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ASPECTS OF THE REPRODUCTIVE BIOLOGY OF THE MULLET *VALAMUGIL CUNNESIUS* IN KARACHI-SIND WATERS

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ABSTRACT

Reproductive characteristics of *Valamugil cunnesius* from Karachi-Sind waters were examined in 1983 and seven stages of gonadal maturity are described. Males and females are sexually nature for the first time at 90-99 mm SL. Sex ratio is not significantly different from 1 : 1. Frequency distribution of ova diameter is suggestive of two spawnings in a year from April to July and December, which also tallies with the higher GSI values during these seasons. Predictive equations between fecundity and standard length, body weight, ovary weight and ovary length are provided.

INTRODUCTION

THE MULLET *Valamugil cunnesius* Valenciennes is one of the common species contributing to the mullet fishery of Karachi-Sind (67°10' 67°49'E, 24°12'—24°42' N). Although the fishery and biology of this species has been studied from Bay of Bengal (Sarojini, 1958), no work from Pakistan has been reported. Therefore, an attempt is made here to determine the maturity stages, sex ratio, gonadosomatic indices (GSI), size at maturity at 50% level, spawning pattern and fecundity of *V. cunnesius* from Karachi-Sind waters.

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MATERIAL AND METHODS

Random samples were collected every fortnight from commercial catches, landed by trawl net at Karachi West Wharf Fish Harbour, between January and December, 1983. The samples were frozen. A total of 896 fish were examined. After thawing the fish, the length, weight, sex and maturity stages were recorded. The gonads were removed, weighed to the nearest 0.002 g and preserved in 5% neutral formalin. Gonadosomatic index (GSI) for each fish was calculated as the ratio of gonad weight to the total fish weight expressed as percentage. The ova diameter frequency distribution of the various size groups of ova in the different stages of maturity, were determined by measuring the ova samples from the middle parts of either ovarian lobes and expressed as percentage of the total number of ova (Clark, 1934 ; Hickling and Rutenberg, 1936). The fecundity was determined, using gravimetric method from four portions, two from the middle regions in each ovarian lobe. The weight of each portion of the lobe and the whole ovary was taken ; the number of the most mature group of ova in stages IV, V and VI (not running) present in the portion was raised to the total weight

of the ovary, which gave the fecundity of the fish (MacGregor, 1957).

defined by a modified scheme of a seven points scales (Laevastu, 1965) (Table 1).

TABLE 1. *Distinctive features of testes and ovaries of* V. cunnesius *at different stages of maturation*

Stages of maturation	Testes	Ovaries
I. Immature virgin	Small (>22 mm in length), thin, strip, whitish, opaque, occupying less than half the length of body cavity. GSI 0.145± 0.25	Small (>16 mm in length, a bit cylindrical, yellowish white, transparent, occupying less than half the length of body cavity. Ova transparent, devoid of yolk deposition, measure 0.167 mm in diameter. GSI 0.368± 0.058
II. Developing virgin	Whitish, transparent, occupying half or more the length of body cavity. GSI 0.601± 0.041	Yellowish, occupying almost half the length of body cavity. Ova yolked, visible to naked eye, measure 0.239-0.251 mm. GSI 0.781± 0.107
III. Developing	More elongate than before, occupying more than 1/3 and less than 2/3 of body cavity. GSI 1.160± 0.063	Opaque, enlarging, granular in consistency, occupying less than 1/3 of body cavity. Developing group of ova visible, measure 0.40-0.50 mm. GSI 2.333± 0.215
IV. Maturing	More elongate, massive, occupying more than 2/3 of body cavity. GSI 1.450± 0.137	Enlarged, occupying nearly 2/3 or more of body cavity. Maturing group of ova measure 0.50-0.59 mm. GSI 3.440± 1.023
V. Mature	Extensive, occupying more than 2/3 to 3/4 of body cavity, milt oozes out from cut ends. GSI 1.684± 0.0236	Yellow, larger than stage IV, massive occupying 2/3 to 3/4 of body cavity. Mature group of ova measure 0.50-0.75 mm. GSI 5.504± 0.55
VI. Ripe or running	More extensive than stage V, milt run under no or only slight pressure from cut ends. GSI 2.306± 0.360	Yellow, full, occupying almost the whole space of body cavity. Ripe ova running with slight pressure, measure 0.75-0.83 mm. GSI 11.207± 0.216
VII. Spent	Shrunken, no milt on pressure. GSI 0.697± 0.169	Spent, flabby, contracted, a few large spent ova present measuring 0.577-0.827 mm. GSI 0.981± 0.054

