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Reproductive biology of striped grouper *Epinephelus latifasciatus* (Temminck and Schlegel, 1842), off Visakhapatnam, middle east coast of India

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Present paper deals with several aspects of reproductive biology viz., maturity of gonads, gonado somatic index (GSI), size at first maturity and fecundity of striped grouper off Visakhapatnam, middle east coast of India. A few species of groupers follow a gonochoric sexual pattern where individuals function either as male or female without post-maturational sex change. Based on present study, striped grouper has been diagnosed as functionally gonochoric. 273 specimens were histologically tested for sex determination. Results of calculates gonadosomatic (GSI) index showed that maturation occurred from November to March with a peak in February. Size distribution and size at sexual maturity calculated as 660 mm TL for males and 610 mm TL for female. Fecundity was estimated from 37 specimens of length range 543 to 885 mm TL, number of ova ranged from 1,53,419 to 37,72,37,72,803 with an average of 18,68,589.

[**Keywords**: Striped grouper, Maturity stages, Gonado Somatic Index, Size at first maturity, Fecundity]

Introduction

As there is increase in catches and export value of grouper fisheries there is a need to have more information on these resources for sustainable development and fishery. *Epinephelus latifasciatus* (Temminck and Schlegel, 1842) commonly called as striped grouper is one of the commonly represented species in the trawl catches of Visakhapatam (Lat. 17°44'N; Long. 83°23' E). This species occurs regularly in the catches throughout the year along with *E. coioides* and *E. malabaricus.* Specimens of striped grouper of length range 78 to 871 mm TL were mainly collected from trawlers operating at 20 – 80 m depth[1]. Although the striped grouper appears in catches of long-line and trawl fisheries, currently there is no catch data for this species. Without quantitative data, there is little means of assessing the impact of commercial fishing on this species and this species is currently listed as Data Deficient on the IUCN Red List[2].

Groupers show a range of reproductive strategies[3,4], they exhibit at least two or possibly three different sexual patterns: protogynous hermaphroditism, gonochorism and bi-directional sex change[5]. Most groupers are protogynous hermaphrodites, in which some (diandrous) or all (monandrous) individuals occur within populations where they develop first as females and change sex later in their lifetime as males. A few species of groupers follow a gonochoric sexual pattern where individuals function either as male or female without post-maturational sex change. Based on literature so far only two species of groupers, *Epinephelus striatus* and *Mycteroperca rosacea* have been diagnosed as functionally gonochoric, although in *E. striatus* sex change may occur under certain conditions[6,7]. Mating behaviour also varies among species. Some spawn in pairs within territories defended by males, others spawn in large groups within massive spawning aggregations, and still others show various combinations of these behaviours[8,9]. Present study consists aspects of reproductive biology viz., maturity of ovaries and testes, gonado somatic index (GSI), size at first maturity and fecundity of striped grouper off Visakhapatnam, middle east coast of India.

Material and Methods

The study was based on the samples collected from trawl catches of Visakhapatnam fisheries harbour during the period February 2008 to January 2011. Each fish was weighed to the nearest milligram, total length was measured to the nearest millimeter. After taking total length, gonads were dissected out and weighed to the nearest 0.1g and preserved in 5%

formalin until further analysis was done. A total of 273 specimens of *E. latifasciatus* of length range 441-947 mm TL were examined for reproductive biology studies. Maturity stages were assigned based on the morphological as well as microscopic examination of gonads. Methods adopted for studying different aspects like ova diameter frequency studies, spawning season, gonado somatic index, size at first maturity, fecundity estimation follows standard procedures[10,11,12].

GSI was calculated using the equation: GSI = (gonad weight/body weight) × 100

Mean GSI values were calculated by pooling the month wise data. Fecundity was estimated by multiplying the number of mature ova (obtained from females at stages III and IV) in the sample taken from anterior, middle and posterior regions of ovaries by the ratio of ovary weight to sample weight. Relationship between fecundity and three variables such as total length (TL), total body weight of fish and weight of gonads were also studied from the following equation. $F=aL^b$

Where L = Total length/fish weight/ovary weight; a and b constants

Results and Discussion

Gonads of *E. latifasciatus* are bilobed structures lying within the posterior part of the abdominal cavity. Two lobes are unequal in length, right ovarian lobe is relatively larger than the left, both of which join posteriorly and descend as an oviduct to open in the genital pore immediately behind the anus.

