World Academy of Science, Engineering and Technology
International Journal of Bioengineering and Life Sciences
Vol:8, No:3, 2014

Length Weight Relationship of *Terapon jarbua* (Forsskal, 1775) from Puducherry Waters

R. Nandikeswari, M. Sambasivam, V. Anandan

***Abstract*—**The present study investigates the length-weight relationship of *Terapon jarbua* from Puducherry (East coast of India). A total of 370 individuals of different sizes were collected from Puducherry landings centre. Length-weight relationships were calculated for all specimens sampled. The length weight relationship equations are W = 0.0050 L3.2742; W = 0.0035 L3.3616; W = 0.0736 L2.4076; W = 0.0098 L3.0807; W = 0.0088 L3.0914; W = 0.0038 L3.3776 for immature male, immature female, matured male, matured female, total male, and total female respectively. The growth exponential (b) values were found to be positively allometric for all the stages except matured male.

***Keywords*—**Allometry, Length weight relationship, Puducherry waters, *Terapon jarbua*.

I. Introduction

AQUACULTURE is one of the developing subjects with reference to brackish water concern. Yet it is to be developed in large scale because of large number of fishes present in both marine and freshwater systems. In relation to this, biology of all fishes and its adaptation to the different environmental aspects should be known. The length-weight relationships (LWR) are significantly important in fisheries science. In fact, these data become one of the standard methods employed in fishery biology. This information is required for the estimation of weight, where only length data are available and vice versa. Reference [4] suggested that the length - weight relationship is calculated to determine the mathematical relation between the two variables i.e., length and weight, in which if one variable is known, another could be computed. Further it is also used to measure the variations from the expected weight from the length of individual or group fishes as inaction of fatness [1]. These parameters are often used to calculate standard stock biomass, condition indices, ontogenetic changes and other aspects of fish population dynamics. However, the growth parameters of estimated LWR can diverge substantially from true estimates of the population parameters if the sampling designs are inadequate [10]. The application of LWR includes estimation of the mean weight of fish of a given body length and, conversion of the length-growth model to corresponding weight growth model. Reference [32] reported that the basic information on LWR is of a great importance, but often it is not available or insufficient for a particular species. The studies of LWR for fish resources of India, other than commercial fishes, are limited and the present study is focused on compensating the gap of information in this area. The length-weight relationship of *Terapon jarbua* has not been studied previously in Puducherry waters. Moreover, due to the high demand of *Terapon jarbua* in the country, the data of LWR would be very useful for assessment of their maturity, growth and production. Hence, the present study of the length-weight relationship of *Terapon jarbua* is performed with the objective that whether any differences exists in both the sexes of this species.

The length weight relationship may give an idea about the variations from the expected weight for a particular length of fish or fish population based on fatness, general well being or gonad development [19]. It also helps to evaluate the condition, reproduction history, life cycle and the general health of fish [7] besides useful in local and interregional morphological and life historical comparisons among fish populations. The relationships of fish were originally used to provide information on the condition of fish and to determine whether somatic growth was isometric or allometric [4], [37]. Its importance is pronounced in estimating the average weight at a given length group [17] and in assessing the relative well being of a fish population [34].

Length weight regressions have been used frequently to estimate weight from length because direct weight measurement can be time consuming in the field [12]. In fishery biology, length weight relationships are useful for the conversion of growth-in-length equations to growth-in-weight or use in stock assessment models and to estimate stocks biomass from limited sample sizes [3]. Establishment of a relationship between weight and length is essential for the calculation of production and biomass of a fish population [5], [15], [31] and also morphological comparisons among species and among populations of the same species from different habitats and/or regions [5].

Length weight relationships are extensively used in fisheries research and are useful for (1) calculating the weight of a given individual fish of known length or total weight of fish from length frequency distribution; (2) estimating age structure, weight growth rate and several other aspects of fish population dynamics; (3) converting growth-in-length equations to growth-in-weight equations for use in stock assessment models; (4) estimating indices of condition of fish in a given geographical area; (5) making between region

R. Nandikeswari is with Kanchi Mamunivar Centre for Post Graduate Studies, Puducherry, Pondicherry University, India (phone: 91-9564789652; e-mail: navinpraem@gmail.com).

M. Sambasivam is with Jawaharlal Nehru Rajkeeya Mahavidyalaya (JNRM), Port Blair, Affiliated to Pondicherry University, (e-mail: snavin06@gmail.com).