RESULTS

The GSI values of the gonads increase from immature stage to the stage of full ripeness through intermediate stages of maturation (Fig. 1). The following maturity stages are

Spawning pattern and size at maturity

The immature stock of ova (Fig. 2, Stage I) gives rise to maturing groups of ova, and this group gradually increases in size with modes at 0.324 mm, 0.408 mm, 0.534 mm and 0.618 mm at maturity stges III, IV, V and VI

respectively which constitute the mature groups of ova destined to be shed during the ensuing spawning season. Mature fish were available

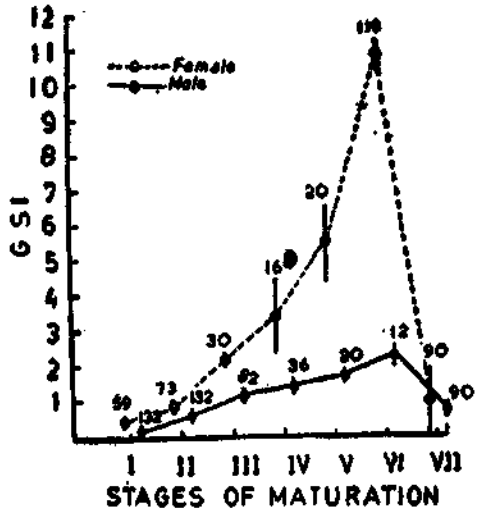

FIG. 1. Variation of GSI with stages of maturation. Bars indicate 95% CL; figures above the bars indicate number of individuals used.

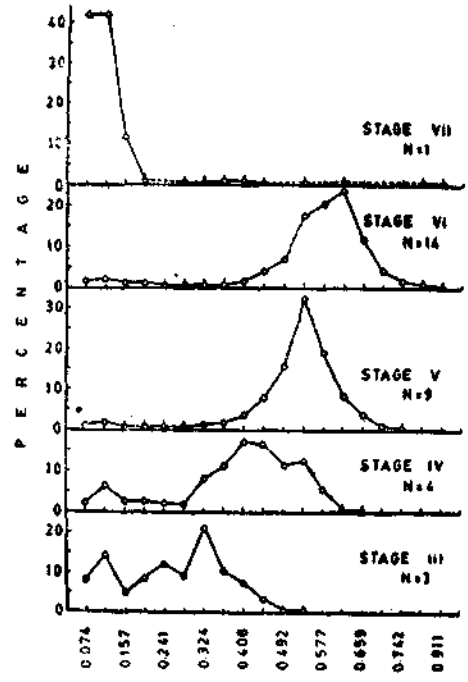

FIG. 2. Ova diameter frequency curves in different maturity stages.

TABLE 2. *Percentage of mature fish (stages IV-VII) in different size during different months*

Month	Male N	Male Immature (N)	Male Mature (N)	Male %	Females N	Females Immature (N)	Females Mature (N)	Females %
January ..	15	13	2	13.3	28	9	19	67.9
February ..	3	3	—		4	4	—	
March ..	52	46	6	11.5	34	29	5	14.71
April ..	44	5	39	88.6	55	3	52	94.5
May ..	61	10	51	83.61	49	—	49	100.0
June ..	42	23	19	45.2	49	—	49	100.0
July ..	37	20	17	45.9	28	—	28	100.0
August ..	43	21	22	51.2	32	12	20	62.5
September ..	31	27	4	12.6	31	21	10	32.3
October ..	45	29	16	35.6	32	10	22	68.8
November ..	18	18	—		28	28	—	—
December ..	23	—	23	100.0	35	—	35	100.0
	414	215	199	48.07	405	116	289	71.36

throughout the year except in February and November. This suggests a prolonged spawning for the species with intensity during April, July and December (Table 2).

