Relative condition factor and food and feeding of Jones’ pony fish

Eubleekeria jonesi (James, 1971) from Mandapam waters, Tamil Nadu, India

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ABSTRACT

The relative condition factor (Kn) based on length-weight relationship and food and feeding habits of Jones’ pony fish Eubleekeria jonesi (James, 1971) off Mandapam waters was studied during December 2016 - April 2018. The Kn values showed variations on a monthly basis with maximum value during September (1.23) for male and March (1.53) for female. Analysis of fullness of stomach of 961 samples within the size range of 51-130 mm revealed 40.87% fishes as actively fed, 36.19% as moderately fed and remaining 22.94% as poorly fed. The monthly mean fullness index (FI) was highest during September for both sexes. Highest gonadosomatic index (GSI), vacuity index (VI) and Kn value were observed during March-April in females, probably indicating a spawning peak and hence meagre feeding, which resulted in lowest fullness index (FI). Fishes of smallest length group (51-70 mm) had highest FI and minimum VI and vice versa. The values of index of relative importance (IRI) indicated that the species was planktivorous as well as detritivorous, with top priority towards crustaceans (27.6%) followed by bivalves (23.6%), foraminifera (15.4%), phytoplankton (12.5%), gastropods (9.1%) and nematodes (8.3%) in the gut contents. Diet did not show significant variation either sex-wise or size-wise.

Keywords: Eubleekeria jonesi, Feeding intensity, Food and feeding, Index of relative importance, Relative condition factor, Mandapam

Introduction

Leiognathids (Family: Leiognathidae), commonly known as silverbellies, slipmouths, ponyfishes or slimys, are small fishes widely distributed in the Indo-Pacific and the Western Central Atlantic Oceans. They occupy shallow-coastal waters up to 40 m depth and sometimes enter estuaries (James and Badrudeen, 1975). The annual landing of ponyfishes in India in 2017 was 89901 t, which registered 7.09% decrease from 2016. The highest contribution of 85.24%, during the period came from Tamil Nadu on the south-east coast of India (CMFRI, 2018). Ponyfishes occupy an efficient ecological niche and are typically characterised by the upward, horizontal or downward extensions of mouth, which enable them to avoid inter- and intra- specific competition for food.

Length-weight relationship (LWR) for a given species gives the best estimates of growth status at a particular point of time (von Bertalanffy, 1938). The value of relative condition factor, Kn is calculated from the LWR and can be used to estimate changes in nutritional condition and well-being of the fish during the course of time (Jin et al., 2015). Diet and feeding strategies play a key role in the trophodynamics of fishes to determine the extent of growth, fecundity, migratory movements and biological interactions in an ecosystem.

Several studies on the food and feeding behaviour of silverbellies along the Indian coast have been carried out viz., on Leiognathus bindus off Calicut (Balan, 1967) and Ratnagiri coast (Borah et al., 2016), L. brevirostris off Palk Bay (James and Badrudeen, 1975) and off Kerala (Sebastian and Inasu, 2011), L. dussumieri off Mandapam waters (James and Badrudeen, 1981) and off Kerala (Sebastian and Inasu, 2011), L. jonesi from Palk Bay and Gulf of Mannar (James, 1986) and L. splendens off Ratnagiri coast (Acharya and Naik, 2016). The present study was carried out to assess the condition factor, diet and feeding habits of Eubleekeria jonesi (James, 1971) from Mandapam waters and to update the earlier observations made more than three decades ago by James (1986).
Material and methods

Fish samples were collected fortnightly from trawl landings at Rameswaram and Mandapam fish landing centres (FLC), Tamil Nadu during December 2016-April 2018. Out of 961 samples, 629 were collected from Rameswaram and remaining 332 from Mandapam FLC. Total length (TL) of the fish was taken as the distance between tip of the snout and tip of the upper caudal lobe and was measured in mm using a graduated measuring scale. Total body weight and stomach weight of the fish were recorded to an accuracy of 0.01 g using an electronic balance.