V. Anandan is with Department of Zoology, Kanchi Mamunivar Centre for Post Graduate Studies, Puducherry, Pondicherry University, India (e-mail: anandanvirappin@gmail.com).

comparisons of life histories and morphology of certain species [6], [11], [18], [20], [30].

The present study was carried out to understand the length weight relationship of male and female *Terapon jarbua* for different maturity stages from Puducherry coast. This information provides the comprehensive report on the length weight relationship of *Terapon jarbua* in this region.

II. Materials and Methods

A total of 208 male and 162 female of *Terapon jarbua* were collected from Bay of Bengal, Puducherry from July 2008 to June 2010 for the determination of length and weight. The collected fishes were carried immediately to the laboratory. After thorough wash with tap water the total length of each fish was measured with a measuring scale to the nearest millimeter and the body weight in gram by an electronic balance. Excess water from the fishes was removed with blotting paper before measuring the weight of the fishes.

The log transformed data of the total length and total weight of all specimens were used to calculate the length-weight relationship. The length-weight relationship was calculated by the least square method applying the Le Cren formula $W = a L^b$ or its logarithmic form, $\log W = \log a + b \log L$. The constants 'a' and 'b' were estimated using the method of least square and the linear equation was fitted separately for male and female. The co-efficient of determination (r^2) was used as an indicator of the quality of the linear regression provided by the value of 'b'. SPSS software package was used for all statistical analysis. Where, W = Weight (g), L = Length (cm), 'a' and 'b' are Constants.

III. Results

The length weight relationship, regression parameters and significance of correlation of *Terapon jarbua* were calculated. The estimates of length weight equation were calculated separately for immature male and female, matured male and female, total male and female. When the empirical values of length were plotted against their respect weight on an arithmetic scale, smooth curves were obtained by LWR regression analysis (Figs. 1-6). Cube law is not confirmed for all fishes because the growth could change their shapes. References [26] and [29] were described that a value less than 3 would indicate that fishes become lighter (negative allometric) and greater than 3 as heavier (positive allometric) for a particular length as well as increase in size. In the present study, the 'b' value for both male and female of all stages except matured male indicated positive allometric growth, indicating that the increase in length is proportionate to increase in weight. In the case of matured male, the 'b' value is negatively allometric which indicates that the increase in length is not proportionate to increase in weight. The observed 'b' values for immature male and female, matured male and female and total male and female were 3.2742, 3.3616, 2.4076, 3.0807, 3.0914 and 3.3776, respectively. The computed length weight relationship, logarithmic transformation, the respective correlation co-efficient and probability values are as follows.

TABLE I
Estimated Parameters of Length Weight Relationship and Logarithmic Length Weight Relationship, Correlation and Regression Coefficients and Growth Pattern between Male and Female of *Terapon Jarbua* during July 2008 - June 2010

Sexes	Stages	LWR	Log LWR
Male	Immature	$W = 0.0050 L^{3.2742}$	log W = - 2.3026 + 3.2740 log L
	Matured	$W = 0.0736 L^{2.4076}$	log W = - 1.1331 + 2.4076 log L
	Total	$W = 0.0088 L^{3.0914}$	log W = - 2.0541 + 3.0914 log L
Female	Immature	$W = 0.0035 L^{3.3616}$	log W = - 2.4558 + 3.3616 log L
	Matured	$W = 0.0098 L^{3.0807}$	log W = - 2.0076 + 3.0807 log L
	Total	$W = 0.0038 L^{3.3776}$	log W = - 2.4161 + 3.3776 log L

The probability value is found to be highly significant ($p < 0.01$) indicating good linear correlation suggesting a good adjustment between length and weight. The present findings on the length weight relationship of *Terapon jarbua* based on the regression coefficient (b) values were noticed in respect of all the stages are positively allometric ($b > 3$) except for matured male.

