MATURATION AND SPAWNING OF LIZARD FISHES (*SAURIDA* SPP.) FROM NORTHWESTERN PART OF BAY OF BENGAL*

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ABSTRACT

Ova-diameter frequencies indicate that the spawning period in *S. tumbil* is protracted, extending from October to March, with the peak in November-December and that the eggs are shed in 5 or 6 batches. The minimum size at first maturity and size at 50% maturity in female have found to be 260 and 300 mm in total length, respectively. The fecundity estimates ranged from 37,569 to 2,14,981 eggs in the size range 290-430 mm. Ova counts per gram of the ovary were calculated for estimating the number of eggs spawned in different batches. A plot of fecundity values against length showed an exponential relationship of the form, $F = AL^B$ while the relationship between the fecundity and weight of fish is expressed by a linear regression equation of the form $Y = A + BX$. The available data indicates that the spawning and maturation in *S. undosquamis* may be similiar to that of *S. tumbil*. The differences between specimens of *S. tumbil*. from Waltair, Mangalore and the East China and Yellow seas in respect of the size of the ova, spawning period and other characters are given.

INTRODUCTION

Very little work has been done on the maturation and spawning of *Saurida* spp. from the Indian waters. Annigeri (1963) determined the frequency and duration of spawning in *S. tumbil* based on ova-diameter frequencies of few specimens. The eggs of *Saurida* sp. were reported by Nair (1952) and Vijayaraghavan (1957) in the plankton from Madras, while Raju (1963) collected the eggs off Waltair. Kuthalingam (1959) artificially fertilised the eggs of *S. tumbil* and studied the development and feeding habits.

Maturation and spawning of *S. tumbil* from the East China and Yellow seas were studied by Okada and Kyushin (1955), and Liu and Tung (1959), while Yamada et al (1955) correlated the changes in fecundity of *S. tumbil* with population density. Tiews et al (1972) have given an account of the reproduction of *S. tumbil* from the Philippine waters. A detailed study on this aspect was undertaken to fill up the lacunae in our present knowledge on this subject.

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* Formed part of the author's thesis approved for the award of Ph.D of the Banares Hindu University.

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MATERIAL AND METHODS

The material was collected from the catches of the Government of India trawlers based at Visakhapatnam and operated in the northwestern part of Bay of Bengal during 1963-1970. The area of operation, gear used etc., are given by Sekharan et al (1973). After noting the length, weight of fish, and stage of maturity, the gonads were preserved in 5% formalin for further studies in the laboratory. The frequency and duration of spawning was determined by the ova-diameter-frequency method of Hickling and Rutenberg (1936). The procedure was similar to that adopted by Clark (1934), de Jong (1939) and Prabhu (1956). For estimating fecundity, the procedure followed earlier by the present author (Rao 1963) was used. Specimens in mature and ripe stages (IV to VI) were used for this purpose. The ova count per gram sample of the ovary has been taken into consderation for estimating the number of mature ova that are likely to be spawned since the eggs in *S. tumbil* are shed in batches. This method is similar to that of Karekar and Bal (1960) and Rao (1963).

OBSERVATIONS

The sexes are separate in *S. tumbil* and *S. undosquamis* but cannot be differentiated by external morphological characters. (Sexual dimorphism, however, has been reported in *S. tumbil* from the East China and Yellow seas by Matsubara and Iwai (1951), Okada and Kyushin (1955), and Liu and Tung (1959). According to these authors the second dorsal ray in males > 15.0 cm in standard length, is prolonged and the appearance of this character is related to the size and maturity of the fish. But, the present author, during the course of this investigation, examined hundreds of specimens and did not come across even a single male specimen with a prolonged second dorsal ray).

Based on a gross examination, the following stages in the development of testis and ovary could be made out:

Males

I. *Immature :* The testes are long and slender thread-like structures extending up to 3|4 length of the body cavity.

II. *Maturing* : The testes are long, ribbon-like bands extending from 2|3 to 3|4 length of the body cavity; white or creamy in colour. No milt exuded by pressure on gonad or from cut surface.