Length-weight relationship was derived using the exponential hypothetical formula \( W = a L^b \) given by Le Cren (1951). This relationship was linearised by logarithmic transformation to get the equation, \( \log W = \log a + b \log L \), where the constants ‘a’ and ‘b’ were derived by linear least squares method. The equations were derived separately for males and females for comparison using Analysis of Covariance (ANACOVA) (Snedecor and Cochran, 1967). The relative condition factor, \( K_n \) (Le Cren, 1951) was computed as the ratio of observed weight to estimated weight for each fish as per the equation:

\[
K_n = \frac{W}{aL^b}
\]

where, ‘W’ and ‘L’ are weight and length of the individual fish respectively, ‘a’ and ‘b’ are constants derived from LWR.

The stomach contents of 961 specimens of *E. jonesi* ranging in size from 60 to 126 mm and in weight from 3.36 to 42.24 g were examined. For each specimen, the total length, sex, maturity stage and weight were noted in fresh condition. Gut was removed and preserved in 5% buffered formalin for further studies. The stomach contents were analysed and index of relative importance (IRI%) was computed following Pinkas *et al.* (1971) through suitable modification to estimate volume index:

\[
\text{IRI} = \frac{\%N + \%V}{%O} \times 100
\]

where, %N, %V and %O represent percentages of number, volume and frequency of occurrence of prey.

The intensity of feeding in each fish was determined by eye examination based on the distension of the stomach and the amount of food contained in the stomach. The various stomach conditions were gorged, full, \( \frac{3}{4} \) full, \( \frac{1}{2} \) full, \( \frac{1}{4} \) full and empty in which gorged and full were considered as indication of ‘actively fed’, \( \frac{3}{4} \) full and \( \frac{1}{2} \) full as indication of ‘moderately fed’ and the rest of the conditions i.e. \( \frac{1}{4} \) full and empty as ‘poorly fed’ (Jayabalan and Ramamoorthi, 1985; Sebastian and Inasu, 2011; Nagarajan, 2014). The gut contents of each fish was emptied into a petridish and examined under binocular microscope (Nikon SMZ1270) at 8x magnification and identified up to generic level in the case of zooplankton and benthos and upto species level for phytoplankton. If the food items were in an advanced state of digestion, they were labelled as ‘semi-digested matter’.

Monthly as well as size-wise feeding intensity was also assessed using the vacuity index, VI (Preciado *et al.*, 2014) and fullness index, FI (Hyslop, 1980). VI is the proportion of empty stomachs, estimated as \( \frac{\text{Nes}}{\text{Ts}} \times 100 \), where Nes is the number of empty stomachs and Ts is the total number of stomachs. Fullness index (FI) is the ratio of weight of stomach content to weight of fish, multiplied by 100.

Monthly feeding intensity in relation to spawning activity was compared with gonadosomatic index (GSI) using the formula (Strum, 1978):

\[
\text{GSI} = \frac{\text{Weight of ovary}}{\text{Weight of fish}} \times 100
\]

Results and discussion

Length-weight relationship

A common LWR, \( W = 0.0177x L^{3.0105} \) \( (r^2 = 0.9484) \), was derived for male and female *E. jonesi* as ANACOVA revealed no significant difference in the regression coefficients of the sexes (Table 1). It can be inferred that the pattern of growth in the two sexes are similar, isometric (b≥3) and follows the cube law (Fig. 1), with a high degree of positive correlation between length and weight of *E. jonesi* as indicated by the correlation co-efficient (r²).
Table 1. Comparison of regression lines of male and female E. jonesi by ANACOVA

| Source           | DF | SS-X | SP | SS-Y | b    | DF | SS  | MS  | F    |
|------------------|----|------|----|------|------|----|-----|-----|------|
| Male             | 279| 225.61| 1064.6 | 1.47 |
| Female           | 528| 526.76| 2891.08 | 5.49 |
| Total            | 805| 1633.44| 2.03 |      |
| Pooled (W)       | 807| 752.36| 3955.68 | 2.14 |
| Difference between slopes | 1 | 70.06 | 441.4 | 2781 |
| Between (B)      | 808| 822.42| 4397.08 | 2.23 |
| Difference between corrected means | 1 | 69.68 | 69.68 | 32.52152 |

