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Reproductive Biology of Shortnose Ponyfish *Leiognathus brevirostris* (Valenciennes) from Portugal Bay in the Puttalam Estuary, Sri Lanka

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Abstract

Results of the study conducted on the reproductive biology of *Leiognathus brevirostris* (Valenciennes) from the northwestern coastal waters of Sri Lanka (latitude 6-10° N and longitude 80-82° E) during the period November 1992 to October 1993 are presented. The length at 50% maturity for the males and females were estimated to be 79 and 81 mm, respectively. Statistical analysis indicates that the overall sex ratio is significantly different from 1:1 almost throughout the study period except in November 1992 and January 1993. During the rest of the period it seems that females predominate. There is a significant difference from 1:1 sex ration for the size range studies. The predominance of females above the total length 89 mm suggests either a possibility of greater natural mortality rate in males after attaining a total length of 89 mm or they may have a behavioral pattern of separating from the females after attaining an age corresponding to this size. The study indicates the possibility of two recruitment and spawning pulses separated by five and four months, respectively. The fecundity as the number of eggs that are to be shed was esti-mated to vary between 12,335 and 18,333 for fish of the size range 95 mm to 115 mm.

Introduction

The ponygfish *Leiognathus brevirostris* (Valenciennes) is a small bottom living fish species found in the coastal waters of the West Indian Ocean (along the coasts of India and Sri Lanka) and the Western Central Pacific, including Australia. It inhabits shallow waters down to depths of about 40m, predominantly near the bottom and is more often found in schools (Fischer and Bianchi 1984). It is one of the major contributors to the trawler by-catch in the Portugal Bay area of the Puttalam Estuary in the northwestern coastal waters of Sri Lanka (Jayawardane and Dayaratne, in preparation).

Although some studies on the reproductive biology of Leiognathids in the Western Indian Ocean have been carried out by Balan (1963), Murty (1990), Jayabalan (1986), James and Badrudeen (1981) and James and Badrudeen (1986), except for the study carried out by James and Badrudeen (1975), a

detailed study on the reproductive biology of this species has not been attempted so far.

The present paper describes the reproductive biology of *Leiognathus brevirostris* from the northwestern coastal waters of Sri Lanka. The aspects of biology studied include size at first maturity, sex ratio, gonadal maturity, gonadosomatic index and its seasonal variation, breeding season, spawning frequency and fecundity.

Materials and Methods

Collection of data

Specimens for this study were collected from trawler catches from the Portugal Bay (latitude 8° 25'-32' N and longitude 79° 46'-51' E) area during the period November 1992 to October 1993 by making regular fortnightly field visits to the major fish landing centre in the Kalpitiya Peninsula (Fig. 1). Random samples of 40 to 50 fish were obtained from the landing site at fortnightly intervals and were immediately preserved in ice. These were then brought to the laboratory at the National Aquatic Resources Agency, Colombo, as soon as possible for further analysis.

In the laboratory, total length was measured to the nearest 1.0 mm using a measuring board. The total weight of each individual was determined to the nearest 0.01 g.

Fish were then dissected open and the sex and maturity stage of the gonads were determined. Identification of the maturity stages was carried out according to a classification scale, which was a modification of the scale developed by Kesteven (1960) (Table 1).

Gonads of each individual were carefully removed and weighed to the nearest 0.001 g to determine the gonadosomatic index. Around 30 ovaries of maturity stages I-VI and 4 ovaries of stage VII were preserved in Gilson's fluid (Bagenal et al. 1978) for 4 to 5 weeks.

The fecundity was estimated volumetrically. Sub-sampling was carried out using a Stemple pipette and the number of eggs in the ovaries of stage V were counted for fecundity estimations. Around 20 ovaries of stage V were used.

For ova diameter frequency studies, the diameters of eggs were measured using a graduated micrometer eye-piece. Around 200 ova from each stage of maturity were measured to the nearest micrometer division. A micrometer division was equal to 0.001 mm.

Analysis of data

Size at 50% maturity for the two sexes was calculated by plotting the percentage of mature fish in each size group against the mean length of the size class (Newman and Pollock 1974). All the fish in the samples were used in this analysis.

Gonadosomatic Index (GSI) of each individual was calculated using the following equation described by Bagenal (1978). All the fish in the samples were used in this analysis.

