



Biology of Silverbelly, *Photopectoralis bindus* (Val. 1835) along Ratnagiri Coast

B. S. Borah¹, V. H. Nirmale¹, S. Y. Metar^{2*}, B. P. Bhosale¹, N. D. Chogale² and R. A. Pawar¹

¹College of fisheries, Shirgaon, Ratnagiri - 415 629, India

²Marine Biological Research Station, Zadgaon, Ratnagiri - 415 629, India

Abstract

Food and feeding habits, reproduction and size at first maturity of *Photopectoralis bindus* from Ratnagiri coast are described, based on commercial catches landed by trawls during 2013-2014. Copepods, diatoms and cladocera form important food of the species. The estimated length at first maturity is 93.5 mm. *P. bindus* is a fractional spawner and appears to release the ova in at least two spawning acts during the peak spawning season extending from October to December. High gonado-somatic indices correspond well with the peak spawning seasons and females always have higher values. The estimated fecundity ranged from 4377 to 10 449.

Keywords: Reproductive biology, *P. bindus*, feeding habit, Ratnagiri.

Introduction

Silverbellies constitute one of the important demersal marine fishery resources of India. Landings of silverbellies in India during the year 2012 were 140.8 thousand tonnes contributing to 13% of the demersal landings (CMFRI, 2013). Silverbellies form an important fishery along the coast of Andhra Pradesh, Tamil Nadu and Kerala (Rao, 1973). Tamil Nadu contributed to the bulk of silverbelly landings (58.9%), followed by Kerala (8.1%), Karnataka (7.2%) and Maharashtra (5.4 %) respectively in the year 2012 (CMFRI, 2013).

To sustain the production of silverbellies, judicious exploitation of the resource is necessary. Detailed biological investigations pertaining to the reproduc-

tion and feeding biology are very important in devising appropriate management measures. *P. bindus* is an important contributor to silverbelly landings in trawl catches from Ratnagiri. Biological studies of this species from Ratnagiri coast are very limited. Therefore the present study was undertaken to understand the reproductive and feeding biology of *P. bindus* along the Ratnagiri coast.

Material and Methods

A total of 574 specimens of *P. bindus* (length range: 78 mm to 131 mm) were collected weekly during February 2013 – March 2014 from Mirkarwada fish landing centre, Ratnagiri. Gut contents were analyzed both qualitatively and quantitatively using numerical method (Biswas, 1993). The different food items found in the stomach were examined either in fresh condition or after preservation in 5% formalin. Various constituents of food were identified into main groups. The intensity of feeding was determined for individual fish based on the distention of the stomach and the amount of food contained therein (Pillai, 1972). Gonado somatic index (GSI) was estimated as per following equation (Bal & Rao, 1984)

$$GSI = \frac{\text{Gonad weight}}{\text{Total body weight}} \times 100$$

Data on sex ratio were analyzed monthwise by χ^2 (chi square) test to find out whether either sex was dominant. Maturity stages of females were identified based on microscopic characteristics of ovaries. The female maturity stages of *P. bindus* were classified as immature (I-II), maturing (III), mature (IV) and ripe (V). Fecundity was determined as per Sinha (1995).

$$F = \frac{TW \times \text{Average number of ova counted in the sample}}{SW}$$

Received:12 March 2015 ,Revised:09 March 2016 , Accepted: 28 March 2016

* Email: santoshmetar@gmail.com

Where, F= Fecundity, TW= Total weight of the ovary, SW= Sub-sample weight

Ova diameter was studied using Motic Image Plus 2.0 digital microscopy software.

For determining the length at first maturity (L_{50}), specimens with ovaries in stages III, IV and V of maturation were considered as mature and the proportion of such mature fish in each length group determined. The length, at which about 50% of the fish are mature, has been taken as the L_{50} . For histological study, procedure described by Weesner (1960) was followed.

