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Reproduction of *Liza dussumieri* (Valenciennes) in Porto Novo Waters

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(i) The maturity and spawning in *L. dussumieri* of Porto Novo waters has been studied from the data obtained from 1045 specimens collected during September 1975–August 1976.

(ii) The males of the species appear to mature earlier than females.

(iii) GSI was high in December and a gradual decline from then on showed that the breeding season was a prolonged one. Relative condition factor *(Kn)* values followed the same pattern and offered corroborative evidence.

(iv) The breeding in *L. dussumieri* was found to be from December to August—throughout the year except in the monsoon time.

(v) The fecundity increases in relation to length.

(vi) The sex ratio showed a general preponderance of females over males and probable congregation during spawning.

Introduction

L. dussumieri (Valenciennes) is the most common grey mullet in Porto Novo waters. The synonymy of *L. dussumieri* with *L. parsia* (Sarojini 1953) has not been supported and they are considered as separate and distinct species morphologically, anatomically, osteologically, serologically and chemotaxonomically (Reddy 1977). Sarojini (1957) studied the biology of *M. parsia* and as she considered *L. dussumieri* as a synonym of *M. parsia*, quite possibly her material might have been a mixture of both the species. Therefore, after validating them as separate species, the biology of *L. dussumieri* was studied by us in detail.

Material and Methods

Material for this study was obtained between Sept. 1975 and Aug. 1976. Fishes were caught three or four times a month during daytime by operating cast nets of different mesh sizes. A total of 1045 fishes were collected ranging from 79 to 248 mm in total length (T.L.). Fishes were brought to the laboratory in ice-box and stored in deep freezer for further study or were utilized in fresh condition as needed.

Results and Discussion

Maturation and Spawning

(i) Development of ova to maturity and frequency of spawning

The maturity stages adopted in the present study are given below along with corresponding maturity scale of the ICES (Wood 1930) for comparison.

L. dussumieri—*Gonadial condition*

Stage	Female	Male	Maturity Scale of ICES
I (Immature)	Pinkish, occupying 1/4 to 1/2 body cavity; ova irregular and transparent	Whitish, ribbon-shaped, occupying 1/2 body cavity	I—II
II (Maturing I)	Yellowish, occupying 1/2 to 2/3 body cavity; ova round, partially yolk-laden	Whitish, occupying 2/3 body cavity	III
III (Maturing II)	Yellowish, occupying 2/3 to 3/4 body cavity; ova round and fully laden with yolk	Whitish, occupying 2/3 to 3/4 body cavity	IV
IV (Matured)	Yellowish, occupying nearly the entire body cavity with some ova visible to the exterier; yolk vacuolated; perivitelline space present	Creamy white, occupying the entire body cavity	V
V (Oozing)	In the oozing stage	Fish in the oozing stage	VI
VI (Spent)	Flaccid with blood vessels prominent over the surface; occupying not more than 1/2 the body cavity	Flaccid, occupying about 1/2 body cavity	VII

A total of 300 ovaries of different maturity stages were examined for ova diameter studies at a magnification which gave a value of 18.2μ to each micrometer division. The diameter of 200 ova was measured as suggested by Clark (1934) and De Jong (1940). Ova measuring three micro divisions (MD) and above were taken into consideration while drawing percentage frequencies. The diameter frequencies have been grouped into 2 MD groups each, like 3–4, 5–6, 7–8 etc.

Figure 1 gives different stages of development of ova. In stage I, majority of the ova measured between 3–5 MD. A few larger ova (9–10 MD) were also recorded but withdrawal of this batch of larger ova from the general stock is not indicated. In stage II, though the diameters of the majority of the ova measured were between 3–5 MD, a separate stock with a distinct batch of eggs measuring 7–8 MD was also discernible. After stage III, the development of these ova seems to be rapid and separation of these mature ova (9–10 MD) from the immature stock (3–5 MD) is quite apparent. In stage IV, the mature group of ova is further separated distinctly from the immature group with its mode at 15–16 MD. Stage V is the most advanced stage observed in this study and because the ova diameter percentage frequency polygon of the mature ovaries presents only a single, well differentiated batch of ova with a mode at 21–22 MD, it is inferred

