Indian J. Fish., 56(4) : 261-265, 2009

Trophodynamics and reproductive biology of *Otolithoides biauritus* (Cantor) landed by trawlers at Vanakbara, Diu along the west coast of india

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ABSTRACT

The trophodynamics and reproductive biology of koth *Otolithoides biauritus* caught by trawlers at Vanakbara, Diu was studied for the period from September 2005 to May 2008. The length-weight relationship showed that growth was allometric and there was no significant difference between the sexes. The overall sex ratio was 1:1.09 with mature females occurring throughout the year. The peak breeding season was in the monsoon season from May to August as evidenced by maturity stages, gonado-somatic index and the size progression of yolked ova. The length at first maturity of the female was 110.15 cm. The absolute fecundity ranged from 1,82,020 to 1,941,400. The mature ovaries of *O. biauritus* contained two batches of mature ova measuring from 0.75 to 0.79 mm and 0.65 to 0.69 mm in diameter. *O. biauritus* was found to feed more intensely during the post-monsoon months. The most important food item was *Acetes* spp. followed by finfishes. Fishes possessing empty stomachs were frequently encountered in the commercial catch. Young ones of *O. biauritus* fed more abundantly than adults with penaeid prawns dominating the gut contents while adults preferred finfishes as their diet.

Keywords: *Otolithoides biauritus*, Reproductive biology, Trawlers, Trophodynamics, Vanakbara

Introduction

The major demersal resources in Gujarat (including Diu) are the sciaenids contributing 9.74% to the total marine fish landing of the state during 2005 – 2007. The landing of sciaenids has increased over the years from 33,000 t in 2005 to 61,000 t in 2007 (Mohanraj *et al*., 2007). *Protonibea diacanthus* (ghol), *Otolithoides biauritus* (koth), *Johnius glaucus*, *Johnius vogleri*, *Johnius dussumieri*, *Otolithes argenteus*, *Otolithoides ruber* and *Johnieops sina* were the important species contributing to the sciaenid fishery of the state. Among them, the larger growing species *viz.,* ghol and koth are commercially the most important and are highly esteemed as table fish. Although they are exploited by a variety of gears, the major catch of sciaenids comes from trawl. Around one third of the total sciaenid catch in the state by trawlers was represented by koth alone. The major landing of koth by multi-day trawlers is at Vanakbara, Diu as there is an excellent fishing ground at 90 – 100 km off Vanakbara coast towards Vapi at the depth range of 18-30 m. Bhatt *et al*. (1964) and Kutty (1967) gave a preliminary account on the biology of koth occurring along the Bombay and Saurashtra coasts respectively. Jayaprakash (1974) studied the food and feeding habits of juvenile koth from the waters of Bombay. Information available on the food and feeding and reproduction of adult koth is inadequate. The present study thus attempts to make an insight into the trophodynamics and reproductive biology of koth caught by the trawlers at Vanakbara, Diu.

Materials and methods

The data for the present study was collected weekly from Vanakbara Fisheries Harbour during September 2005 to May 2008. A total of 455 specimens of *O. biauritus* in the size range of 30 to 155.9 cm were collected randomly for biological studies and sampled for recording total length (in cm) and body weight (in g to 0.01 g precision). The length-weight relationship was calculated following the formula $W=aL^b$ (Le Cren, 1951), separately for both the sexes and significant differences in the slopes of the regression lines for males and females were ascertained by ANACOVA (Snedecor and Cochran, 1967). The month-wise sex ratio was determined from 455 specimens and Chi-square test was performed to test the homogeneity of male and female distribution. The size at first maturity of the population (L_{50}) was determined from 237 female specimens by plotting the percentage of mature specimens (stage III and above) against their total length. Proportions of gravid and ripe females (stage V and VI) over time were taken to determine the spawning season. The gonado-somatic index (GSI) for females was calculated by the following formula (n = 237):

$$\text{Gonado Somastic Index (GSI)} = \frac{\text{Weight of gonad}}{\text{Weight of fish}} \text{ X } 100$$

Fecundity was worked out by raising the number of ova in all subsamples of the mature and ripe ovary (stage V and VI) to the total ovary weight. The ovary subsamples were obtained from the anterior, middle and the posterior regions of the ovary. The ova diameter distribution in each subsample of the ovary was studied under a microscope using calibrated ocular micrometer. The feeding intensity from 455 specimens was assessed based on the distension of their stomach and the volume of food contained in it and was classified as full, ¾ full, ½ full, ¼ full and empty. The relative importance of various food items in the stomach was calculated by the index of relative importance (Pinkas *et al*., 1971). The index of relative importance (IRI) was used as it takes into account the frequency of occurrence as well as the number and volume of each food item providing a definite and measurable basis for grading different food items. The IRI was computed as given below:

IRI = (%N + %V) x %F; where N = number, V = volume and F = frequency of occurrence.