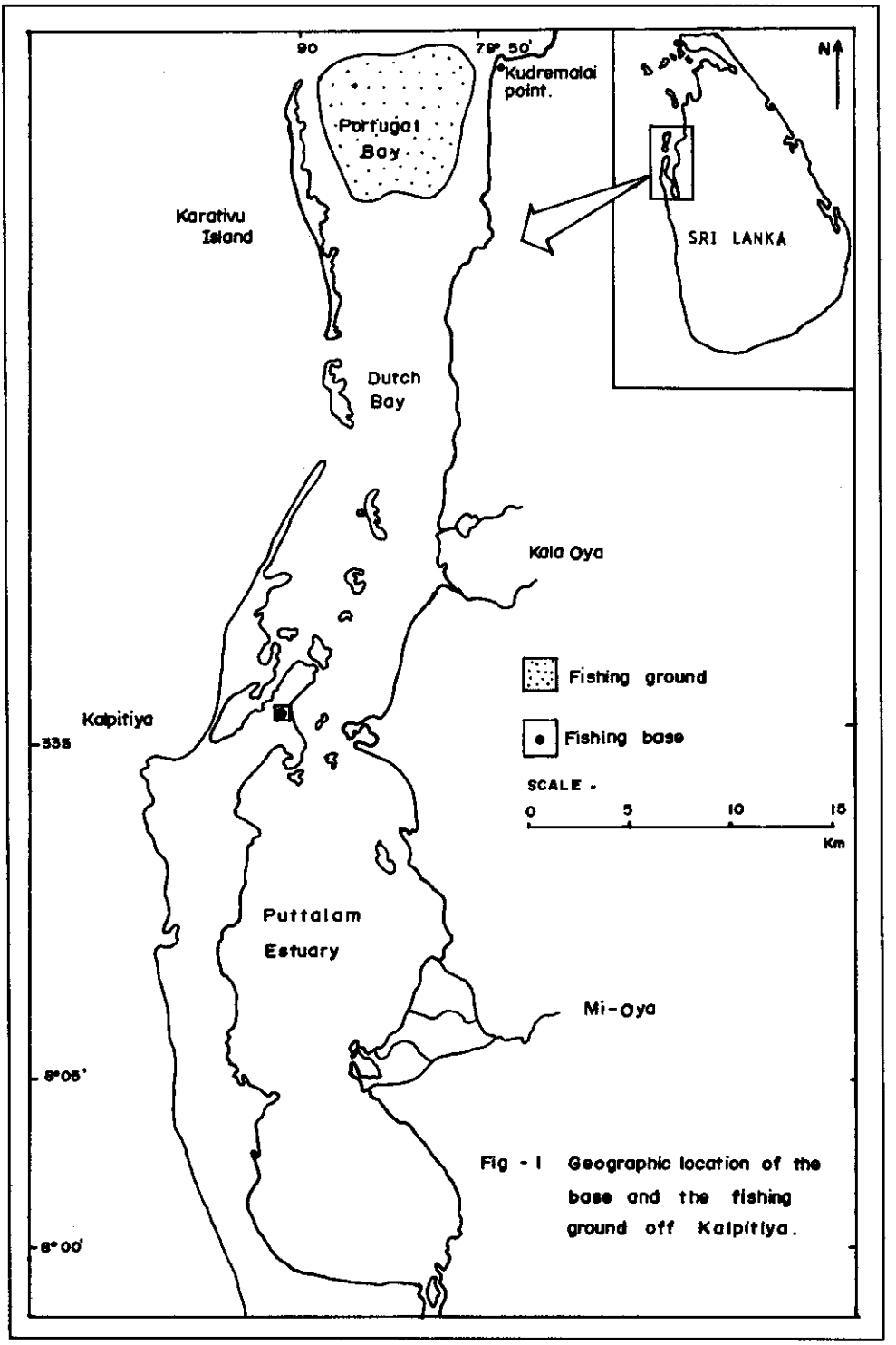

Fig - 1 Geographic location of the base and the fishing ground off Kalpitiya.

Fig. 1. Geographic location of the base and the fishing ground off Kalpitiya.

Table 1. Classification of maturity stages of gonads.

