

Spawning Frequency and Reproductive Potential of Gangetic Anchovy, *Setipinna phasa* (Ham.)

Brijesh Kumar Chaubey & Daya Shankar

Department of Zoology,
Mariahu P.G. College Mariahu,
Jaunpur -222161, U.P.

Abstract

Ova diameter study revealed the occurrence of three sets of ova, i.e., immature, maturing and mature in the population of *Setipinna phasa* of Hooghly estuary whereas, only one batch of mature ova was noticed in the specimens collected from Ganga river passing from Allahabad-Varanasi region. The study showed that this fish spawn once in a year in Ganga river and twice in a year in Hooghly estuary. The absolute fecundity varied from 3567 to 23430 in this fish of size range 160-340mm in standard length. The five maturity stages in both sexes of this fish were identified. The females outnumbered the males.

Key Words- Spawning frequency, fecundity, *Setipinna*.

The Gangetic anchovy, *Setipinna phase* forms one of the important fisheries of the Ganga river and estuaries of India. The catch of this fish is on decline at present due to their reckless exploitation. Although, the demand of this fish always exceeds the supply in the market. This situation indicates that there is considerable scope of this fish to increase their production through aquaculture practices. The anchovy, *S. phasa* inhabits freshwater and brackishwater bodies in India, Bangladesh and Burma. It is distributed in the estuaries of Orissa, Bengal, Cachar and Burma (Day, 1889). Jones and Menon (1952) reported that it abounds in all the deltaic branches of Ganga river system. The maximum size of *S. phasa* recorded by Jhingran (1961) and Day (1889) was 324mm and 406mm respectively. However, in the present study, a maximum length of 220mm was recorded in river Ganga at Allahabad-Varanasi region and 340mm in Hooghly estuary.

A very little information is available on the biology of this fish despite of its abundance, palatability and consumer appeal. Jhingran (1961) studied on the maturity and fecundity of the Gangetic anchovy, *S. phasa* and De and Mitra (1981) reported on the fecundity of *S. taty*.

Materials and Methods

Monthly samples of this fish were obtained for a period of twelve months from January to December 2002. A total of 652 individuals of *S. phasa* in the size range of 60 to 340mm comprising 257 males and 395 females were obtained by using cast and drag nets and brought to the laboratory packed in ice. A total of 303 specimens of this fish were collected from Ganga river and 349 specimens from Hooghly estuary.

Stage of maturity was determined after following the scheme of classification suggested by Qayyum and Qasim (1964). Length, weight, sex, stage of gonad development, gonad length, and gonad weight were recorded. The extracted gonads were preserved in 5% formalin. Intraovarian eggs were taken out and their diameter was measured with the help of an ocular micrometer using 8x12.5 magnification binocular dissecting microscope. This of spawning was determined by using the gonadosomatic index (GSI): $100 \times G.W./F.W.$, where G.W. is the fresh gonad weight to the nearest 0.01g and F.W. is the body weight of fish to the nearest 1.0g. Mean value of these indices were plotted monthly in order to indicate duration and peak of spawning. The linear regression fecundity on total body length, body weight, ovary length and ovary weight were calculated based on mature (stage IV) ovaries. One ovary randomly selected from a pair was blotted dry and weighed to the nearest 0.01g. The selected ovary was crumbled and all ovarian tissue removed. The eggs were then filtered, blotted dry and weighed on an electric balance. The sub samples (10-20mg) from anterior, middle and posterior regions of each ovary were taken and ova present in each sub sample were counted and their average count was multiplied by the total weight of the ovary for determining the absolute fecundity. Relative fecundities (number of ova in unit length and weight of body and ovary) were also counted.

Results

Sexual Maturation, Gonad and Ova Diameter

Paired gonads elongated with ripening and extended towards the posterior half of the abdomen. The five maturity stages of gonads were determined in both the populations (Ganga river and Hooghly estuary) of *Setipinna phasae* (Table-1). The gonads showed a regular seasonal development with little overlap in different stages of maturation. The percentage of various maturity stages in different months is indicated in Figs. 1 and 2. In both sexes high values of gonadosomatic index (GSI) comprising only one peak (Fig. 3A) were recorded in the specimens collected from Ganga river during the period February through June indicating full development of their gonads. However, the two peaks (Fig. 3B) of GSI (April-June and September-November) were observed in one year cycle in the specimens of Hooghly estuary. The details of GSI of both the populations are given in Table-3.

The frequency distribution of ova diameter measurements from a ripe ovary (stage IV) of *S. phasa* collected from Hooghly estuary (Fig. 4A) showed that there are three groups of ova, viz. immature, maturing and mature. These three groups of ova were well marked and separated indicating that the fish spawns more than once in a year. The modal size of the ova of ripening stage in the specimens of Hooghly estuary (Fig. 4B) ranged between 0.29 to 1.19. Fully developed and ripe eggs (diameter 0.80-1.19mm) were encountered during May and November. However, in the specimens of Ganga river the size of ova ranged between 0.25 to 1.05mm, and fully developed and ripe eggs (diameter 0.76-1.05mm) were recorded during April.

Sexual Dimorphism and Sex Ratio

The pectoral fin was found to be dark in colour along their margins in females and remained uniformly white in colour in males with the approach of ripening (III) and ripe (IV) stages of maturity. The sexual dimorphism was not found to be apparent in early stages of maturity.

The sex ratio varied with the season (Fig. 5). Females outnumbered the males marginally in all the months except February and October in Ganga river and February and May in Hooghly estuary. The male: female ratio ranged from 1:0.7 to 1:6.5, with the average value being 1:2.3 in the population of Ganga river. The same ratio varied 1:0.7 to 1:2.3, with the average value being 1:1.4 in the specimens collected from Hooghly estuary. However, the chi-square test showed no significant departure from the hypothetical 1:1 ratio except during April through August and December in the Hooghly estuary. The sex ratio also varied with size (Table-2).