There were no samples available on length and weight, food and feeding and reproductive biology of koth from June to August due to monsoon ban on the trawl fishery in the state.

Results

Length-weight relationship

A total of 218 male and 237 female specimens were considered separately for determining the length-weight relationship, which are given below

Male: $W = 0.0184L^{2.696326}$ (r = 0.993)

Female: $W = 0.0180L^{2.703514}$ (r = 0.995)

Since there was no significant difference between the slopes at 5% level, a combined relationship of males and females was obtained.

$W = 0.0182L^{2.699682}$ (r = 0.994)

Feeding intensity and food composition

Since there was not much difference in the food and feeding habits of males and females, the data on both the sexes (n = 455) were pooled. The food items in the diet of *O. biauritus* were classified broadly into three major groups: non-penaeid prawns, penaeid prawns and finfishes. Non-penaeids were present in the gut throughout the year and the average IRI % was 83.94 and was ranked as the most important food item. The highest index (87 – 92 %) for non-penaeids was observed in the post-monsoon season from September to December (Fig. 1). *Acetes* spp. alone formed 98% of the non-penaeid prawns in the gut, the rest being constituted by *Nematopalaemon tenuipes* and *Exhippolysmata ensirostris*. Finfishes formed the next most

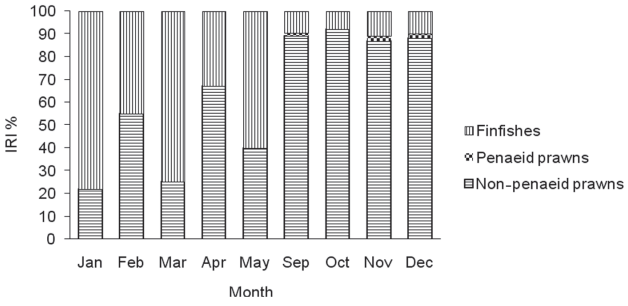

Fig. 1. Index of relative importance (IRI %) of food items (n = 455) in *Otolithoides biauritus*

dominant food item of *O. biauritus* and the average IRI % was 15.35. Among finfishes, *Coilia dussumieri* (IRI% - 11.2) was the most preferred food item followed by *Harpadon nehereus* (IRI % - 1.16), *Otolithes cuvieri* (IRI% - 1.03), *Johnius glaucus* (IRI% - 0.71), *Apogon* spp. (IRI% - 0.71) and *Bregmaceros mcclellandi* (IRI% - 0.55). Finfishes dominated the gut contents in the months of January, March and May (Fig.1). Penaeid prawn represented by *Parapenaeopsis stylifera* was encountered in the stomachs of *O. biauritus* sporadically during the post-monsoon season and the average IRI % was a meager 0.71. The analysis of food items in relation to body size depicted that while juveniles fed almost entirely on *Acetes* spp., adults preferred both non-penaeids and finfishes. Fishes possessing empty stomachs were encountered frequently in all the months (Fig. 2). The intensity of feeding was found to be more in the post-monsoon season and in juveniles than that of adult mature fishes (Fig. 2). The average contribution of fishes in the feeding conditions of full stomach, ¾ full stomach, ½ full stomach, ¼ full stomach and empty stomach were 13.23%, nil, 9.38%, 16.08% and 61.31%, respectively. The sizewise feeding differences revealed that young ones of *O. biauritus* fed more abundantly than that of adults. Only half of the fishes in the length range of 30 to 59 cm were found to possess empty stomachs and in the rest one-third, the stomach was fully

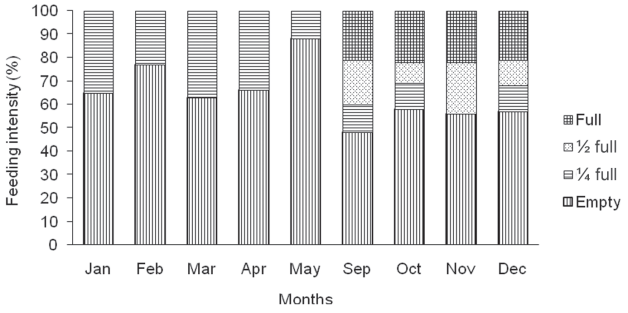

Fig. 2. Monthwise feeding intensity (n = 455) of *Otolithoides biauritus*

gorged with food items. On the contrary, larger fishes (>60 cm) were found mostly (95%) to possess empty stomachs and in no fishes the volume of food exceeded one-fourth the volume of stomach (Fig. 3).

