OBSERVATIONS ON THE MATURITY AND SPAWNING OF *PSETTODES ERUMEI* (SCHNEIDER)

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INTRODUCTION

Psettodes erumei (SCHNEIDER), popularly called the 'Indian Turbot' and locally known as 'Bhakas' in Bombay, belongs to the group of flatfishes known as Heterosomata. This group comprises the Halibut, Turbot, Sole and Plaice, which in Western countries form a very important group of commercial fishes. Off the Bombay coast, however, the flatfish fishery is of lesser importance owing largely to a traditional prejudice against this group of fishes and it was not until the introduction of trawlers that the importance of flatfishes, particularly that of *P. erumei*, was realised. Not only is there a considerable increase in the catch of this fish, but there is a progressive demand for it as a prime food fish. Considering these potentialities investigation on the fishery of *P. erumei* and its biology was undertaken.

Very little work has been done on the biology of flatfishes in this country. Among the few publications, mention must be made of Gopinath (1946), Jones and Menon (1951), Seshappa and Bhimachar (1951, 1954, 1955) and Pradhan (1959), a few other available references on *P. erumei* being those of Ranga Rao (1935), Hefford (1949), John (1951), Jones and Pantulu (1958). The present paper is the result of investigations carried out during the period August 1957 to October 1958 and deals with observations on the spawning and maturity of *P. erumei*.

The material for the present investigation was obtained at random from the fish landed by the trawlers of the New India Fisheries Ltd., operating off the Bombay coast. In all 305 males and 1,147 females of various sizes were examined during the course of the investigation. The extension of the gonads in the body cavity, their general appearance and length and weight were noted. A small portion of the ovary was teased out, and after examining the size and structure of ova in fresh condition, the ovary was preserved in 10% formaldehyde and was taken for further study when sufficiently hardened.

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A sample of ova taken from anterior, middle and posterior regions of few ovaries in different maturity stages indicated a more or less uniform pattern of distribution in different parts and hence about 300 ova from middle portion of the ovary were measured by means of micrometer eye piece. The method adopted by Clark (1934) was followed while counting ova diameters. All ova below 0·07 mm. were not taken into consideration while counting, as these were found to be present in the ovaries of all stages of development.

Testes

Sexes cannot be easily distinguished externally but when individuals of about 150 mm.† in total length are dissected the sexes can be made out by the posteriorly directed apex of the triangular gonad which is rounded in males and pointed in the case of females. The size of male *P. erumei* in the catch varied between 175–564 mm. in total length. However, males above 450 mm. size appeared to be rather rare as only 11 specimens were recorded in the sample of 305 males. On the basis of the general appearance of the testes, the following four main stages of maturity have been determined:

1. *Immature.*—Testes very small and thin with light pink colouration.

2. *Maturing.*—Testes slightly swollen and lobulated. Colouration whitish pink; milt not coming out even on pressing.

3. *Mature.*—Testes milky white in appearance and due to swollen form have a very smooth surface which marks out tabulated condition more prominently. Milt flows out even on slight pressure.

4. *Spent.*—Testes appear shrunk, flaccid and have brownish colour.

P. erumei with immature testes were common during the months November to April and those with maturing testes were observed during the period May to July, while mature ones were recorded in the months August, September and October. Specimens with spent testes occurred during September and October. The smallest male in mature stage was 280 mm. in total length while the largest one in mature or spent condition measured 430 mm.

The Ovary

The immature ovaries are paired sac-like triangular structures, the base of which just projects into the posterior part of the abdominal cavity

† Observation based on a sample from Madras.

TABLE I

Provisional key to the stages of sexual maturity of the Indian Turbot, Psettodes erumei (*Schn.*) (*female*)

