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Note

Reproductive biology of the orangefin ponyfish *Photopectoralis bindus* (Valenciennes, 1835) off Mangaluru coast, Karnataka

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ABSTRACT

The spawning periodicity of *Photopectoralis bindus* (Valenciennes, 1835) was studied off Mangaluru coast from September 2015 to April 2016 using 490 specimens with total length 6.8-12.3 cm (9.6±0.9 cm) and body weight 4.6 -30.28 g (14.20±3.59 g). Results indicated that the average sizes at maturity were 9.3 cm (males) and 9.5 cm (females). The male-female ratio was 1:0.72. Absolute fecundity estimated was 9349±853 eggs that increased with fish size ($R^2 = 0.92$). Higher gonado-somatic index (GSI) was observed in post-monsoon season with peak value in December (female: 3.39±1.00%; male: 2.84±0.796%) indicating seasonal spawning of the fish.

Keywords: Fecundity, Orangefin ponyfish, *Photopectoralis bindus*, Spawning periodicity

Silverbellies (Perciformes: Leiognathidae) are benthopelagic fishes dispersed in Indo-Pacific Ocean, contributing to a significant share in the marine fish landings in India (Kizhakudan and Reddy, 2012). They formed 2.34% of the all India total marine landings in 2017 (CMFRI, 2018). Silverbellies are important constituents of demersal finfish landings along the Indian coastline, particularly by trawl nets (Murty *et al.,* 2003). They are bottom dwelling fishes in shallow coastal waters and their seaward distribution is only up to a depth of 30 m with several species entering brackishwaters, especially river estuaries. They are locally known as Kuruchi in Kannada, Mullen in Malayalam, Kallikaral in Tamil and Karlu in Telugu.

Silverbellies are small sized, with lengths ranging from 10.0 to 17.0 cm. Of the 49 valid species reported world over, about 26 species are reported from Western Indian Ocean (Fricke and Eschmeyer, 2009). The highly diverse group, represented mainly by 21 species belonging to three traditional genera *viz.*, *Leiognathus, Gazza* and *Secutor*, is reported from the east and west coasts of India (Murty *et al*., 2003), particularly along the coasts of Veraval, Mangaluru, Calicut, Cochin, Palk bay, Gulf of Mannar, Chennai, Kakinada, Visakhapatnam and West Bengal (Abraham *et al*., 2010). Presently the classification has been updated to include new and valid nomenclature comprising 9 genera *i.e., Devexim*entum, *Equulites, Eubleekeria, Photopectoralis, Gazza, Leiognathus, Aurigequula, Karalla* and *Nuchequula* based on morphological characteristics (Wiadnya *et al.,* 2014).

The present study focuses on the orangefin ponyfish, *Photopectoralis bindus* (Valenciennes, 1835). It is deeply oval in shape and has a strongly compressed and ventrally convex body. The mouth is protracted, pointing forward to slightly downward. The spinous part of dorsal fin is black at its half height, while the membrane between the second and fifth spines bears a bright orange blotch, turning yellow on preservation in formalin (Abraham *et al.,* 2011). In India, the maturation and spawning status *of P. bindus* has been studied along the coasts of Calicut (Balan, 1963), Kakinada (Murty, 1983) and Vishakhapatnam (Rao, 2015). Information available on the reproductive biology of this species off Mangaluru coast is meagre. Hence, the present study was undertaken to understand the spawning periodicity in *P. bindus* off Mangaluru coast, Karnataka.

The study was carried out from September 2015 to April 2016. Fresh samples were collected twice a week from the landings of artisanal (gillnet) as well as mechanised gears (trawls) at Mangaluru Fishing Harbour (12.8500°N; 74.8354°E) operating up to the depth of 30 m. A total of 490 specimens ranging between 6.8 cm and 12.5 cm total length (TL) were used for the study.

The fish were measured for total length and weight to the nearest 0.05 cm and 0.6 g respectively and gonads were examined for confirming the sex of each specimen.