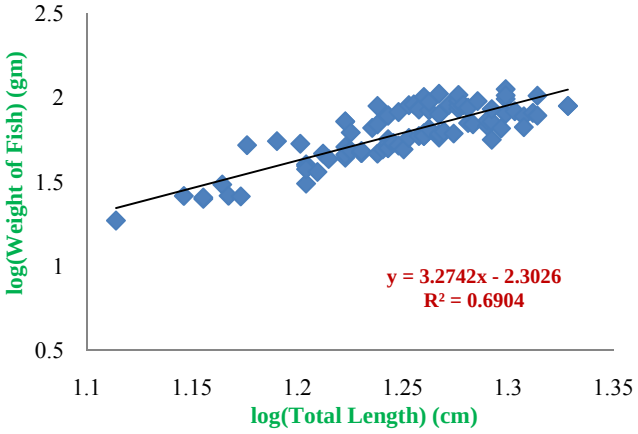

Fig. 1 Logarithmic Length weight relationship of immature male *Terapon jarbua*

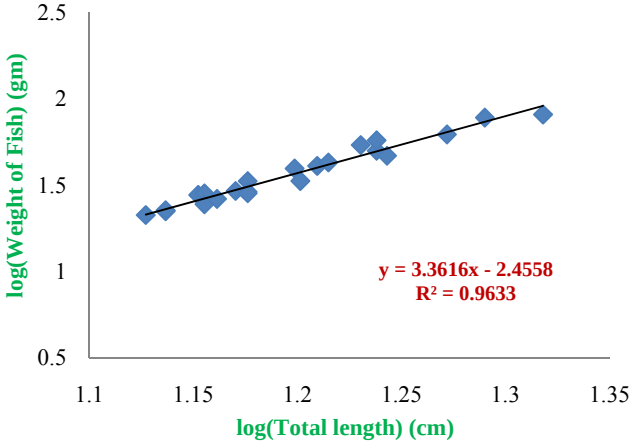

Fig. 2 Logarithmic Length weight relationship of immature female *Terapon jarbua*

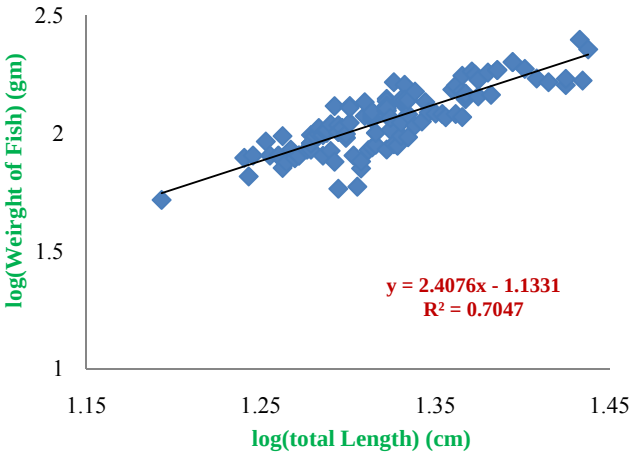

Fig. 3 Logarithmic Length weight relationship of matured male *Terapon jarbua*

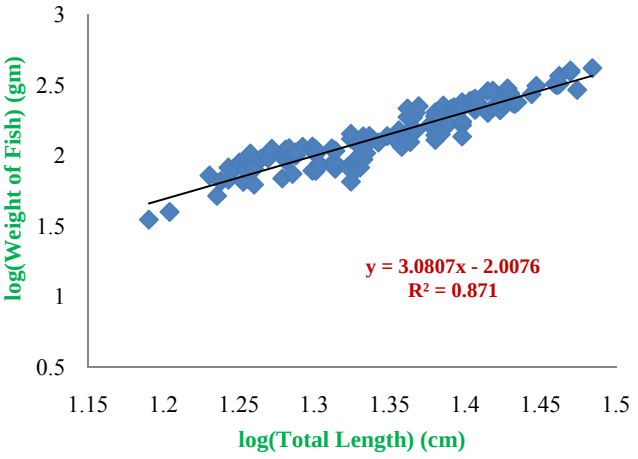

Fig. 4 Logarithmic Length weight relationship of matured female of *Terapon jarbua*

