

**MATURITY AND SPAWNING IN  
*OTOLITHUS RUBER* (SCHN.) AND *JOHNIUS DUSSUMIERI* (C. & V.)**

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**ABSTRACT**

From the ova diameter measurements, it has been observed that *O. ruber* spawns only once a year during July to October, and *J. dussumieri* spawns twice a year, first between January and February and again between June and September. Indication of sexual maturity is observed in the 170 mm size group in *O. ruber* and a majority (62.86%) is mature at 200 mm. In *J. dussumieri* sexual maturity is manifest in the 140 mm size group and a majority of fish (51.85%) is mature at 160 mm. Fecundity in the size range of 180-290 mm varies between 44,621 and 179,659 mature eggs in *O. ruber*, and in *J. dussumieri* of size range 195-235 mm the number of mature eggs varies between 142,005 and 225,988.

**INTRODUCTION**

Detailed investigations on the maturity and spawning behaviour of sciaenid fishes, which form a considerable proportion of the catches all along the east and west coasts of India, are lacking, although some information is available in respect of some species, such as *Pseudosciaena diacanthus* (Rao, K. V. 1961, 1967), *Otolithoides brunneus* (Karandikar and Thakur, 1951 and Kutty, 1961, 1968), *Otolithus argenteus* (Annigeri, 1963) and *Pseudosciaena aneus*, *Pseudosciaena bleekeri* and *Johnius carutta* (Rao, T.A. 1967).

An attempt is made in the present study to deal with size at first sexual maturity, fecundity, ponderal index and period and duration of spawning in *Otolithus ruber* (Schn.) and *Johnius dussumieri* (C. & V.) which form a fairly large bulk of the mixed sciaenid component commonly known as 'dhoma' in the trawler landings in the north-western coast of India.

**MATERIAL AND METHODS**

The material for this study was collected from the fish landings of the Government of India trawlers and the New India Fisheries Company's trawlers operating from Bombay base during the period July 1967 to June 1968. About 25 fish of each

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of the two species were examined on each observation day. The percentage occurrence of each sex and the stages of maturity were assessed and the gonads were preserved in 10 per cent formalin for ova diameter measurements. As no significant difference in the distribution pattern of the ova in the anterior, posterior and middle regions of the ovary was observed, the material for this study was always taken from the middle portion of the ovary. This was teased on a slide and the diameters of the ova were measured under an ocular micrometer, with each division giving 0.0188 mm. Ova of less than 5 microdivisions which occurred in large numbers in all samples were not taken into consideration. The frequencies of the ova from the ovaries of the same stages of the maturity were pooled and plotted. The stages of maturity were fixed according to the ICES scale for herring (Wood, 1930). For estimating the fecundity, the ova in the penultimate stage of maturity in a weighed portion of the ovary were counted and the total number of ova was calculated for the entire weight of the ovary.

#### MATURATION IN *O. RUBER* AND *J. DUSSUMIERI*

The different stages of maturity in the females of the two species are described in Table 1.

In *O. ruber* the ovaries in stage I are in the form of two asymmetrical longitudinal strips extending from the genital pore to one third or more the length of body cavity. They measure up to 25 mm and weigh from 0.5 to 1.0 g. The ovaries contain only immature ova; such ova are present in large quantities in all ovaries, irrespective of their stages of maturity. Fishes which have not spawned before and those which are recovering contain these eggs in abundance.

The ovaries in stage II, also immature, measure from 20 to 35 mm in length and weigh upto 1.5 g. Most of the ova in ovary of this stage are immature, belonging to the first stage of maturity but some slightly larger ova exhibit a tendency towards yolk formation. In these larger immature ova the deposition of yolk granules starts usually around the nucleus and gives them a more or less semi-transparent appearance.

The ovaries in stage III contain, in addition to the already described immature ova, some maturing ones, which are for the first time clearly visible to the naked eye as small granules. The maturing ovary measures from 35 to 60 mm in length and weighs from 1.5 to 3.6 g. Deposition of yolk in the ova is intensified as a result of which the nucleus becomes partly or fully hidden, and the ova appear as creamy white in colour and are partly opaque, being more so at the centre than at the periphery.