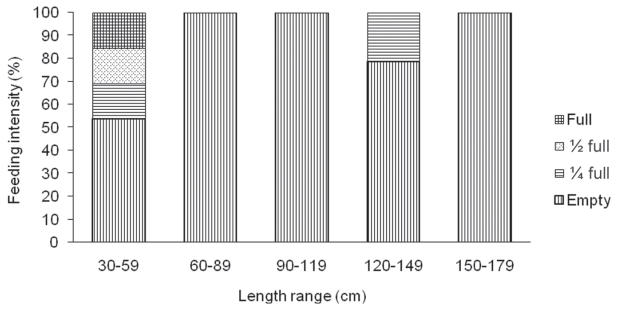

Fig. 3. Sizewise feeding intensity (n = 455) of *Otolithoides biauritus*

Size at first maturity

Females dominated the commercial catches during January - May while the males outnumbered females from September - December. The overall sex ratio was 1:1.087. The chi-square values indicated significant (5%) dominance by females in April and May and by males in November and December. *O. biauritus* attained sexual maturity at a size of 110.15 cm total length (Fig. 4). However, gonadal development and sexual maturity in the species was observed to commence from 93 cm onwards.

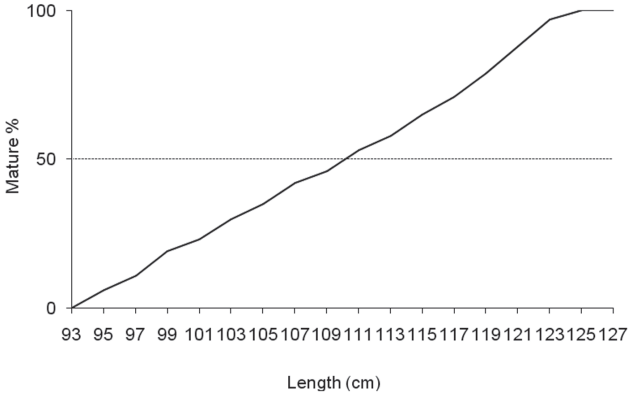

Fig. 4. Size at first maturity of females of *Otolithoides biauritus*

Spawning season

Gravid and ripe females were recorded in all the months with their peak occurrence observed during May (Fig. 5). This suggested a prolonged spawning season for *O. biauritus*. The gonado-somatic index for females (n = 237) during the different months showed that it increased from January and attained a peak of 4.1 in May, after which it decreased from September to December (Fig. 6). This is in agreement with the peak spawning season observed in the species. The mature ovaries of *O. biauritus* contained both maturing and mature ova. The first batch of mature ova, which is fully mature, measured from 0.75 to 0.79 mm in diameter whereas the second batch measured from 0.65 to 0.69 mm (Fig. 7). The presence of yolked ova of different sizes in mature ovary for most months of the year (January to September) indicated prolonged spawning. However the largest sizes of yolked ova were encountered only in May further confirming this to be the peak breeding season of *O. biauritus*.

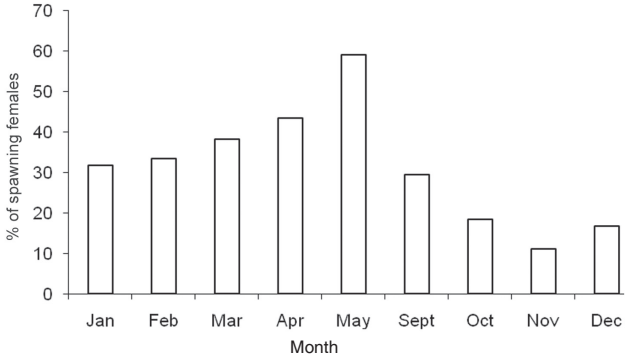

Fig. 5. Month-wise occurrence of spawning population of *Otolithoides biauritus*

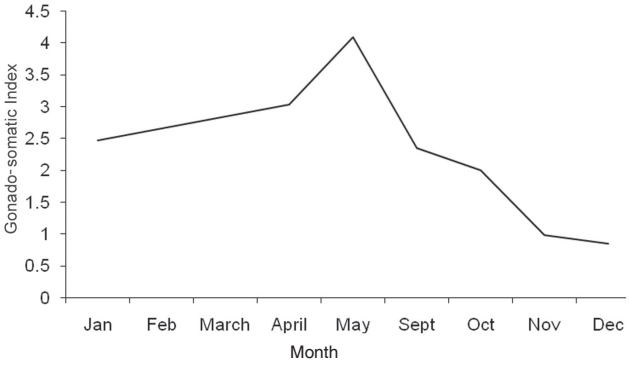

Fig. 6. Gonado-somatic index of females (n = 237) of *Otolithoides biauritus* during different months