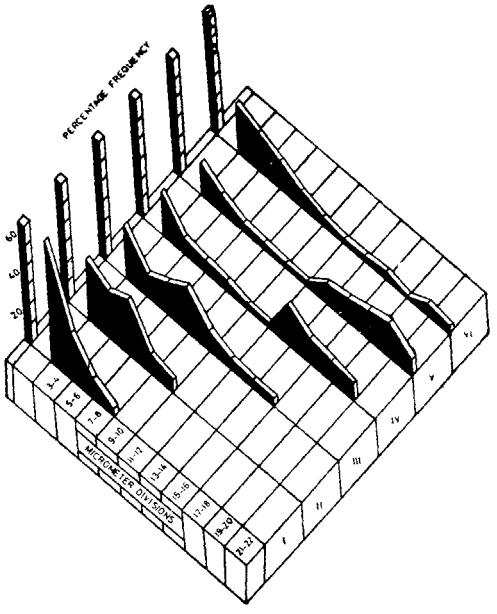


Figure 1 Ova diameter percentage frequency of different maturity stages of *L. dussumieri*

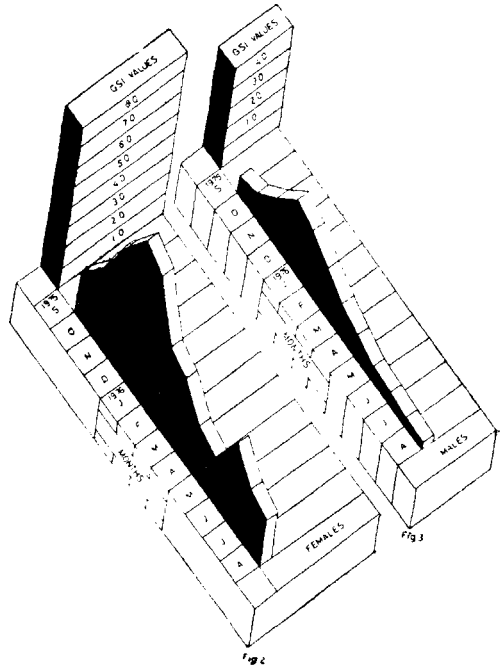
Table 1 *Gonado-somatic index (GSI) values of* L. dussumieri *from September 1975–August 1976*

Month & Year	GSI	
	Males	Females
1975		
Sept.	0.8647	1.9363
Oct.	1.1496	3.2966
Nov.	2.0483	5.4632
Dec.	3.1684	7.0340
1976		
Jan.	2.7042	6.4521
Feb.	2.0463	4.0496
Mar.	1.4812	3.6479
Apr.	1.0182	2.4617
May	0.6301	2.0142
June	0.5182	3.9842
July	0.4504	2.7014
Aug.	0.3646	2.3469

that the individual fish breeds only once in a season. This is further supported by the ova diameter percentage frequency polygon of the spent ovary (Stage VI), which, after spawning is left only with an immature stock of eggs and with or without few degenerating ova. It is thus probable that the actual period of spawning during which mature ova (15-24 MD) are discharged might be a prolonged one (Rangaswamy 1972) and this is further supported by monthly observations made for one year (see figure 6).

(ii) Gonado-Somatic Index (GSI)

Applying the method of June (1953) and Yuen (1955), the relative weight or GSI of *L. dussumieri* was calculated by using the formula : GSI=weight of ovary/weight of fish × 100. This index was calculated for both males and females for each individual and monthly averages were then calculated separately (table 1). It is evident that in females (figure 2) and males (figure 3)



Figures 2–3 GSI values of females of *L. dussumieri* from September 1975–August 1976; GSI values of males of *L. dussumieri* from September 1975–August 1976

maximum GSI values were noticed in December after which a gradual decrease was seen up to August, followed by an increase leading to maximum values in December.

High values in males and females indicate full development of the gonads during those months. Monthly variations in the GSI offer not only additional proof for the duration of breeding season, but are also indicative of the major phases of the reproductive cycle. The data clearly show that *L. dussumieri* has one prolonged and extended breeding season (December to August) in Porto Novo waters. In other words it does not breed during the monsoon months alone but breeds throughout the rest of the year.