The ovaries in stage IV are also maturing and present a granular appearance, creamy yellow in colour. Blood vessels are seen ramifying on the dorsal side of the ovary above the air bladder. They show a symmetry quite distinctly. The ovaries

TABLE 1. Key to the maturity stages in females of *O. ruber* and *J. dussumieri*

Maturity stages	State of maturity	Nature and extent of ovary in the body cavity	Appearance of ova under microscope	Range of ova diameter in mm	
				<i>O. ruber</i>	<i>J. dussumieri</i>
I	Immature	Ovary pale creamy in colour, extending up to 1/3 the length of body cavity. Ova invisible to naked eye.	Small, yolkless, transparent with prominent nucleus.	0.018 — 0.19	0.018 — 0.17
II	Immature	Ovary wine-coloured, occupying 1/3 — 1/2 of the body cavity. Gonads asymmetrical, ova invisible to naked eye.	Yolk formation just commenced around the nucleus.	0.20 — 0.27	0.19 — 0.25
III	Maturing	Ovary pink creamy to yellow, granular, extends 1/2 — 2/3 in the body cavity.	Small, semi-opaque; nucleus is partly or completely hidden by yolk.	0.28 — 0.34	0.26 — 0.43
IV	Maturing	Ovary creamy to yellow, blood vessels seen on the dorsal side; extending to 2/3 in the body cavity, ova are easily seen.	Medium-sized opaque ova, not free from the follicular cells.	0.35 — 0.57	0.44 — 0.51
V	Mature	Ovary reddish yellow in colour, blood vessels prominent, length 3/4 - 4/5 in the body cavity. Ova prominently seen.	Large-sized mature highly opaque ova, free from follicle.	0.58 — 0.72	0.52 — 0.62
VI	Ripe	Ovary reddish, "plum pudding" appearance, extending the entire length of body cavity, ova seen from the ovarian wall.	Large-sized ripe ova, transparent, yolk vacuolated, with oil globule.	0.73 — 0.87	0.63 — 0.86
VII	Spent	Ovary blood-shot, shrunk, flaccid and baggy as a result of spawning.	—	—	—

measure from 60 to 80 mm in length. The ova are large and densely packed with yolk granules, appearing highly opaque under microscope.

The ovaries in stage V are mature, reddish yellow because of the close ramification of blood vessels and measure from 70 to 104 mm. They weigh from 3.0 to 14 g. The ova are larger and more densely filled with yolk, which gives it a segmented appearance under the microscope. There is a small perivitelline space around the egg.

The ovaries in stage VI are ripe, occupying fully the abdominal cavity, pushing aside the digestive organs. They become slightly reddish in colour and present what is termed as 'plum pudding' appearance because of the creamy transparent ripe ova seen through the ovarian wall which is thin and delicate. Ova ooze out on slight pressure. The ovaries weigh up to 15 g. There are one or two oil droplets, the larger one measuring up to 0.2 mm. The yolk is vacuolated.

The ovaries in stage VII are spent. They are blood-shot and shrunk because the contents have been spawned out. Microscopic examination shows only a few large eggs with numerous small immature eggs.

The maturity stages of *J. dussumieri* closely resemble those of *O. ruber* described above.

#### SPAWNING IN *O. RUBER*

Fig. 1 shows the frequency polygons of ova diameter measurements of *O. ruber* in different stages of maturity. In stage I there is only an immature stock of eggs represented by mode *a*. The shifting of the mode *b* from 0.19 mm in stage II to 0.27 mm in stage III indicates the passing of the immature eggs into maturing ones. In stage IV the mode *c* at 0.34 mm separates the maturing eggs from the stock of immature eggs, which grows to maturity at 0.49 mm in stage V. Stage VI has ripe eggs at mode 0.72 mm with a size range of 0.57 to 0.87 mm. In stage VII the larger eggs are absent as they have been spawned out. There is a group of maturing eggs at *c*<sup>1</sup> at 0.41 mm, separating off from the immature eggs (*b*) already mentioned.

The sharp and distinctly separated mode *c* of mature ova in stage VI indicates spawning restricted to a definite period (Hickling and Rutenberg, 1936). Fish with running ovaries are available between July and October (Table 2), and juveniles during October to December, which indicate that the spawning season of this species is from July to October. The findings of Vaidya (1960) also corroborate the conclusion of the author regarding the spawning season.

