J. mar. biol. Ass. India, 1995, 37 (1 & 2) : 39 - 48

BREEDING BIOLOGY OF A GOBIID FISH *ACENTROGOBIUS VIRIDIPUNCTATUS* FROM THE MANGROVE ÍBEA OF KARACHI COAST

S. M. SHAMSUL HODA
Department of Zoology, University of Karachi, Karachi, Pakistan

ABSTRACT

The breeding biology of a gobiid fish *Acentrogobius viridipunctatus* was studied over a 13-month period in the mangrove area of Karachi Coast (24° 51′ 30″ - 24° 51′ 35″ N, 66° 54′ - 66° 58′ E) for maturity, sex ratio, spawning frequency and fecundity. The gonads were classified into seven maturity stages. The breeding seasons were found to extend from February to May with the peaks in March-April, spawning once a year as substantiated by changes in gonosomatic indices (GSI), gonad maturity rate (GMR) and monthly frequency of maturity stages. An overall male to female ratio is 1.24 : 1.00. The sexual maturity occurs at a slightly smaller size at 98 mm in females than in males at 110 mm TL. The absolute fecundity is 12447-36058 (2007 ± 6952), the relative fecundity 905 ± 227 and ova/g ovary weight 11699 ± 5972. The mathematical equations describing the fecundity relationships with length and weight of the fish and ovary have been estimated. Chi-square test indicates that the fecundity - fish weight relationship is more valid than the fecundity - length relationship.

INTRODUCTION

VERY little work has been done on the biology of commercially less significant small fishes like gobioids than other large teleosts. *Acentrogobius viridipunctatus* (Cuvier and Valenciennes) is inhabitant of sandy mud bottoms in the mangrove areas bordering Karachi-Sind Coast of Pakistan (24° 51′ 30″ – 24° 51′ 35″ N, 66° 54′ – 66° 58′ E). Although this fish is of some food value, no attention has hitherto been given to the study of its biology except the information on its early development (Jones, 1937, 1939). Hence a detailed study on its breeding biology comprising maturity stages, group maturity rate (GMR), gonosomatic index (GSI), sex ratio and fecundity has been undertaken to fill up the lacuna in our present knowledge on this species.

I thank Mr. Gholam Hussain of Statistics Department for statistical advice.

MATERIAL AND METHODS

A fortnightly collection of the samples totalling 469 (M 260, F 209) was made by cast net or small seine net from the mangrove swamps along the Karachi Coast at Sandspit from October 1985 to October 1986. Each fish was cleaned, measured and dissected. The general colouration, shape, size and extension of the gonad into the body cavity were noted and the gonads preserved in 10% neutral formalin for further studies on maturation and fecundity. Maturity stages were classified arbitrarily into seven stages based on the appearance of fresh gonads, sizes, changes in GSI, extension of the gonads into body cavity and frequency distribution of ova diameters. The spawning was investigated by analysing the frequency distribution of ova diameters (Hickling and Rutenberg, 1936). In each sample

2 subsamples were taken per ovary and about 400-500 ova were measured in their long axis under a micrometer eye piece. Ova less than 0.065 mm were not considered. GSI was calculated as percentage of gonad weight to body weight. The group maturity rate (GMR) in each month and in each size group of 10 mm intervals was obtained from the formula :

$$GMR = \frac{\text{Number of females at stages IV–VII}}{\text{Total number of females}}$$

Determination of absolute fecundity was based on the gravimetric method (MacGregor, 1922; Bagenal, 1957) by counting the number of ripe ova from a piece of known weight of the middle region of both ovarian lobes and their average value raised to total ovary weight :

$$F = \frac{1}{2} (n_1/w_1 + n_2/w_2) W$$

(F = absolute fecundity, W = total weight of ovary, w_1 and w_2 = weight of the subsamples of either lobes of ovary and n_1 and n_2 = number of ova from the samples weighing w_1 and w_2 respectively).

The relative fecundity was determined as the number of ova per gram of body weight.

RESULTS

Maturity stages

The gonads increase in weight in relation to body weight as indicated by GSI (Fig. 1) and concurrently extend into the body cavity. The ova increase in diameter with the advancing stages of gonadal maturity and large ova are shed in batches (Fig. 2) during the breeding season of the year. The brief descriptions of arbitrarily classified seven maturity stages of males and females are given (Table 1).