Length-weight relationships of silverbellies in the Indian sub-continent have been studied by several authors. James and Badrudeen (1981) reported the $b$ values of male and female L. dussumieri from the Gulf of Mannar as 2.9591 and 3.3976 respectively. Karthikeyan et al. (1989) have reported the value of $b$ to be 2.87 for L. jonesi from Palk Bay and Batcha and Badrudeen (1992) reported it to be 3.004 for L. brevirostris from the same ground. The regression coefficient, $b$ of L. bindus (3.0515), S. insidiator (2.905) and G. minuta (2.9228) has been recorded from Chennai coast by Kizhakudan and Reddy (2012). Puvaneswari and Karuppusamy (2019) reported the $b$ value of G. minuta from Tuticorin as 2.95 and 3.07 for male and female respectively. The values of $b$ obtained for E. jonesi in the present study also fall in the same range.

Relative condition factor

The relative condition factor, Kn computed for male and female E. jonesi in each month during 2017 are presented in Fig. 2. The value of Kn showed fluctuations across months and between the sexes. The highest value was recorded during September (1.23) for male and March (1.53) for female. Both sexes had minimum Kn value during August (0.87 and 0.93 for male and female respectively. Monthly trend in Kn indicated spawning peaks in March 2017 and September 2017. The differences in the condition factor noticed in different months may be attributed to variations in environmental condition, food availability and gonad maturity (Jhingran, 1952; Shafi and Quddus, 1974). The ‘condition’ or well-being of fish determined by Kn-factor is based on the hypothesis that heavier fish for a given length is in better condition (Bagenal and Tesch, 1978).

Stomach condition

Monthly variation in the stomach conditions of E. jonesi is shown in Tables 2 and 3. Vigorous feeding in male fishes was observed during September, July, October and December as maximum percentage of gorged (46, 45.5, 12.5 and 24.2%) and full stomachs (47.6, 27.3, 50 and 39.4%) were encountered during these months. Higher incidences of empty stomachs were found during April (42.9%) and November (58.33%). In females, occurrence of 3/4 full, full and gorged stomachs was prevalent in all months except during April 2017 (37.5% empty stomachs) and April 2018 (50% empty stomachs). Poor feeding activity was observed particularly during March to July, probably coinciding with the spawning season. Fully developed gonads resulted in highest Kn value and fishes seem to be ingesting minimum food during spawning period (Gulati, 1987). Jayabal and Ramamoorthi (1985) also reported higher numbers of gorged and full stomachs in Gazza minuta from Porto Novo waters during September-January. The results of the present study show dissimilarity with earlier observations on the diet of the co-existing Photopectoralis bindus from Visakhapatnam waters (Rao et al., 2015); which is probably a way to avoid overlap in the ecological niche.
Table 2. Month-wise % occurrence of different stomach conditions of male *E. jonesi* during December 2016 - April 2018