Stage of Maturity	State	Description	
		Male	Female
I	Immature	Small, transparent, pale in colour, occupying a very small portion of body cavity	Small, transparent, pale in colour occupying a very small portion of body cavity, ona invisible to naked eye
II	Immature	Pale witish, semitransparent, slightly larger, occupying nearly 1/3 of body cavity	Pinkish in color, semitransparent, occupying both 1/3 of body cavity, ova not visible to naked eye
III	Maturing	Creamy white, translucent, occupying nearly ½ of body cavity	Pale yellow, granular ova visible to naked eye, occupying about ½ of body cavity
IV	Maturing	Creamy white, occupying about ¾ of body cavity	Yellowish, blood vessels visible on dorsal side, ova clearly seen, occupying about ¾ of body cavity
V	Mature	Creamy white, soft, occupying about full length of body cavity	Pinkish yellow, blood vessels prominent, occupying about full length of body cavity
VI	Running	Creamy white, soft occupying entire length of body cavity, milt produce under slight pressure	Yellowish, occupying entire length of body cavity roe and milt run under slight pressure
VII	Spent	Not encountered	Flaccid, loose, occupying nearly ½ of body cavity

* Source - (Jayabalan 1986)

$$\text{Gonadosomatic Index} = \frac{\text{Gonad weight X 100}}{\text{Body weight}}$$

Calculated values of the sex ratios for each month were subjected to chi-square test (Zar 1984) to determine whether these are significantly different from 1 : 1 ratio, the same being done for each length class also.

Results

Mean size at maturity

Percentage of mature individuals in each length group of *L. brevirostris* is shown in Fig. 2. The lengths at 50 % maturity were estimated at 79.8 mm and 81 mm for males and females, respectively.

Gonado Somatic Index

The highest value for GSI was recorded for the maturity stage V. The monthly variation pattern of mean GSI values of males and females are shown

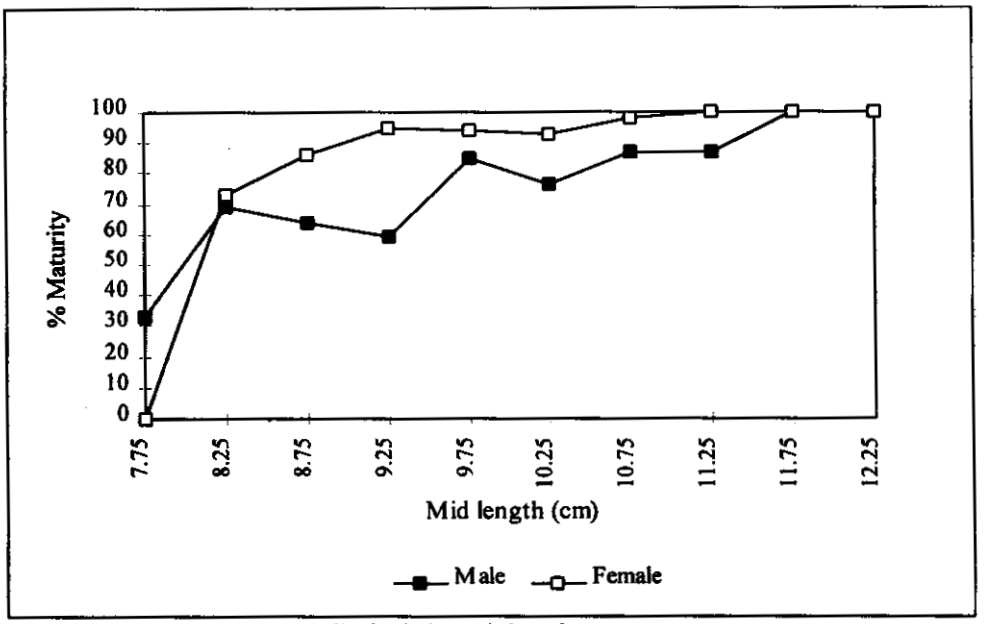

Fig. 2. Percentage of mature individuals in each length group.