Extent of ovary in body cavity	General appearance of the ovary	Range of ova diameters (in mm.)	Appearance of ova (under the microscope)	State and stage of maturity
Posterior projection not more than 10 mm. in length	Almost transparent with slight whitish-pink colouration; ova invisible to naked eye	0·07–0·22	Yolkless transpareut ova, some semi-transparent ova in slightly advanced stages with yolk along periphery of cell wall and nucleoli surrounding the centrally placed nucleus	Immature I
Posterior projection about 20-40 mm. in length and anterior portion extending a little in the body cavity	Ovaries semi-transparent with reddish-yellow colour, ova visible to naked eye	0·22–0·45	Small semi-opaque ova	Virgin Maturing II, Recovering Spent VII-II
Posterior projection about 40–60 mm. in length and ovary extends anteriorly 1/3 in the body cavity	Creamy to yellowish in colour and ova readily visible	0·45–0·52	Opaque yellowish-white medium-sized ova	Maturing II
Posterior projection about 50–70 mm. in length and ovary extends ½–½ in the body cavity	Almost as in Stage III	0·52–0·82	Large size white opaque ova	Maturing IV
Posterior projection about 60–70 mm. or sometimes more in length and anteriorly, ovary extends ½–¾ in the body cavity	Yellowish in colour; more eggs not free in the lumen, eggs do not come out even on pressure	0·82–1·20	Some ova appear translucent	Maturing V
The posterior projection almost as above but the anterior extension of ovary almost obliterates the body cavity	Colour of ovary as above but ova free in the lumen and come out on little pressure	0·82–1·20	Many transparent ova	Mature V
Anterior extension not more than ¼ in body cavity	Ovary blond shot and thick and flaccid in appearance	..	Many large size ova in reabsorbing and degenerating stage	Spent VII

and the apex projects backwards towards the tail, lying between the haemal spine and muscles of the trunk. During maturation, the triangular ovary extends antero-dorsally, antero-ventrally as well as posteriorly. The anteriorly directed arms press on the alimentary canal and obliterate the body cavity. On the basis of the extension of ovary in the body cavity, its general appearance, size and structure of ova, a provisional key to the stages of maturity has been prepared (Table I).

Spawning Season

The size distribution of ova of *P. erumei* in different stages of maturity is shown in Fig. 1. It is seen that in the mature ovary (Stages V and VI),