| Months | Degree of fullness | Sample size |
|--------|-------------------|-------------|
|        | Empty  | 1/4 full | 1/2 full | 3/4 full | Full  | Gorged |          |
| Dec 16 | 8.3    | 0.0      | 58.3     | 16.7     | 16.7  | 0.0    | 12       |
| Jan 17 | 0.0    | 11.1     | 11.1     | 33.3     | 44.4  | 11.1   | 9        |
| Feb    | 29.4   | 35.3     | 29.4     | 0.0      | 5.9   | 0.0    | 17       |
| Mar    | 29.4   | 52.9     | 11.8     | 0.0      | 5.9   | 0.0    | 17       |
| Apr    | 42.9   | 35.7     | 21.4     | 0.0      | 0.0   | 0.0    | 14       |
| May    | Trawl ban period from 16th April to 14th June-2017 |
| Jun    | 0.0    | 16.7     | 16.7     | 16.7     | 16.7  | 33.3   | 5        |
| Jul    | 0.0    | 9.1      | 9.1      | 9.1      | 27.3  | 45.5   | 11       |
| Aug    | 15.8   | 47.4     | 21.1     | 0.0      | 15.8  | 0.0    | 19       |
| Sep    | 0.0    | 0.0      | 0.0      | 6.3      | 47.6  | 46.0   | 63       |
| Oct    | 0.0    | 12.5     | 0.0      | 25.0     | 50.0  | 12.5   | 7        |
| Nov    | 58.3   | 25.0     | 0.0      | 8.3      | 8.3   | 0.0    | 12       |
| Dec 17 | 0.0    | 6.1      | 9.1      | 21.2     | 39.4  | 24.2   | 33       |
| Jan 18 | 19.0   | 52.4     | 19.0     | 0.0      | 9.5   | 0.0    | 21       |
| Feb    | 0.0    | 53.8     | 7.7      | 23.1     | 15.4  | 0.0    | 13       |
| Mar    | 11.1   | 66.7     | 22.2     | 0.0      | 0.0   | 0.0    | 9        |
| Apr    | 28.6   | 42.9     | 14.3     | 14.3     | 0     | 0      | 7        |
| May    | Trawl ban period from 15th April to 15th June 2018 |

Table 3. Month-wise % occurrence of different stomach conditions of female *E. jonesi* during December 2016 - April 2018

| Months | Degree of fullness | Sample size |
|--------|-------------------|-------------|
|        | Empty  | 1/4 full | 1/2 full | 3/4 full | Full  | Gorged |          |
| Dec 16 | 2.6    | 10.3     | 12.8     | 33.3     | 23.1  | 17.9   | 39       |
| Jan 17 | 0.0    | 2.8      | 8.3      | 5.6      | 19.4  | 63.9   | 36       |
| Feb    | 0.0    | 4.3      | 8.7      | 26.1     | 43.5  | 17.4   | 23       |
| Mar    | 17.4   | 13.0     | 13.0     | 30.4     | 21.7  | 4.3    | 23       |
| Apr    | 37.5   | 25.0     | 28.1     | 3.1      | 6.3   | 0.0    | 32       |
| May    | Trawl ban period from 16th April to 14th June-2017 |
| Jun    | 2.7    | 0.0      | 0.0      | 13.5     | 13.5  | 70.3   | 37       |
| Jul    | 5.3    | 5.3      | 5.3      | 26.3     | 0.0   | 57.9   | 19       |
| Aug    | 0.0    | 3.8      | 11.5     | 53.8     | 19.2  | 11.5   | 26       |
| Sep    | 0.0    | 4.9      | 9.8      | 6.6      | 42.6  | 36.1   | 61       |
| Oct    | 0.0    | 5.4      | 5.4      | 29.7     | 40.5  | 18.9   | 37       |
| Nov    | 0.0    | 21.4     | 33.3     | 28.6     | 16.7  | 0.0    | 42       |
| Dec 17 | 0.0    | 0.0      | 0.0      | 5.9      | 44.1  | 50.0   | 34       |
| Jan 18 | 0.0    | 20.0     | 20.0     | 30.0     | 16.7  | 13.3   | 30       |
| Feb    | 2.8    | 36.1     | 30.6     | 5.6      | 25.0  | 0.0    | 36       |
| Mar    | 5.9    | 47.1     | 39.2     | 7.8      | 0.0   | 0.0    | 51       |
| Apr    | 50.0   | 25.0     | 14.3     | 7.1      | 3.6   | 0.0    | 28       |
| May 18 | Trawl ban period from 15th April to 15th June 2018 |

101-110 mm. Empty stomachs were observed to be present in all the length groups except 71-80 mm. In females, higher numbers of gorged and full stomachs were found in the length classes from 81-90 to 121-130 mm (Fig. 4). Similar incidence of full stomachs in the length classes 101-110 and 111-120 mm was also reported by Nagarajan (2014) in female *L. dussumieri* off Tuticorin.