Fecundity

Absolute fecundity varied between 3567-23430, with an average value being 10154 in the specimens of *S. phasa* ranging between 16.0-34.0cm in size. Length-wise the fecundity factor varied between 212-689 eggs/cm length, with an average of 415 eggs/cm, and weight-wise the value varied between 169-317 eggs/g, with an average of 214 eggs/g of the body weight of the fish (Fig. 6A-B).

Ovaries ranging between 2.6-6.7cm in size and 1.7-6.9g in weight were also studied. The number of ova per cm of ovary-length varied between 1249-3497, with an average of 2526 eggs/cm ovary length. Ova per g of ovary weight varied between 1911-3388, with an average of 2583 eggs/g of ovary weight. Regression analysis indicated that the body length, body weight, ovary length and ovary weight could be used to predict fecundity of this fish. The equations describing the relationships and coefficient of determinations (r) are given in (Figs. 6-7).

Discussion

Cyclic changes in the maturation and regression of gonads, intraovarian oocytes and GSI in *S. phasa* clearly pointed to spawning non synchronous with the onset of monsoon. The ripe gonad and high values of GSI were recorded during February-May in the population of Gangetic anchovy indicated that the fish spawn during this period in this region. This fact was further supported by the condition of all the ova in an ovary being at the same stage of development that is indicative of the fact that the spawning in this fish take place only once in a year in Ganga river. Although, the same fish spawn twice in Hooghly estuary as indicated by the multimodal occurrence of the ova in the ripe specimens and, moreover, ripe gonad and high values of GSI were recorded during the periods, April-June and September-November. Factors like hormone and temperature may be a reason which could control the breeding cycle and spawning of this fish as it has been shown by many workers such as Bullough (1939), Peter (1982) and Jobling (1995) in other fishes. However, Mookerjee and Mookerjee (1950) reported that the *S. phasa* spawn in tidal area during the period from January through July while Jones and Menon (1952) collected developing egg, larvae and juveniles during October-November from river Hooghly in and around Barrackpore (W.B.) and considered this

period as peak spawning period of *S. phasa*. This fish go into a quiescent phase in their reproductive cycle during winter season as indicated by low GSI in both the populations (Ganga river and Hooghly estuary) of this fish in the present study. The high and low values of GSI in both sexes may be due to high and low values of photoperiod and temperature. Several workers (Pickford and Atz, 1957; Abidin, 1986; Fatima and Khan, 1993) have suggested that high temperature and intense sunlight are environmental factors that regulate reproductive activity in fishes.

Fecundity was found to be low in *S. phasa* due to the large size of the eggs (0.80-1.19mm). Several scientists (Karim and Hossain, 1972; Serajuddin, 1995) correlated the size with fecundity. Fecundity is significantly correlated with both length and weight of the fish as well as the length and weight of the ovary. A linear relationship was found to exist between fecundity and each one of these four characters. Combinations of two independent variables, length and weight improved predictability only slightly, therefore, separate equations were derived for length on fecundity and weight on fecundity. Comparison of the quantitative variation in fecundity with both length as well as weight of the ovary revealed a marked increase in egg production with increase in ovary length. Similar results were also obtained by Piska and Waghray (1985) in *Salmostoma bacaila*, Pathani (1981) in *Tor putitora* and Bisht and Upadhyay (1979) in *Barilius bendelisis*.

Dominance of male population over female in *S. phasa* may be due to natural or artificial mortality of female. Similar results have also been reported by Hoda and Qureshi (1989) and Gowda and Shanbhogue (1988) for different other fishes. The possible reasons suggested for the dominance of one sex in the catches are seasonal segregation of sexes, size differences and gear selectivity.

References

- Abidin, A.Z. (1986). The reproductive biology of tropical cyprinid, *Hampala maruloides* (Van Hasselt) from Zoo Negara Lake, Kuala Lumpur, Malaysia. *J. Fish Biology*, 29: 381-391.
- Bisht, J.S. and Upadhyay, J.C. (1979). Studies on the fecundity of a freshwater teleost, *Barilius bundelisis* (Ham.) II. All India Seminars on Ichthyology. Abstract No. 148.
- Bullough, W.S. (1939). A study of the reproductive cycle of the minnow in relation to the environment. *Proc. Zool. Soc. Lond.* 109: 79-102.
- Day, F. (1889). *Fauna of British India Fishes*, London, 2, pp 458.
- De, D.K and Mitra, P.M. (1981). Studies on the fecundity of *Setipinna taty*. *Indian J. Fish.* 28: 272-275.
- Fatima, M. and Khan, A.A. (1993). Cyclic changes in the gonads of *Rhinomugil corsula* (Ham.) from river Yamuna, India. *Asian Fish Sci.* 6: 23-29.
- Gowda, G. and Shanbhogue, S.L. (1988). On the reproductive biology of grey mullet, *Valamugil seheli* (Forsk.) from Mangalore waters. *Mahasagar* 21: 150-112.