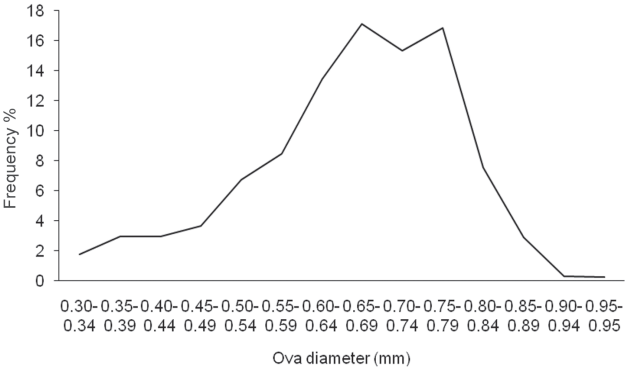

Fig. 7. Ova diameter frequency distribution in mature and ripe ovaries of *Otolithoides biauritus*

Fecundity

The number of eggs released generally increased with the weight and size of the fish (Fig. 8 and 9). The number of ova per gram weight of mature ovary ranged from 1479.8 to 4450.9 with an average of 2613.7. The number of ova per gram body weight ranged from 42.3 to 121.3, the

average being 65.7. The total fecundity ranged between 1,82,020 to 1,941,400. The relationship calculated between body length and fecundity and body weight and fecundity was:

$$\log F = -4.74288 + 4.971228 \log L \quad (r = 0.9)$$

$$\log F = 0.375133 + 1.357923 \log W \quad (r = 0.91)$$

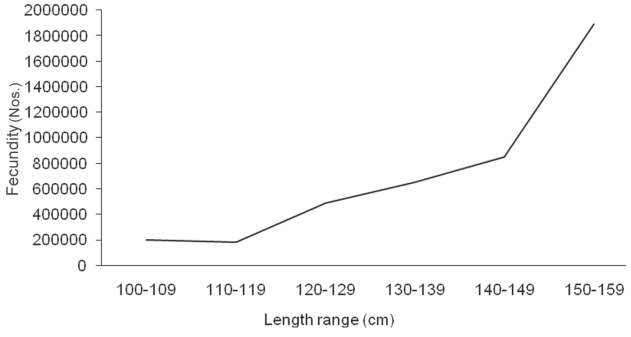

Fig. 8. Relationship between total length and fecundity of *Otolithoides biauritus*

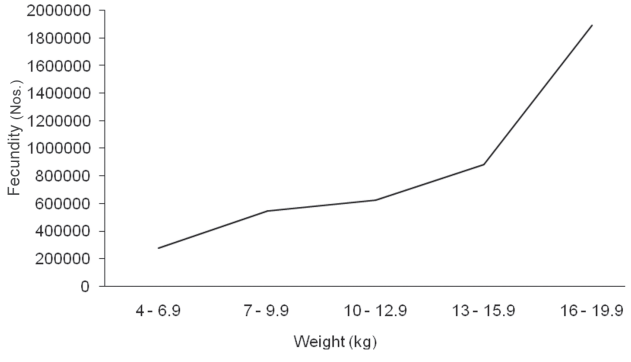

Fig. 9. Relationship between total weight and fecundity of *Otolithoides biauritus*

Discussion

The growth rate of *O. biauritus* was allometric and no significant variation in growth rate was observed between the two sexes. The 'b' value of 2.7 obtained in the present study compared very well with that of 2.76 reported by Kutty (1967). However, higher value of 'b' for the combined population of *O. biauritus* was reported by Pauly (1978). This variation is possibly due to factors related to ecosystem and biological phenomena like maturity stages, feeding behaviour, competition for food, *etc*. There was significant dominance by females in April and May and by males in of November and December. This could be attributed to the differential fishing because of the changes in the pattern of migration of sexes to and from the fishing grounds. However, the actual pattern of spawning migration with regard to the temporal and spatial aspects and its effect on the fishery can be understood only by further studies.