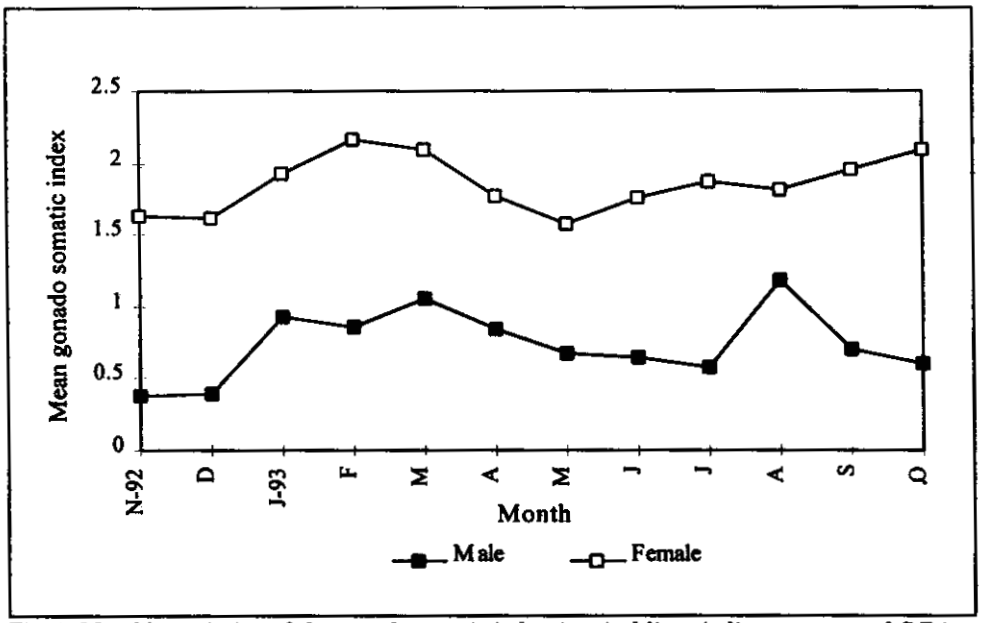

Fig. 3. Monthly variation of the gonadosomatic index (vertical lines indicate range and S.D.).

in Fig. 3. During the present study, relatively higher values of GSI were observed for males in the months of March and August and for females in February and October.

Sex ratio

Monthly variation pattern of percentage frequency of males and females is shown in Fig. 4. During the present investigation, sex ratio was determined for mature fish only. Generally, the percentage of males and females in the population deviated from the 50% level, except in November 1992 and January 1993. The results of the statistical analysis of the sex ratios on a monthly basis for the study period are given in Table 2.

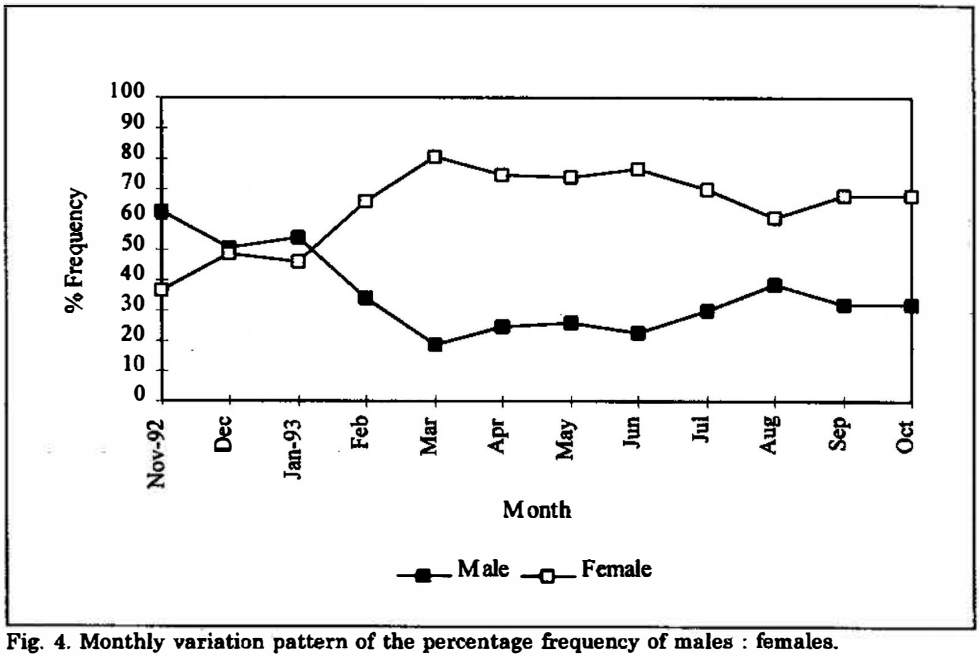

Fig. 4. Monthly variation pattern of the percentage frequency of males : females.

Table 2. Results of statistical analysis of the samples without the male to female ration of 1:1 on monthly basis with information on the proportion of mature/immature fish.