Morphological and microscopic classification of ovaries and ova diameter frequency studies:

Based on macroscopic as well as microscopic characters of several developmental groups of ova present in the ovaries of *E. latifasciatus*, four stages (with two sub stages in the first and second stages) *viz.,* stage I-P (Immature–primitive), stage I-A (Immature-advanced), stage II-P (Early maturing), stage II-A (Late maturing), stage III (Mature) and stage IV (Ripe) were identified (Fig.1).

Stage I-P Immature primitive: The ovary small, thin and thread-like. Sex cannot be determined by gross examination. Microscopic examination revealed that the immature ova are not easily separable.

Stage I-A Immature advanced: The ovary enlarged, translucent and white to pinkish in colour and occupy about one fourth the length of body cavity. Ova cannot visible to the naked eye, but under the microscope it appears translucent with a central nucleus, without yolk.

Stage II-P Maturing – primitive: pinkish brown and occupying one third of the body cavity. No oocytes visible through ovary wall.

Stage II-A Maturing – advanced: Ovary occupy almost half the length of body cavity; maturing ova appear semi transparent, yellowish in colour and three fourth of each ovum is occupied by yolk.

Stage III Mature: ovaries enlarged and occupying about two third the length of the body cavity; have reddish tinge imparted due to profuse blood supply; ovary appears granular due to the eggs that are visible to the naked eye. Under microscope each ova appear opaque at the centre and transparent towards periphery due to the deposition of yolk.

Stage IV Ripe: yellowish orange in colour; ovary greatly enlarged and packed with ripe eggs occupying almost the entire body cavity; mature ova large, spherical and easily separable; the ova are round and translucent with a large oil globules.

Ova diameter frequency polygons of different maturity stages of *E. latifasciatus* are given in Fig. 2. Observations based on ova diameter frequency polygons are as follows:

In stage I, the immature eggs formed a mode at 0.04 mm with maximum diameter of 0.16 mm. In stage II primitive (Early maturing), maturing eggs formed a single mode at 0.13 mm with maximum oocyte diameter of 0.28 mm. In stage II Advance (Late maturing), maturing eggs formed a single mode at 0.16 mm with maximum oocyte diameter of 0.40 mm. In stage III, one major mode was observed at 0.58 mm and one minor mode at 0.37 mm with maximum oocyte diameter of 0.94 mm. In ripe ovaries stage IV, one major mode from 0.52 to 0.58 mm and two minor modes at 0.82 mm and 0.88 mm with maximum oocytes diameter of 1.12 mm observed. This indicates that immature and