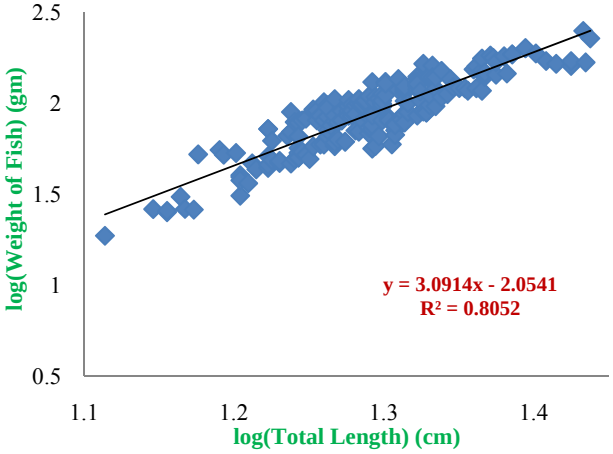

Fig. 5 Logarithmic Length weight relationship of total male *Terapon jarbua*

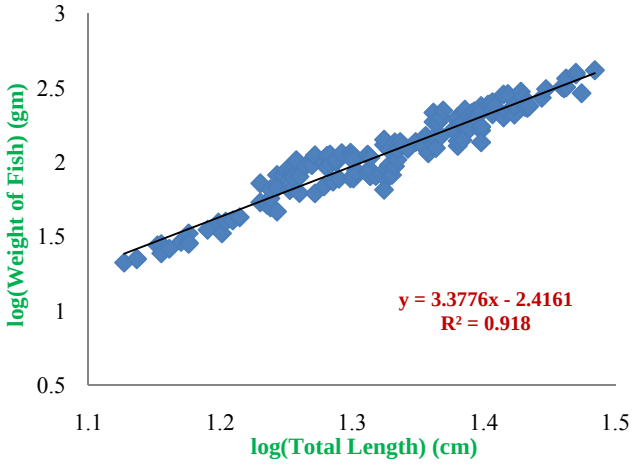

Fig. 6 Logarithmic Length weight relationship of total female *Terapon jarbua*

IV. Discussion

The present study on the length weight relationship of *Terapon jarbua* from Puducherry coast has been studied. Length weight relationship parameters of fishes are an important fishery management tool and it is very much useful for cultivators and fisheries managers to ascertain the growth of the species. In this study, an efficient sampling protocol was followed to include the widest possible ranges of length and weight, which were generally obtained with large samples and non selective fishing techniques. The variation in fish sizes indicated that the fish population ranged from immature specimens to fully matured one. Several works have been carried out on estimation of length weight relationship in different fish species. Exponent of the arithmetic form and slope of the regression line in logarithmic form, 'b' is the most important parameter in LWR [26].

The reported exponent values of 'b' for different fishes ranged between 2.5 to 4.0 [28], [36] and 2.0 to 4.0 [9], [33]. If 'b = 3', then small specimens in the samples under consideration have the same form and condition as large

specimens. If b > 3, then large specimens have increased in height or width more than in length, either as the result of a notable ontogenetic change in body shape with size, which is rare, or because most large specimens in the sample were thicker than small specimens, which is common. Conversely, if b < 3, then large specimens have changed the body shape to become more elongated or small specimens were in better nutritional condition at the time of sampling [26]. The allometric model seems to be the most appropriate for describing the LWR in fishes and applies to the vast majority of relationship and morphological characteristics with body length [22]-[25], [35]. Yet, allometric calculations should not be considered optimally applicable to all metric comparisons and one must always examine its validity [27]. Based on the results of the present study, as well as of previous once [22]-[25], it is also apparent that such relationship might reflect the effect of different factors such as habitat type and feeding habits

In the present study, the calculated values of 'b' for length and weight of *Terpaon jarbua* were greater than 3 for immature male (3.2742), immature female (3.3616), matured female (3.0807), total male (3.0914) and total female (3.3776) except matured male (2.4076). The correlation coefficient was close to one suggesting a good adjustment between length and weight of *Terpaon jarbua* which were of expected range and indicated that the growth is positively allometric (b > 3) which means large specimens have increased in height or width more than in length except matured male which was negatively allometeric (b < 3) indicating that the rate of increase in body length is not proportional to the rate of increase in body weight. The matured male is found to have b < 3 which may be due to lesser feed intake during peak breeding. Decrease in the feeding activity due to an increased spawning activity of the fish *Sillago sihama* was reported by [8]. Also, similar patterns have been registered in the feeding habits and spawning activity of the species *Sillago schomburgkii* [14] and *Sillago sihama* [21] because the fluctuation in feeding habit is one of the major factors that influence the slope values 'b'. Reference [16] reported the mixed length-weight relationship of *Terapon jarbua*. Lengths were higher in male and weights were heavier in female, which could be relating to the continuous breeding of this species.

The significant differences of regression coefficient (b) from the positive allometric growth in *Terapon jarbua* except matured male indicate the general parabolic equation $W = a L^b$ expresses the length weight relationship of these species. In consequence, current parameters can be used to derive weight estimates from a given value of length or vice versa.