TABLE 1. *Maturity stages*

Stages		Description
I.	Immature virgin	*Ovaries* : Transparent, pale, slender, occupying about 57.22 ± 6.87% of body cavity. GSI 0.156 ± 0.057. Ova transparent, spherical without yolk measuring about 0.119 mm.
		Testes : Whitish, slender, thread-like, occupying about 57.66 ± 11.52% of body cavity. GSI 0.091 ± 0.021.
II.	Developing virgin	*Ovaries* : Transparent, yellowish, slender, occupying about 65.78 ± 10.90% of body cavity. GSI 0.407 ± 0.112. Ova yolked measuring 0.293 mm in diameter with a mode at 0.206 mm.
		Testes : Whitish, longer than before, occupying 59.99 ± 8.89% of body cavity. GSI 0.173 ± 0.063.
III.	Developing	*Ovaries* : Yellowish, broader sac-like, occupying about 68.68 ± 16.13% of body cavity. GSI 0.661 ± 0.139. Ova yolked, measuring 0.423 mm with a mode at 0.336 mm.
		Testes : Whitish, larger, occupying about 69.16 ± 10.54% of body cavity. GSI 0.380 ± 0.074.
IV.	Maturing	*Ovaries* : Yellowish or yellow, increased in dimension, occupying about 71.56 ± 15.92% of body cavity. GSI 2.749 ± 0.063. Ova measuring 0.553 mm with a mode at 0.423 mm.
		Testes : Whitish, larger than before, occupying about 74.023 ± 7.962% of body cavity. GSI 1.143 ± 0.074.
V.	Mature	*Ovaries* : Yellow (deep yellow toward posterior region), expanded, occupying about 75.24 ± 12.11% of body cavity. GSI 6.442 ± 1.017. Ova measuring 0.683 mm with a mode at 0.553 mm.
		Testes : Whitish, expanded, occupying about 77.59 ± 6.005% of body cavity. GSI 1.765 ± 0.256.

TABLE 1. *Contd.*

VI. Ripe	*Ovaries* : Yellow, large and expanded, occupying about 82.50 ± 8.05% of body cavity. GSI 8.291 ± 0.970. Ova measuring 0.813 mm with a mode at 0.639 mm. Ova emit on slight pressure or are already in running condition.
	Testes : Whitish, expanded, occupying about 81.003 ± 13.442% of body cavity. GSI 4.703 ± 0.953. Milt emit at slight pressure.
VII. Spent	*Ovaries* : Yellowish, shrunken, occupying about 53.32 ± 14.44% of body cavity. GSI 0.389 ± 0.704. Very few mature ova remain to be absorbed, measuring about 0.501-0.639 mm.
	Testes : Whitish, shrunken, occupying about 64.19 ± 13.940% of body cavity. GSI 1.207 ± 1.593. No milt on pressure.

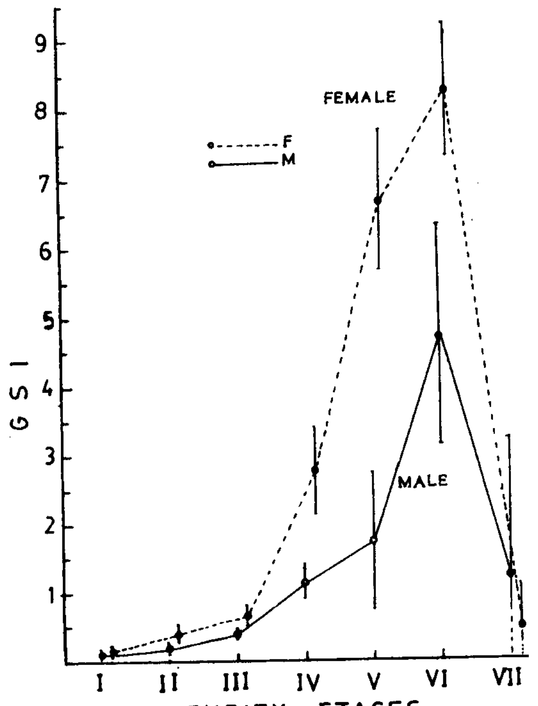

Fig. 1. Mean values of gonosomatic index (GSI) at 95% confidence limit.

Monthly percentage frequency of maturity stages

Fig. 3 a. shows a high proportion of stage I females caught during January and May.