#### *Sex ratio*

The percentage occurrence of each sex in the commercial catches in different months is presented in Table 3. There is an indication of segregation in certain months, as males are in higher proportion prior to spawning.

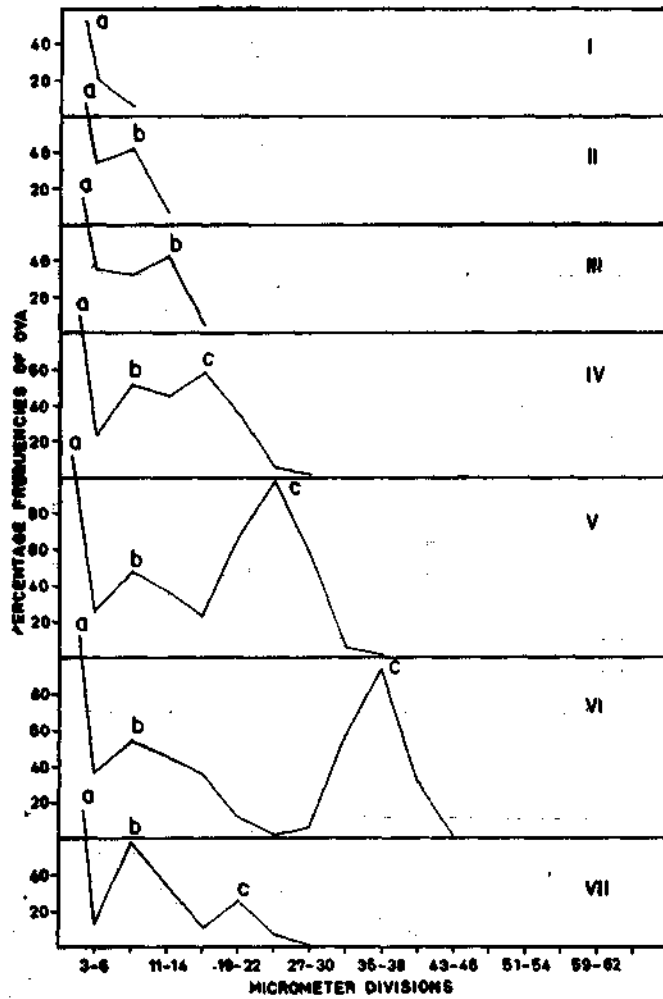


FIG. 1. Ova diameter frequency of *Otolithus ruber* from stages I to VII.

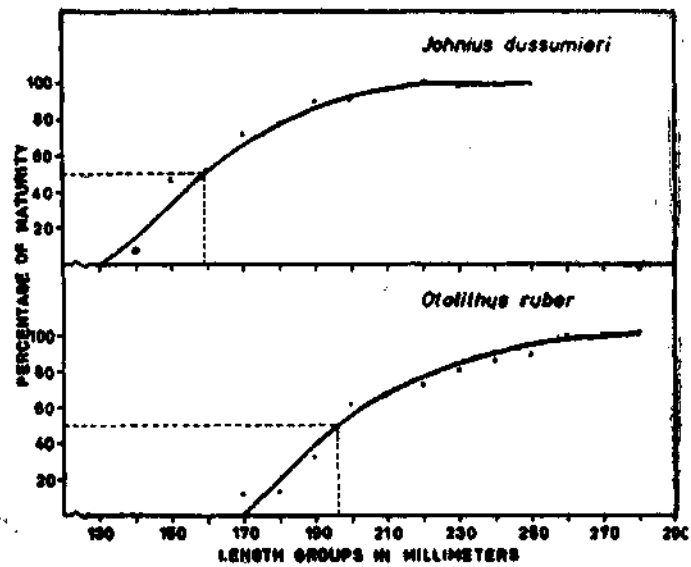
Analysis of sex composition according to size range showed (Table 4) the females dominating the catches at the smaller size groups up to 200 mm (except at 160 - 169 mm size group where a slight male domination was registered) and again beyond 230 mm. The largest female specimen obtained during this study measured 310 mm though, according to Munro (1955), this species attains a size of 75 cm.