Monthly sex ratio was determined and chi-square ($\chi 2$) test on sex-ratio was done to find out if sex ratio departed significantly from the expected ratio of 1:1. Maturity stages were determined following Abraham *et al*. (2011) based on the macroscopic appearance of the ovary and testes, area occupied in the body cavity as well as based on the microscopic structure of ova. Five maturity stages were recognised *viz*., stage I - immature, stages II and III - early maturing, stage IV - late maturing and stage V - mature. Reprersentative samples from the anterior, middle and posterior portions of the ovary (preserved in 5% neutral formalin) was taken and pooled for equal representation of all stages of ova for estimating ova-diameter frequency. Ova-diameter was measured following Clark (1925), using an ocular micrometer. Frequency distribution in mature ovaries (stages IV onwards) was followed for understanding the periodicity of spawning as per Hickling and Rutenberg (1936) and De Jong (1940). The length at first maturity (L_m) was estimated graphically as the length at which 50% of he fishes were mature. The gonadosomatic index was estimated using the formula: GSI = (Gonad weight/ Total body weight) × 100 (De Vlaming *et al*., 1982). Fecundity was estimated from 110 mature ovaries. The average fecundity of fishes of each length group against the corresponding average length, body weight and ovary weight was estimated using the equation: log Y = a+b log X) (Le Cren, 1951), where Y = fecundity, X = length (cm) or weight of fish (g) or ovary weight; a = intercept; b = slope).

The overall sex ratio was estimated as 1:0.72 (M:F). Monthly sex ratio indicated dominance of males over females in all the months except in March and January (Table 1). Chi-square analysis indicated that there was a significant difference ($p<0.001$) between the two sexes in their occurrence in September and April. Rossoni *et al*. (2010) reported that differential growth of males and females may influence sex ratio, resulting in the predominance of one sex or the other throughout the development stages. Rao *et al*. (2015) reported significant difference ($p<0.05$) between the sexes in *P. bindus* along the east coast of India. Several authors have reported that differential growth, influence of gear selectivity, exploitation rate, coupled with ecological factors such as temperature could cause deviation from the expected sex ratio of 1:1 (male-female) (Bohlen *et al*., 2008; Imam *et al*., 2012).

Ova-diameter range was observed to be 0.03-0.13 mm in stage I and stage II ovaries, 0.13-0.36 mm in stage III, 0.24-0.45 mm in stage IV and 0.35-0.49 mm in stage V, with modes at 0.10, 0.11, 0.29, 0.39 and 0.46 mm respectively in each stage (Fig. 1).

The ova in stages I-II ovaries represented immature stock. Two types of ova are present in the ovaries of stages III-V: (i) maturing ova, which are spherical, partially opaque, and heavily yolked with invisible nucleus and (ii) mature ova, which are spherical and opaque with complete yolk deposition. In stage V, ova show a distinct perivitelline space. Three modes in the diameter-frequency distribution were observed in stage III: at 26 md (1 md = 0.001cm) (mode a), 29 md (mode b) and at 31 md (mode c). Progressing modes from 29, 35 and 39 md were observed in stage IV and 36 md, 46 md and 49 md in stage V ovaries. The ova forming a mode at 36 md in stage V may be at half of the maturation process and may take only less than half the time to ripen and spawn. The ova forming a mode at 46 and 49 md in stage V are the mature ova and may be released in one batch after a short time. The coexistence of oocytes of almost all maturity stages in the ovaries, in approximately all gravid females sampled pointed to a high spawning frequency. Balan (1963) reported that spawning occurred in *P. bindus* from December to February at Calicut. Murty (1983) reported

Table 1. Month-wise sex ratio of *P. bindus*

Months	Total no. of fishes	Male (M)		Female (F)		M: F	χ^2 values	p (<0.001)
		N	%	N	%			
September 2015	37	29	78.38	8	21.62	1: 0.28	11.919	0.001
October	106	62	58.49	44	41.51	1: 0.71	3.057	0.080
November	81	43	53.09	38	46.91	1: 0.88	0.309	0.579
December	134	71	52.99	63	47.01	1: 0.89	0.478	0.490
January 2016	32	15	46.88	17	53.13	1: 1.13	0.125	0.724
February	51	33	64.71	18	35.29	1: 0.55	1.471	0.225
March	40	16	40.00	24	60.00	1: 1.50	0.400	0.527
April	73	53	72.60	20	27.40	1: 0.38	14.918	0.000
Pooled	490	288	57.96	202	42.04	1:0.70	15.094	0.000