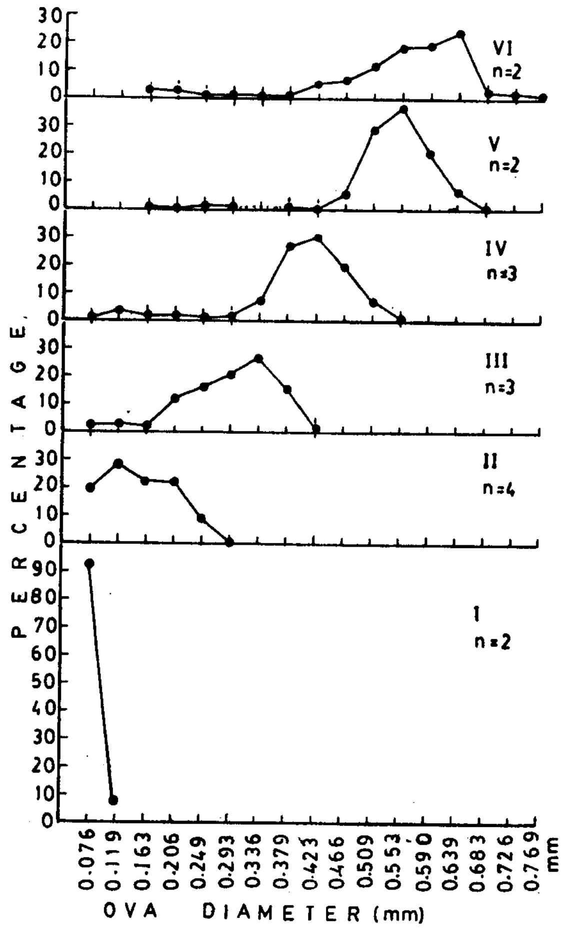

Fig. 2. Percentage frequency distribution of ova in each development stage of ovary.

Stages II and III present a much higher proportion than those of stages IV and V except March and April. Since the ovaries in stages IV and V were developing into the body cavity, their immediate development into stage VI was expected which is seen in higher proportion during February to May. Fish having spent ovaries were caught in June-July.

Fig. 3 b. shows a high percentage of stage I males in October, November and June, stage II in December and August, and stage VII in November, January and July to September.

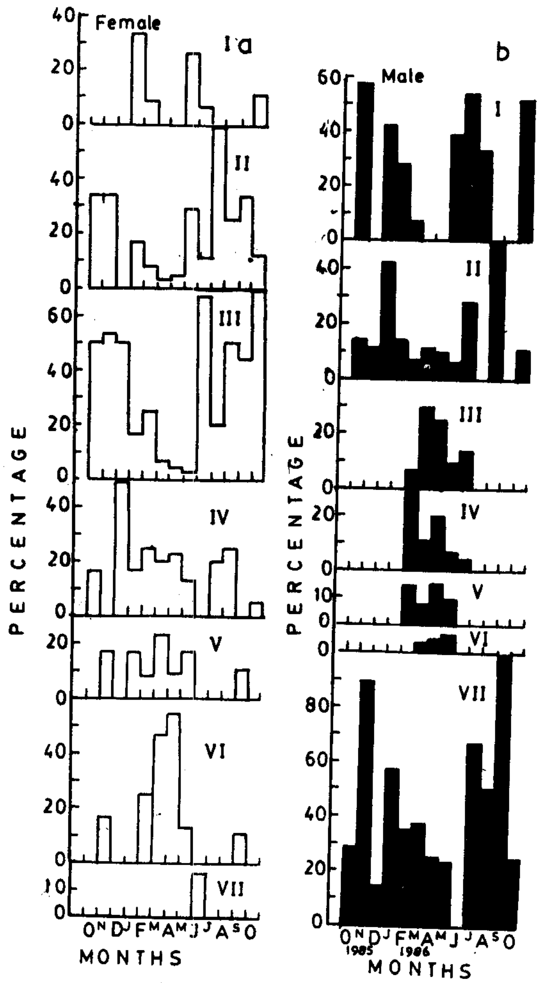

Fig. 3. Monthly percentage frequency of maturity stages.

Stage VI females and stages III-VII males spread over February to May are suggestive of the population having spawning completed during these months.

GMR and GSI

As shown in Fig. 4 the fish have higher GMR during February to May attaining peaks

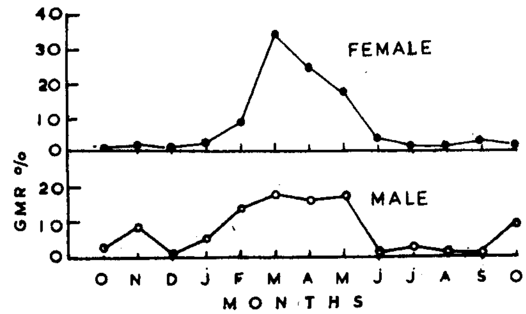

Fig. 4. Group maturity rate (GMR) in months.