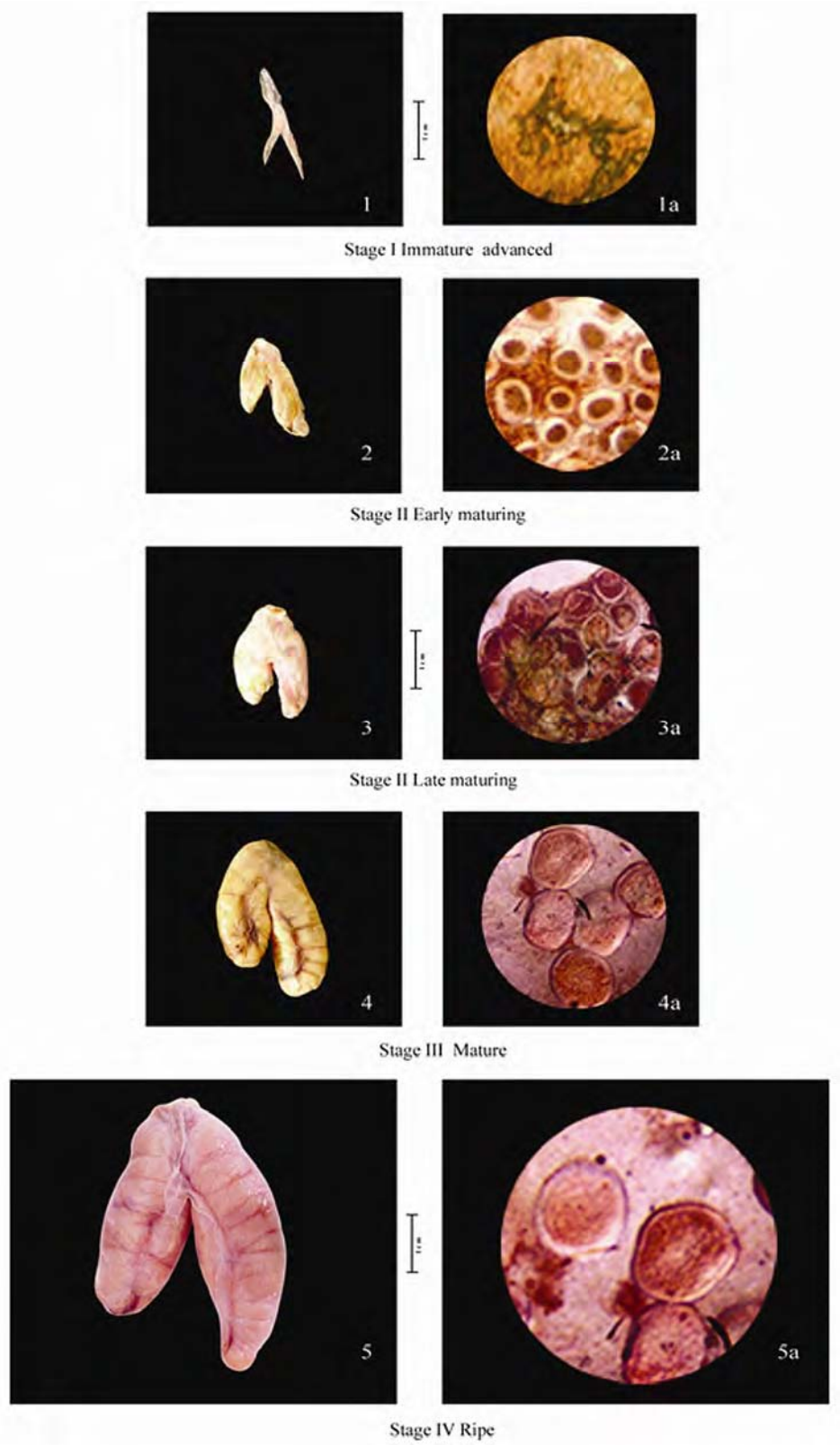

Fig. 1—Female gonads (ovary) of *Epinephelus latifasciatus* showing different stages (1 to 5) of maturation; microscopic view of eggs (1a to 5a)