IIII. *Mature* : The testes are ribbon-like bands extending up to 3|4 length of the body cavity. They are broader, thicker and softer than those in stage II. White or creamy in colour. Milt oozes out on pressing the gonad or from cut surface.

IV. *Spent* : The testes are flaccid and blood-shot, ribbon-like bands extending up to 2|3 length of he body cavity. No milt comes out on pressing the gonad or from cut surface.

Females

The stages of maturity for females are classified as follows:

Stage I : The ovaries are narrow ribbon-like bands, light red or pink in colour, extending to 1|2 length of the body cavity. Ova not discernible. Only immature ova (0.02 to 0.16 mm), which are completely transparent, are present.

Stage II : Similar to stage I in external appearance. Maturing (0-16 to 0.38 mm) ova wherein yolk formation has commenced in the central part present in good numbers, but majority of ova still immature.

Stage III : Ovary longer, broader and thicker than in the stage II, extending up to 2|3 length of the body cavity; red or reddsh-brown in colour. Immature, maturing and completely opaque mature (0.40 to 0.90 mm) ova present. Immature ova form the majority.

The ovaries of the recovering-spents in stages II to III are longer and broader than those of virgins; deep red in colour with conspicuous veination. Disorted (unhealthy), unspawned mature or ripe ova present. Fish in recovering stages II and III are comparatively rare and this suggests that development through these stages is fast.

Stage IV : Ovary long and broad, filling 2|3 to 3|4 body cavity; red or reddish-yellow in colour. Immature, maturing and mature ova present. Mature ova more numerous than maturing ova.

Stage V : Ovary long and broad, swollen and almost filling the body cavity; red or reddish-yellow in colour. Veination conspicuous. Besides immature, maturing and mature ova, ripening ova which are transparent peripherally, 0.90 to 1.10 mm in diameter, also present. Opaque mature ova more numerous than maturing or ripening ova.

Stage VI : Ovary long and broad, campletely swollen and almost filling the body cavity. Colour: reddish-yellow or red. Veination very conspicuous. Ripening and ripe ova, which are completely transparent, (1.10 to 1.70 mm) with hexagonal markings numerous. Mature ova also more or less equally numerous.

Stage VII a : Partially spent - Ovary shrunken and flaccid but not as completely hollow and sac-like as in stage VII b. In external appearance partially spent ovaries resemble ovaries in stage IV or V and it is very difficult to differentiate a partially spent ovary from one in stage IV or V by macroscopic examination. Colour: red or reddish-yellow. Few crumpled or distorted and distintegrating ripe ova present. Mature ova numerous. Such partially spent ovaries have been observed by the present author (Rao 1963) in *Pseudosciaena diacanthus* also from Bombay and Saurashtra waters.

Stage VII b: Spent - Ovary hollow, sac-like, flaccid and blood shot. Deep red in colour. Veination very conspicuous. Ovaries shrunken, extending up to 1|2 or 2|3 body cavity. Distorted or crumpled and disintegrating ripe and mature ova present besides the immature ova on the ovigerous lamellae.

Frequency and Duration of Spawning

The ova-diameter--frequency curves for ovaries in different stages of maturity are fiven in Figs. 1, A to K.

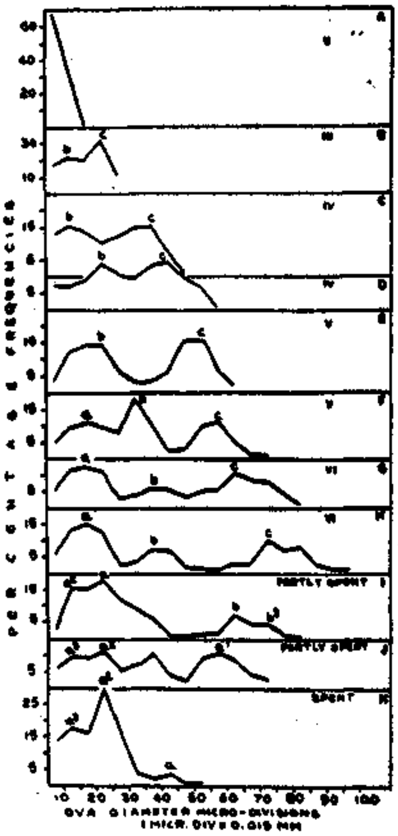

FIG. 1 Ova-diameter-frequency curves for ovaries of *S. tumbil* in different stages of maturity.