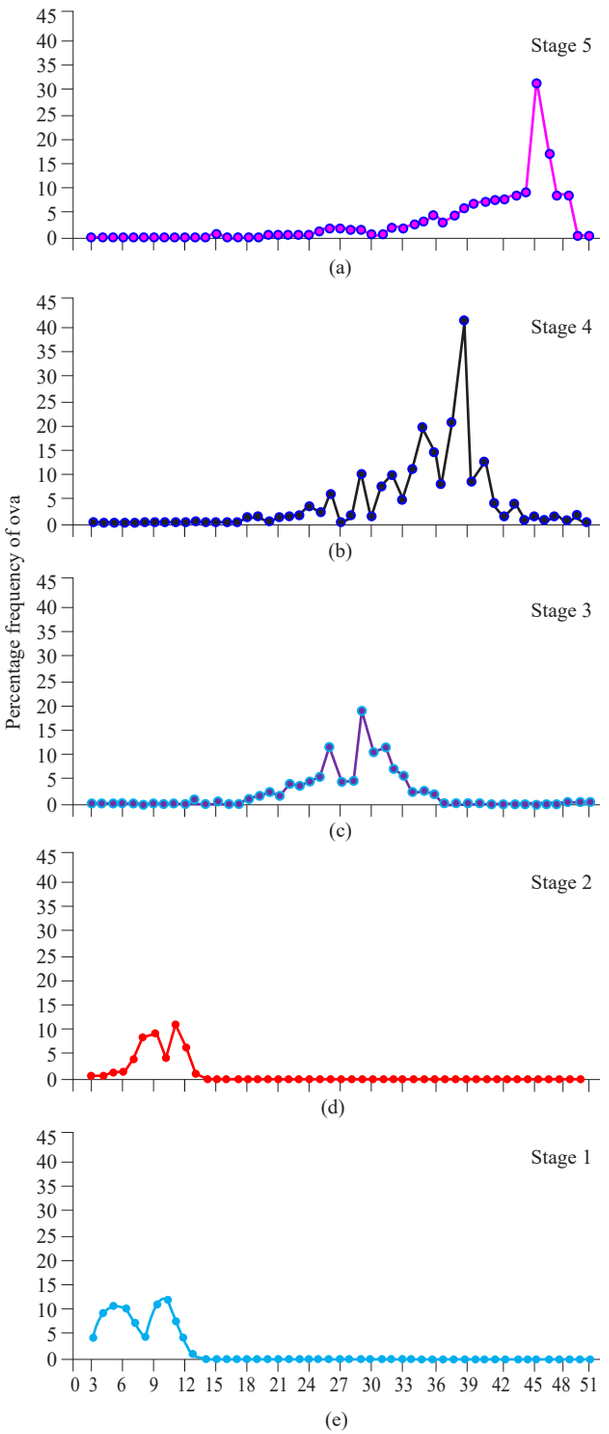

Fig. 1. Ova-diameter frequency distribution in ovaries (1 md = 0.001cm)

year-round spawning, with a peak during December-February. From the present study, it appears that *P. bindus* is a fractional spawner releasing the mature ova in at least two batches in the course of one year during the spawning season. It shares the same general reproductive features of other silverbellies distributed off the Indian subcontinent, a dieocous species spawning in the marine environment, releasing at least two batches of oocytes throughout an extended spawning season (Murty, 1983).

The occurrence of mature fish showed a gradual increase from 8 cm until a length of 12.1 cm. Above 12.1 cm, all were mature. The length at maturity was calculated at 9.3 cm for males and 9.5 cm for females (Fig. 2). Murty (1983) reported the length at first maturity as 80 mm for *L. bindus* from Kakinada. Balan (1963) reported the minimum size (total-length) at first sexual maturity from this species as 87 mm from Calicut. Rao *et al.* (2015) reported the mean length at first maturity as 85 mm in females from Visakhapatnam along the east coast of India. In the present study, it was observed that mature and ovulating females fall in 8.0-12.0 cm length groups, forming the spawning individuals at Mangaluru.

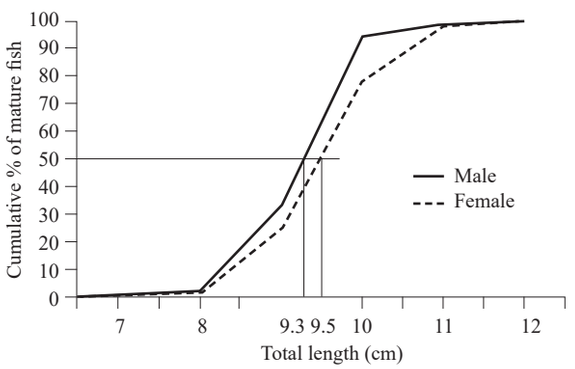

Fig. 2. Length at first maturity of *P. bindus* along Manguluru coast.