As reported by [13] adequate feeding and gonad development increases body weight and 'b' values. Reference [2] found that higher metabolic activity with spawning season lowered the 'b' value while less metabolic activities, accumulation of fat and weight of gonads during the pre-spawning period increased the values. In the present study the higher regression coefficient in female *Terapon jarbua* may be attributed to the higher fat accumulation and higher gonadal weight when compared to its male counterpart.

REFERENCES

[1] B. M. Kurup, and C. T. Samuel, "Length-weight Relationship and Relative Condition Factor in *Daysciaena albida* (Cuv.) and *Gerres filamentosus* (Cuv.)," *Fish Technology,* vol. 24, pp. 88-92, 1987.

[2] B. Mitra, and M. Naser, "Length-weight Relationship in *Clarius batrachus* (Linn.)," *Proceedings of the Zoological Society,* Calcutta, Vol. 36, pp. 29-35, 1987.

[3] C. Binohlan, and D. Pauly, "The length-weight table. *In:* Fishbase 1998: Concepts, design and data sources," Froese, R. and Pauly, D. (Eds.), *ICLARM,* Manila, Philippines, 1998, pp. 121-123.

[4] C. D. Le Cren, "The length-weight relationship and seasonal cycle in gonad weight and condition in perch, *Perca fluviatilis," Journal of Animal Ecology*, vol. 20, pp. 201-209, 1951.

[5] D. K. Moutopoulos, and K. I. Stergiou, "Length-weight and length-length relationships of fish species from the Aegean Sea (Greece)," *Journal of Applied Ichthyology,* vol. 18, pp. 200-203, 2002.

[6] D. K. Moutopoulos, and K. I. Stergiou, "Weight-length and length-length relationships for 40 fish species of the Aegean Sea (Hellas)," *Journal of Applied Ichthyology*, vol. 18, pp. 200-203, 2000.

[7] D. Pauly, "Editorial Fish byte," *Naga, ICLARM Quarterly,* vol. 16, 1993, 26p.

[8] E. F. Shamsan, and Z. A. Ansari, "Ecobiology and Fisheries of an Economically Important Estuarine Fish, *Sillago sihama* (Forsskal),"Thesis submitted for the degree of doctor of philosophy in Marine Science, Goa University, 2008.

[9] E. T. Koutrakis, and A. C. Tsikliras, "Length- weight relationships of fishes from three northern Aegean estuarine systems (Greece)," *Journal of Applied Ichthyology*, vol. 19, pp. 258-260, 2003.

[10] G. Gowda, S. L. Shanbougu, and K. S. Udupa, "Length-weight relationship and relative condition of Grey mullet, *Valamugil sehci* (Forskal), from Manglore waters," *Indian Journal of Fisheries*, vol. 34, pp. 340-342, 1987.

[11] G. Petrakis, and K. I. Stergiou, "Weight-length relationships for 33 fish species in Greek waters," *Fishery Research,* vol. 21, pp. 465-469, 1995.

[12] G. Sinovcic, M. Franicevic, Zorica and V. Ciles-Kec, "Length-weight and length-length relationships for 10 pelagic fish species from the Adriatic Sea (Crotia)," *Journal of Applied Ichthyology*, vol. 20, pp. 56-158, 2004.

[13] G. W. Nikolsky, "The ecology of fishes," London and New York: Academic Press, 1963, 352p.

[14] H. H. Gowda, P. S. Joseph, and M. M. Joseph, "Growth, condition and *Sillago schomburgkii* in South-Western Australian near Shore Waters and Comparisons of Life History Styles of a Suite of *Sillago* Species," *Environmental Biology of Fishes,* vol. 49, pp. 435-447, 1988.

[15] J. Dulcic, and M. Kraljevic, "Weight-length relationships for 40 fish species in the Eastern Adriatic (Croatian waters)," *Fishery Research,* vol. 28, pp. 243-251, 1996.

[16] J. Manoharan, A. Gopalakrishnan, D. Varadharajan, C. Udayakumar, and S. Priyadharsini, "Length-Weight Relationship of Crescent Perch *Terapon Jarbua* (Forsskal) from Parangipettai Coast, South East Coast of India," *Journal of Aquaculture and Research Development*, vol. 4, p. 3, 2013.

[17] J. W. Beyer, "On the length-weight relationships Part I: class," *Fish Byte,* vol. 5, pp. 11-13, 1987.