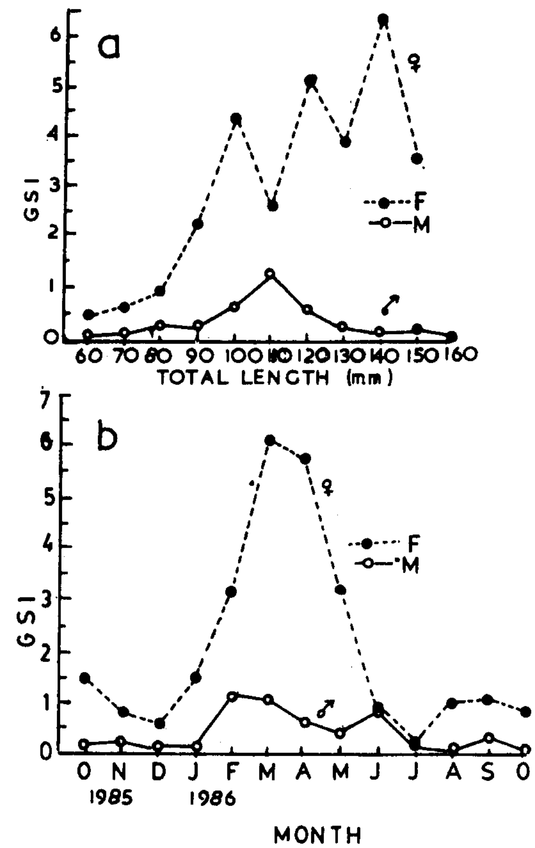

Fig. 5. Mean GSI values : a. In different sizes and b. In different months.

in March-April in either sexes. GMR remained consistently low during other seasons. High GSI values during February to May in both sexes are marked.

The modes at 100-110 mm TL in either sexes with an extension to 120 and 140 mm TL in females indicate that the breeding takes place during February to May at these lengths (Fig. 5).

Size at first maturity and breeding time

The fish mature at 80-89 mm TL forming 4.35% in males and 18.18% in females, and that 50% fish mature at 98 mm in females and 110 mm in males (Fig. 6). The size

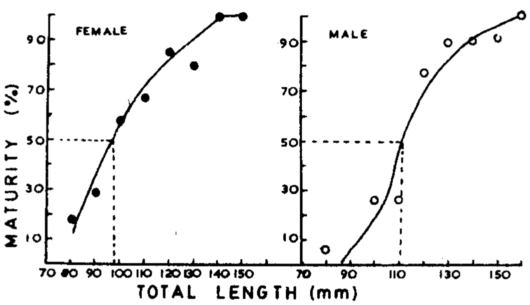

Fig. 6. Size at sexual maturity in males and females.

frequency distribution of ova in small portions of ovaries in each stage of maturity is shown in Fig. 2. Immature stock of ova greater than 0.119 mm in stage I grow out progressively onward exhibiting modes at 0.336, 0.423, 0.553 and 0.639 mm in stage III to VI respectively. As the shedding of ova takes place in batches, a single batch of ripe ova observed in these stages is suggestive of only one spawning in a year in *A. viridipunctatus*.

Sex ratio

The overall male-female ratio is 1.24 : 1.00 which is significantly differt from 1:1. In size group of 80-89 mm and larger than 120 mm TL; the males outnumbered the females constituting 4.35 and 76% maturation, respectively (Table 2). The females outnumbered males in March-April which is the peak time of the breeding seasons between February and May (Table 3). The outnumbering of either sexes may be attributed to differential sex mortality or other physiological factors.

Fecundity

23 ovaries were examined to establish the relationship between the distributing individual fecundity (F) to total length (TL), weight of the fish (Wf), weight of the ovary (Wov) and length of the ovary (Lov) (Fig. 7 a-d). The regression equations computed have been given in Table 4. To find the degree of relationship in groups, the data for length, weight and fecundity were grouped at 10 mm intervals and the relationships based on four formulae were computed as follows, and their validity was tested by the Chi-square (X^2). The least value was found for fecundity - body weight relationship (Table 5), having higher coefficient of determination (r^2 = 0.992).