**Feeding intensity**

Male fishes with actively fed stomachs were prevalent during September (93.7%), July (72.7%) and December (63.6%) 2017 (Fig. 5). Moderately fed fish were observed in higher percentages (75%) during December 2016. Higher percentage of poorly fed fishes was recorded.
during March, April, October and November. Female fishes displayed more actively fed stomachs during January (83.3%), June (83.8%), September (78.7%) and December (94.1%) (Fig. 6). Moderately and poorly fed female fishes were maximum in August (65.4%) and April (75%) respectively.

The percentage of feeding intensity of male and female fishes in relation to various length groups is presented in Figs. 7 and 8 respectively. Fishes with actively fed stomachs were minimum in the smallest length group of 71-80 mm for both male (11.5%) and female (14.3%). Thereafter it slowly increased to 35.4% in the size group 101-110 mm in males and 60% in the size group 111-120 mm in females. These results indicated that the feeding intensity of *E. jonesi* varied with season and size, with the larger size groups being in relatively better fed states than the younger size groups. As the fish grow, the size of the mouth increases proportionately, their swimming capacity is modified and their energy requirements may also vary (Qasim, 1971).
female fishes (Fig. 10), maximum Kn value (1.53) and a higher GSI (3.04) was recorded during March. This was followed by the highest GSI (3.73) and VI (37.5%) with lowest FI value (0.79) during April. The highest GSI, VI and Kn values during March and April indicated a spawning peak and hence meagre feeding, which resulted in lowest FI (unpublished data).

The feeding intensity also changed according to size of the fish. Vacuity Index was nil up to length class 61-70 mm in male and up to 71-80 mm in female fishes (Fig. 11 and 12). Thereafter the mean VI became 12% in male and 2.02% in female and reached the highest values (22.22% in male and 10% in female) at 111-120 mm size. Thereafter the VI again became zero. On the contrary, both sexes had the highest FI value (3 in male and 4 in female) in the smallest size classes, followed by a gradual decline to 1 in male at the largest size (121-130 mm) and 1.8 in female at 111-120 mm. The FI of female again increased to 2.26 as it grew to the largest size of 121-130 mm. The Kn value remained between 1.00 and 1.01 for both sexes in all length class. Even though scanty details are available in literature, the present work tried to bring a combination of different indices for describing feeding biology of *E. jonesi* and can be considered as a first of its kind.

The seasonal patterns in this study were consistent with observations by Valinassab et al. (2011) on *Pomadasys kaakan* and Ouakka et al. (2017) on *S. pilchardus* for increase in VI simultaneous with the spawning season.

**Diet analysis**

The gut contents of *E. jonesi* across different sampling months were analysed with the IRI of different food items as shown in Table 4. There was no significant difference in the food choice of both sexes. Crustaceans dominated the food (27.6%) except during April and November. This was followed by bivalves (23.6%), foraminifera (15.4%), phytoplankton (12.5%), gastropods (9.1%), nematodes (8.3%) and semi-digested matter (1.3%). Even though the content was little, *Kinorhynchus* and fish scales each with 0.2% were present in certain months. In April,
crustaceans were displaced by foraminifera and bivalves, whereas in November, phytoplankton (42.8%), bivalves, gastropods and scales outnumbered crustaceans. Bivalves were significantly high in December and April 2017, fairly so in March 2017, December 2016 and November 2017. Nematodes were found in good quantities in September (22.3%), August (21.2%) and June (20.1%). Gastropods were abundant in November 2017 and relatively high during February to April 2018. Foraminifera appeared as chief food during January (34.4%) and April 2017 (34%). Eggs were also present as diet in the gut from April to August 2017 (9.3-4%) with a peak in July (12.7%).