Month	Recorded Length Range	No. of fish		X^2	P	No. below 50% maturity level	No. above 50% maturity level
		Males	Females				
Nov. 1992	8.8-12.0	41	39	0.05	0.05	-	80
Dec.	8.8-12.4	39	47	0.74	0.05	-	86
Jan. 1993	8.6-11.8	24	23	0.02	0.05	-	47
Feb.	8.2-11.1	27	71	19.76*	0.05	-	98
Mar.	8.1-11.5	10	62	37.56*	0.05	-	72
Apr	8.1-11.7	14	51	21.06*	0.05	-	66
May	8.3-12.9	17	69	31.44*	0.05	-	86
Jun	8.1-12.1	15	60	27.00*	0.05	-	63
Jul	8.6-12.0	15	48	17.29*	0.05	-	63
Aug	8.3-12.5	32	57	7.02*	0.05	-	89
Sep	7.7-12.2	20	60	20.00*	0.05	11	69
Oct	8.3-12.1	27	60	12.52*	0.05	-	87

$X^2 0.05, 1 = 3.841$

* Male:female sex ratio is statistically significantly different from 1:1.

The change in sex ratio in different length classes is shown in Fig. 5. There was a significant difference from 1 : 1 sex ratio for the size range studied. It was observed that females predominate above the total length of 88.9 mm. The results of the statistical analysis of the sex ratio on the basis of size are given in Table 3.

Oocyte diameter distribution

Size distribution of ova in different stages of maturity is shown in Fig. 6. Except in maturity stages I and II, ova less than 0.003 mm were not measured. In matury stage I, the majority of ova were below 0.0054 mm while a

Table 3. The results of the statistical analysis of the male to female sex ratio on the basis of the length group.

Length group	Number of fish		X^2	P
	Males	Females		
7.5- 8.0	8	2	3.60	0.05
8.0 - 8.5	37	22	3.81	0.05
8.5 - 9.0	92	73	2.19	0.05
9.0 - 9.5	85	169	22.78 *	0.05
9.5 - 10.0	54	172	61.61 *	0.05
10.0 - 10.5	41	152	63.84 *	0.05
10.5 - 11.0	16	87	48.94 *	0.05
11.0 - 11.5	4	56	45.07 *	0.05
11.5 - 12.0	1	27	24.14 *	0.05
12.0 - 12.5	0	9	9.00 *	0.05

X^2 0.05, 1 = 3.841

* Male:female sex ratio is statistically significantly different from 1:1

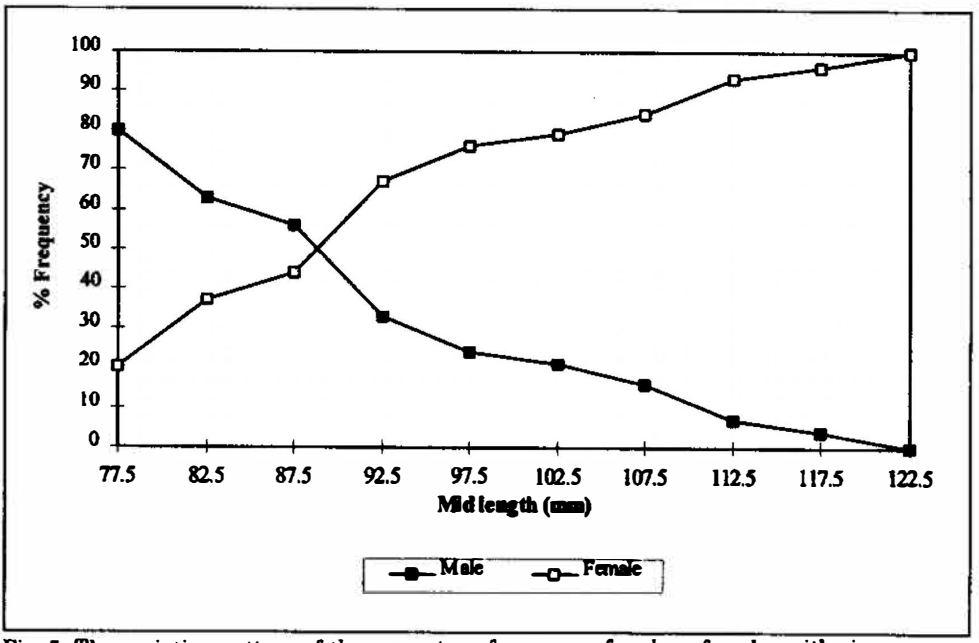

Fig. 5. The variation pattern of the percentage frequency of males : females with size.

