Length-weight relationship of coral reef associated fishes of Cuddalore, southeast coast of India

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Abstract
Length-Weight relationships (LWR) provide basic information in fisheries biology. In the present study, LW relationships of ten species of coral reef associated fishes from Cuddalore, southeast coast of India was estimated. A total of 1263 individuals, belonging to eight families were measured and weighed. The exponent b of length-weight relationships ranged from 2.71 to 3.20. The LWR were significant (p<0.05) for these species. In terms of growth type, seven species had negative allometric (b<3), Epinephelus coioides had isometric (b=3) and Trachinocephalus myops and Upeneus vittatus had positive allometric (b>3) growth.

Keywords
Length-weight relationship; coral reef fishes; Growth type; Cuddalore, India

Introduction
Length–weight relationships (LWR) have important implications in fisheries science and population dynamics (Erzini, 1994). Size of the fish is generally relevant than age, mainly because several ecological and physiological factors are more size dependent than age dependent (Santos et al., 2002). It is useful in fishery assessments for predicting weights from the more easily measured lengths, because direct weight measurements can take more time in the field yield assessment and biomass calculation (Ricker, 1975; Petrakis and Stergiou, 1995; Martin-Smith, 1996; Garcia et al., 1998; Sinovcic et al., 2004; Froese, 2006). Knowledge of the relationship between length and weight of a fish species in a given geographic region is useful for three reasons: (a) estimation of weight-at-age from total reported catch weight and length-frequency distributions; (b) a practical index of the condition of fish; (c) comparisons of life history between-regions (Petrakis and Stergiou, 1995).

Length and weight measurements can give information on the stock composition, life span, mortality, growth and production (Bolger and Connoly, 1989; King, 1996; Moutopoulos and Stergiou, 2000). Length and weight data are useful standard results of fish sampling programs (Morato et al., 2001). Length-weight relationships provide essential information in fisheries biology, being useful to determine the weight of an individual fish of known length or total weight from length-frequency distribution, and to compare specific growth among different regions (Froese, 1998; Koutrakis and Tsikliras, 2003). This relationship was initially used to obtain information on the growth condition of fish and to find out whether the somatic growth was isometric or allometric (Le Cren, 1951; Ricker, 1975).

Among biometric relations in fishes, the length-weight relationships were widely presented by authors as useful tools with several applications in the domains of fisheries sciences, population dynamics, ecology and stock assessment (e.g Pauly, 1993; Erzini, 1994; King, 1995; Petrakis and Stergiou, 1995; Santos et al., 2002). The establishment of length-weight relationships are also essential for the calculation of production and biomass of a fish population (Anderson and Gutreuter, 1983).

While considering the length-weight relationship of reef associated fishes very few studies are available. Letourneur et al. (1998) has investigated the length-weight relationship of fishes from coral reefs and lagoons of New Caledonia. Mbaru et al. (2010, 2011) studied the length-weight relationship of 39 selected reef fishes in Kenyan coastal water. In India
length-weight relationship have been studied for various fishes like *Siganus canaliculatus* from Gulf of Mannar (Jayasankar, 1990; Anand and Sita Rami Reddy, 2012), *Sillago sihama* from Mandapam region (Jayasankar, 1991), *Sphyraena obtusata* from Bombay waters (Jaiswar et al. 2004), marine ornamental fish (Murty, 2002) *Scarus ghobban* from Lakshadweep (Molly Varghese et al. 2009), *Trachinocephalus myops* from Chennai (Shoba and Gomathy, 2007), *Lethrinus lentjan* and *Lethrinus nebulosus* in Thoothukudi coast (Vasantharajan et al., 2013), *Myrpristis murdjan* in Cuddalore coast (Anbalagan et al., 2009), *Upeneus vittatus* off Visakhapatnam (Rajkumar, 2004), *Scatophagus argus* (Gandhi et al. 2013). But in Cuddalore coast the length weight relationship of reef associated fishes is very scarce. Hence the present study will provide further contribution to the available length-weight relationships for most of the commercially exploited coral reef associated fishes of Cuddalore, southeast coast of India.