Results and Discussion

The details of qualitative and quantitative analysis of stomach contents of *P. bindus* during different months are presented in Table 1. The gut content analysis indicated that copepods, diatoms and cladocera formed the main food items of the species with semi-digested matter contributed considerable quantity. The average proportion of the gut contents for the period of study were: copepods 23.78%; diatoms 20.29%; fish eggs 7.97%; crustaceans remains 16.27%; tintinids 3.57%; cladocera 10.69% and semi digested matter 17.43%.

Diatoms were recorded in higher quantities from March to September. Zooplankton such as copepods, cladocera, fish eggs, tintinids and crustacean remains, were dominant throughout the study period. Semi-digested food was also present in appreciable amount in all the months. The results on food and feeding of *P. bindus* indicate that, it is a plankton feeder, feeding mainly on various groups of zooplankton followed by diatoms. Semi digested material was found mostly in younger fishes.

Balan (1963) studied the food and feeding habit of *P. bindus* from Calicut and reported that copepods formed the most important food item of *P. bindus* and phytoplankton contributed only 10% to the total proportion of food. James & Badrudeen (1975) observed that diatoms, copepods, *Lucifer*, nematodes and polychaetes form important food items of *L. brevirostris*. The main food items of pony fishes in the coastal waters of southern South China Sea reported by Seah et al., (2009) were polychaetes and copepods. Important food items for the species included polychaetes, copepods, amphipods, bivalves, gastropods and foraminiferans as reported by Vivekanandan, (2011).

The details of percentage composition of various food items in the stomach contents of *P. bindus* in various size groups are given in Fig. 1. Diatoms were observed to be the most important and they were recorded from all the size groups. The group with size of 100-104 mm recorded highest percentage (21.59%) of diatoms, while the lowest (6.47%) was recorded in 95-99 mm. Crustacean remains were found to occur in size groups of 90-94 mm to 125-129 mm. Copepods were found in all the size groups of 80-84 mm to 125-129 mm. Fish eggs were found to occur in size groups 80-84 mm to 120-124 mm. Tintinids are found in all the size groups of 80-84 mm to 125-129 mm. Semi digested matter was recorded in all size groups.

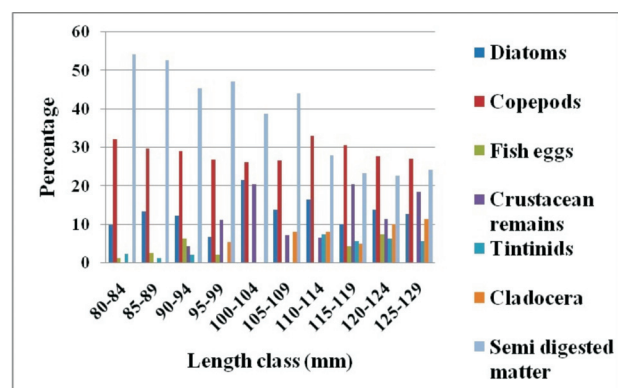


Fig. 1. Percentage composition of food items of *P. bindus* in relation to size

Monthly variations in the fullness of stomach in *P. bindus* is shown in Fig 2. During the study period, 12.25% of the stomachs were full, 20.97% three quarters, 30.26% half, 30.06% quarter and 5.82% were empty stomach. The month of February recorded highest percentage of full stomachs (34%) followed by January and March (28.85% and 25%). The month of May recorded the highest percentage of one quarter full stomachs followed by September (44.87%). Three quarter full stomachs were highest in month of March (32.5%) and half full stomachs in February (44.87%). Month-wise data shows the highest percentage of empty stomachs in May (20%) followed by September (19.23%).