High values of GSI during May-June in both sexes may be related to the maturation and spawning; the gonads begin to increase in weight in December also (Fig. 3 a). From

Table 3 it my be seen that 31.7% males were mature at 90-99 mm SL, while 58.5% females were mature at this length, at 110-119 mm SL 54.2% of males and 71.0% of females were mature. All males were mature at 130 mm SL and all females were mature at 140 mm SL. The foregoing indicates that the females mature earlier than males.

males dominated in size groups 80 and 90 mm and females from 100 mm size groups onwards. This also indicates that females could grow faster than males.

Fecundity

The ovaries of 49 mature females *V. cunnesius* measuring 93-154 mm SL and 17.65-74.96 g,

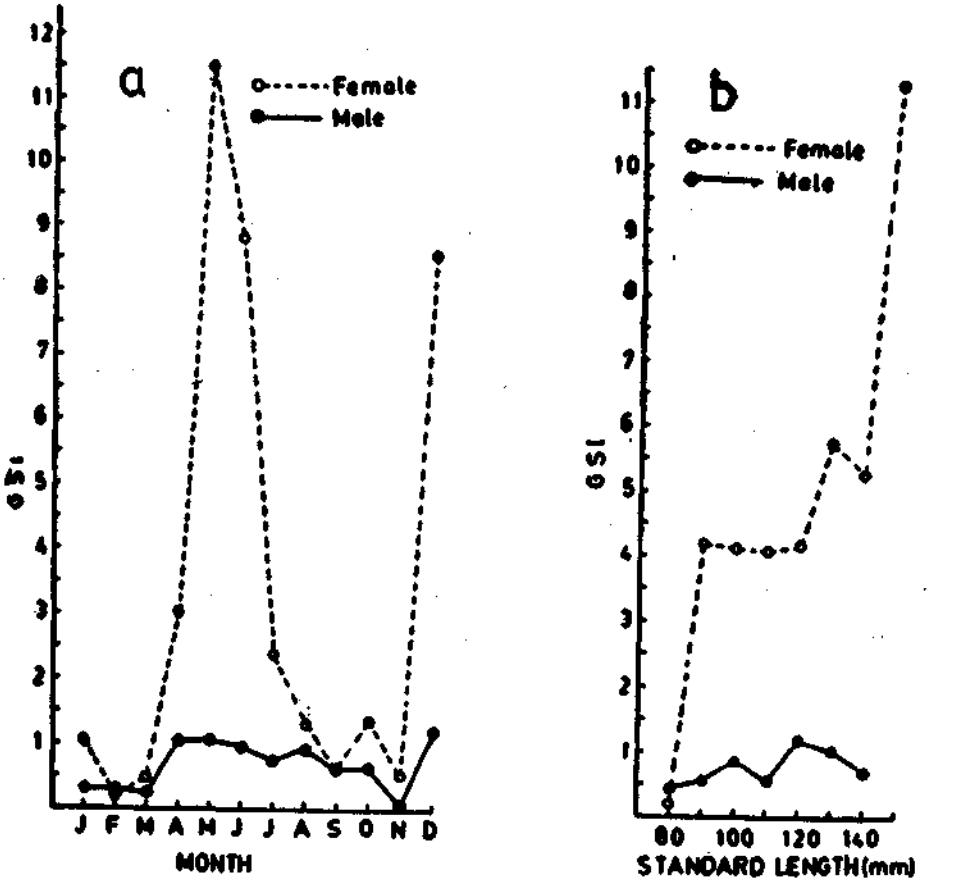

FIG. 3. Variation in GSI values : a. different seasons and b. different sizes.

Sex ratio

The overall sex ratio of 51 : 49 males to females was not significantly different from 1 : 1, but the monthly sex ratio was inequal in January and March with preponderance of females in January and of males in March Table 4). From Table 5, it may be seen that

were considered for the study of fecundity It was estimated in relation to SL (Standard length) Wf (body weight), Wov (ovary weight) and Lov (ovary length) using regression lines calculated by least square-method (Fig. 4 a-c)

$$\text{Log } F = 0.422 + 1.999 \text{ Log SL (mm)}$$

(S. E. 'a' = 0.5286, S.E. 'b' = 0.2578 ; r = 0.75 ; t = 7.77).