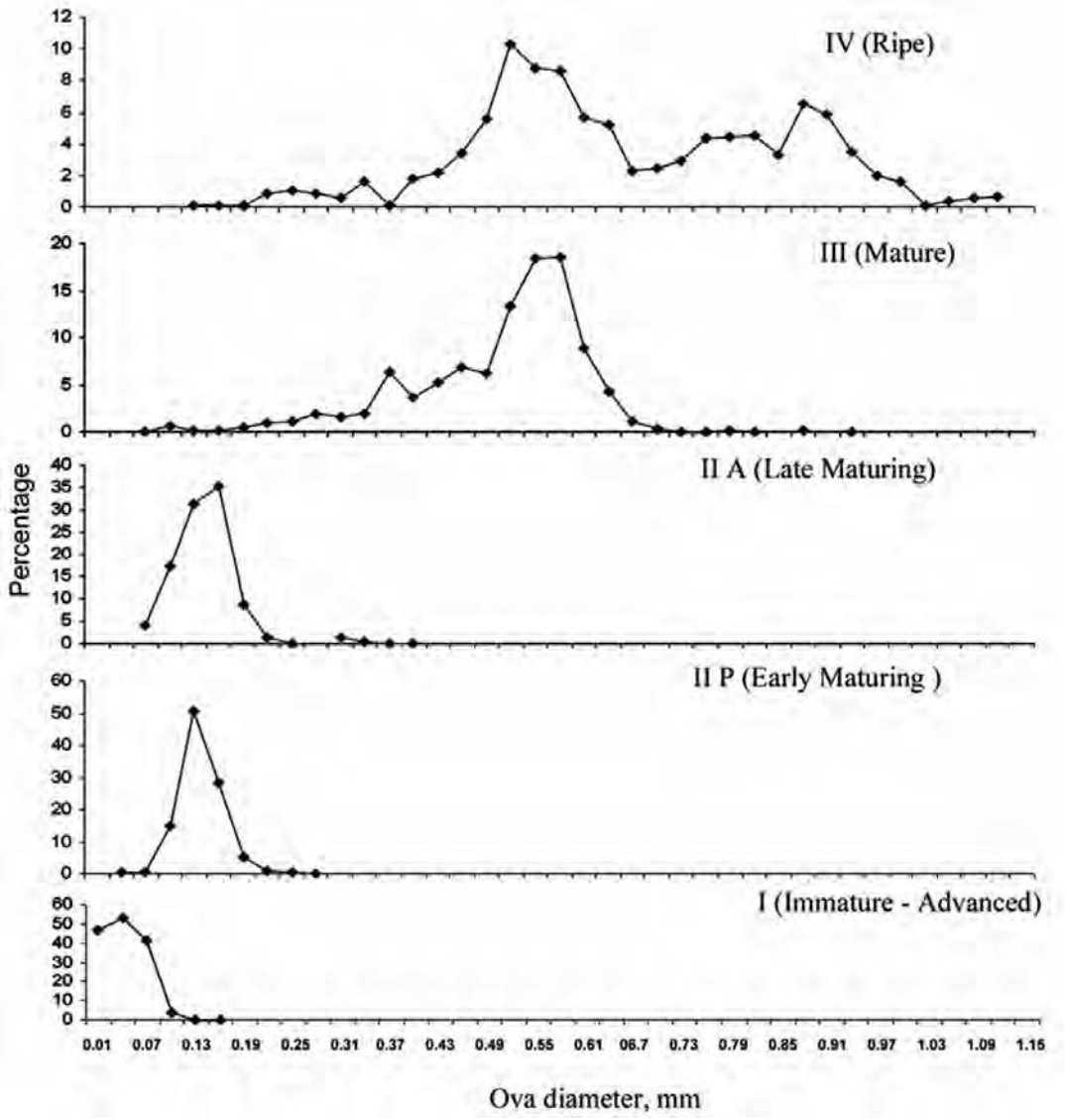

Fig. 2—Ova diameter frequency polygon of different maturity stages of *Epinephelus latifasciatus* off Visakhapatnam

mature ova also present besides ripe ova in stage IV. The presence of immature and mature ova suggest a prolonged spawning period in which the mature/ ova are being continuosly replace by immature and maturing group of ova.

Morphological and microscopic classification of testis:

Based on the morphological and microscopic examination of small sections taken from different regions of the testes, four stages were identified (Fig. 3).

Stage I Immature: very slender, thin and thread like. Sex can only be determined microscopically.

Stage II Maturing: enlarged testes; size of lobules increases; the spermatogonia and spermatocytes start developing and occupy about half of the body cavity.

Stage III Mature: their maximum size opaque-whitish, soft and exudes milt on cutting. Blood vessles become less conspicuous. Creamy white in colour, the lobular wall becomes thinner, volume increases and spermatozoa can be seen.

Stage IV Ripe: Occupies entire length of body cavity. The milt may be extruded out of the fish with slight pressure on abdomen; blood vessels absent.