The gonado-somatic index (GSI) was calculated for each individual and grouped by sex and averaged for each month. Monthly variation in GSI is given in Table 2. GSI showed wide variations between sexes and was higher for female throughout the

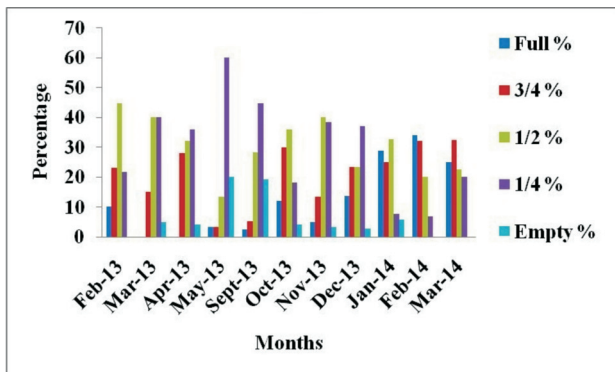


Fig. 2. Month-wise fullness of stomach in *P. bindus*

sampling period. GSI was highest for females during October (4.52) and November (3.32) showing occurrence of more ripe individuals. For males, the highest value of GSI was noted during October (2.00). Jayabalan (1986) studied *L. splendens* along the Porto Novo coast and reported that highest GSI values (2.08 for females and 1.24 for males) were recorded in December. He further reported GSI values were higher in females than males. Seah et al., (2009) studied the reproductive biology of ponyfishes from coastal waters of southern South China Sea and reported that the mean value of GSI for *P. bindus* was 4.0 ± 0.65 . The present study shows occurrence of ripe females and males during October to December, indicating possible spawning season during the post-monsoon period. The study conforms to the earlier observations of Jayabalan (1986).

Month wise sex ratio of the males and females was found to be 1:0.93 for the entire period of study (Table 3). Chi-square test indicated significant difference between sex ratio during September only ($p < 0.05$). James & Badrudeen (1975) reported the dominance of females of *L. brevirostris* in the trawl catches. Similarly, Murty (1990) has reported dominance of females of *S. insidiator* in the catches along Kakinada coast. Jayabalan (1986) has reported the sex ratio of *P. splendens* as 1:0.91.

In the present study, the ovaries were classified on the basis of the external appearance of the fresh ovary, as well as the intra-ovarian ova diameter and structure. The average percentage of various gonadal stages in females of *P. bindus* is given in Table 4. The maturity stage I (Immature) was observed in the month of March, April and May. Stage II (Immature) occurred in all months of study.

However, stage II was dominant during September, February and March. Stage III (Maturing) and stage IV (mature) specimen were also observed in all months of study. Maximum specimens in Stage IV were noted in December. Stage V (Ripe) occurred in all months except April, May, September and February.

The following maturity stages have been recognized.

Stage I (Immature female): Ovaries small, transparent, pale in colour, occupying a very small portion of body cavity, ova invisible to naked eye.

Stage II (Immature female): Ovaries pinkish in colour, semitransparent, occupying nearly 1/3 of body cavity, ova not visible to naked eye.

Stage III (Maturing female): Ovaries yellowish, blood vessels visible on dorsal side, ova clearly seen, occupying about 3/4 of body cavity.

Stage IV (Mature female): Ovaries pinkish yellow, blood vessels prominent, occupying about full length of body cavity.

Stage V (Ripe female): Ovaries yellowish, occupying entire length of body cavity and ova run under slight pressure.

Based on the study of maturity stages in females, spawning season generally appears to be from October to December. The study agrees with the findings of Balan (1963) and James (1973) who had reported that the spawning commences in December and ends in February from Calicut and Palk Bay and Gulf of Mannar respectively.

For determination of size at first maturity, a total of 258 females were sampled. The size at first maturity was estimated using the distribution of cumulative percentages of stages III to V. For this purpose, cumulative percentage frequencies of fish belonging to the above stages were plotted against size groups. The size at 50% cumulative percentage frequency was considered to indicate the overall reproductive maturity of the population as a whole. The L50% maturity of the females was determined at 93 mm (Fig.3) According to Balan (1963) the length at first maturity of *P. bindus* at Calicut was 87 mm. Murty (1983) reported the size at first maturity for this species as 80 mm from Kakinada waters. Murty et