Log F = 3.439 + 0.716 Log Wf (g)
(S.E. 'a' = 0.1251, S.E. 'b' = 0.0082 ; r = 0.78 ; t = 8.55)

Log F = 4.176 + 0.640 Log Wov (g)
(S.E. 'a' = 0.0372, S.E. 'b' = 0.0669 ; r = 0.72 ; t = 10.61)

The numbers of ova increased with size of females. On an average 1013 ova are produced per gram-weight of the body and 9315 ova per gram-weight of the ovary (Table 6). The maximum fecundity was found to be 62833 from a fish measuring 150 mm SL and the minimum 21933 from a fish of 95 mm SL.

TABLE 3. *Percentage of matured fish (Stages IV-VII) in different size groups*

Size groups (mm)	Male N	Male Immature (N)	Male Mature (N)	Male %	Female N	Female Immature (N)	Female Mature (N)	Female %
90-99 ..	60	41	19	31.7	53	22	31	58.5
100-109 ..	218	118	100	45.9	145	45	100	69.0
110-119 ..	118	54	64	54.2	138	40	98	71.0
120-129 ..	16	2	14	87.5	49	8	41	83.4
130-139 ..	2	—	2	100.0	17	1	16	94.1
140-149 ..	—	—	—	—	2	—	2	100.0
150-159 ..	—	—	—	—	1	—	1	100.0
	414	215	199	48.07	405	116	289	71.36

Log F = 1.548 + 1.386 Log Lov (mm)
(S.E. 'a' = 0.4086, S.E. 'b' = 0.245 ; r = 0.73 ; t = 7.30)

TABLE 4. *Sex Ratios (male : female) of* V. Cunnesius *in different months*

Month	Ratio	Proportion of male	X^2
January ..	15 : 28	0.35	3.93*
February ..	27 : 26	0.51	0.02
March ..	64 : 42	0.60	4.57*
April ..	45 : 55	0.45	1.00
May ..	68 : 49	0.58	3.09
June ..	42 : 51	0.45	0.87
July ..	37 : 28	0.57	1.25
August ..	43 : 32	0.57	1.61
September ..	31 : 31	0.50	0.00
October ..	46 : 32	0.59	2.51
November ..	18 : 28	0.39	2.17
December ..	23 : 35	0.4	2.48
Total ..	459 : 437	0.51	0.54

* Significant at 5% level.

DISCUSSION

The sex ratio of 1.05 : 1.00 in *V. cunnesius* conforms to the general pattern of 1 : 1, which

TABLE 5. *Sex ratios (male : female) of* V. cunnesiu *in different size groups*

Size group (mm)	Ratio	Proportion of male	X^2
70 ..	0 : 1	0.00	0.00
80 ..	15 : 9	0.63	1.50
90 ..	69 : 61	0.53	0.49
100 ..	227 : 153	0.47	14.41*
110 ..	123 : 143	0.46	1.504
120 ..	19 : 50	0.27	13.93*
130 ..	5 : 17	0.23	6.55*
140 ..	1 : 2	0.33	0.33
150 ..	459 : 437	0.00	0.00
Total ..	459 : 437	0.51	0.54

* Significant at 5% level.

agrees with other mullets like *Liza tade* (Pillay, 1953), *L. parsia* (Sarojini, 1957) and

L. macrolepis (Luther, 1963). The skewed ratio might be found in fish either males and females migrating in schools or gathering on spawning grounds or biased sampling from the landings or having biannual or triannual peaks of availability to capture (Sarojini, 1957 ; the males of *M. cephalus* are mature at a smaller size than females, a common phenomenon in species like *L. parsia* (Sarojini, 1957), *L. ramanda* (Perlmulter, 1957) *Crenimugil labrosus* (Hickling, 1970) and *L. subviridis* (Chan and Chua, 1980).