(iii) Relative condition factor 'Kn':

The relative condition factor *Kn* for *L. dussumieri* was calculated from September 1975 to August 1976 for both the sexes (table 2) employing the formula $Kn = W/\omega \times 100$ where W represents the observed weight and ω, the calculated weight of fish obtained by using logarithmic formula. *Kn* values are graphically represented for both the sexes. In females and males (figure 4, 5) high *Kn* values were evident in December; thereafter a gradual decrease was noticed up to August, followed by an increase in the values up to December.

Table 2 *Relative condition factor ('Kn') values of* L. dussumieri *from September 1975–August 1976*

Month & Year	*Kn*	
	Males	Females
1975		
Sept.	0.9869	0.9336
Oct.	1.0026	1.0411
Nov.	1.1106	1.0791
Dec.	1.1361	1.1554
1976		
Jan.	1.1009	1.1215
Feb.	0.9545	1.0998
Mar.	0.9379	1.0583
Apr.	0.9701	1.0348
May	0.9102	0.9817
June	0.9024	0.9504
July	0.8987	0.8842
Aug.	0.8142	0.8214

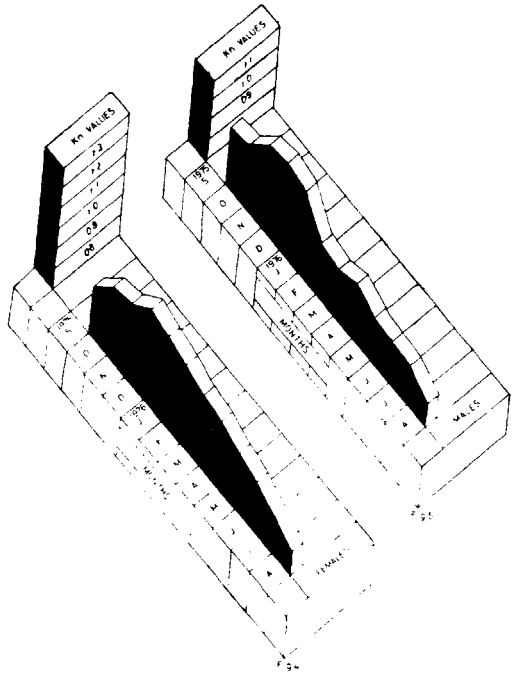


Figure 4 *'Kn'* values of females of *L. dussumieri* from September 1975–August 1976

Figure 5 *'Kn'* values of male of *L. dussumieri* from September 1975–August 1976

The rise in *Kn* value in both the sexes is perhaps due to the preponderance of ripe gonads and the drop is due to spawning which caused a drop in the weight of the gonads. Monthly variations in *Kn* values further strengthen our conclusion that *L. dussumieri* has one prolonged breeding period (December to August) in Porto Novo waters.

Table 3 *Percentage occurrence of different maturity stages of* L. dussumieri *from September 1975–August 1976*

Month & Year	Males						Females					
	I	II	III	IV	V	VI	I	II	III	IV	V	VI
1975												
Sept.	83.33	16.67	—	—	—	—	9.09	54.55	27.27	—	—	9.09
Oct.	23.08	46.15	30.77	—	—	—	25.00	50.00	25.00	—	—	—
Nov.	60.00	12.50	10.00	17.50	—	—	54.55	18.18	9.09	—	—	18.18
Dec.	27.91	23.26	16.28	18.60	13.95	—	55.17	20.69	10.35	13.79	—	—
1976												
Jan.	22.22	13.89	30.56	11.11	22.22	—	7.57	4.55	4.55	24.24	40.91	18.18
Feb.	36.84	15.79	—	26.32	21.05	—	7.69	7.69	5.13	19.23	39.74	20.52
Mar.	7.32	17.07	17.07	29.27	9.76	19.51	5.38	15.05	4.30	18.28	27.96	29.03
Apr.	11.11	11.11	26.68	33.33	4.44	13.33	2.94	13.73	9.80	22.55	27.45	23.53
May	25.81	19.35	12.90	16.13	9.68	16.13	5.26	10.53	7.90	23.68	28.95	23.68
June	21.43	21.43	28.56	—	14.29	14.29	4.82	13.25	7.23	38.56	15.66	20.48
July	9.09	18.18	36.36	—	9.09	27.28	12.33	16.44	9.59	26.03	21.92	13.92
Aug.	28.57	—	28.57	—	42.86	—	25.81	29.03	12.90	—	20.97	11.29

Breeding season

The percentage occurrence of various stages of maturity (table 3) is represented graphically in figure 6. Evidence on spawning is offered by gonads in stage V (oozing) which were recorded from December to August—the obvious breeding period. Occurrence of gonads in stage IV (mature), from November to July further confirms the breeding period.