- Hoda, S.S.M. and Qureshi, N. (1989). Maturity, sex ratio, ova diameter and fecundity of mullet, *Liza klunzingeri* Day from Karachi-Sind waters. India J Fish. 36: 183-192.
- Jhingran, A.G. (1961). Studies on the maturity and fecundity of Gangetic anchovy, *Setipinna phasa* (Ham.) India J. Fish. 8: 291-311.
- Jobling, Malcolm. (1995). Environmental biology of fishes. Chapman and Hall, London. 447 pp.
- Jones, S. and Menon, P.M.G. (1952). Observations on the life history, bionomics and fishery of the Gangetic anchovy, *S. phasa* (Ham.) J. Zool. Soc. India 3: 323-333.
- Karim, M.A. and Hossain, A (1972). Studies on the biology of *Mastacembelus pancalus* (Spiny eel, Ham.) in artificial ponds. Part II, sexual maturity and fecundity. Bangladesh J. Biol. Agric. Sci. 1: 15-18.
- Mookerjee, H.K. and Mookerjee, P.S. (1950). On some aspects of the natural history of *Engraulis hamiltonii* and *Engraulis tetara*. Proc. 37th Indian Sci. Congr., part III, Abstract: P. 251.
- Pathani, S.S. (1981). Fecundity of mahseer, *Tor putitora* (Ham.) Proc. Indian Acad. Sci. 90: 253-260.
- Peter, R.E. (1982). Neuroendocrine control of reproduction in teleosts. J. Fish. Aquat. Sci. 39: 48-55.
- Pickford, G.E. and Atz, J.W. (1957). The physiology of the pituitary gland of fishes. New York Zool. Soc.
- Piska, R.S. and Waghray, S. (1989). Fecundity of carp minnow, *Salmostoma bacaila* (Ham.) Indian. J. Fish. 36: 80-81.
- Qayyum, A. and Qasim, S.Z. (1964). Studies on the biology of some freshwater fishes. Part I. *Ophiocephalus punctatus* (Bloch). J. Bombay Nat. Hist. Soc. 61: 74-89.
- Serajuddin, M. (1995). Ph.D. Thesis, A.M.U. Aligarh.

Table 1: Gonad stages of male and female *S. phasa*

Stag	Testes	Ovaries
I (Immature)	Testes small, slightly clongated, distinguished microscopically. Vasdeference thin. GSI: 0.22 ± 0.035 (Ganga river); 0.62 ± 0.124 (Hooghly estuary).	Ovaries small, thin and white in colour. Eggs very minute and distinet only under microscope. Ova diameter: 0.14-0.21mm (Ganga river); 0.72-0.19mm (Hooghly estuary). GSI: 0.61 ± 0.157 (Ganga river); 0.17 ± 0.120 (Hooghly estuary)
II Maturing or Recovering	Testes elongated, whitish and opaque Vasdeferentia wide but reduced. GSI: 1.22 ± 0.185 (Ganga river); 1.29 ± 0.180 (Hooghly estuary).	Ovaries yellow in colour, granular in consistency, ova visible to the naked eye. Oviduct reduced. Ova diameter: 0.22-0.35 mm (Ganga river); 0.26-0.39mm (Hooghly estuary). GSI: 3.45 ± 0.619 (Ganga river); 1.43 ± 0.139 (Hooghly estuary).
III (Reipening)	Testes creamy white or reddish white in colour occuyping more than 1/2 of the body cavity. Viscous fluid oozes out from cut ends GSI: 0.88 ± 0.092 (Ganga river); 1.57 ± 0.269 (Hooghly estuary).	Ovaries yellowish in colour, elongated and more voluminous. Blood vessels visible over the surface of the ovaries, oviduct reduced. Ova diameter: 0.36-0.65 mm (Ganga river); 0.40-0.76mm (Hooghly estuary). GSI: 2.06 ± 0.382 (Ganga river); 2.30 ± 0.354 (Hooghly estuary).
IV (Ripe)	Testes elongated reddish or creamy white in colour, milt oozes out on slight pressure. Vasdeferens not discernibl. GSI: 0.47 ± 0.074 (Ganga river); 1.97 ± 0.331 (Hooghly estuary).	Ovaries yellow occupying whole body cavity, enclosing the intestine by lateral extension. Ova extruded on light pressure. Eggs opaque and very distinet. Ova diameter: 0.76-1.05mm (Ganga river); 0.79-1.19mm (Hooghly estuary). GSI: 1.11 ± 0.236 (Ganga river); 4.22 ± 0.523 (Hooghly estuary).
V (Spent)	Testes white and longer than the ripe testes, weight drastically reduced. No milting on pressure. GSI: 0.34 ± 0.06 (Ganga river); 0.61 ± 0.103 (Hooghly estuary).	Ovaries flaccid contracted and usually empty. The ovary has few remnants of mature ova in recent spawned fish. Weight reduced. GSI: 0.71 ± 0.142 (Ganga river); 0.95 ± 0.160 (Hooghly estuary).

Table 2: Sex ratio of *S. phasa* in different size groups

Ganga river				Hooghly estuary			
Sizes (mm)	Sex ratio (M/F)	Chi-square (χ^2)	Significance	Size (mm)	Sex ratio (M/F)	Chi-square (χ^2)	Significance
60-70	1:4.00	5.625	S*	60-80	1:1.75	1.768	NS
71-80	1:3.33	5.308	S*	81-100	1:0.90	0.053	NS
81-90	1:3.00	4.000	S*	101-120	1:1.33	0.583	NS
91-100	1:3.00	5.333	S*	121-140	1:1.27	0.365	NS
101-110	1:2.60	4.431	S*	141-160	1:1.00	0.000	-
111-120	1:3.50	4.015	S*	161-180	1:1.44	0.752	NS
121-130	1:1.00	0.000	-	181-200	1:1.67	0.533	NS
131-140	1:0.75	0.438	NS	201-220	1:0.78	0.398	NS
141-150	1:1.89	2.719	NS	221-240	1:1.34	1.463	NS
151-160	1:2.50	6.300	S*	241-260	1:1.28	0.508	NS
161-170	1:2.33	3.809	NS	261-280	1:1.23	0.314	NS
171-180	1:2.12	4.094	S*	281-300	1:2.23	4.874	S*
181-190	1:0.40	3.150	NS	301-320	1:1.21	0.293	NS
191-200	1:1.72	1.413	NS	321-340	1:1.31	0.688	NS
201-210	1:3.50	4.018	S*				
211-220	1:2.66	2.865	NS				
221-230	0:3.00	3.000	NS				
231-240	1:1.29	0.254	NS				
241-250	1:1.50	0.417s	NS				
Total				Total	1:24.88		
Mean	1:2.33			Mean	1:1.78		

S* Significant-Chi-square value significantly different at 5% level, the tabular value being 3.841