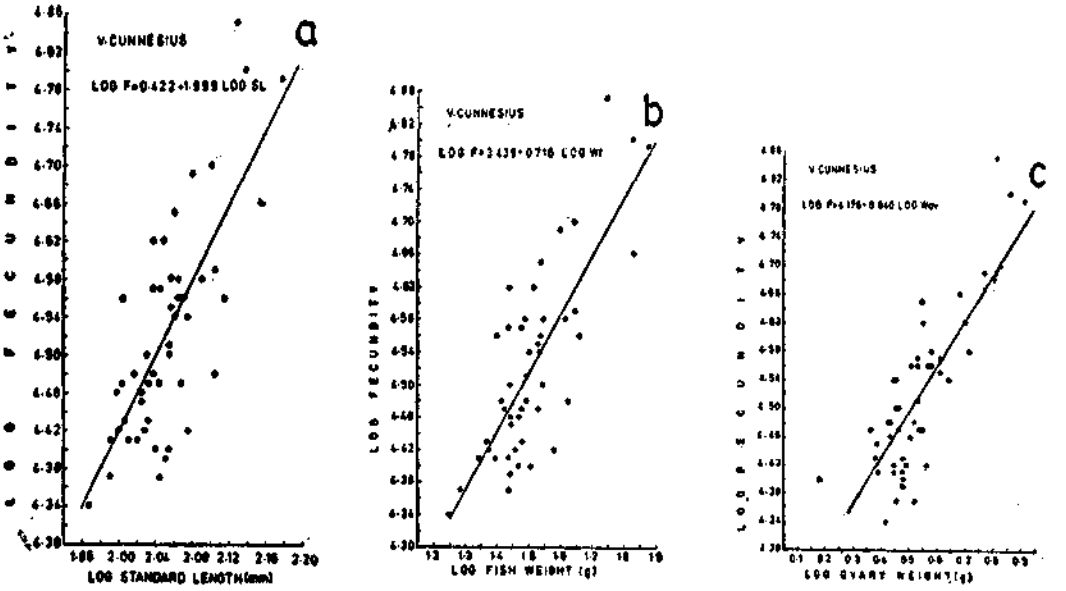

FIG. 4. Log-Log fecundity relationships with a. SL, b. fish weight and c. ovary weight.

Lasiak, 1982). The preponderance of males in size groups greater than 120 mm SI is in conformity with *Mugil cephalus* (Kestevan, 1942 ; Silva and DeSilva, 1981). This also indicates difference in linear growth rate between sexes (Luther, 1985). Female appears to grow faster than male.

Sexual maturty (at 50% level) is attained at a smaller size in femles than in males. This agrees with *M. cephalus* where the females and males matured at 31 and 34 cm respectively (Silva and DeSilva, 1981), while Thomson (1951) and Rangaswamy (1975) observed that

The fecundity presents variations depending upon the size and weight of the fish as well as ovary. The present egg count in *V. cunnesius* is 22-63 $\times 10^3$ from Karachi-Sind waters. An equivalent figure 15-56 $\times 10^3$ was determined by Sarojini (1958) from the same species from Hooghly waters of Bay of Bengal. The low fecundity in this species may be related to a reduced accommodation capacity for increased egg production such as 16-27 $\times 10^3$ in *L. malinoptera* (Ching V. Chong, 1977) and 21-40.5 $\times 10^3$ in *L. klunzingeri* (Hod and Qureshi, 1989).

Sarojini (1958) observed only one spawning season (May-June to July-August) in a year in *V. cunnesius* from Bay of Bengal, while the present study on this species from Karachi Coast indicates two spawning seasons (April to July and in December) as evidenced by the GSI values, which may be due to some climatic changes.

TABLE 6. *Mean fecundity counts at various length ranges in* V. cunnesius

Frequency	Length range SL	Mean SL of fish (mm)	Mean Wt. of fish (g)	Mean Wt. of fish ovary (g)	Mean no. of ova	No. of ova per gm wt. of body wt.	No. of ova per gm wt. of ovary
1	90-94	93	17.650	2.600	21953	1244	8443
3	95-99	98.5	23.592	2.853	26133	1108	9159
6	100-104	101.67	24.917	2.852	28983	1153	1016
10	105-109	107.45	28.913	3.109	30577	1058	10575
11	110-114	112.23	31.101	3.383	33143	1066	9797
8	115-119	116.81	34.659	3.428	35083	1012	10235
2	120-124	124.5	40.505	5.525	43891	1084	7944
3	125-129	126.67	43.583	4.611	40012	918	8678
2	130-134	132.25	50.750	4.925	53793	1060	10923
1	135-139	137	67.000	7.250	62833	938	8667
1	140-144	143	67.500	4.800	46200	684	9625
—	145-149	—	—	—	—	—	—
1	150-154	150	74.960	8.150	61736	824	7575
49	90-154	120.26	42.094	4.457	40361	1013	9315

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