1. $F = a + b L$

   $F = -30.000 + 0.425 L$ ($r^2 = 0.924$) (Fig. 8 a)

2. $F = a + b L^3$

   $F = 3.10 + 0.0001 L^3$ ($r^2 = 0.963$)

3. $F = a L^b$ or $\text{Log } F = \text{Log } a + b \text{ Log } L$

   $\text{Log } F = -8.34 + 2.34 \text{ Log } L$ ($r^2 = 0.963$)

4. $F = a + b \cdot W$

   $F = 4.41 + 0.688 W_f$ ($r^2 = 0.992$) (Fig. 8 b)

The number of ova produced by an individual fish varied from 12954 to 36058 from fish measuring 97 to 149 mm TL and 11.5 to

46.2 g respectively. Mean absolute fecundity was 20007 ± 6952 and relative fecundity was 905 ± 227. The number of ova/g ovary weight was 11699 ± 5972 (Table 6). The fecundity increased with length and weight of fish and an inverse relationship with the unit to the fish. Although the older fish are more fecund, it is the younger fish (90-119 mm TL) that they produce more ova per gram body weight.

Unimodal ova diameter polygons are suggestive of a single spawning in a year. This phenomenon agrees well with *Gobiopterus chuno* (Pillay and Sarojini, 1950), *Leucopsarion petersi* (Tamura and Honma, 1969; Matsui, 1986), *Glossogobius giuris* (Saxsena, 1976 a,b) and *Boleophthalmus dussumieri* (Mutsaddi and Bal, 1969), but differs from *Chaenogobius urotaenia* (Dotsu, 1955), *Gillichthys mirabilis* (Barlow and De Vlaming, 1965), *Oligolepis acutipennes* (Gibson and Ezzi, 1978, 1981; Geevarghese and John, 1983), *B. dentatus* (Hoda and Akhtar, 1985) and *B. dussumieri* (Hoda, 1986) in having two protracted breedings. Miller (1984) opined that nearly all gobies repeat spawning, in some

TABLE 2. *Sex ratio at different size groups*

	Sizes mm											
	60	70	80	90	100	110	120	130	140	150	160	Total
Males	10	25	49	22	27	28	35	27	17	13	7	260
Females	9	27	27	33	42	34	22	11	3	1	–	209
% males	52.63	48.08	64.47	40.00	39.13	45.16	61.40	71.05	85.00	92.86	100	55.44
X^2	0.05	0.08	6.37*	2.20	3.26	0.58	2.96*	6.74*	9.80*	10.29*	0000	5.55*

* Significant at 95% C.L.

TABLE 3. *Sex ratio in different months*

	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Total
Males	8	19	11	8	15	31	22	42	34	6	6	9	49	260
Females	7	18	5	6	14	33	23	36	20	10	4	12	21	209
% males	53.33	51.35	68.69	57.14	51.72	48.44	48.89	53.85	62.96	37.50	60.00	42.86	70.00	55.44
X^2	0.07	0.03	2.25	0.29	0.03	0.06	0.02	0.46	3.63*	1.00	0.40	0.43	11.20*	5.55*

* Significant at 95% C.L.

TABLE 4. *Regression equations of fecundity with length and weight of fish and ovary*

Variables			a	b	r	SE of 'a'	SE of 'b'
Log	F–Log	TL (mm)	- 0.3194	2.2142	0.7954	0.7295	0.3676
Log	F–Log	Wf (g)	3.3715	0.6793	0.7954	0.1519	0.1130
Log	F–Log	Wov (mg)	3.0565	0.3778	0.5863	0.3691	0.5220
Log	F–Log	Lov (mm)	3.3260	0.6506	0.3187	0.6181	0.4221

DISCUSSION

A. viridipunctatus breeds during February to May attaining peaks in March-April as evidenced by high values of GSI, GMR, ripe ovaries and distributions of ova diameters.

TABLE 5. *Relation between fecundity (in thousands) and length and weight of body and ovary. Mean value for 10 mm groups observed and calculated and differences between them*

Mean length (mm)	Mean weight (g)	Mean number of ovabserved	Observed-calculated							
			F = a + bl	Diff	F = a + bl³	Diff	F = al^b	Diff	F = a + bW	Diff
97.50	12.40	13.00	11.37	1.63	12.16	0.84	12.36	0.64	12.93	0.07
104.20	13.66	13.95	14.21	- 0.26	14.16	- 0.21	14.47	- 0.52	13.80	0.15
115.00	20.05	19.04	18.80	0.24	17.96	1.08	18.29	0.75	18.29	0.75
125.00	24.79	20.51	23.04	- 2.53	22.19	- 1.68	22.28	- 1.77	21.45	- 0.94
133.33	30.08	24.42	26.58	- 2.16	26.26	- 1.84	25.97	- 1.55	25.09	- 0.67
144.50	42.80	34.40	31.32	3.08	32.59	1.81	31.42	2.98	33.84	0.56
Durban-Watson statistic			1.68		2.08		2.15		2.20	
X^2 (Chi-square)				0.993		0.483		0.189		0.102