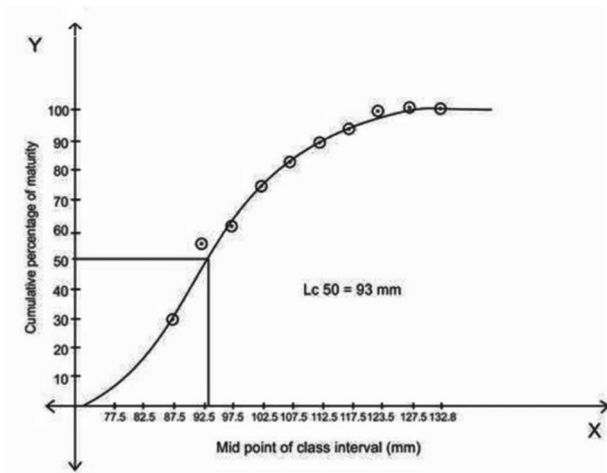


Fig. 3. Size at first sexual maturity of *P. bindus* along Ratnagiri coast

al., (1992) determined the length at first maturity for males and females of *L. dussumieri* along Andhra Pradesh and Tamil Nadu coast as 78 mm and 83 mm respectively and reported that the size at first maturity is the result of distinct stocks of a particular species occurring along the coasts and is dependent upon environmental factors and availability of food.

Fecundity study was undertaken on 25, randomly selected ovaries. The fecundity of *P. bindus* ranged from 4 377 to 10 449 eggs with an average of 7 176 eggs. A positive correlation was found between fecundity and total length, total weight and ovary weight. Logarithmic relationship between fecundity on body length (L) is expressed by the formula: $\log F = -6619.63 + 126.057 \log L$ ($r = 0.87$); the Logarithmic relationship between fecundity and body weight (W) is expressed by the formula as: $\log F = 5331.772 + 1787.774 \log W$ ($r = 0.73$) while logarithmic relationship between fecundity and ovary weight (OW) is expressed by the formula as $\log F = 2911.004 + 211.5593 \log OW$ ($r = 0.92$). Arora, (1951) reported average fecundity of *L. splendens* from Indian waters was 7 566 eggs. He further reported that larger fish may contain up to 1 100 eggs. Balan (1963) reported the fecundity of *P. bindus* in the range of 4 950 to 7 735 from Mangalore waters. James (1973) reported the average fecundity of *P. bindus* along Karnataka coast as 6 162 eggs. Pillai (1972) had observed fecundity ranging from 7 252 - 15 700 with an average of 10 621 eggs for *S. insidiator*, 3563 to 11563 with an average of 7 191 for *S. ruconius*, 5 397 - 32 528 with an average 14

299 eggs for *L. dussumieri* and for *G. minuta*, 7 950 to 28 432 eggs with average of 13 526 eggs.

Typical ovaries belonging to the five stages of maturity described above were selected and the ova diameter frequency polygons were drawn (Fig. 4). In Stage I, the size of ova ranged from 0.050 mm to 0.200 mm with a mode at 0.150 mm. In Stage II, the immature group was a mode at 0.300 mm, while the largest ova measured at 0.357 mm. In Stage III, the maturing group had a mode at 0.375 mm. While in Stage IV the ova at the mode was at 0.725 mm. In Stage V, a group of mature eggs formed the mode at 0.820 mm and the maximum size observed was 0.920 mm. The ova in stage II and III were observed during the months from January to March. Some ova in stage I and II were found in ovaries during April and May. Stage III and IV seen in September progressed to stages IV and V during October and first batch of ripe ova was released. It can be inferred that in *P. bindus*, spawning is continuous, ova are released in batches and spawning take place more than twice during spawning season which is from