Percentage composition of different phytoplankton is presented in Fig. 13. Various species of phytoplankton encountered in the diet were *Gyrosigma attenuatum* (28%), *G. acuminatum* (12%), *Coscinodiscus jonesianus* (29%), *Triceratium* sp. (12%), *Rhizosolenia styliformis* (9%), *Nitzschia closterium* (7%), *Bacteriastrum curvatum* (2%) and *Cylindrotheca closterium* (1%). Percentage composition of different crustaceans in the guts of Table 4. IRI of *E. jonesi* during December 2016-April 2018.

| Food items          | 16-Dec | 17-Jan | 17-Feb | 17-Mar | 17-Apr | 17-May | 17-Jun | 17-Jul | 17-Aug | 17-Sep | 17-Oct | 17-Nov | 17-Dec | 18-Jan | 18-Feb | 18-Mar | 18-Apr | 18-May |
|---------------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
| Phytoplankton       | 6.7    | 0      | 6.6    | 23.3   | 2.5    | 17.5   | 13.6   | 17.7   | 27.8   | 15.1   | 42.8   | 12.1   | 1.7    | 2.1    | 5.2    | 0.5    |        |        |        |
| Foraminifera        | 24.1   | 29.4   | 10     | 15     | 27.8   | 13.4   | 10.8   | 3.7    | 0      | 0      | 5.4    | 34.4   | 12.3   | 21.1   | 34     |        |        |        |        |
| Kinorhyncha         | 0      | 0.1    | 2.4    | 0.1    | 0      | 0.2    | 0      | 0      | 0      | 0      | 0      | 0      | 0      | 0.2    | 0      |        |        |        |        |
| Crustaceans         | 25.7   | 48.1   | 42.2   | 20.9   | 0.5    | 17.7   | 23.2   | 30.8   | 38.3   | 68.1   | 1.1    | 18     | 24.5   | 40.5   | 17.6   | 15.1   |        |        |        |
| Nematodes           | 0      | 1      | 8.2    | 2.6    | 0      | 20.1   | 13.1   | 21.2   | 22.3   | 14.9   | 0.1    | 0      | 5.5    | 12.1   | 9.3    | 0.1    |        |        |        |
| Bivalves            | 35.3   | 21.1   | 29.6   | 37.8   | 38.8   | 21.9   | 16.6   | 10.3   | 6.1    | 0      | 31.4   | 44.5   | 13.3   | 14.5   | 20.1   | 28     |        |        |        |
| Gastropods          | 4.9    | 0      | 0.7    | 0      | 13.5   | 5.8    | 9.8    | 7.4    | 4      | 1.9    | 24.3   | 6.1    | 1.2    | 18.1   | 24.1   | 21.2   |        |        |        |
| Fish scale          | 0      | 0      | 0      | 0      | 0      | 3.2    | 0      | 0      | 0.2    | 0.2    | 0.2    | 0.2    | 0.2    | 0.2    | 0.2    |        |        |        |        |
| Eggs                | 0.2    | 0      | 0.2    | 0      | 9.3    | 0      | 12.7   | 4      | 0      | 0      | 0.2    | 0      | 0      | 0.8    | 0.8    |        |        |        |        |
| Semi - digested     | 3.1    | 0      | 0.1    | 0      | 1.7    | 0      | 0.3    | 2.1    | 1.5    | 0      | 9.4    | 0      | 0.2    | 1.2    | 0      |        |        |        |        |

*E. jonesi* is shown in Fig. 14. Ostracods (42.5%) formed the principal food item followed by harpacticoids (25%), amphipods (16%), calanoids (10%), cyclopoids (5%), cumaceans (1%) and mysids (0.5%).