TABLE 6. *Absolute and relative fecundity at 10 mm length ranges* (Mean SD)

TL (mm)	Mean length	N	Mean weight	Mean Fecundity	Relative fecundity	Mean ovary weight	Fecundity/g ovary weight
90-99	97.50	2	12.40 (1.56)	12967 (18.38)	1053.93 (130.74)	1.60 (0.68)	8978.66 (3956.55)
100-109	104.20	5	13.66 (2.01)	13947 (1524.60)	1054.72 (197.50)	1.40 (0.68)	12519.26 (7091.07)
110-119	115.00	2	20.05 (1.63)	19038 (6253.65)	965.35 (390.21)	1.87 (0.69)	1160.79 (7622.92)
120-129	125.00	9	24.79 (2.46)	20509 (4893.84)	828.26 (189.29)	1.60 (0.60)	14063.17 (5968.46)
130-139	133.33	3	30.08 (2.89)	24416 (4478.64)	811.20 (171.93)	2.47 (0.56)	10105.06 (2797.53)
140-149	144.50	2	42.80 (4.80)	34396 (2350.43)	805.64 (35.59)	4.30 (0.85)	8212.91 (2167.28)
90-149	119.92	23	23.14 (8.92)	20007 (6951.80)	904.84 (226.98)	1.93 (1.001)	11699.24 (5971.76)