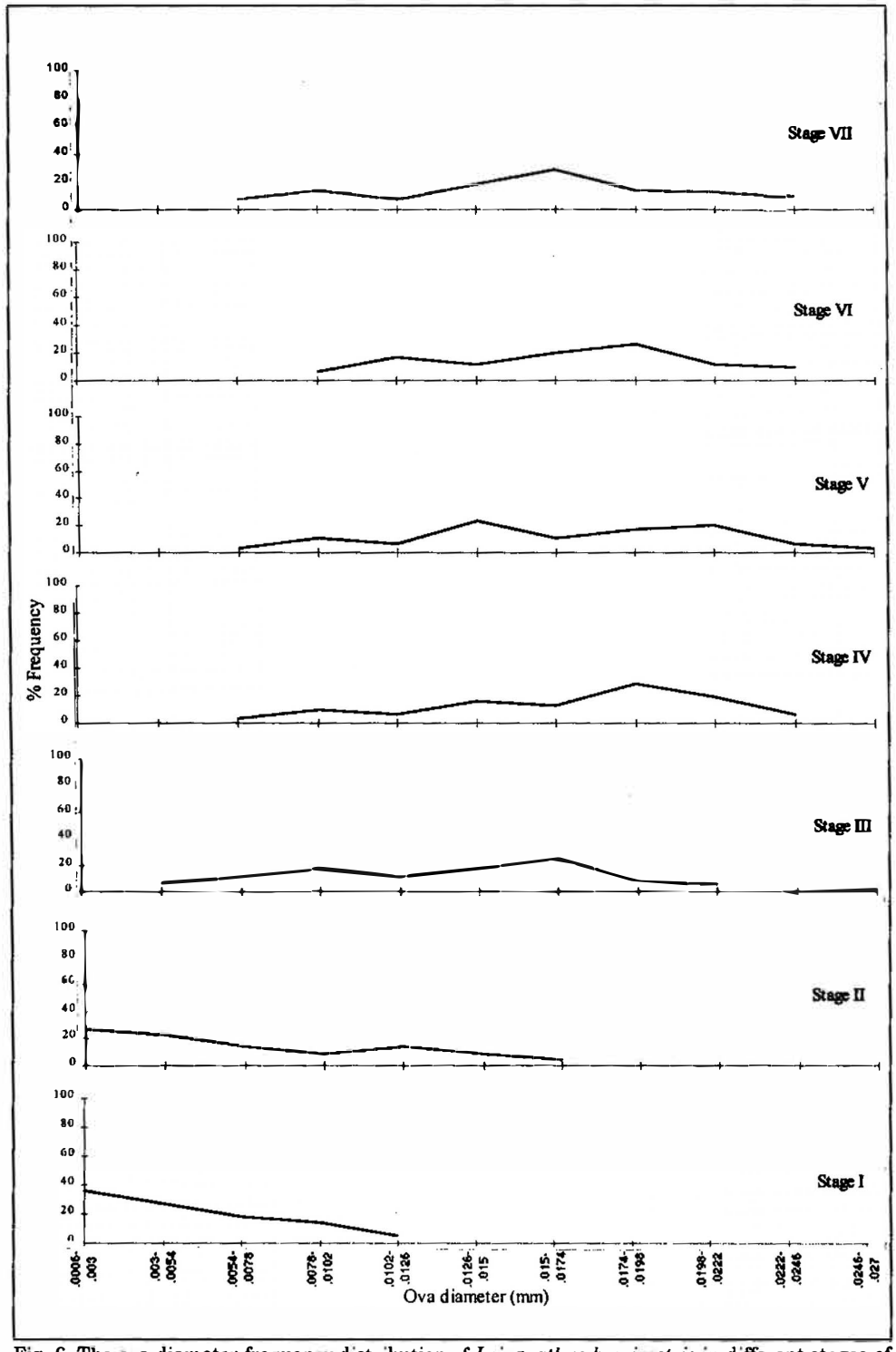

Fig. 6. The ova diameter frequency distribution of *Leiognathus brevirostris* in different stages of maturity.

few grew as much as 0.0114 mm. In maturity stage II, a small group of ova got separated from the general stock and formed a mode at 0.0114 mm, forming the first batch of maturing ova. This batch of maturing ova advanced further and formed a mode at 0.0162 mm in stage II where, in addition to the former, a new batch of maturing ova with the mode around 0.009 mm also made its appearance.