NS= Non significant

Table 3: Seasonal fluctuation of gonado-somatic index in *S. phasa*

Months	Ganga river				Hooghly estuary			
	Rang	Gonado-somatic index(males)	Range	Gonado-somatic index (females)	Range	Gonado-somatic index (males)	Range	Gonado-somatic index (females)
January	0.17-0.96	0.54±0.097	0.34-1.63	0.99±0.127	0.28-0.93	0.54±0.063	0.29-0.97	0.84±0.052
February	0.35-1.98	1.26±0.160	1.21-6.21	3.60±0.639	0.31-0.87	0.69±0.042	0.62-1.96	1.68±0.099
March	0.73-2.34	1.33±0.244	1.22-0.23	4.50±0.667	0.63-1.38	1.05±0.074	1.37-7.37	2.74±0.336
April	0.89-1.87	1.16±0.171	1.11-9.13	3.48±0.580	0.72-1.97	1.68±0.088	1.28-9.31	3.28±0.469
May	0.24-1.73	0.97±0.112	0.97-6.57	2.56±0.389	0.76-2.74	1.99±0.218	1.30-9.70	3.99±0.580
June	0.43-0.98	0.79±0.072	1.02-2.72	1.56±0.126	0.31-1.62	1.33±0.111	1.03-7.53	2.85±0.394
July	0.13-0.72	0.43±0.061	0.32-1.63	1.06±0.086	0.21-0.73	0.61±0.034	0.92-1.63	1.21±0.066
August	0.36-1.03	0.68±0.087	0.32-2.03	1.16±0.127	0.23-0.69	0.56±0.033	0.37-0.98	0.81±0.043
September	0.12-0.72	0.33±0.067	0.42-0.97	0.75±0.068	0.63-1.63	1.38±0.088	1.37-3.12	2.12±0.185
October	0.13-0.72	0.37±0.053	0.47-0.98	0.71±0.057	1.02-2.73	2.25±0.277	1.79-9.02	3.32±0.454
November	0.03-0.54	0.23±0.041	0.30-0.68	0.62±0.022	1.07-2.03	1.39±0.128	1.37-9.38	4.45±0.799
December	0.12-0.47	0.22±0.030	0.21-0.75	0.61±0.024	0.47-0.76	0.68±0.022	0.69-1.38	1.07±0.087

Table 4: Regression analysis of fecundity relations in *S. phase*

Parameters	Regression equation		Correlation co-efficient	Significance
	Logarithmic	Parabolic		
Body length vs fecundity 'L' 'F'	$\text{Log } F = 0.8937 + 2.2182 \text{ Log } L$	$F = 0.8 \times 10^1 L^{2.22}$	0.9826	P 0.001
Body weight vs fecundity 'BW' 'F'	$\text{Log } F = 2.5493 + 0.8765 \text{ Log } W$	$F = 3.5 \times 10^2 W^{0.88}$	0.9639	P 0.001
Ovary length vs Fecundity 'OL' 'F'	$\text{Log } F = 2.8067 + 1.9406 \text{ Log } OL$	$F = 6.4 \times 10^2 OL^{1.94}$	0.9652	P 0.001
Ovary weight vs Fecundity 'OW' 'F'	$\text{Log } F = 3.2161 + 1.2958 \text{ Log } OW$	$F = 1.6 \times 10^3 OW^{1.29}$	0.9730	P 0.001

Fig. 1 : Monthly fluctuation of maturity stages of Male & Female *S. phasa* in Ganga river