*Size at first maturity*

All the female fish examined during the spawning season were pooled for this study. All individuals below the size group 120 mm did not show any indication of sex, and those up to 160 mm were all immature. The majority were mature at 200 mm and all females were ripe in size group 260 mm and above (Fig.2).

TABLE 2. Month-wise occurrence of different maturity stages in *Otolithus ruber* and *Johnius dussumieri*

Month	<i>O. ruber</i>					<i>J. dussumieri</i>				
	No. of fish examined	Immature	Maturing	Mature	Spent	No. of fish examined	Immature	Maturing	Mature	Spent
Jul 1967	19	2	7	3	7	13	2	8	2	1
Aug	22	4	6	6	6	24	2	2	8	12
Sep	43	5	22	2	14	48	13	23	7	5
Oct	25	9	7	4	5	36	3	15	18	—
Nov	59	37	6	16	—	29	—	13	16	—
Dec 1968	30	29	1	—	—	19	—	5	14	—
Jan	11	11	—	—	—	27	—	4	23	—
Feb	41	41	—	—	—	36	—	16	17	3
Mar	34	22	12	—	—	10	—	5	4	1
Apr	11	4	7	—	—	20	—	11	9	—
May	33	—	15	18	—	97	9	48	40	—
Jun	40	—	19	21	—	26	4	14	6	2

FIG. 2. Size at sexual maturity of females of *O. ruber* and *J. dussumieri*.

*Fecundity*

Fecundity with regard to six ovaries was worked out to study the relationship between the size of the fish and the number of eggs produced.

Length of the fish in mm	Number of eggs
188	44,621
190	57,744
218	86,630
240	156,386
245	158,766
290	179,659

It is seen from the above figures that the fecundity is correlated with the length of the fish.

SPAWNING IN *JOHNIUS DUSSUMIERI* (C. & V.)

The size distribution of ova of *J. dussumieri* in different stages of maturity (stage III - VI) is presented in Fig. 3. Spent ovaries of the species were collected during February - March and June - September and ripe ovaries during the end of December and January (Table 2).

In ripe ovary (stage VI) the mode *a* at 0.13 mm represents immature egg stock, the mode *b* at 0.44 mm maturing eggs with incomplete yolk formation, and the mode *c* at 0.62 mm fully ripe eggs with vacuolated yolk, invariably with one or two oil globules (Fig. 3). The batch of maturing eggs is sharply differentiated from the mature eggs and the general stock of immature eggs. The spawning period, therefore, appears to be not prolonged while there is clear indication of a second spawning also. The interval between two successive spawnings is short due to the fact that the eggs at 0.44 mm are in advanced stage IV of maturity and they may not take a long time to ripen.

The presence of mature individuals with ovaries ready for spawning during December - January (73-85%) (Table 2) is an indication of spawning in the following months and this is confirmed by the incidence of spent ones in the catches during February and March. A similar indication is that the second spawning takes place during June to September. The conclusions arrived at by Bal and Pradhan (1946) and Sawant (1963) also indicate that this fish spawns twice a year.

*Sex ratio*

As seen from Table 3 the females of *J. dussumieri* dominate the commercial catches throughout the year unlike in *O. ruber* where the males appear more in number during certain months. From analysis of the size groups, it is found that the percentage occurrence of males is relatively higher at the lower sizes, from 110 to 139

mm, and again at 160 to 179 mm. In all the higher size groups from 180 to 189 mm onwards the females have been found to be dominant in the catches (Table 4).