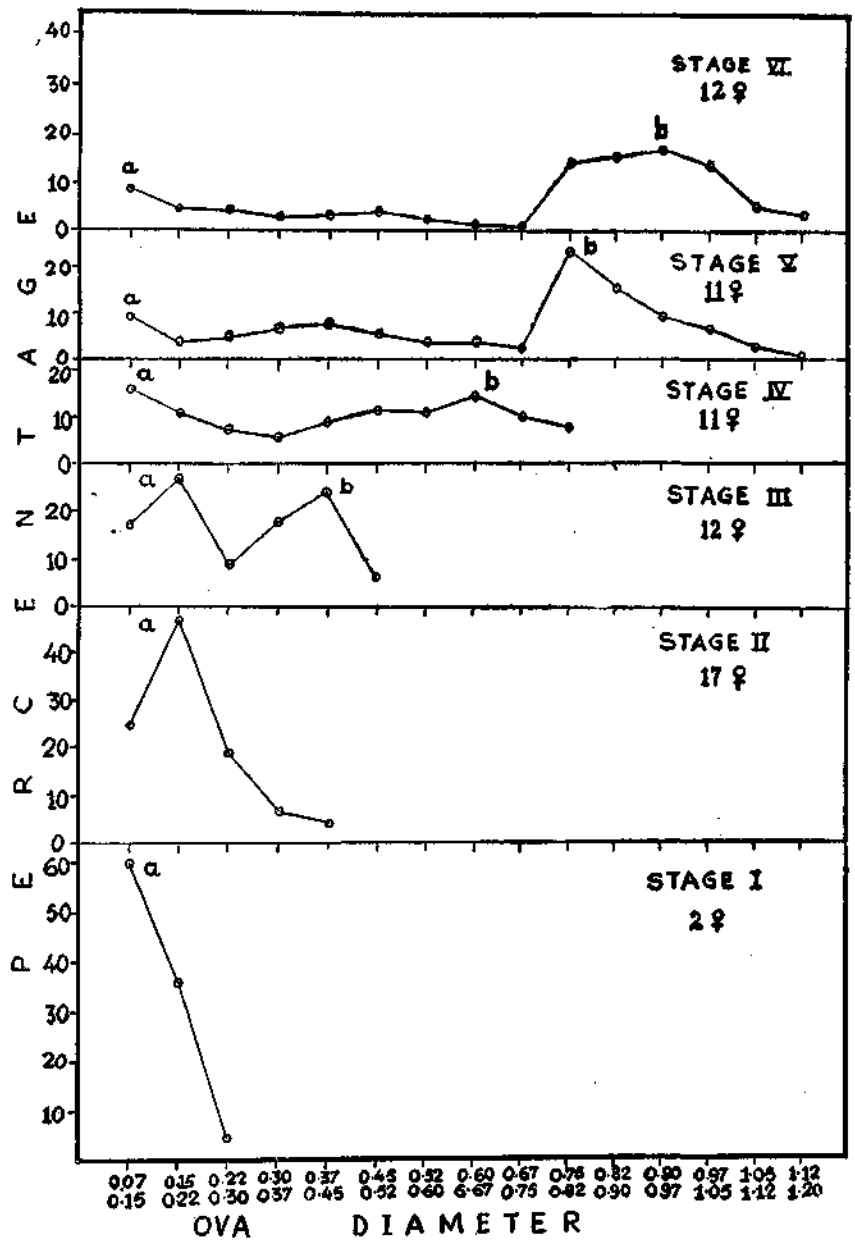

Fig. 1. Frequency percentages of ova-diameters of *P. erumei* in various stages of maturity

TABLE II

Number and percentages of various stages of maturity of female P. erumei *in different months during the period August* 1957 *to October* 1958

Month	Maturity Stages														Total of specimens
	I		II & VII–II		III		IV		V		VI		VII		
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	
1957															
August	..	..	6	33·33	12	66·67	..	..	..	..	..	..	..	..	18
September	..	..	5	16·66	11	36·68	4	13·33	6	20·00	3	10·00	1	3·33	30
October	..	..	30	50·00	4	6·67	3	5·00	13	21·66	4	6·67	6	10·00	60
November	..	..	102	100·00	..	..	..	..	..	..	..	..	..	..	102
December	..	..	144	100·00	..	..	..	..	..	..	..	..	..	..	144
1958															
January	..	..	127	100·00	..	..	..	..	..	..	..	..	..	..	127
February	..	..	176	100·00	..	..	..	..	..	..	..	..	..	..	176
March	..	..	163	100·00	..	..	..	..	..	..	..	..	..	..	163
April	3	3·20	91	96·80	..	..	..	..	..	..	..	..	..	..	94
May	..	..	12	27·27	32	72·73	..	..	..	..	..	..	..	..	44
June	1	2·50	8	20·00	31	77·50	..	..	..	..	..	..	..	..	40
July	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
August	..	..	6	16·67	7	19·44	23	63·89	..	..	..	..	..	..	36
September	..	..	3	4·55	26	39·39	23	34·86	2	3·03	9	13·62	3	4·55	66
October	..	..	20	42·55	..	..	4	8·51	12	25·53	3	6·38	8	17·03	47

there is a distinct stock of mature (*b*) and immature ova (*a*) with some advanced maturing ova. The maturing ova which are comparatively few may attain maturation and get extruded during the spawning season or may be degenerating if not extruded. Hickling and Rutenberg (1936), studied the size distribution of ova in different species whose spawning season was known and have generalised the spawning periodicities into four types. According to this, *P. erumei* belongs to the category of fishes in which spawning takes place once a year, during a definite short period.

The data regarding the percentage of females in each stage of maturity during the period under investigation are shown in Table II. It is evident

from this that mature individuals with ovary ready for spawning or spent ones occur during September and October. This suggests that *P. erumei* attains complete maturity and spawns in the months, September and October. Hefford (1949) observed large size specimens in sexually ripe condition in the trawl catches made off Bombay in the month of October and recorded the biggest catch of *P. erumei* in the same month. He ascribed this increase in catch due to an aggregation for spawning purpose. The author (Pradhan, 1960) observed a similar upward trend in the catch-per-unit of effort of *P. erumei* in the months, September and October. Further, a declining trend in the catch-per-unit of effort was observed in the month of November, probably due to the migration of fish from the fishing grounds in the post-spawning period. Another noteworthy fact is the remarkable increase in the incidence of males (Table III) during the months August to October and their sudden withdrawal in the month of November, which furnishes further evidence in confirmation of the above-mentioned spawning season.

TABLE III

Percentages of the occurrence of males and females of P. erumei *in different months during the period August* 1957 *to October* 1958

Month	Male		Female	
	No.	%	No.	%
1957				
August ..	24	57·14	18	42·86
September ..	27	47·37	30	52·63
October ..	41	40 60	60	59·40
November ..	12	10·53	102	89·47
December ..	3	2·05	144	97·95
1958				
January ..	10	7·29	127	92·71
February ..	12	6·38	176	93·62
March ..	5	2·97	163	97·03
April ..	6	6·00	94	94·00
May ..	2	4·35	44	95·65
June ..	9	18·37	40	81·63
July ..	..	..	..	..
August ..	59	62·11	36	37·89
September ..	33	33·36	66	66·64
October ..	62	56·88	47	43·12

Along this coast, eggs, larvae and post-larvae of *P. erumei* have not been reported so far. However, from Trivandrum waters John (1951) recorded early juveniles in the month of July, while Jones and Pantulu (1958) have reported two early larval stages of this species from Orissa coast in the month of January. In view of these records, the spawning season of *P. erumei* on the south-west and east coasts of India appears to be somewhat different and a detailed study of samples from these regions would be, therefore, interesting.