1 Materials and Methods

Ten species of coral reef associated fishes were collected from Cuddalore landing centre (11º42΄ N; 74º 46΄ E), southeast coast of India (Figure 1). Cuddalore is one of the important fish landing centres of Tamil Nadu having a coastline of 11km. The river Pennaiyar, Paravanar, Uppanar and Gadilam merge with Bay of Bengal near Cuddalore forming a vibrant estuarine system before discharge into the sea. The fishing harbour is located near the mouth of Uppanar estuary. Fishes were identified using standard fish identification manuals (Day, 1878; Fischer and Bianchi, 1984; Talwar and Jhingran, 1991; Froese and Pauly, 2015). The total length was measured to the nearest cm using a measuring board and the total weight was measured to the nearest g using an electronic balance. The LWR was calculated employing Le Cren’s (1951) formula,

\[ W = aL^b \]

and its logarithmic form: \( \log W = \log a + b \log L \) as followed by Ramasesaiah and Murty (1997). Where \( W \) is the total weight, \( L \) is the total length, “a” is the intercept, and “b” is the slope. Length-weight relationships may help determine whether somatic growth is isometric (\( b=3 \)) or allometric (negative if \( b<3 \) or positive if \( b>3 \)) (Ricker, 1973; Spiegel, 1991). The degree of association between the variables was computed by the determination of the regression coefficient \( r^2 \) and statistical significance level of \( r^2 \) and 95% confidence limits of parameters a and b were estimated (Santos et al., 2002).

2 Result

In the present study length weight relationships of ten species of coral reef associated fishes (*Siganus canaliculatus, Siganus javus, Trachinocephalus myops, Lutjanus fulviflamma, Lutjanus russellii, Acanthurus tristis, Upeneus vittatus, Scolopsis vosmeri, Scatophagus argus* and *Epinephelus coioides*) were analysed. Totally 1263 individuals belonging to eight families (Siganidae, Synodontidae, Lutjanidae, Acanthuridae, Mullidae, Nemipteridae, Scatophagidae, Serranidae) were sampled. The sample size, minimum and maximum value of length and weight and mean values of length and weight of each species as well as the parameters a and b of the length - weight relationships, and the coefficient of determination \( r^2 \) are presented in Table 1. The length of the fishes ranged from 9.2cm (*Siganus javus* and *Scatophagus argus*) to 31.2cm (*Epinephelus coioides*) and weight ranged from 16.1g (*Siganus canaliculatus* and *Acanthurus tristis*) and 373.1g (*Epinephelus coioides*). The \( r^2 \) values ranged from 0.93 (*Epinephelus coioides*) and 0.98 (*Lutjanus russellii*).

The exponent b of length-weight relationships ranged between 2.71 for *Scatophagus argus* and 3.20 for *Upeneus vittatus*. The LWR were significant (p<0.05) for these coral reef associated species. In terms of growth type, the results revealed that seven species...
had negative allometric (b<3), one species had isometric (b=3) and two species had positive allometric (b>3) growth.

3 Discussion

The b values for all the ten species of fishes fall between 2.5 to 3.5 this will agree with the suggestion of Carlander (1969) and Froese (2006). The values of b< 2.5 or >3.5 are mostly caused by samples with narrow size ranges Carlander (1977). The b values reported by Letourneur et al. (1998) for Lutjanus fulviflamma (2.906), Lutjanus russellii (2.907), Epinephelus coioides (3.084) and Upeneus vittatus (3.309) in New Caledonia agree with values presented here, but the value of Scatophagus argus (2.922) and Siganus canaliculatus (3.010) was slightly higher when compared to the present study. Jayasankar (1990) and Gandhi et al. (2013) reported almost similar b values for Siganus canaliculatus (2.819) and Scatophagus argus (2.842) in Gulf of Mannar. Shoba Joe and Gomathy (2007) also reported more or less similar b value (3.047) for Trachinocephalus myops at Chennai. These differences could be due to difference in environmental and biological parameters and also to the type of the sampling, like size ranges, number of individuals collected and period of collection. In addition the LWR are not stable for fishes from various regions, it may vary in relation to their environmental factors like temperature, salinity, food (quality, quantity and size), habitat and gonad maturity, spawning period, season, sex, absence of juveniles, health, fishing time and fishing gears (Ricker, 1973; Safran, 1992; Froese, 2006).