In maturity stage IV, the first batch of maturing ova grew further and reached a mode at 0.0186 mm. Similarly, the second mode which made its initial appearance in stage III advanced further and formed a mode at 0.0138 mm. As the process of maturation moved on to stage V, three batches of ova were distinct with modes at 0.009 mm, 0.0138 mm and 0.021 mm. Apparently, it was the 0.0186 mm mode of stage IV which had shifted to 0.021 mm in stage V while the second mode which appeared around 0.0138 mm in stage IV remained the same. Also in stage V, a new group of maturing ova made its appearance and formed a mode at 0.009 mm.

In maturity stage VI, the group of ova which formed the mode at 0.021 mm in stage V disappeared probably due to an elimination. However, the batches which formed modes at 0.009 mm and 0.0138 mm in stage V further advanced in stage VI and formed modes at 0.0114 mm and 0.0186 mm, respectively. In maturity stage VII, the ripe eggs which formed mode at 0.0186 mm in stage VI seem to be already extruded while there were only two modes left, at 0.0162 mm and 0.009 mm, respectively.

Monthly variation in the percentage occurrence of gonads of different maturity stages

Monthly variation in the percentage occurrence of gonads of different maturity stages of *Leiognathus brevirostris* (females) is shown in Fig. 7. The results of the present study indicate the occurrence of both mature as well as immature fish throughout the study period. It was also revealed that, except for the months of October, November, June and July, majority of fish were in mature condition. Although spent fish seem to occur in all the months, the number of spent fish were significant in the months of February, March and August.

Fecundity

The relationship between size and fecundity was estimated to be Fecundity = 1640.9 x total length - 2717 ($n = 20$, $r = 0.6$, $P < 0.05$). Using the statistically significant relationship of size and fecundity, it was estimated that the fecundity of *Leiognathus brevirostris* varies between 12,870 and 16,151 for the size range 95 mm and 115 mm. These were very close to the observed values for this size range which were 12,337 and 18,333.

Discussion

The estimated values for the mean sizes at maturity for males and females of *Leiognathus brevirostris* during the present investigation were 79.8 mm and 81 mm, respectively. James and Badrudeen (1975) observed the minimum length at first maturity for *Leiognathus brevirostris* from Palk Bay and