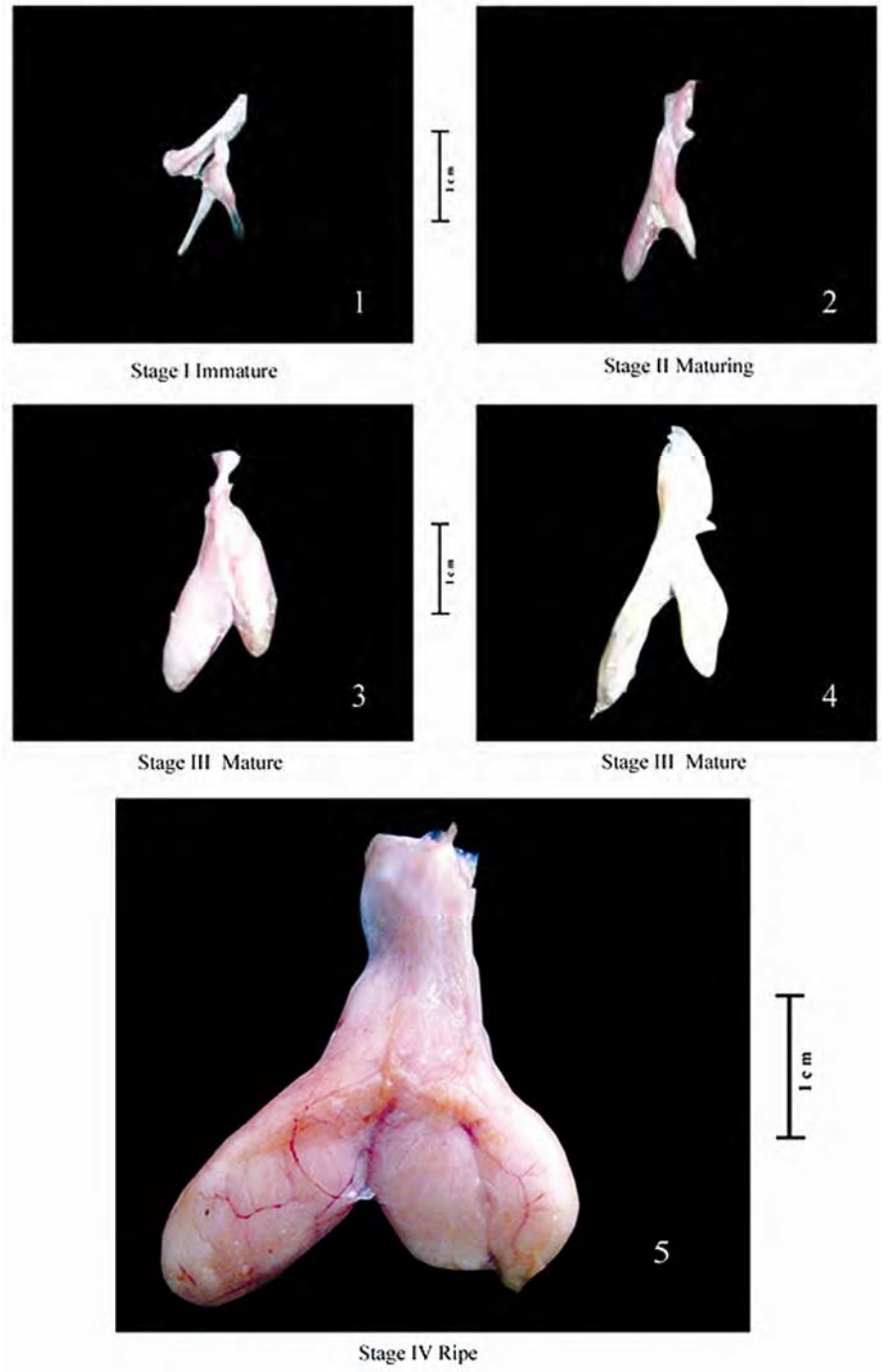

Fig. 3—Male gonads (testis) of *Epinephelus latifasciatus* showing different stages of maturation

Gonado somatic index (GSI):

Monthly trends in GSI values obtained from pooled data of male and female of *E. latifasciatus,* were represented in Fig. 4. The mean GSI values of female increases rapidly from November to March and reaches its peak during February and the GSI values observed to decrease afterwards to October. In males GSI value increases gradually from January to March reaches peak during February.

Percentage occurrence of females of *E. latifasciatus* in different stages of maturity in different months during the present study period is given in Table 1. The peak period of occurrence of mature fish from November to March,

Table 1—Percentage occurrence of females of *Epinephelus latifasciatus* in different stages of maturity in various months represented in the catches of Visakhapatnam during February 2008 to January 2011. (n=319)

Maturity Stages		Jan n=70	Feb n=98	Mar n=78	Apr n=4	May n=5	Jun n=5	Jul n=10	Aug n=20	Sep n=8	Oct n=6	Nov n=9	Dec n=6
Stage I	- P	-	1	-	-	-	-	-	-	-	33	-	-
Stage I	- A	40	28	37	25	100	80	30	50	40	34	10	33
Stage II	- P	25	18	39	50	-	20	17	40	60	34	55	-
Stage II	- A	20	10	6	25	-	-	-	10	-	-	25	34
Stage III		15	23	10	-	-	-	-	-	-	-	10	34
Stage IV		-	20	7	-	-	-	-	-	-	-	-	-

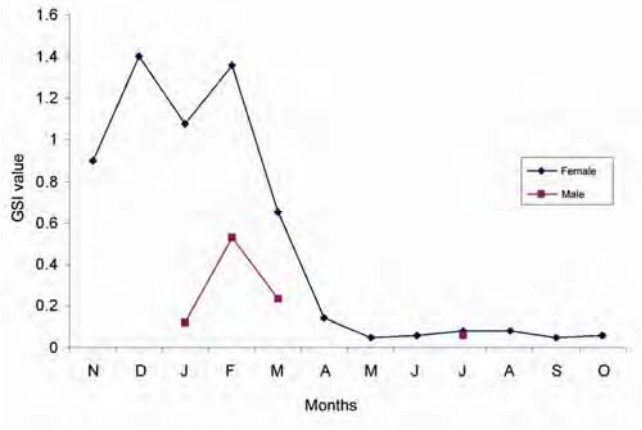

Fig. 4—Monthly trends in gonado somatic index of female and male *Epinephelus latifasciatus* off Visakhapatnam