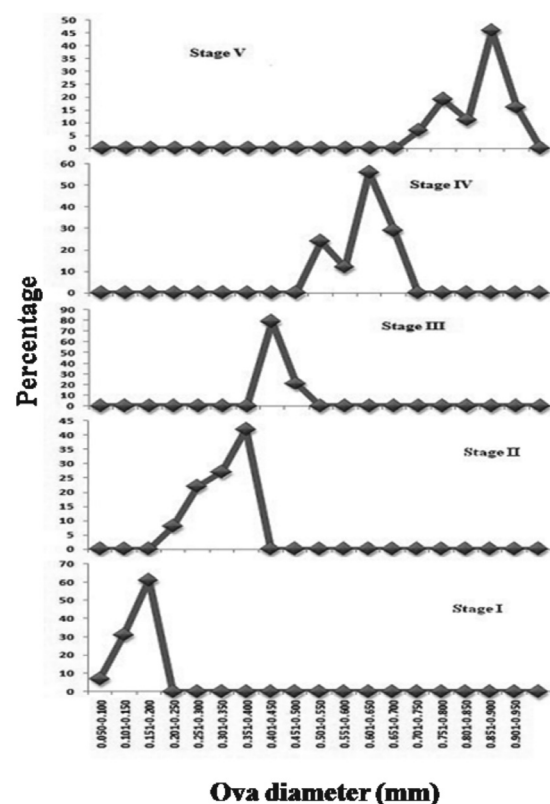


Fig. 4 Month wise ova diameter trend in *P. bindus*

October to December. The study agrees with the reports of Abraham et al., (2011) and Murty (1983) that *P. bindus* is a fractional spawner releasing the ripe ova in at least two batches in the course of one year.

The histological slides were studied microscopically and the stages observed are shown in Plates 1 and 2. The classification of the ovaries with respect to the stages in *P. bindus* are as follows: I) Immature II) Immature III) Maturing IV) Mature and V) Ripe. At immature stage, oogonia changes to primary oocytes and then secondary oocytes. The oogonia are small rounded cells with relatively clear zone of cytoplasm. In maturing stage gonads appear with visible nucleus and cytoplasmic layer are thick and transparent. The testes at this stage are flat, leaf-like but slightly thick. They had spherical nucleus

with distinguishable nuclear membrane. The follicles were observed to be containing spermatocytes, but no spermatozoa were seen. In mature stage, ovaries are oblong, transparent with opaque eggs. Oocytes are surrounded by isolated layer of follicular epithelium. In case of testis spermatogonia, primary and secondary spermatocytes are detected at mature stage. In ripe stage, the testis are observed to occupy the entire body cavity and flabby. The ovaries during ripe stage occupy entire body cavity, with a few large eggs. The yolk granules and nucleus appear intermingled with cytoplasm. In spent stage, testis are loose, the follicles collapsed, residual sperms and phagocytes are present, while in females the gonads are observed to be loose, follicles are collapsed, residual eggs and phagocytes are present.