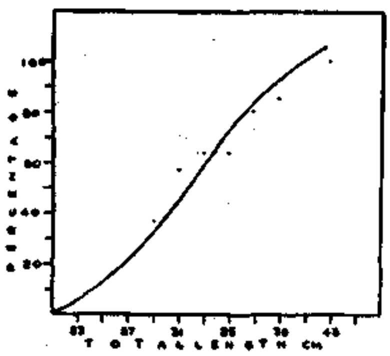

FIG. 2. Size at 50% maturity in females of *S. tumbil*.

Fig. 1, A is the ova-diameter frequency curve for an ovary in stage II and this shows unimodal distribution, the majority of ova being immature and transparent (< 10 m. d.).

The curve for an ovary in stage III (Fig. 1B), in addition to the mode comprising the immature transperent ova, shows two modes (*b* and *c*) which are not sharply separated. The ova under mode *b* are maturing ova wherein yolk formation has commenced but not complete (8-19 m.d.) while in ova under mode *c* (20-30 m.d.) yolk formation is complete and they are opaque.

Figs. 1 C and D are the frequency curves for ovaries in stage IV and these curves also show two modes (*b* and *c*) which are not sharply separated. The ova under mode *b* are maturing while those under mode *c* are mature. In Fig. 1, D the ova under both the modes are mature and more or less in the same stage of development as far as yolk deposition is concerned. The size range of the mature ova in Fig. 1 D is more, i.e 20-55 m.d. and it is likely, therefore, that the actual period of spawning, during which ova of this group represented by modes *b* and *c* are discharged, may be a prolonged one. Sometimes ova represented by more than one mode, adjacent to each other, actually may indicate ova in the same stage of maturity as observed by Prabhu (1956). The modes at 12.5 and 22. 5 m.d. in stage III ovary progress to 22.5 and 42.5 m.d. respectively in stage IV ovary (Fig. 1 D). The presence of an intermediate group of maturing ova represented by mode *b* may not necessarily indicate a second spawning season as may be seen from the account given below. The ova under the mode *b* may be shed after those under mode *c* in the same spawning season indicating that the spawning season in *S. tumbil* is protracted during which two or more batches of eggs are shed.

Figs 1 E and F represent ova-diameter-frequency curves of ovaries in stage V. In Fig. 1 E only two modes (*b* and *c*), more sharply separated than in stage IV, could be made out. Nearly half the ova under mode *b* are maturing and the other half are mature. The majority of ova under mode *c* are mature (opaque) while some are becoming transparent peripherally (ripening ova). Fig. 1 F shows three modes. The modes *b* and *c* in Fig 1 E progress further and, in addition to these two modes, another mode *a* appears. Majority of ova under mode *a* are maturing and some are mature and these represent a fresh batch of ova separated from the immature stock. All the ova of mode *b* are mature while majority of ova (> 55 m.d.) under mode *c* are ripening ova which are peripherally or partly transparent. The modes *b* and *c* at 17.5 and 37.5 m.d. in stage IV (Fig. C)progress to 32.5 and 57.5 m.d. respectively in stage V ovary (Fig. I F).

The frequency curves of two fully ripe ovaries (Stage VI) are given in Fig. 1 G and H. The curve in Fig. 1 G is similar to that in Fig. 1 F with three modes, but the modes *b* and *c* have progressed further to 37.5 and 62.5 m.d. respectively. The mode *a* consisting of maturing and mature ova has not progressed. All the ova under mode *b* are mature while those under mode *c* are ripe (completely transparent). Fig. H is similar to that of Fig. G except for the further increase in size of ova under mode *c*. The ripe ova represented by modes *c* (72.5 m.d) and *c*1 (82.5 m.d) have developed from the ripe and ripening ova represented by mode *c* (62.5 m.d.) in Fig. G. The bimodal appearance of the ripe ova in Fig. H (modes *c* and *c*1) may be due to some of the ova under mode *c* in Fig. G. growing faster than the others and differentiating themselves into a batch (mode *c*1).