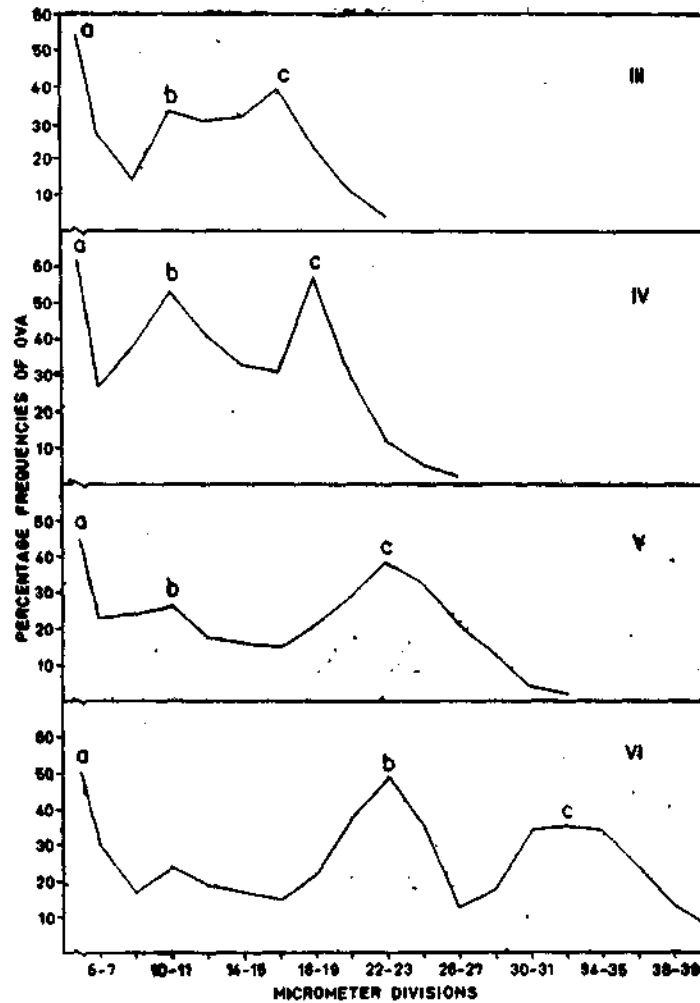


FIG. 3. Ova diameter frequency of *J. dussumieri* from stages III to VI.

#### *Size at sexual maturity*

In females of *J. dussumieri* sexual differentiation was not seen below 110 mm. Individuals up to 130 mm size group were all immature. The majority of mature individuals (51.85%) was in the 160 mm size group. In the 220 mm size group and above, all females were sexually mature (Fig. 2).



TABLE 3. Sex ratio of *O. ruber* and *J. dussumieri* in different months

Month	<i>O. ruber</i>		<i>J. dussumieri</i>	
	No. of fish examined	Male : Female	No. of fish examined	Male:Female
July 1967	42	62.0 : 38.0	18	33.33 : 66.67
Aug	32	50.5 : 50.5	24	16.67 : 83.33
Sep	52	21.1 : 78.9	61	24.59 : 75.41
Oct	48	47.9 : 52.1	44	18.18 : 81.82
Nov	120	50.8 : 49.2	41	29.27 : 70.73
Dec	52	42.3 : 57.7	26	26.92 : 73.08
Jan 1968	15	26.7 : 73.3	33	18.18 : 81.82
Feb	65	36.9 : 63.1	68	32.35 : 67.65
Mar	55	38.2 : 61.8	13	23.08 : 76.92
Apr	23	52.2 : 47.8	26	23.08 : 76.92
May	84	60.7 : 39.3	125	22.40 : 77.60
Jun	83	52.0 : 48.0	34	23.53 : 77.47

TABLE 4. Sex ratios in various size groups of *O. ruber* and *J. dussumieri*

Size group mm	<i>O. ruber</i>		<i>J. dussumieri</i>	
	No. examined	Male:Female	No. examined	Male:Female
110—119	—	—	—	—
120—129	12	—	13	100.00 : 00.00
130—139	15	—	7	85.71 : 14.29
140—149	11	45.4 : 54.6	12	41.67 : 58.33
150—159	12	25.0 : 75.0	17	35.29 : 64.71
160—169	30	53.3 : 46.7	30	53.33 : 46.67
170—179	41	46.3 : 53.7	39	53.85 : 46.15
180—189	82	48.8 : 51.2	58	26.69 : 73.31
190—199	70	48.6 : 51.4	56	19.64 : 80.36
200—209	40	50.0 : 50.0	37	2.70 : 97.30
210—219	60	56.7 : 43.3	25	8.00 : 92.00
220—229	44	61.4 : 38.6	5	0.00 : 100.00
230—239	46	45.6 : 54.4	5	20.00 : 80.00
240—249	47	46.8 : 53.2	—	—
250—259	22	40.9 : 59.1	—	—
260—269	15	33.3 : 66.7	—	—
270—279	18	38.9 : 61.1	—	—
280—289	9	33.3 : 66.7	—	—
290—299	5	40.0 : 60.0	—	—
300—309	6	16.7 : 83.3	—	—

*Fecundity*

Six ovaries were examined for computing the total number of eggs present in *J. dussumieri*, adopting the same procedure as was followed in the case of *O. ruber*.