Fecundity

In order to study the relationship between the size of fish and number of eggs produced, six mature gonads were examined. The following values of total number of mature eggs in these ovaries have been obtained after counting the number of mature eggs per gramme sample of each ovary.

Length of the fish	Number of eggs
mm.	
435	313,803
435	498,782
464	498,457
465	359,835
492	1,219,077
524	1,070,354
Average ..	660,051

Thus it is seen that in *P. erumei* up to 465 mm. the total number of mature eggs is below the average, while in 492 mm. and 524 mm. size fish, the number of mature eggs produced is considerably high.

Size at First Maturity

The females examined during the spawning season have been pooled for this study. The presence of Stage III and above was taken as an indication that the individuals would spawn during the same season. The percentage of mature fish in 20 mm. size-group is given in Fig. 2. It is seen

from this that up to 311–330 mm. size-group, none of the females appear above Stage III of maturity. In 331–350 mm. size-group individuals in Stage III or above are first seen and in the subsequent size-groups with the exception of 391–410 mm. size-group, increase in their percentage is evident and is 100 in size-groups above 451 mm. Since the percentage of mature is 56 in 411–430 mm. size group, the size at first maturity has been fixed as about 411 mm.

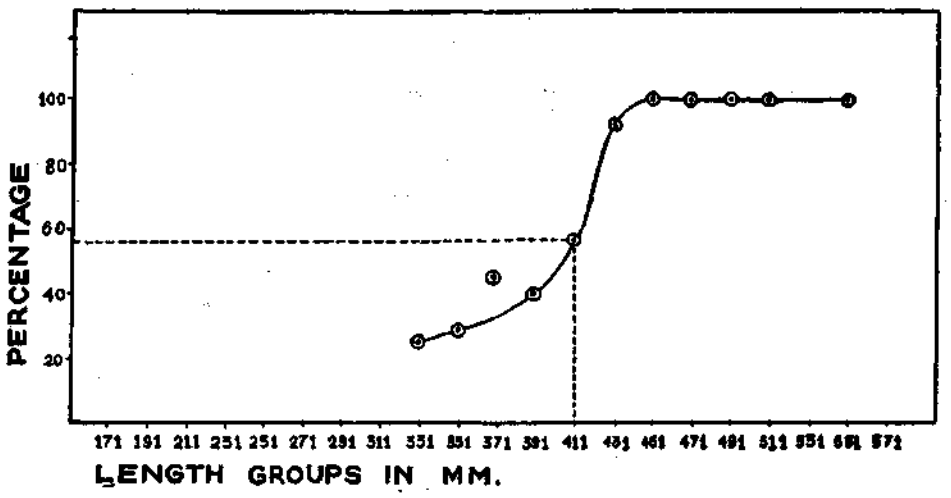

FIG. 2. Percentages of "maturing spawners" in each 20 mm. length group of *P. erumei* examined during the period September, October in the years 1957 and 1958.

SEX RATIO

The analysis of occurrence of males and females in different percentages in various months is presented in Table III. It is seen that the percentage of males in the samples in the months August, September and October is fairly high. Increasing trend in the incidence of males is seen since June and the percentage of males is considerably high prior to spawning season, *i.e.*, in August. After spawning season the percentage of males in the samples is very low and this indicates sexual segregation in certain months.

SUMMARY

The study of spawning and maturity of *P. erumei* is based on examination of 305 males and 1,147 females.

A provisional key to the identification of stages of maturity in case of males and females has been prepared.

The study of ova-diameter measurements has shown that in *P. erumei* spawning takes place once a year during a short period. The spawning period has been determined as September-October and increase in catch of *P. erumei* during these months indicates an aggregation for spawning purpose.

In size ranges 435–524 mm., the total number of mature ova produced varied between 313,803 and 1,219,077.

The size at first maturity of female *P. erumei* has been fixed at about 410 mm.

The studies on sex-ratio indicate sexual segregation in certain months.

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