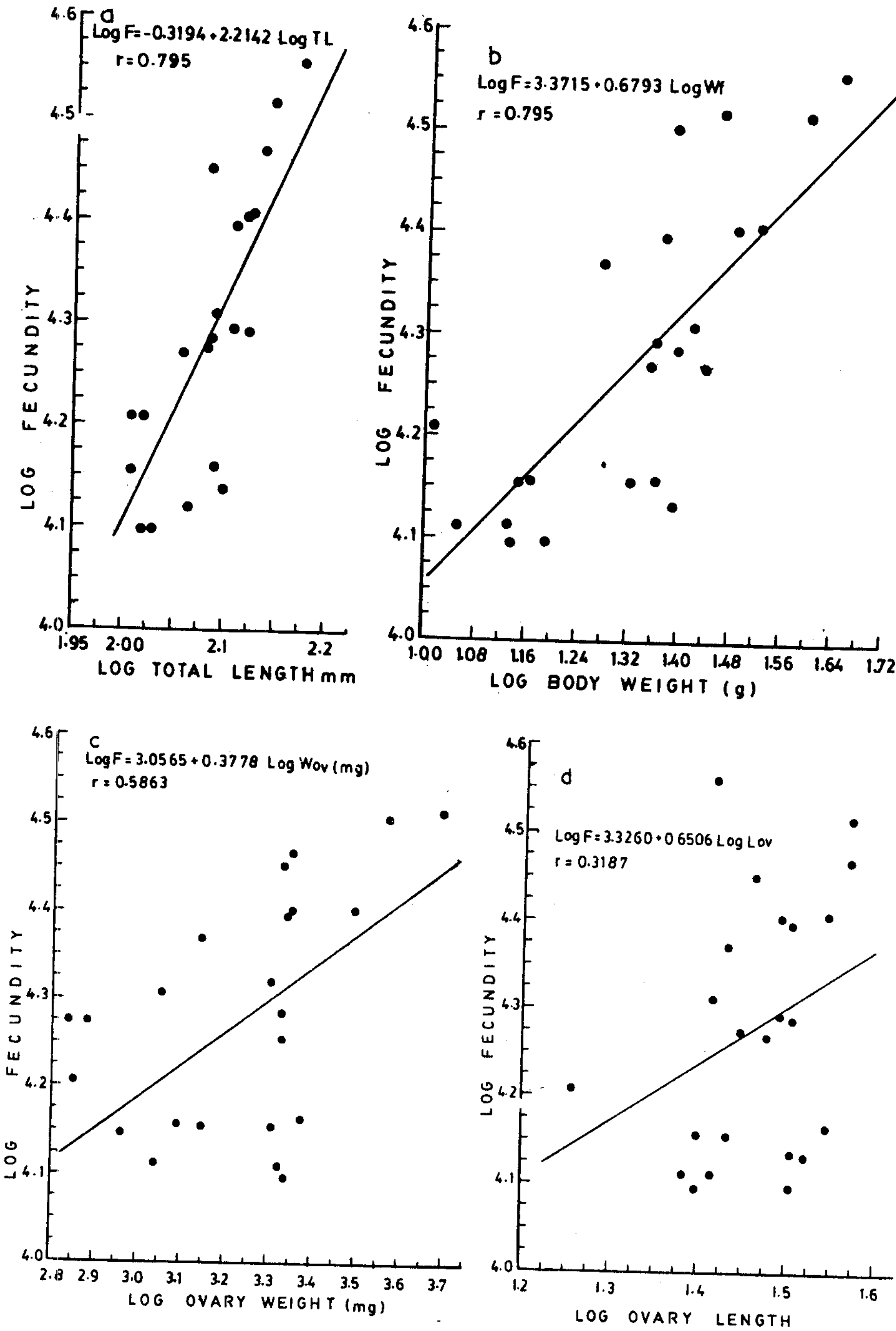

Fig. 7. Log relationship between : a. total length and fecundity, b. body weight and fecundity, c. ovary weight and fecundity and d. ovary length and fecundity.

cases at least several times in a season thus for the average female *Gobius paganellus* spawned twice per season and *Pomatoscistus micropsexhibitis* likely six spawnings in three months.

(Hoda, 1986). Wenner (1972) accounted several possibilities for unequal sex ratio in teleosts (*i.e.* mortality, growth, sex difference in activity). Variations in *A. viridipunctaus* may be affected by sex difference in activity or

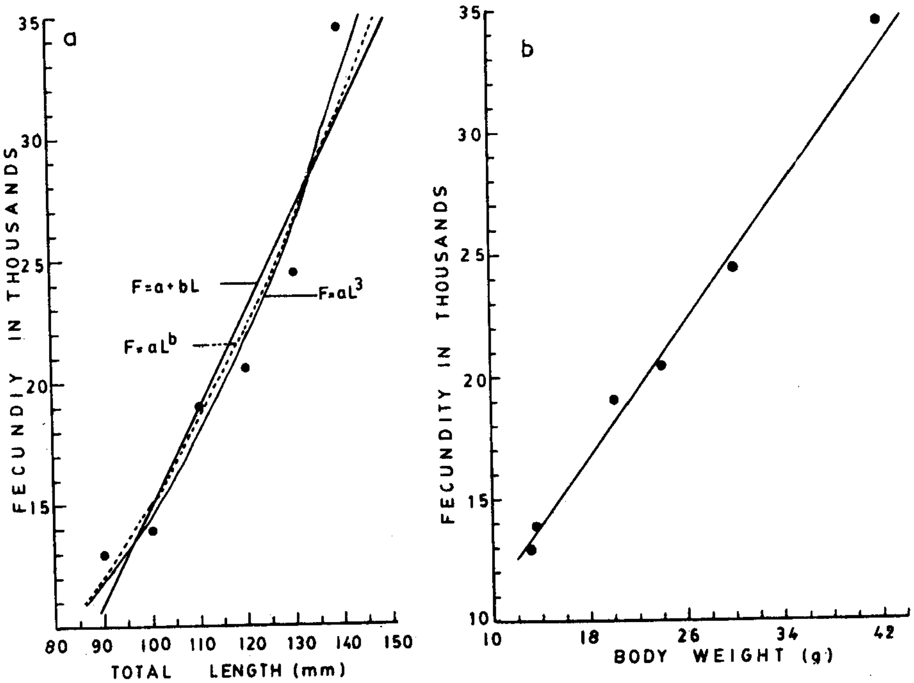

Fig. 8. Relationship between : a. total length and fecundity, and b. body weight and facundity

The sex composition of the gobliid population is available for at least 26 species and most do not depart from a 1 : 1 ratio (Miller, 1984). The sex frequency data in the fish under study showed 1.24♂ : 1.00♀ which differs from *Lesuerigobius friesii* 1.12 : 1.00 (Gibson and Ezzi, 1978), *Gobius cobitis* and *O. acutipennes* as 1 : 2 (Gibson, 1970; Geevarghese and John, 1983), *G. giuris* as 5 : 1 (Geevarghese, 1976), *B. dentatus* 1.00 : 1.04 (Hoda and Akhtar, 1985), *B. dussumieri* 1.00 : 1.60 (Mutsaddi and Bal, 1969) and 1.00 : 1.42

mortality or some other physiological conditions.

Great variations in the fecundity of gobioid fishes have been known between the similar sized samples (Miller, 1984). However, the present estimate 12954-36058 (20007 ± 6952) is nearing 15000-51000 in *Synechgobius hasta* (Takita, 1975), but differing greatly from 264-961 in *A. masago* (Dotsu, 1958). Fecundity is either equally or more closely related to weight than length in *A. viridipunctatus*.