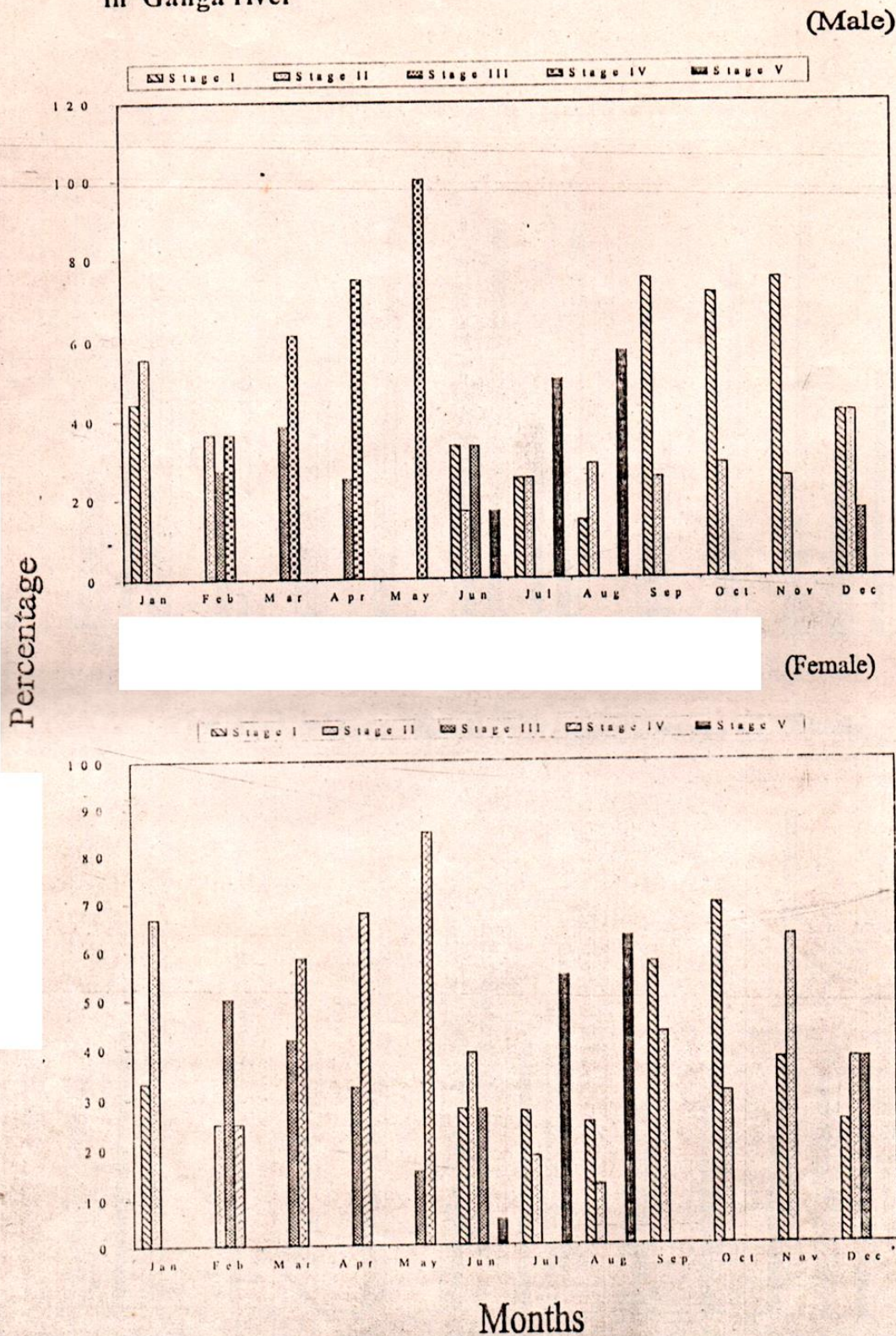


Fig. 2 : Monthly fluctuation of maturity stages of Male & Female *S. phasa* in Hooghly estuary