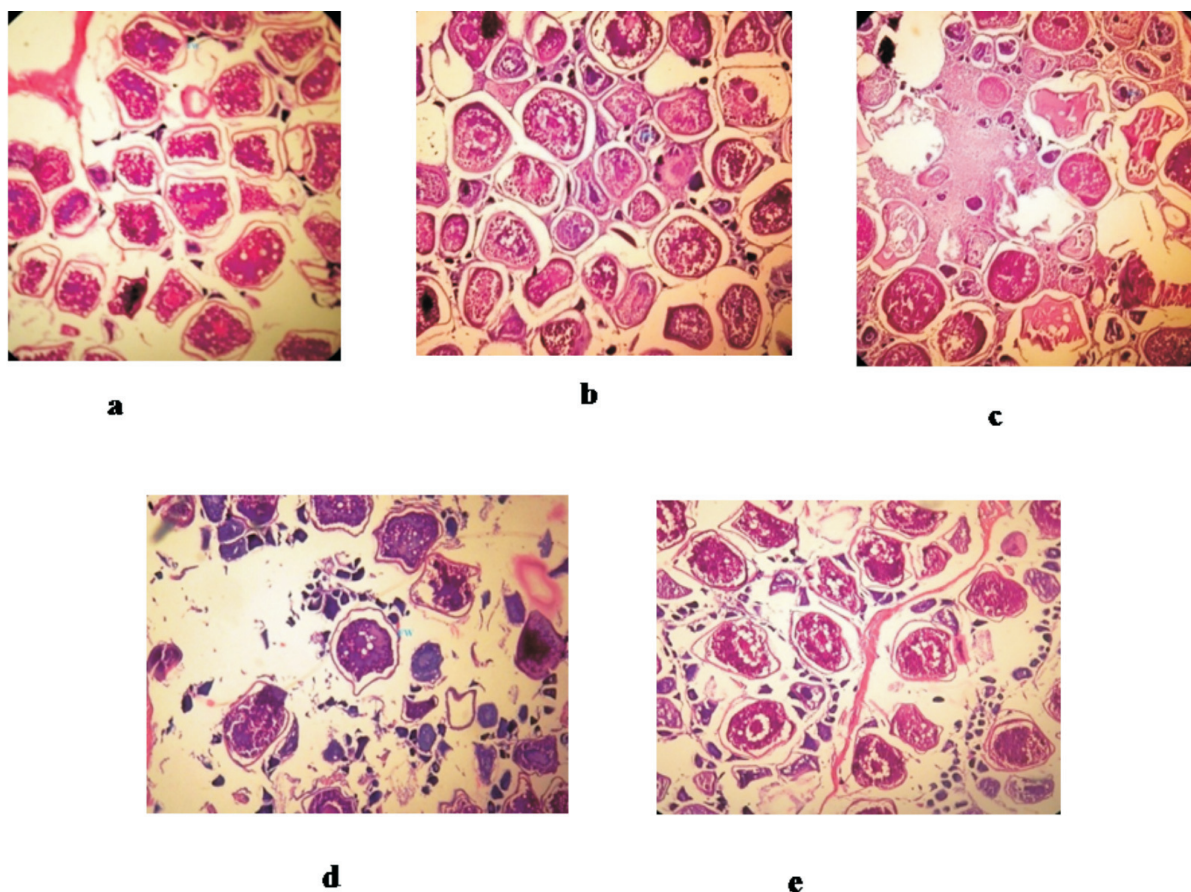


Plate 1. Histological sections of ovary. a-immature female; b-maturing female; c-mature female; d-ripe female; e-spent female

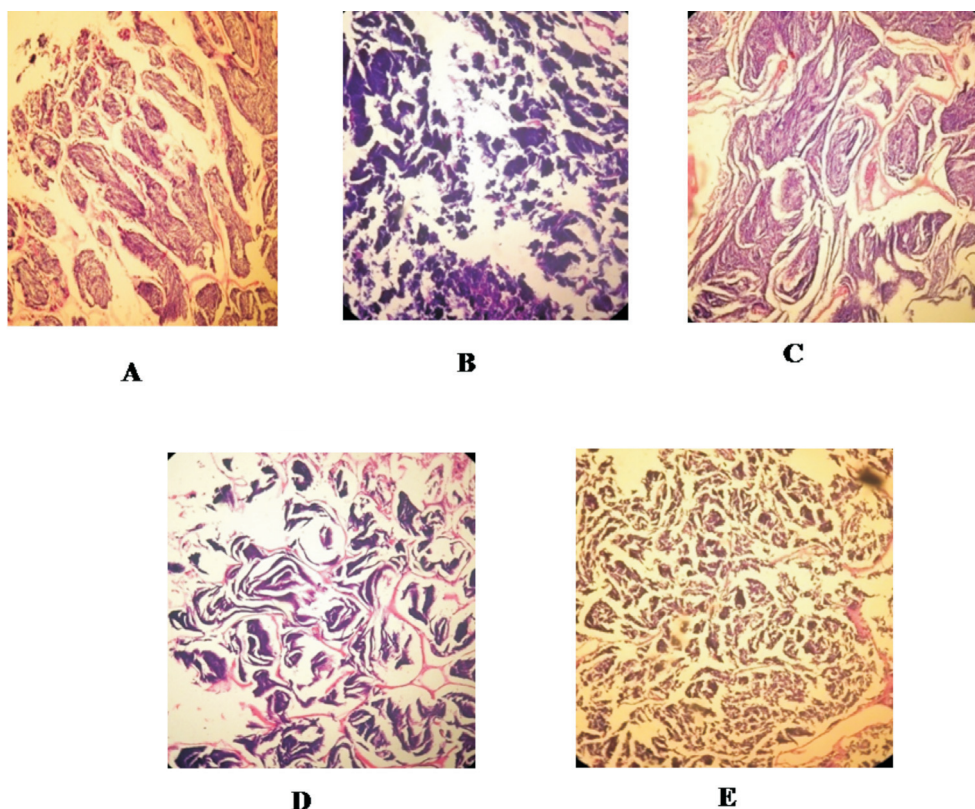


Plate 2. Histological sections of testis. A-Immature male; B-maturing male; C-mature male; D-ripe male; E-spent male