Length of fish in mm	Number of eggs
195	142,005
202	144,074
211	180,720
215	198,991
230	221,965
235	225,988

It is seen from the above table that, with increase in length of fish, the number of eggs also increases. The fecundity is greater in *J. dussumieri* than in *O. ruber*.

## PONDERAL INDEX

Hickling (1930) and several Indian investigators have correlated the lower level of condition with the attainment of sexual maturity and spawning in fishes. The length-weight data collected throughout the period of investigation were pooled for this purpose. 'K' was calculated by using the formula  $100W/L^3$ , where W is the weight of the fish in g, L the length of fish in cm and K the ponderal index. The available data for larger fishes were limited. Those measuring up to the total length of 22 cm in *J. dussumieri* and up to 27 cm in *O. ruber* were taken into account for the purpose of this study. The results are presented in Fig. 4.

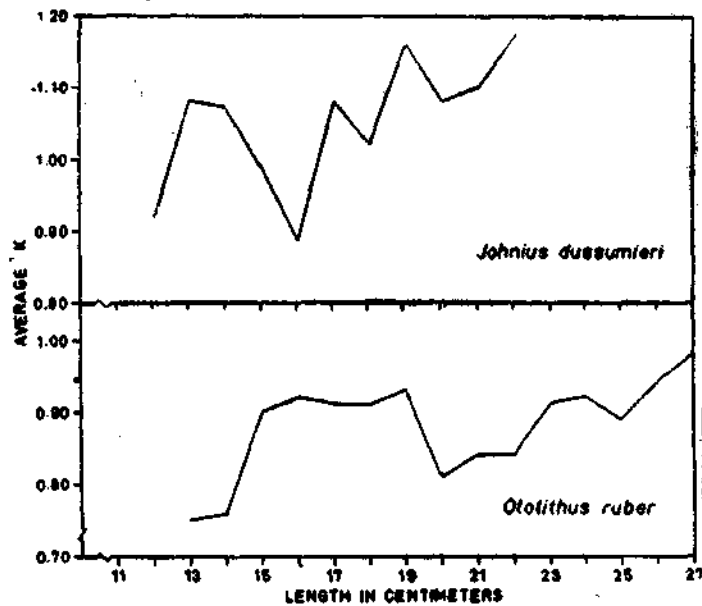


FIG. 4. The average Ponderal Index (K) at different lengths of *O. ruber* and *J. dussumieri*.

Hart (1946) has observed that with the increase in size there is a lower level of condition due to the strain of spawning. The point of inflexion on a curve showing the diminution of 'K' with increasing length is thus an approximate indication of the length at which sexual maturity is attained. On the basis of the curve pattern in Fig. 4, it may be said that *O. ruber* matures at 20.0 cm size and *J. dussumieri* at 16 cm size. Both these inferences are further supported by the data on maturation studies.

#### REMARKS

*O. ruber* and *J. dussumieri* exhibit certain differences in the duration and frequency of spawning. That species belonging to the same family of fish exhibit such differences has been pointed out by Prabhu (1956) in Theraponidae, Annigeri (1963) and Dharmamba (1959) in Clupeidae. In *O. ruber* spawning is only once a year, for a short and definite period. The mature eggs in the ovary are differentiated sharply from the general immature egg stock and in the whole ovary of a fish in penultimate stage of maturity there is only one group of ripe eggs to be spawned out during the next spawning season, i.e. July to October in this species. In *J. dussumieri* spawning occurs twice a year. Here, in the ovary at the penultimate stage of maturity, in addition to the batch of eggs in the ripe condition, another batch of eggs half way to maturity, forming a distinctly separate mode, is also present.

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