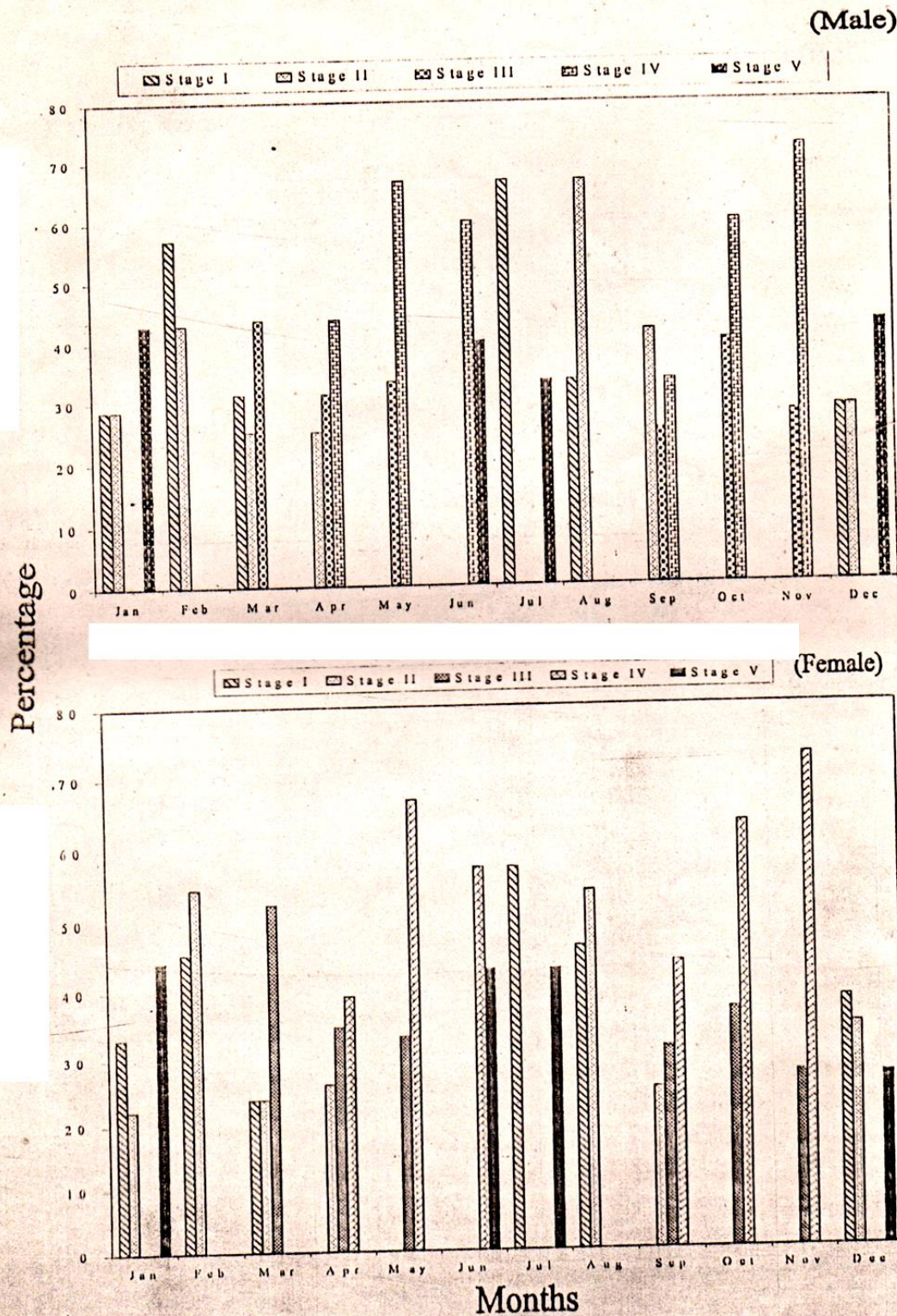


Fig. 3 : Monthly fluctuation in gonadosomatic index (GSI) in *S. phasa*

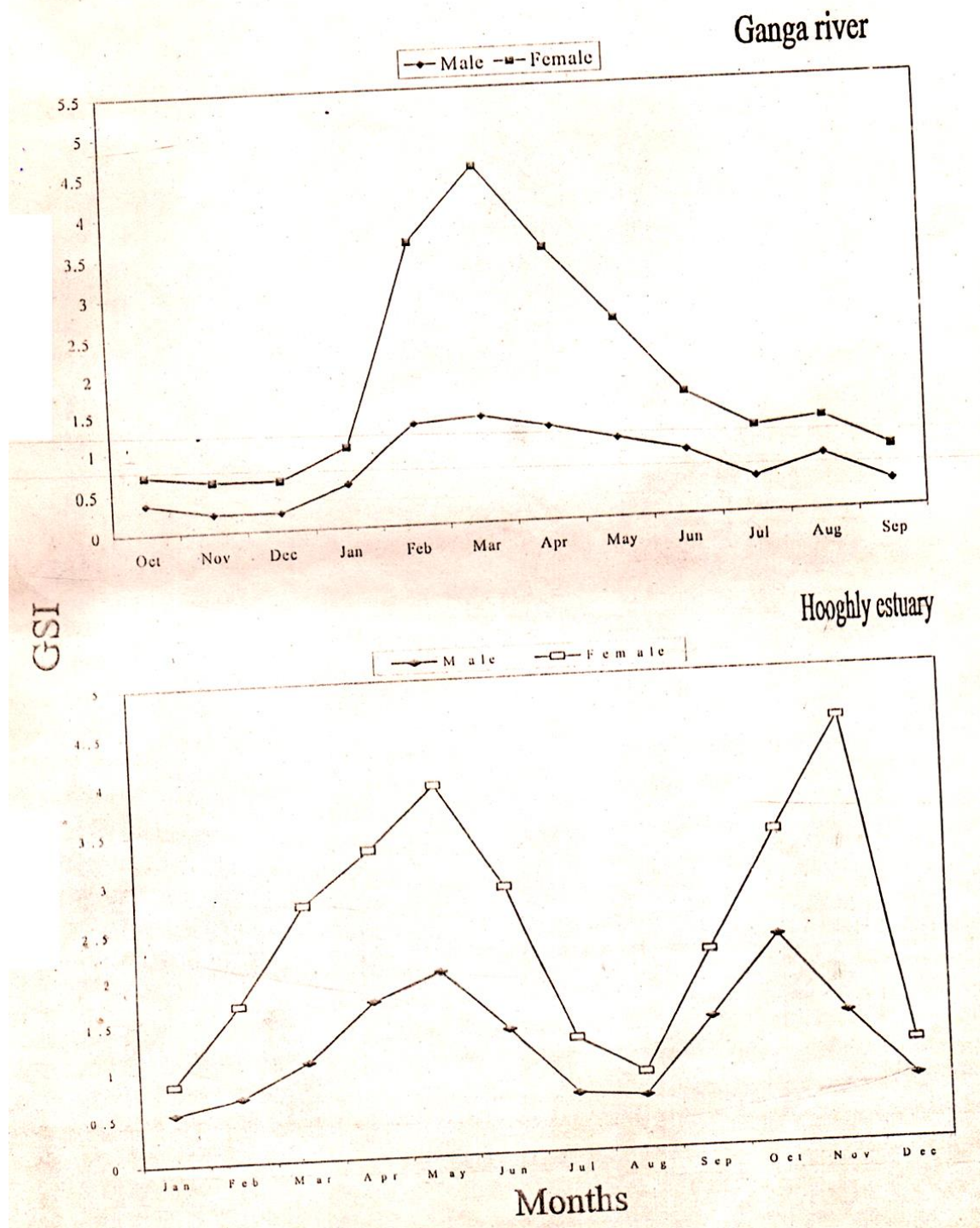


Fig. 4 : Size frequency distribution of intraovarian oocytes of *S. phasa*