References

BAGENAL, T. B. 1957. A short review of fish fecundity. *In* : S. S. D. Gerking [Ed.] *The biological basis of freshwater fish production.* Oxford, Blackwell Scientific Publications, pp. 89-112.

BARLOW, G. W. AND V. L. VLAMING 1965. Ovarian cycle in long jaw goby *Gillichthys mirabilis* from the Salton Sea. *Calif. Fish and Game.*, **58** (1) : 50-57.

DOTSU, Y. 1955. The life history of a goby *Chaenogobius urotaenia* (Hilgendrof). *Sci. Bull. Fac. Agric. Kyushu Univ.*, **15** : 367-374.

——— 1958. The life history of the gobiid fish *Acentrogobius mesago. Ibid.*, **16** : 359-370.

GEEVARGHESE, C. 1976. Studies on some aspects of the biology of *Glossogobius giuris* (Ham.) with a taxonomic note on six gobioid fishes occurring in and around Trivandrum. *M. Phil. Dissertation, Kerala University, India*; 90 pp.

——— AND P. A. JOHN 1983. Maturation and spawning of a gobiid fish *Oligolepis acutipennis* (Cuv. & Val.) from the Southwest coast of India. *J. Fish Biol.*, **23** : 611-624.

GIBSON, R. N. 1970. Observations on the biology of the giant goby *Gobius cobitis* Pall. *Ibid.*, **2** : 281-288.

——— AND I. A. EZZI 1978. The biology of a Scottish population of Fries' goby *Lesuerigobius friessi. Ibid.*, **12** : 371-389.

——— AND ——— 1981. The biology of the Norway goby *Pomatoschistus norvegicus* (Collett) on the west coast of Scotland. *Ibid.*, **19** : 697-714.

HICKLING, C. F. AND E. RUTENBERG 1936. The ovary as an indicator of the spawning period of fishes. *J. Mar. Biol. Ass. U.K.*, **2** : 311-317.

HODA, S. M. S. AND YASMIN AKHTAR 1985. Maturation and fecundity of the mudskipper *Boleophthalmus dentatus* in the northern Arabian Sea. *Indian J. Fish.*, **32** : 64-73.

——— 1986. Maturation and fecundity of the mudskipper *Beleophthalmus dusscumieri* Cuv. and Val. from the Karachi Coast. *Mahasagar, Bull. nat. Inst. Oceanogr.*, **19** : 73-78.

JONES, S. 1937. Observations on the breeding habits and development of certain brackishwater fishes of Adyar, Madras. *Proc. Indian Acad. Sci.*, **5** (6) : 261-289.

——— 1939. On the external gills of *Acentrogobius viridipunctatus. Ibid.*, **9** (5) : 256-266.

MACGREGOR, J. S. 1922. Fecundity of the Pacific sardine (*Sardinella caerules*). *U. S. Fish and Wild Services, Fish. Bull.*, **121** : 427-449.

MATSUI, S. 1986. Studies on the ecology and propagation of the Ice goby *Leucosparion petersi* Hilgendrof. *Sci. Bull. Fac. Agric. Kyushu Univ.*, **40** : 135-174.

MILLER, P. J. 1984. The tokology of the gobioid fishes. *Fish Reproduction* ISB No. 12 56 1660., **4** : 120-153.

MUTSADDI, K. B. AND D. N. BAL 1969. Maturation and spawning of *Boleophthalmus dussumieri* (Cuv. & Val.). *J. Univ. Bombay*, **39** (66) : 59-76.

PILLAY, T. V. R. AND K. K. SAROJINI 1950. On the larval development of the Indian transparent goby *Gobiopterus chuno* (Hamilton) with observations on its bionomics. *Proc. nat. Inst. Sci. India*, **16** (3) : 181-187.

SAXSENA, D. N. 1976. Reproductive organs and reproductive cycle of the female Indian fresh water goby *Glossogobius giuris* (Ham.). *Res. Bull. Punjab Univ. N. S. Sci.*, **13** : 263-268.

TAKITA, T. 1975. Spawning and early development of *Synechgohius hasta* in an aquarium with description of larvae and juveniles. *Japn. J. Ichthyol.*, **22** (1) : 31-39.

TAMURA, E. AND Y. HONMA 1969. Histological changes in the organs and tissues of the gobiid fishes throughout the life span. I. *Bull. Japn. Soc. Sci. Fish.*, **35** : 875-884.

WENNER, A. 1972. Sex ratio as a function of the size of marine Crustacea. *Am. Nat.*, **106** : 321-350.