Occurrence of spent females in September, November, January and February could be due to some late or some odd spawners. The following points evidently show that *L. dussumieri* has a prolonged breeding period.

(i) Stage V (oozing) gonads could be recorded only between December and August

(ii) Spent ovaries occurred for more than 6 months (September to February)

(iii) Clearly separated mature group of ova from an immature stock (two distinct stocks with two distinct modes) in the ovary

(iv) Occurrence of mature ova numbered more than half of the total intra-ovarian eggs

(v) Corroborative proof obtained from gonado somatic index and relative condition factor.

Sarojini (1957) observed fluctuation in the relative condition factor, influenced by changes in the weight of the gonads and seasonal progression of size frequency distributions of ova in *M. parsia* (from Bengal waters) whose breeding period extended from December to March with two spawning maxima, one in January and another in March.

(iv) Length at first maturity

Percentage of mature fishes of both the sexes are given in table 4. In figure 7 it can be seen that in 99–108 mm length group all the females were immature and the percentage of mature females increased with

length up to 209–218 mm when all the individuals examined were found to be mature. Below 79–88 (figure 8) length group, all the males were immature and the percentage of mature individuals steadily increased till 159–168 mm, when all the

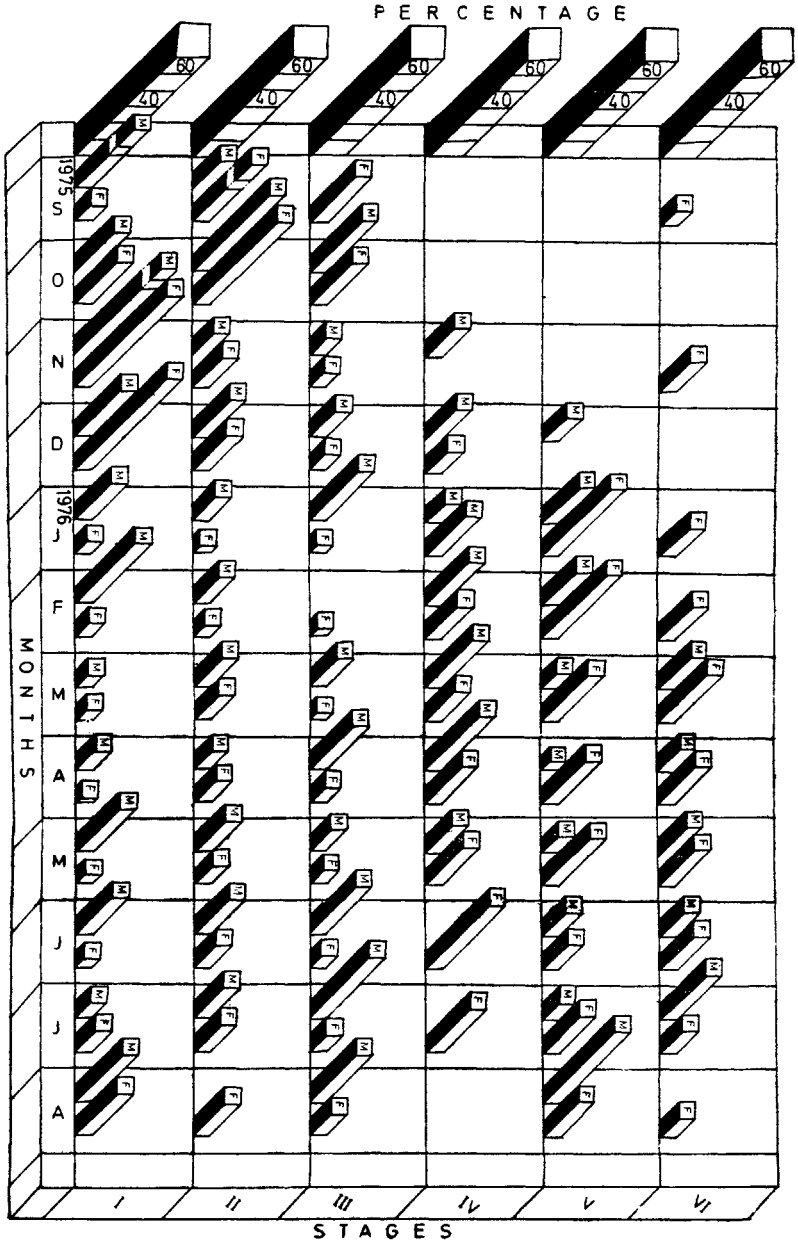


Figure 6 Percentage distribution of different maturity stages of *L. dussumieri* from September 1975–August 1976