Results of the present study indicate that *E. jonesi* is a planktivorous fish feeding mainly on planktonic crustaceans and phytoplankton followed by micro invertebrates and miscellaneous items. Ostracods were found to be dominant among crustaceans followed by harpacticoids and amphipods. Among phytoplankton *Gyrosigma* and *Coscinodiscus* together contributed more than 60%. No significant change was noticed in diet composition with increase in size of the fish. The downward protruding mouths with slender and minute teeth on jaws enable this fish to eat zooplankton and invertebrates associated with the sea bottom. Diurnal vertical migration exhibited by *E. jonesi* results in the
ingestion of phytoplankton during its night stay in the pelagic realm (Venkataraman and Badrudeen, 1974). James and Badrudeen (1975) also identified similar food items in the guts of _L. bevirostris_ inhabiting Palk Bay. James (1986), based on his observation on diet composition of _E. jonesi_ from Mandapam opined that the species prefers planktonic organisms.

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Bagenal, T. B. and Tesch, F. W. 1978. Age and growth. In: Bagenal, T. B. (Ed.), _Methods for the assessment of fish production in freshwaters_. Blackwell Scientific Publication, Oxford, UK, p. 101-136.

Balasubramaniam, K. 1967. Biology of the silverbelly, _Leiognathus bindus_ (Val.) of the Calicut coast. _Indian J. Fish.,_ 10: 118-134.

Batcha, H. and Badrudeen, M. 1992. Length-weight relationship and relative condition of _Leiognathus bevirostris_ (Valenciennes) from the Palk Bay. _J. Mar. Biol. Ass. India_, 34 (1 and 2): 269-270.

Borah, B. S., Nirmale, V. H., Metar, S. Y., Bhosale, B. P., Chogale, N. D. and Pawar, R. A. 2016. Biology of silverbellies, _Photoperctoralis bindus_ (Val. 1835) along Ratnagiri Coast. _Fish Technol.,_ 53: 89-95.

CMFRI 2018. *Annual Report 2017-18*. ICAR-Central Marine Fisheries Research Institute, Kochi, India, p. 33-90.

Gulati, D. K. 1987. *Morphometry, biology and stock assessment of Otolithes cuvieri* (Trevawas) off the Bombay coast. M. Sc. Thesis, Bombay University, India, 185 pp.

Hynes, H. B. N. 1950. The food of freshwater sticklebacks (*Gasterosteus aculeatus* and *Pygosteus pungitius*) with a review of methods used in studies of the food of fishes. _J. Anim. Ecol._, 19: 36-58. DOI: 10.2307/1570.579.

Hyslop, E. J. 1980. Stomach contents analysis - a review of methods and their application. _J. Fish Biol._, 17: 411-429. doi.org/10.1111/j.1095-8649.1980.tb02775.x.

James, P. S. B. R. and Badrudeen, M. 1975. Biology and fishery of _Leiognathus brevirostris_ (Val.) from the Palk Bay and the Gulf of Mannar. _Indian J. Mar. Sci._, 4: 50-59.

James, P. S. B. R. and Badrudeen, M. 1981. Biology and fishery of silverbelly _Leiognathus dussumiari_ (Val.) from Gulf of Mannar. _Indian J. Fish.,_ 28 (1 and 2): 154-182.

James, P. S. B. R. 1986. Biology and fishery of _Leiognathus jonesi_ James from the Palk Bay and Gulf of Mannar. In: _Recent advances in marine biology_. Today and Tomorrow Printers and Publishers, New Delhi, India, p. 29-101.

Jayabal, N. and Ramamoorthi, K. 1985. Food and feeding habits of the silverbelly, _Gazza minuta_ (Bloch) in Porto Novo waters. _Indian J. Mar. Sci._, 14: 110-112.

Jhingran, V. J. 1952. Length-weight relationship of three major carps in India. _Proc. Nat. Inst. India, XVII_(5): 449-460. 