The size at first maturity of 110 cm, estimated in the present study,was slightly lower than 120 cm reported by Kutty (1967). The length at first capture estimated by the same authors for *O. biauritus* in an earlier study was 32.44 cm. This was very low when compared to the size at first maturity (110.15 cm) indicating that majority of them were caught before they matured and spawned at least once in their life. This indicated stress on spawning stock and could be addressed by enhancing their size and age at exploitation, which meant that increase in cod end mesh size of trawls is required to avoid the young fishes. Based on the mature gonads collected during different months, Bhatt *et al*. (1964) opined that the spawning season for koth may be around May or June. The peak spawning period of May indicated by GSI is in general conformity with the percentage occurrence of maturity stages in different months. However, there was no data available on reproductive biology of koth from June to August due to monsoon ban imposed on the trawl net fishery. Hence, it would be premature to consider that this species breeds maximally in the month of May alone. Rather a more realistic approach would be to consider that the monsoon period from May to August is the peak breeding season of this species.

Qasim (1973) studying the maturation and spawning in marine teleosts from the Indian waters concluded that along the west coast, spawning takes place during monsoon. Monsoon and upwelling with consequent replenishment of nutrients effect a plankton bloom giving better chance for the larvae to survive as food is plenty. Moreover, growth becomes faster and the larvae pass quickly through the critical stages. *Protonibea diacanthus*, a closely related species, was found to spawn in the waters of Bombay from June to August (Rao, 1963). These observations on the spawning season of *O. biauritus* are further supported by the size progression of yolked ova during different months. Kutty (1967) estimated the fecundity of more than 6 million ova for koth. Similar estimates on fecundity, ova per gram weight of mature ovary and ova per gram body weight for *P. diacanthus* was reported by Rao (1963). The relationship between fecundity and body length and between fecundity and body weight indicated that the increase in fecundity in relation to the weight of fish is much lower than that of the length of fish. This exponential increase in rate of egg production with length and weight of fish is highly significant in the context of protection and conservation of mega spawners of long lived large marine fishes. The indiscriminate removal of mega spawners from the sea pose a serious threat to the population structure leading to instability, considering the huge number of young ones released if they would have been allowed to stay in the sea.

Kutty (1967) reported that koth mainly fed on fishes and crustaceans such as crabs and squilla. Our study revealed that non-penaeid prawns and finfishes dominated as the first

two main food items in order, though their amount varied in the gut contents depending on size and season. The intake of *Acetes* spp. appeared to have a relation with the size of fish since juveniles fed almost entirely on *Acetes* spp. but as fish grows, it showed preferences for finfishes. Similarly Jayaprakash (1974) studying the food and feeding habits from the coast of Bombay reported that the juveniles of koth preferred only prawns. He further commented that with increase in age, *O. biauritus* showed a piscivorous tendency. The index values of non-penaeid prawns decreased from the smallest to the largest size groups of koth, while there was gradual increase in the intake of teleosts (Jayaprakash, 1974). The feeding intensity of *O. biauritus* observed in the present study was more in the post-monsoon season. This could be attributed to the fact that the preferred food items of koth are non-penaeid prawns and small teleosts, which themselves in turn feed on small planktonic organisms like copepods, chaetognaths and salpids. Thus there is an indirect relationship between the plankton abundance and the feeding intensity in koth not withstanding the fact that this fish is not a plankton feeder. The upwelling caused because of the monsoon rains resulted in the replenishment of nutrients and emergence of plankton blooms which indirectly helped this fish to thrive and feed actively in the post-monsoon months. Jayaprakash (1974) reported disgorging and extrovertion of the stomachs in *O. biauritus*. Mohamed (1955) and Rao (1963) observed the same phenomena in ghol and reported that 95% of the adult population had extroverted stomachs. Similarly in the present study more than 60% of the fish examined had their stomachs empty and this is because of their disgorging tendency. The shock and suffocation to which the fish were subjected while being trapped in the trawl net and subsequent hauling probably caused such high incidence of extrovertion of stomachs. Koth is ecologically a subsurface demersal fish and the total absence of crabs and molluscs and sand or mud in the gut contents proved that it is not a bottom feeder.

Acknowledgements

The authors are thankful to Dr. G. Syda Rao, Director, CMFRI for the encouragement and the facilities provided. They are grateful to Dr. N. G. K. Pillai, Head, PFD, CMFRI and Dr. E. Vivekanandan, Head, DFD, CMFRI for critically going through the manuscript and the suggestions offered during the course of this study.

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Date of Receipt : 27/10/2008
Date of Acceptance : 15/12/2009