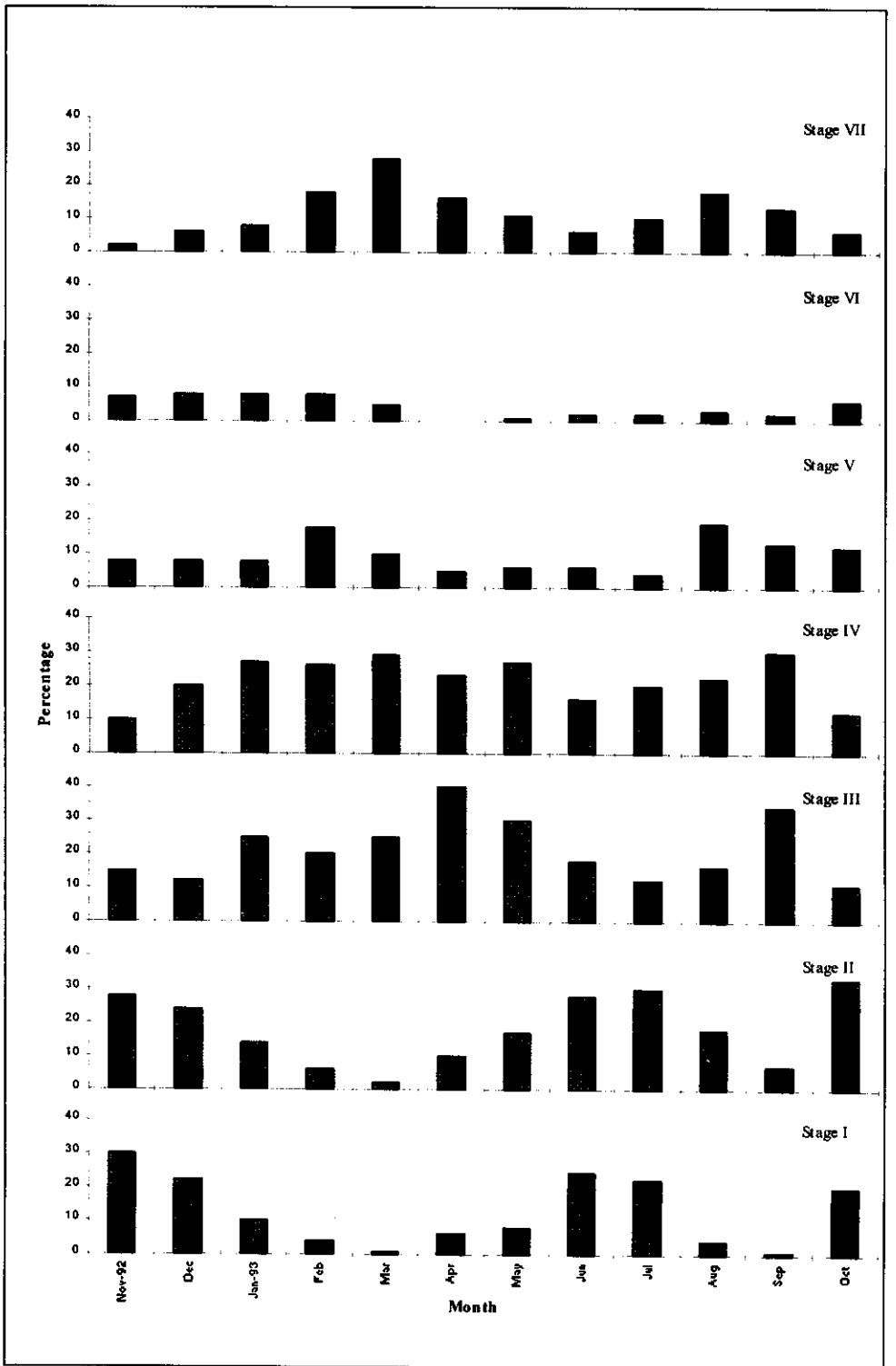

Fig. 7. Monthly variation in the percentage occurrence of gonads of different maturity stages (female).

Gulf of Mannar at 63 mm for females and 68 mm for males which were closer to the mean size at maturity estimated during the present study. In addition, the estimated length at first capture (Lc) of *Leiognathus brevirostris* was 87.5 mm (Jayawardane and Dayaratne, in preparation). Therefore, it is understood that the way trawler fishery is carried out has no adverse effect on the spawning stock of *Leiognathus brevirostris*.

The length frequency analysis has indicated the possibility of two recruitment pulses of different magnitude, one around April and the other around October (Jayawardane and Dayaratne, in preparation). These two pulses were separated by a five-month interval. The first pulse contained 27.8% of the recruits and the other consisted of 72.2% of the recruits. Monthly variation pattern of gonadosomatic index of females also indicated the presence of two pulses in February and July.

Statistical analysis indicates that the overall sex ratio is significantly different from 1:1 almost throughout the study period except in November 1992 and January 1993. The predominance of females in certain months and in the larger length groups suggests either a faster growth rate in females or differential mortality. A similar observation was made on *Leiognathus brevirostris* by James and Badrudeen (1975) when they observed a predominance of females over males in both trawl and shore seine catches from Mandapam, Rameswaram and Vedalai. However, in the gillnet catches from Vedalai, males were in greater numbers than females.

The analysis of sex ratios of *Leiognathus brevirostris* of different size classes indicates that there is a significant difference from 1:1 sex ratio for the size range studied. It is also understood that both sexes are not represented in all length groups. The predominance of females above the total length of 88.9 mm suggests either a possibility of greater natural mortality rate in males after attaining the total length 88.9 mm or that males may have a behavioral pattern of separating from the females after reaching an age corresponding to this size, which is about the size at first maturity.

The ova-diameter frequency distributions of maturity stages IV and V indicate that, in addition to the most advanced froup of ova, there was at least one group which had partially undergone the maturation process. Therefore, the presence of such an intermediate group in the ova-diameter frequency curve of a mature fish indicates either the occurrence of more than one spawning act per year or the serial spawning behavior of the fish.

Since the mature fish occur in a number of months and spent fish were recorded throughout the year, it is reasonable to conclude that the *Leiognathus brevirostris* is a serial spawner, although peaks are recorded in the months of February and July.

The results of the present investigation indicate that the fecundity of *Leiognathus brevirostris* varies between 12,337 and 18,333 for the size range 95 mm and 115 mm. The fecundity of this species in the size range 106 mm to 132 mm was estimated to vary between 3,646 and 16,243 by James and Badrudeen (1975). The wide variation in fecundity could be associated with the serial spawning behavior of the species, where the eggs are shed in batches rather than all at once. The high fecundity estimate at one end probably represents the number of eggs at the onset of spawning. The low fecundity estimate at the other end indicates that some of the eggs are released in subsequent batches.

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