Acknowledgment

The authors are grateful to Associate Dean College of Fisheries Ratnagiri, for the encouragement and facilities provided.

References

- Abraham, K. J., Murty, V. S. R. and Joshi, K. K. (2011) Maturity and spawning of *Secutor insidiator* along the Kerala coast. J. Mar. Biol. Ass. Ind. 53(2): 178-183
- Arora, H. L. (1951) Contributions to the biology of the silverbelly *Leiognathus bindus*. Cuv. Proc. Indo-Pacific Fish council-3, Tech. Pap. 4: 75-80
- Balan, V. (1963) Biology of the silverbelly, *Leiognathus bindus* (Val) of the Calicut coast. Ind. J. Fish. 10: 118-134
- Bal, D.V. and Rao, K.V. (1984) Marine fisheries, Tata Mcgraw-Hill, New Delhi, pp. 470
- Biswas, S.P. (1993) Manual of methods in fish biology. South Asian Publishers Pvt. Ltd., New Delhi: 157pp
- CMFRI (2013) Annual Report 2012-13. Central Marine Fisheries Research Institute, Cochin, pp 14-15
- James, P. S. B. R. (1973) The fishery potential of silverbellies. The proceedings of symposium of Living Resources of the seas around India. CMFRI Special Publication, pp 439-444
- James, P. S. B. R. and Badrudeen (1975) Biology & fishery of *Leiognathus brevirostris* (Valenciennes) from the Palk Bay & Gulf of Mannar, India. J. Mar. Sci. 4: 50-59
- Jayabalan, N. 1986. Reproductive biology of silverbelly *Leiognathus splendens* (Cuvier) at Porto Novo. Indian. J. Mar. Sci. 17(1): 171-179
- Murty, V. S. (1983) Observations on some aspects of biology of silverbelly *Leiognathus bindus* (Valenciennes) from Kakinada. Indian J. Fish. 30(1): 61-68
- Murty, V. S. (1990) Biology and population dynamics of the silverbelly *Secutor insidiator* (Bloch) from Kakinada. J. Mar. Boil. Ass. India. 32(1&2): 10-24
- Murty, V. S., Srinath, M., Livingston, P., Sastry, Y. A. and Srinivasarengan, S. (1992) Stock assessment of silverbellies of India with particular reference to Andhra Pradesh and Tamil Nadu. Ind. J. Fish. 39(1,2): 42-64
- Pillai, M. P. K. (1972) Fecundity and spawning habits of some silverbellies. Indian J. Fish 19: 196-199

- Seah, Y. G., Abdullah, S., Zaidi, C. C. and Mazlan, A. G. (2009) Systematic accounts and some aspects of feeding and reproductive biology of Ponyfishes (Perciformes: Leiognathidae). Sains Malaysian. 38(1): 47-56
- Sinha R.K. (1995) Some aspects of biology of freshwater catfish *Clarias batrachus* (Linn. 1758) of the Bombay region M.Sc. Thesis, C.I.F.E. (Deemed University) Versova, Bombay. pp 1-74
- Vivekanandan, E. (2011) Demersal Fisheries in Handbook of fisheries and Aquaculture, Indian Council of Agricultural Research, New Delhi: pp 99-100
- Weesner, F. M. (1960) General Zoological microtechniques. Baltimore; Williams and Wilkins, 230 pp
- Zar, J. H. (2005) Biostatistical analysis, Fourth Edition, Pearson Education (Singapore) Pvt. Ltd, Indian Branch, Delhi: 633p