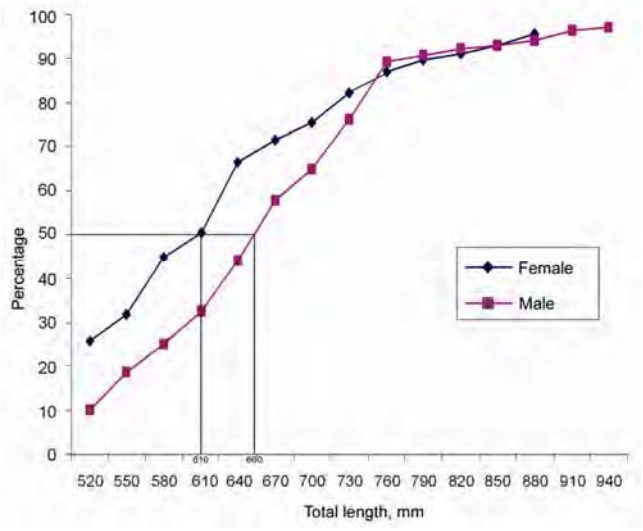

Fig. 5—Size at first maturity of female and male *Epinephelus latifasciatus* off Visakhapatnam

suggests that in this species the peak months of spawning may be from November to March.

Size at first maturity:

The size at first maturity has been estimated from a plot of percentage of mature fish in sample against total length. From the maturity curve Fig.5 it may be observed that 50% of female *E. latifasciatus* attain maturity at 610 mm TL and males at 660 mm TL. During the present study it was observed that all the fish of length range 330 mm to 416 mm TL are in stage I. They pass to maturing condition from 420 mm TL onwards. Above 500 mm TL all fish are mature (Stage II- Advance).

Fecundity:

Fecundity of fishes is usually determined from the number of ova of the mature group in the ovary. Fecundity studies on *E. latifasciatus* were made on the enumeration of eggs from 37 specimens of length range 543 to 885 mm TL with mature (stage III) and ripe ovaries (stage IV). The fecundity varied from 1,53,419 to 37,72,803 with an average of 18,68,589 ova (Table 2). Highest fecundity observed in the fish measuring 800 mm TL, with ovary weight of 43372g,510,72g and showed exceptionally high fecundity of 51,49,661 and 52,88,650.

The relation between fecundity (F) and total length (L) given in Fig 6 a. is as follows:

$F = 4.3469L^{-9.2714}$; correlation coefficient $R^2 = 0.4572$

The relation between fecundity (F) and body weight (W) given in Fig. 6b. is as follows:

$F = 1.2469W^{-1.5419}$; correlation coefficient $R^2 = 0.4562$

The relation between fecundity (F) and ovary weight given in Fig. 6c. is as follows:

$F = 0.9629O^{1.1319}$; correlation coefficient $R^2 = 0.9324$

The overall sex-ratio of our samples was two females for each male (2:1).

Table 2—Fecundity estimates of *E. latifasciatus* represented in the catches of Visakhapatnam.

S. No	Total length (mm)	Body weight (grams)	Gonad weight (grams)	Fecundity in thousands
1	543	2150	13.55	153.419
2	633	4000	64.17	709.358
3	636	4100	45.32	505.184
4	647	3600	90.48	1263.226
5	661	4400	70.62	1066.471
6	692	5000	146.72	1635.507
7	696	5500	347.97	3772.803
8	703	5250	138.08	1327.457
9	706	5250	155.22	1941.905
10	712	6000	79.32	659.694
11	713	6100	149.72	1927.178
12	728	6000	189.72	2515.240
13	730	6000	180.97	2044.474
14	736	5800	109.84	1326.063
15	754	5500	224.72	2813.617
16	755	6500	187.97	2526.632
17	757	6800	339.44	2457.872
18	758	6500	194.10	1597.808
19	771	6750	107.22	1404.750
20	774	6500	129.22	1199.233
21	781	8000	248.22	2225.622
22	791	8500	160.72	1595.891
23	792	8500	150.71	1577.325
24	793	8700	127.72	1861.345
25	798	9000	197.72	2378.467
26	800	9250	433.72	5149.661
27	814	9000	224.72	2428.833
28	814	9100	77.22	891.956
29	818	9250	510.72	5288.650
30	819	9800	214.47	3109.916
31	830	9800	200.00	2283.582
32	831	9900	248.22	3245.124
33	835	9920	200.22	1658.168
34	837	9950	237.97	2770.732
35	850	9950	222.00	2245.371
36	868	10000	117.05	1248.023
37	885	10100	228.00	3032.400