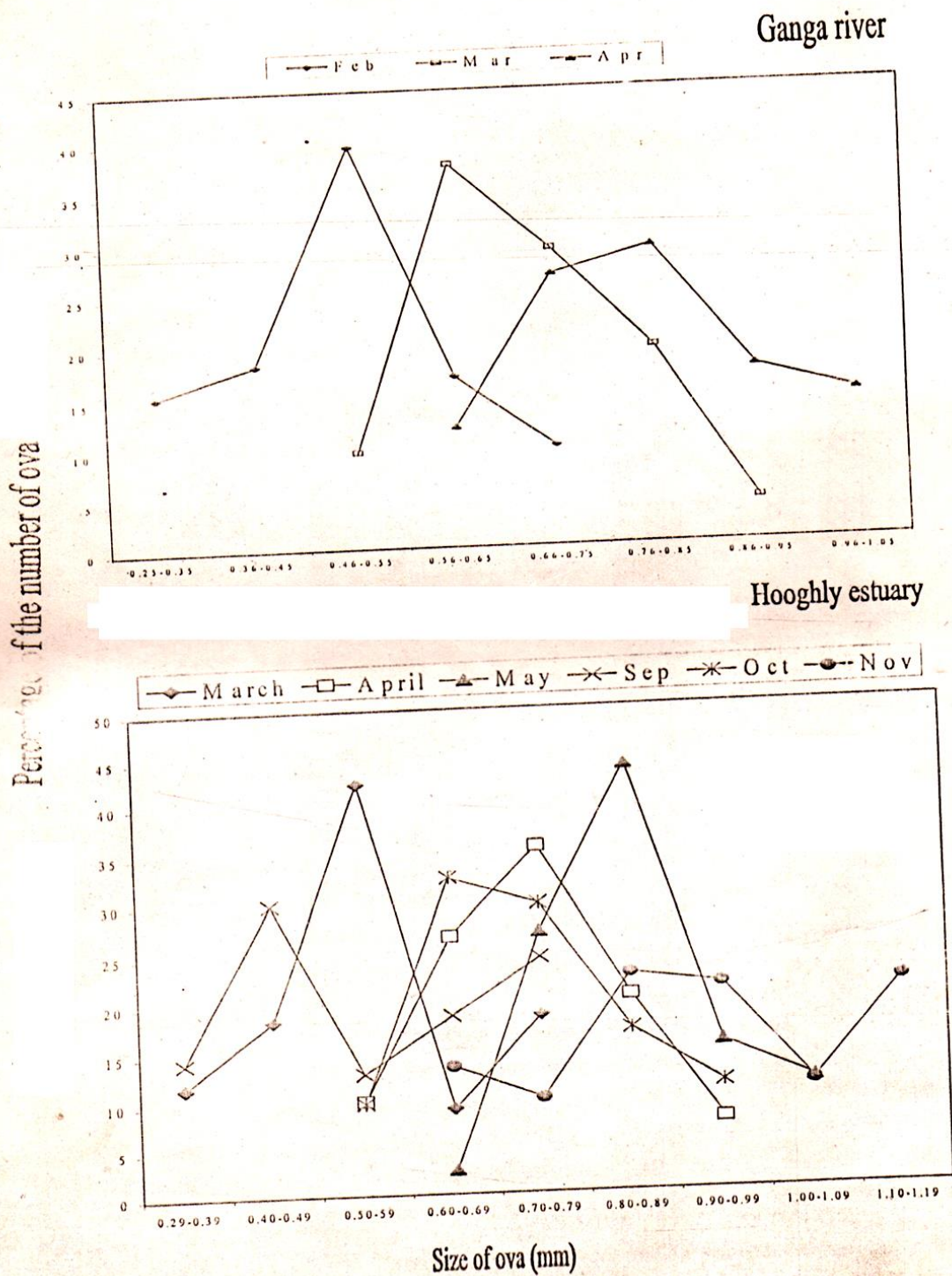


Fig. 5 : Monthly fluctuations of sexes in *Setipinna phasa*

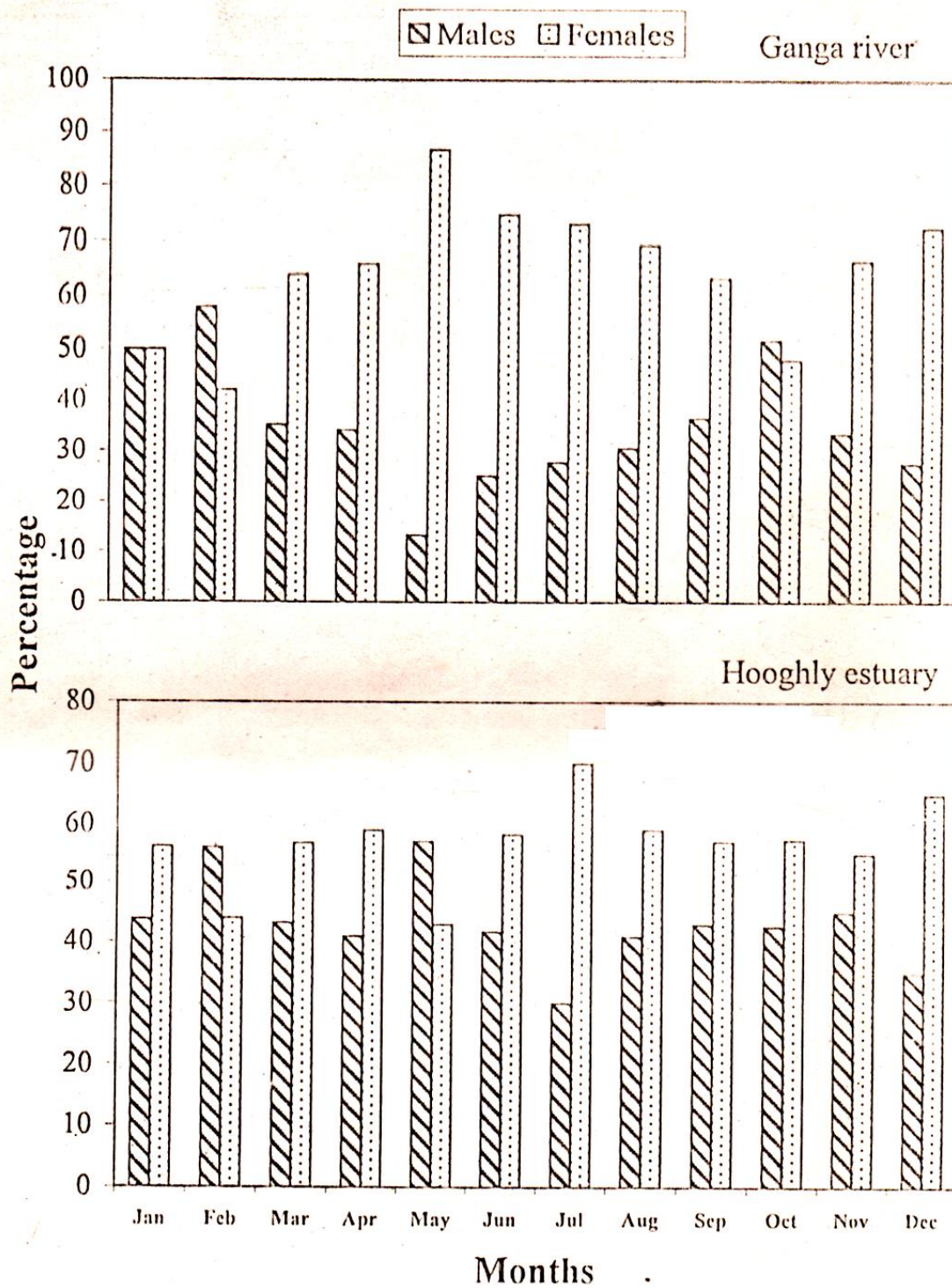


Fig. 6 : Relationship between fecundity and two predictors: (A) body length (B) body weight of *S. phasa*