Table 4 *Percentage of matured* L. dussumieri *in 10 mm length groups*

Length group (mm)	Males			Females		
	No. of fish examined	Matured	Percentage	No. of fish examined	Matured	Percentage
79–88	42	12	28.57	—	—	—
89–98	30	11	36.67	—	—	—
99–108	38	15	39.47	—	—	—
109–118	24	13	54.17	44	14	31.82
119–128	38	23	60.53	66	23	35.85
129–138	35	22	62.86	72	29	41.28
139–148	19	15	78.95	34	16	47.06
149–158	34	32	94.12	58	32	56.17
159–168	29	29	100.00	52	34	65.38
169–178	34	34	100.00	61	42	68.85
179 188	—	—	—	53	38	71.69
189–198	—	—	—	54	48	88.89
199–208	—	—	—	49	44	90.55
209–218	—	—	—	33	33	100.00
219–228	—	—	—	40	40	100.00
229–238	—	—	—	49	49	100.00
239–248	—	—	—	57	57	100.00

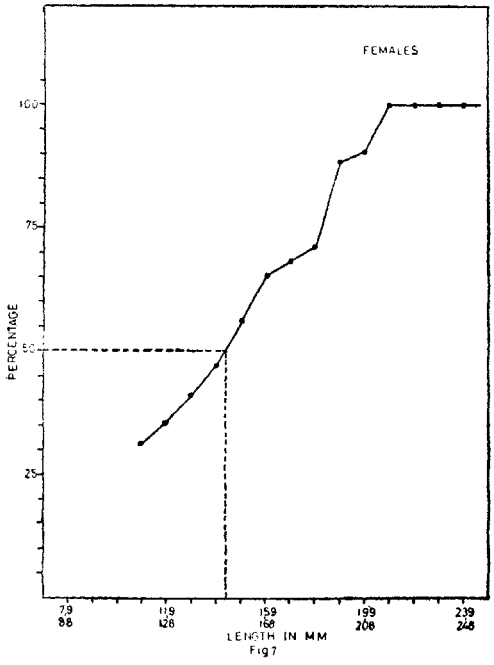


Figure 7 Length of first maturity in females of *L. dussumieri*

males were mature (figure 8). The 50% level in the maturity curves, which may be taken to represent the mean length at which maturity was obtained, were 143 mm for females and 106 mm for males. Evidently males of this species reached maturity earlier than females.

(v) Fecundity

For this study, ovaries of stages III and IV were taken into consideration. From an ovary of known weight a small portion was cut and weighed in a balance. The piece was teased and the ova were spread evenly on a counting chamber. The number of ova in five squares was counted and the total number of ova was computed based on this and on the total weight of the ovary. The fecundity of specimens of *L. dussumieri* ranging in length from 118–278 mm is given in table 5.