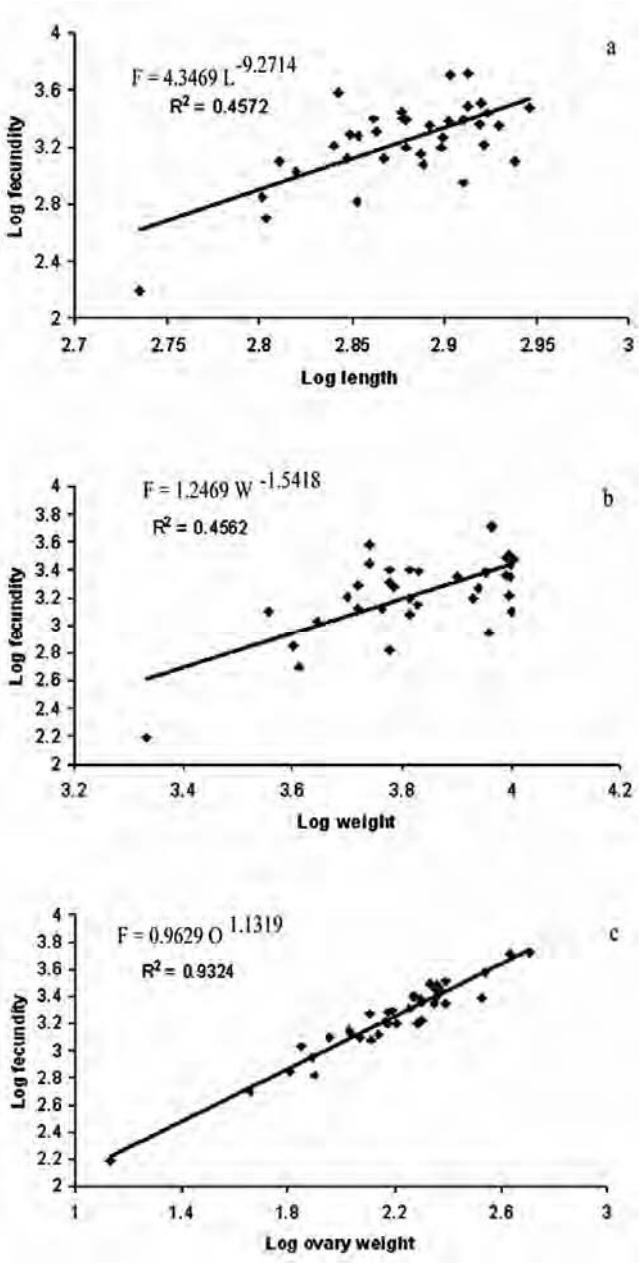

Fig. 6—Fecundity in relation to (a) total length (b) body weight and (c) ovary weight of *Epinephelus latifasciatus*

A few species of groupers follow a gonochoric sexual pattern where individuals function either as male or female without post-maturational sex change. As in *E. striatus*[6] and *Mycteroperca rosacea*[8] gonochoric sexual pattern has only been diagnosed for this species. In the present study of *E. latifasciatus* there is no histological evidence of post-maturational sex change, although some juveniles do pass through an immature bisexual phase of gonadal development prior to reaching sexual maturity as a male or female. The size range, average body size, and size at sexual maturity of males and females are similar. Finally, adults spawn in groups of 4 to 60 fish, and no evidence of pair spawning has been found for this species. The sexual and behavioural pattern of *E. latifasciatus* have important implications for management as sex change is not observed and their population dynamics may vary with certain fishing practices than protogynous groupers and may be less

adversely affected by traditional size and catch-limit regulations. To support policies for the management of many grouper fisheries the current databases are highly inadequate. The present studies show that many of the individuals caught, especially by trawlers have not been able to reach maturity and consequently have not contributed to the reproductive effort of the population.

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