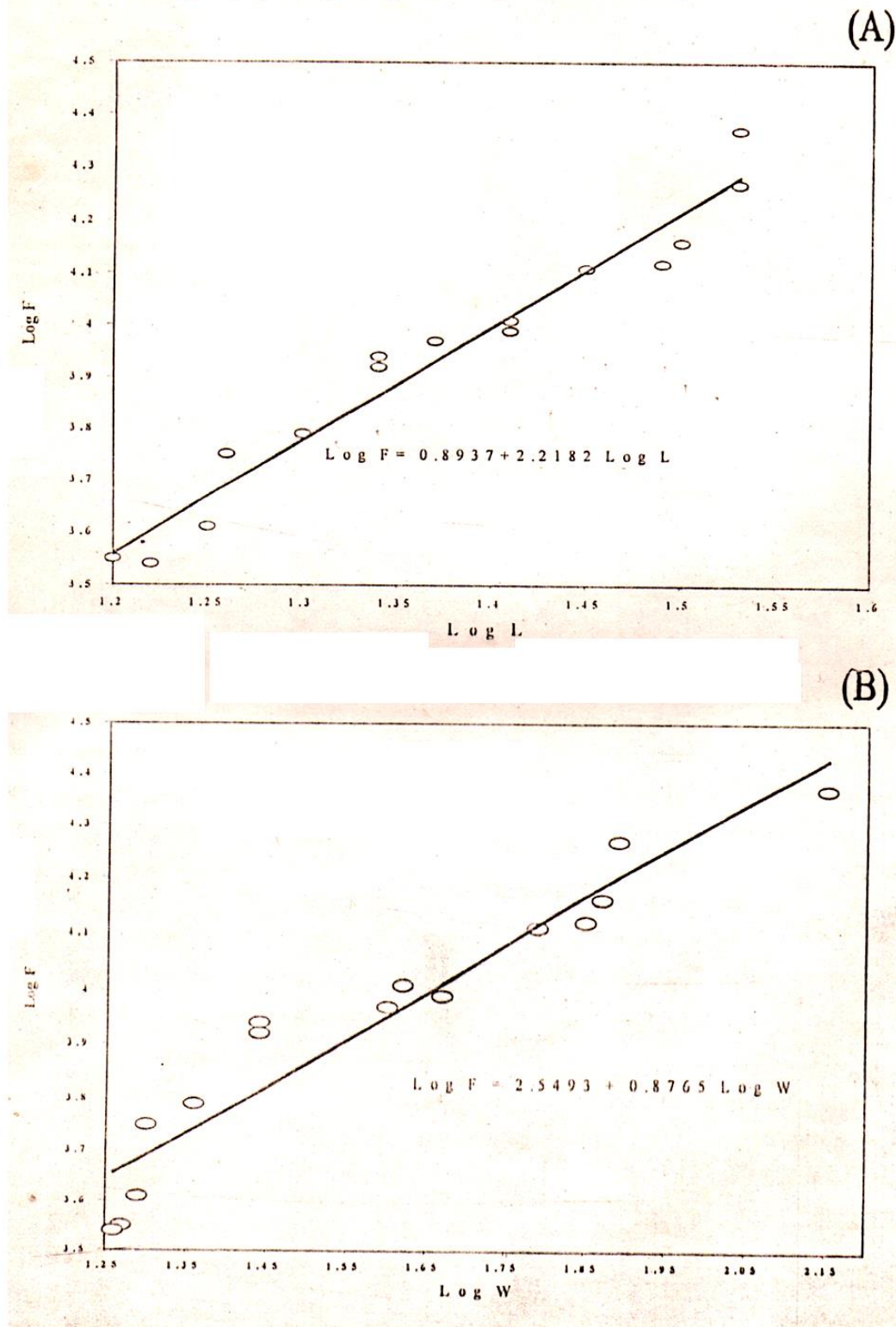
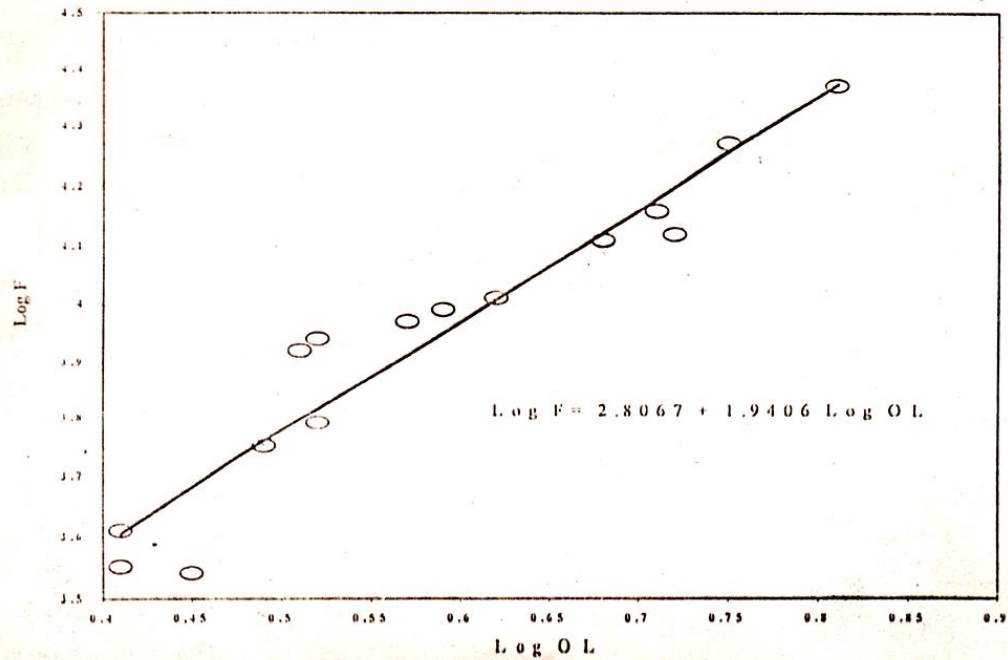


Fig.7 : Relationship between fecundity and two predictors : (A) ovary length (B) ovary weight of *S. phasa*

(A)



(B)