According to Petrakis and Stergiou (1995), the use of these length-weight relationships must be thoroughly restricted to the size ranges applied in the estimation of the linear regression parameters. For this reason, it is risky to extrapolate data to fish larvae, juveniles or immature stages (Begenal and Tesch, 1978; Safran, 1992 and Pepin, 1995). The length-weight relationship parameters may differ considerably due to biological and environmental situation or geographical, temporal and sampling factor (Bagenal and Tesch, 1978; Froese, 2006). Regarding the growth type most of the fishes showing negative allometry it points out that growth prolong throughout the life span of fish but growth rate decreasing with age. This will prove that growth was disproportionately slow.

From these ten species there is no record of LWR for Scolopsis vosmeri in FishBase, hence this study provides the first reference on LWR for this species (Froese and Pauly, 2015). Similarly to the best of our knowledge there is no information currently existing on the LWR for Acanthurus tristis, Lutjanus russellii and Lutjanus fulviflamma in Indian waters.

4 Conclusion

In spite of the existence of various studies regarding many aspects of fisheries from Indian waters, the information available on length-weight relationship is scattered and frequently limited to the most common

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**Table 1 Statistical description and LWR parameters obtained for 10 coral reef associated fishes length parameters (length ranges in cm (minimum and maximum), mean and standard deviation (SD)), weight parameters (weight ranges (minimum and maximum), mean and standard deviation (SD)), parameters of the LWR (N: number of specimens sampled, a: intercept, b: slope and r^2 coefficient of determination) and type of growth (isometric (I) or allometric (A), (positive or negative))**

| Species                    | N  | Length (cm) Min-max | Weight (g) Min-max | Parameters of LWR | Growth type |
|----------------------------|----|---------------------|--------------------|-------------------|-------------|
|                            |    | Mean ± S.D.         | Mean ± S.D.        | a                 | b           | r^2       |   |
| *Siganus canaliculatus*    | 204| 11.2-27.4           | 18.6±4.1           | 16.1-186.4        | 97.9±55.0   | 0.0172   | 2.91 | 0.95 | - A |
| *Siganus javus*            | 188| 9.2-22.6            | 14.9±2.9           | 16.1-165.4        | 69.4±40.2   | 0.0308   | 2.81 | 0.94 | - A |
| *Trachinocephalus myops*   | 228| 13.2-27.9           | 19.9±3.0           | 19.2-187.2        | 79.4±38.4   | 0.0055   | 3.17 | 0.95 | + A |
| *Lutjanus russellii*       | 176| 12.1-25.6           | 18.4±3.9           | 25-198.6          | 98.4±58.0   | 0.0176   | 2.91 | 0.98 | - A |
| *Lutjanus fulviflamma*     | 71 | 11.3-25.7           | 18.6±4.8           | 17-205.2          | 106.0±68.6  | 0.0151   | 2.96 | 0.97 | - A |
| *Acanthusus tristis*       | 166| 9.7-22.8            | 14.6±3.3           | 16.1-166.2        | 64.0±41.6   | 0.0305   | 2.80 | 0.97 | - A |
| *Upeneus vittatus*         | 80 | 11-20.7             | 15.5±2.6           | 20.3-160          | 64.2±37.8   | 0.0088   | 3.20 | 0.98 | + A |
| *Scolopsis vosmeri*        | 50 | 11.3-17.5           | 14.1±1.8           | 28.5-96.4         | 60.6±21.8   | 0.0285   | 2.87 | 0.96 | - A |
| *Scatophagus argus*        | 30 | 9.2-14.8            | 11.4±1.5           | 22.6-78.6         | 44.8±17.2   | 0.0562   | 2.71 | 0.94 | - A |
| *Epinephelus coioides*     | 70 | 18.4-31.2           | 24.5±3.5           | 86.4-373.1        | 212.7±89.4  | 0.0132   | 3.00 | 0.93 | I   |

Note: *Refer to the log W = log a + b log L regression
and studied fish species. Hence, the present study will provide additional information on available data and new to some of the species along southeast coast of India.

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