Mature adults occurred from October onwards with 100% mature specimens recorded in February (Fig. 3a, b). The GSI in females was estimated as 0.995 (± 0.8413) in stage I; 1.4249 (± 0.6832) in stage II; 2.0349 (± 0.7441) in stage III; 2.7568 (± 0.9161) in stage IV and 3.153 (± 1.1625) in stage V. High GSI values in both sexes observed during November-January corresponded with peak spawning activity (Fig. 4). Males had lower gonado-somatic indices than females of corresponding gonad stage of development. This is in line with the assertion that gonado-somatic indices are generally higher in females than males on account of additional weight gain of ovaries in the breeding period as a result of accumulation of yolk in the eggs and also due to uptake of fluid by ripe oocytes (Shinkafi and Ipinjolu, 2012).

Absolute fecundity ranged from 5,715 in a fish of 8.8 cm TL to 37,160 in a fish of 10.6 cm TL, with an average of 9349 ± 853 eggs. Balan (1967) reported an

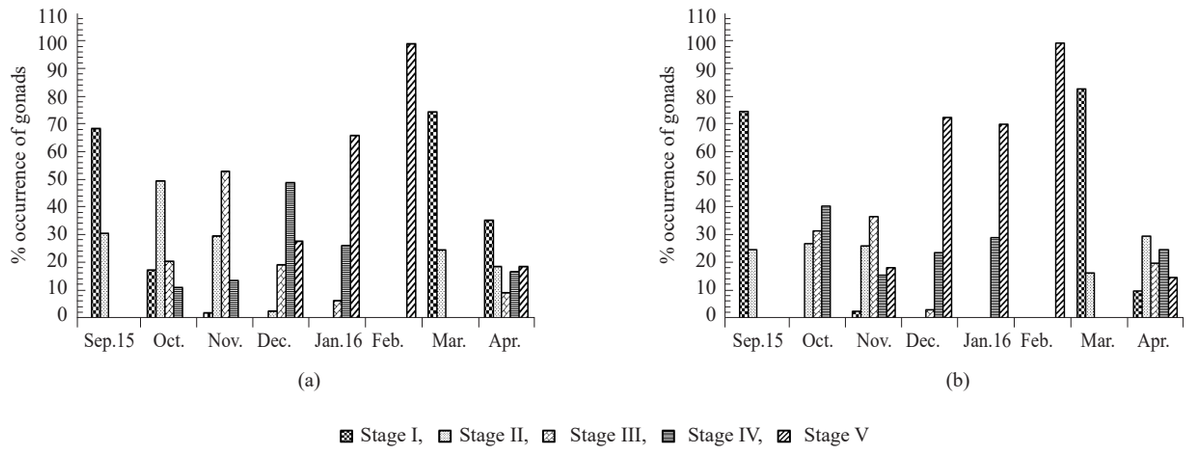

Fig. 3. Monthly variation of maturity stages in (a) Male and (b) Female *P. bindus*

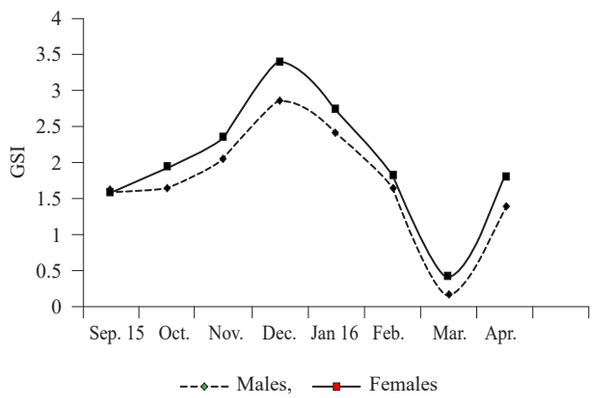

Fig. 4. Monthly gonado-somatic index (GSI) of male and female *P. bindus* off Manguluru

average of 6,162 ripe eggs; with higher fecundity in larger fish upto 7,735 eggs. Rao *et al.* (2015) reported that the fecundity for this species varied from 6,009 to 18,786 ova. The relation between fecundity and total length/total weight/ovary weight were estimated as:

log fecundity = 0.599 + 3.4017 log length (R^2 = 0.9389)

log fecundity = 2.4694 + 1.2816 log weight (R^2 = 0.7953)

log fecundity = 4.2606 + 0.9074 log ovary weight (R^2 = 0.8639)

The population characteristics of fishes, particularly concerning their reproduction, are important inputs in the assessment and management of fish stocks (Froese, 2004). Reproductive characteristics of stocks form the basis for estimating minimum legal size (MLS) as well as for establishing closed fishing seasons and the compulsory release of live gravid females during catch segregation (Morgan, 2008). The present study provides primary information on the reproductive characteristics of the ornagefin ponyfish off Manguluru, where it forms an important component of the trawl bycatch. The results presented will form a baseline for further research on the stock structure as well as ecological significance of this species.

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