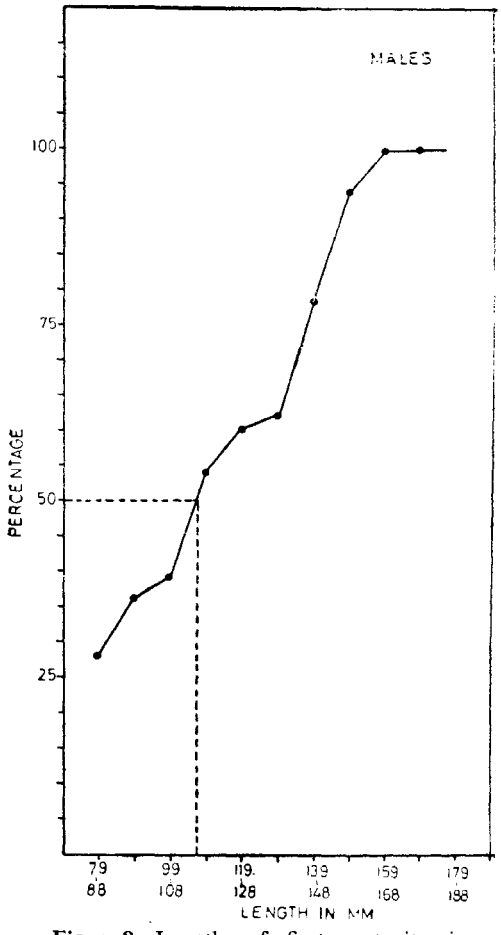


Figure 8 Length of first maturity in males of *L. dussumieri*

Table 5 *Fecundity of* L. dussumieri

Total length in mm	No. of ova
118	29,336
123	33,762
134	38,728
140	48,803
153	60,310
157	63,851
160	66,510
165	70,929
175	79,778
180	84,210
182	85,970
186	89,509
194	96,600
201	102,789
204	105,450
212	112,524
234	131,992
248	144,400

Fecundity varied between 29,336 to 1,44, 400 ova. Sarojini (1957) has observed 2 lakhs to 6 lakhs ova in *M. parsia.*

The regression between total length (x) and number of ova (y) is calculated and graphically represented in (figure 9). The regression equation can be expressed as $y = -76.9410 + 0.8940\ x$

(vi) Sex ratio

The sex composition of the random samples examined each month is presented in table 6. The ratio was tested by Chi-square analysis by using the formula

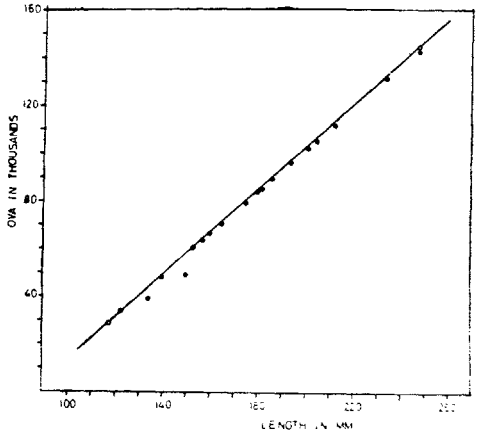


Figure 9 Relationship between fecundity and total length of *L. dussumieri*

Table 6 *Sex ratio of* L. dussumieri *from September 1975 to August 1976*

Month & year	Males	Females	Ratio males: females (*in per-cent*)	Chi-square values
1975				
Sept.	12	22	54.55	
Oct.	13	16	81.25	
Nov.	40	22	181.82	
Dec.	43	29	148.28	
1976				
Jan.	36	66	54.55	
Feb.	19	78	24.36	99.5877
Mar.	41	93	44.09	$P<0.001$
Apr.	45	102	44.12	
May	31	76	40.79	
June	14	83	16.87	
July	22	73	30.14	
Aug.	7	62	11.29	

$X^2 = \Sigma \frac{(O-E)^2}{E}$ to test the homogeneity in the distribution of males and females. A highly significant ($P < 0.001$) value was found indicating, that, the ratio of males to females and vice versa, are not homogeneously distributed in different months but there is significant heterogeneity.

The ratio of females to males was 2.24 : 1.

The sex ratio for different maturity stages is given in table 7; females dominated males except in stage I. The ratio of females to males almost reached equilibrium at stages V (5.18) and VI (5.07). This indicates that the two sexes probably congregate during the spawning season.

Table 7 *Sex ratio of* L. dussumieri *in different maturity stages*

Stage	Males	Females	Males (%)	Females (%)	Ratio females to males
I	87	86	50.29	49.71	0.99
II	56	116	32.56	67.44	2.07
III	63	63	50.00	50.00	1.00
IV	56	144	28.00	72.00	2.57
V	34	176	16.19	83.81	5.18
VI	27	137	16.46	83.54	5.07

Acknowledgements

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