[18] K. I. Stergiou, and D. K. Moutopoulos, "A review of length-weight relationships of fishes from Greek Marine Waters," *Naga, The ICLARM Quarterly*, vol. 24 (1&2), pp. 23-39, 2001.

[19] K. Sivashanthini, "Reproductive Biology of the Whipfin Silverbiddy *Gerres filamentosus* (Cuvier, 1829) from the Parangipettai Waters (SE coast of India)," *Asian Fisheries Science,* vol. 21, pp. 127-145, 2008.

[20] N. E. Kohler, J. G. Casey, and P. A. Turner, "Length-weight relationships for 13 species of sharks from the western North Atlantic," *Fishery Bulletin,* vol. 93, pp. 412- 418, 1995.

[21] P. Jayasankar, "Length weight relationship and relative condition factor in *Sillago sihama* (Forskal) from Mamdapam region," *Indian Journal of Marine Sciences*, vol. 38, pp. 183-186, 1991.

[22] P. K. Karachle, and K. I. Stergiou, "Length-Length and Length-Weight Relationships of Several Fish Species from the North Aegean Sea (Greece)," *Journal of Biological Research*, vol. 10, pp. 149-157, 2008.

[23] P. K. Karachle, and K. I. Stergiou, "Mouth Allometry and Feeding Habits in Fishes," *Acta Ichthyologica et Piscatoria*, vol. 41(4), pp. 265-275, 2011.

[24] P. K. Karachle, and K. I. Stergiou, "Gut Length for Several Marine Fishes: Relationships with Body Length and Trophic Implications," *Marine Biodiversity Records*, vol. 3, pp. 1-10, 2010b.
[25] P. K. Karachle, and K. I. Stergiou, "Intestine Morphometrics: a Compilation and Analysis of Bibliographic Data," *Acta Ichthyologica et Piscatoria*, vol. 40 (1), pp. 45-54, 2010a.
[26] R. Froese, "Cube law, condition factor and weight–length relationships: history, meta-analysis and recommendations," *Journal of Applied Ichthyology,* vol. 22, pp. 241-253, 2006.
[27] R. H. Peters, "The ecological implications of body size," Cambridge University Press, New York, USA, 1983, 329p.
[28] R. Hile, "Age and growth of the Cisco, *Leucichys artedi* (Le sueur) in the lakes of the north-eastern highlands. Wisconsin Bull," *Bulletin of the United States Bureau of Fisheries*, vol. 8, pp. 311-317, 1936.
[29] R. J. Wooton, "Ecology of Teleost Fishes," Chapman and Hall, London. 1990, 404p.
[30] R. O. Anderson, and R. M. Neumann, "Length, weight, and associated structural indices," *In:* B.R. Murphy and D.W. Willis (eds). Fisheries techniques, 2nd ed. *American Fisheries Society,* Bethesda, Maryland, 1996, pp. 447-482.
[31] R. O. Anderson, and S.J. Gutreuter, "Length-weight and Associated Structural Indices," *In:* Fisheries Techniques, Nelsen, L. A. and D. L. Johnson (Eds.), *American Fisheries Society*, Bethesda, MD., 1983, pp. 283-300.
[32] R.P.T. Antony, "Length weight relationship in the oil sardine *Sardinella longicep*.(Val.)," *Indian Journal of Fisheries*, vol. 14, pp. 159-190, 1967.
[33] T. B. Bagenal, and F. W. Tesch, "Age and growth, *In:* Methods for assessment of fish production in fresh waters," edited by T.B. Baegnal, IBP Hand book No.3, Third edition. London: Blackwell Scientific Publication, 1978, pp. 101-136.
[34] T. Bolger, and P.L. Connolly, "The selection of suitable indices for the measurement and analysis of fish condition," *Journal of Fish Biology*, vol. 34, pp. 171-182, 1989.
[35] V. S. Karpouzi, and K. I. Stergiou, "The Relationships between Mouth Size and Shape and Body Length for 18 Species of Marine Fishes and Their Trophic Implications," *Journal of Fish Biology*, vol. 62, pp. 1353-1365, 2003.
[36] W. R. Martin, "The mechanics of environmental control of body form in fishes," *University of Toronto* studies, Biological series 58, *Ontario Fisheries Research Laboratory*, vol. 70, pp. 1-91, 1949.
[37] W. R. Ricker, "Hand book of computations of biological statistics of fish populations," *Bulletin of Fisheries Research Board of Canada,* p. 119, 1958.