.99	0.000	0.000

DISCUSSION

The determination of growth parameters of the fish has a great role in fisheries research. Growth parameters do not only differ from species to species but also among different populations of the same species. These parameters may be estimated from the absolute or relative age of the fish species or may be estimated by the length-frequency analysis [22]. VBGF is usually used for the estimation of growth parameters of fish and was built keeping in view the growth as balance among the anabolic and catabolic process in a species [23].

In the present study, the values of asymptic length (L_∞) of *Liza tade* obtained 31.50 cm. In Parangipettai water, the values of L_∞ of *Mugil cephalus* found 51 cm and 57 cm for males and females [24]. The highest of *Mugli cephalus* L_∞ values 57.6 cm and 49.9 cm were found in the marine zones in the Black sea [25]. The L_∞ of *Liza klunzingeri* estimated from Iranian water of the Persian Gulf and Oman Sea was 20.3 cm [26]. The value of (L_∞) was 16.69 cm for *Osteomugil cunnesius* from Indian Sundarbans respectively [27].

The growth rate (K) for *Liza tade* as 0.99 yr^{-1} was estimated in the present study by using ELEFAN and von Bertalanffy method. The growth curvature of *Mugil cephalus* (K) was 0.95 yr^{-1} and 0.82 yr^{-1} for males and females from Parangipettai water [24]. Growth coefficient K of *Liza klunzingeri* as 0.6 yr^{-1}, was recorded from Iranian water of the Persian Gulf and Oman Sea [26] and K of 0.94 yr^{-1} for *Osteomugil cunnesius* have been estimated from Indian Sundarbans respectively [27]. From the result of the present investigation, the recruitment pattern of *L. tade* was expressed two peaks- one during June, July and another during October.

For *L. tade*, the value of growth performance index (Ø´) was 2.99 and estimated t_0 value was 0.16 yr. The estimated observed extreme length was 30 cm and predicted extreme length was 32.37 cm. Growth performance indexes (Ø´) of *Liza klunzingeri* 2.39 have been recorded from Iranian water of the Persian Gulf and Oman Sea [26]. In Parangipettai water, the estimated growth performance indexes (Ø´) for males and females of *Mugil cephalus* were 3.37 and 3.39 respectively [24].

Mortality rates were estimated to know the rate of population decay. The total mortality (Z), natural mortality (M), fishing mortality (F) of *L. tade* of present study were 1.97 $year^{-1}$, 1.78 $year^{-1}$ and 0.19 $year^{-1}$ respectively. Total mortality, natural mortality and fishing mortality of *mugil cephalus* were recorded 2.33 yr^{-1}, 1.50 yr^{-1} and 0.975 yr^{-1} for males and 1.173 yr^{-1}, 0.471 yr^{-1} and 0.344 yr^{-1} for females from Parangipettai water respectively [24]. Z, M and F of *L. klunzingeri* were observed 2.31 yr^{-1}, 1.09 $yr^{-1}$and 1.22 yr^{-1} from Iranian water of the Persian Gulf and Oman Sea [26] and (Z= 3.02 yr^{-1}, M= 2.02 yr^{-1} and F= 1 yr^{-1}) for *Osteomugil cunnesius* from Indian Sundarbans respectively [27].

Explotation rate (E) was calculated from E= F/Z. The optimum exploitation rate for any exploited stock is E_{opt}= 0.5 [28]. The present study observed exploition rate of 0.10 for *L. tade*, estimated from the motality rates, suggest that the species were moderately exploitated in Mon State. E value of *L. klunzingeri* was 0.52 from Iranian water of the Persian Gulf and Oman Sea [26] and E= 0.33 for *Osteomugil cunnesius* from Indian Sundarbans [27]. Exploitation rate (E) of *Mugil cephalus* was calculated as 0.674 and 0.227 for males and females from Parangipettai water respectively [24]. In comparison of E, The value of exploitation rate of the present study was lower than the other areas.

Growth parameters and natural mortality rates are not only required input to several stock assessment methods and management strategies, but also allow tests of life-history hypothesis and empirical estimations of important parameters of biological and fishery relevance such as length at first maturity and length at maximum yield per recruit [29]. In conclusion, the present study that the fishing mortality rate of *Liza tade* species was lower than natural mortality rate. This expressed that these species were dominated in the present study area. The explotation rates (E) of *L. tade* was lower than the optimal value of 0.5. This might be supported that the species had not over exploitation and they did not reached under optimal fishing level in this study area.

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