Jin, S., Yan, X., Zhang, H. and Fan, W. 2015. Weight-length relationships and Fulton’s condition factors of skipjack tuna (*Katsuwonus pelamis*) in the western and central Pacific Ocean. _Peer J._, 1-11.

Karthikeyan, M., Pillai, N. G. K. and Badrudeen, M. 1989. Population dynamics of silverbelly, _Leiognathus jonesi_, James in the trawling grounds of Rameswaram, _Indian J. Fish._, 36(2): 103-106.

Kizhakudan, S. J. and Reddy, P. S. 2012. Length-weight relationship in three species of silverbellies from Chennai coast. _Indian J. Fish._, 59(3): 65-68.

Le Cren, C. D. 1951. Length-weight relationship and seasonal cycle in gonad weights and condition in the perch (*Perca fluviatilis*). _J. Anim. Ecol._, 20: 201-219.

Nagarajan, D. 2014. Food and feeding in _Leiognathus dussumiari_ (Valenciennes) from Tuticorin, south-east coast of India. _Trans. Eng. Sci._, 2(5): 1-6.

Ouakka, K., Yahyaoui, A., Mesfioui, A. and Ayoubi, S. E. 2017. Stomach fullness index and condition factor of European sardine (*Sardina pilchardus*) in the south Moroccan Atlantic coast. _ACCL Bioflux_, 10(1): 56-63.

Pinkas, L., Oliphant, M. S. and Iverson, I. L. K. 1971. Food habits of albacore, bluefin tuna and bonito in Californian waters. _Fish. Bull._, 152: 1-105.
Preciado, J. A. R., Amezcua, F., Bellgraph, B. and Madrid, J. V. 2014. Feeding habits and trophic level of the Panama grunt *Pomadasys panamensis*, an important bycatch species from the shrimp trawl fishery in the Gulf of California. *Sci. World J.*, 2014: 1-7. doi.org/10.1155/2014/864241.

Puvaneswari, S. and Karuppusamy, R. 2019. Length-weight relationship of the toothed pony fish, *Gazza minuta* (Bloch, 1797) from Tuticorin waters of India. *LISRBS*, 6(3): 119-123. doi.org/10.26438/ijarbs/v6i3.119123.

Qasim, S. Z. 1971. Dynamics of food and feeding habits of some marine fishes. *Indian J. Fish.*, 19 (1 and 2): 12-28.

Rao, P. Y., Veni, D. N. K. and Sirisha, R. 2015. Biology of orange fin pony fish, *Photopectoralis bindus* (Valenciennes, 1835), off Visakhapatnam, east coast of India. *Int. J. Environ. Sci.*, 5(6): 1159-1171.

Sebastian, H. and Inasu, N. D. 2011. Observations on the diet of the silverbelly *Leiognathus brevirostris* (Valenciennes 1835) from Kerala coast. *J. Mar. Biol. Ass. India*, 53(2): 202-207.

Shafi, M. and Quddus, M. M. 1974. Length-weight relationship and condition factor in *Hilsa ilisha* (Hamilton) (Clupeiformes: Clupeidae). *Bangladesh J. Zool.*, 2(2): 179-185.

Snedecor, G. W. and Cochran, W. G. 1967. *Statistical methods*. Oxford and IBH Publishing Co., New Delhi, 593 pp.

Strum, L. M. G. 1978. Aspects of the biology of *Scombemorus maculates* (Mitchill) in Trinidad. *J. Fish Biol.*, 13: 155-172.

Valinassab, T., Jalali, S., Hafezieh, M. and Zarshenas, G. A. 2011. Evaluation of some feeding indices of *Pomadasys kaakan* in the Northern Persian Gulf. *Iran. J. Fish. Sci.*, 10(3): 497-504.

Venkataraman, G. and Badrudeen, M. 1974. On the diurnal variation in the catches of silverbells in the Palk Bay. *Indian J. Fish.*, 2(1): 254-265.

von Bertalanffy, L. 1938. A quantitative theory of organic growth. *Hum. Biol.*, 10: 181-213.