The two modes *c* and *c*1 (Fig. 1 H) are not sharply separated and the ova are in the same stage of development, i.e. fully ripe and about to be shed. The ripe ova in mode *c*1 may be shed immediately, followed by those in mode *c* shortly afterwards (few days). The ripe ova represented by the modes *c* and *c*1 are sharply separated from the mature ova. The mature ova under mode *b* are in an advanced stage of development and these also may ripen and be shed in the same spawning season after the ova under the modes *c* and *c*1 are spawned. The maturing ova represented by mode *a* in Fig. 1 F (stage V) have not progressed further in stage VI ovary (Fig. 1 H).

The frequency curves for ovaries in two different stages of partially-spent condition are shown in Figs. 1 I and J. In Fig. 1 four modes a2 (12.5 m.d.), *a* (22.5 m.d), *b* (62.5 m.d.) and *b*1 (72.5 m.d.) could be made out. Mode *a*2 represents a fresh batch of maturing ova while those under the mode *a* are mature ova developed from an earlier batch of maturing ova represented by mode *a* in Figs. 1 F, G, and H. The modes *a*2 and *a* are not sharply separated. The ova under the modes *b*1 and *b* are ripe ova which are about to be shed. The ripe ova under the modes *b* and *b*1 are likely to have developed from the mature ova under mode *b* (37.5 m.d.) in Fig. 1 H (stage VI ovary). The bimodal nature of the ripe ova, as stated earlier, may be due to some of the ova under the mode *b* in Fig. H growing faster in size and differentiating themsleves to form another mode (*b*1). The ova under both the modes (*b* and *b*1) are in the same stage of development. The ova under the mode *b*1 are likely to be shed immediately followed by those under the mode *b*.

Fig. I J represents the ova diameter-frequency curve of an ovary in another stage of partially spent condition. Four modes, *a*3, *a*2, *a* and a1 at 12.5, 22.5, 37.5 and 57.5 m.d respectively could be clearly made out. Ova under the mode *a*3 represent another fresh-batch of maturing ova. The ova under the mode *a*2 are likely to be the same as those under mode *a*2 in Fig. 1, which has progressed from 12.5 to 22.5 m. d. The ova under the mode *a* are mature ova. Mode *a*1 comprises of both ripening and ripe ova. It is likely that the ova under the modes *a* and *a*1 have developed from the same batch of ova represented by mode a in Fig. 1 I. Some of the ova under the mode *a* in Fig. 1 I, may have grown faster than others and differentiated into a batch of ripening and ripe ova represented by mode *a*1 in Fig. J while the others which are still mature and lagging behind are represented by the mode *a*. The ripening and ripe ova under the mode *a*1 in *Fig.* 1 J are likely to be shed in the same spawning season. The mode *a* at 37.5 m. d. in Fig 1J can be traced to the mode *a* at 42.5 m.d. in Fig. 1 K representing the curve for a completely spent ovary collected in February towards the end of the spawning season. Hence it is unlikely that this batch would develop further and be shed in the same season. They are likely to distintegrate and get resorbed. Since these ova are in sufficiently advanced stage, the possibility of their ripening and getting spawned after some time cannot be ruled out in view of the fact that a few late spawners in partially spent condition were observed during April-May in 1964 and 1966.

The frequency curve of an ovary in completely spent condition collected towards the end of spawning season (February) is given in Fig. 1 K. Three modes *a*3, *a*2, and *a* at 12.5, 22.5 and 42.5 m.d. are evident in the curve. The modes *a*3 and *a*2 represent maturing and mature ova observed in partly spent ovary (Fig. J) which have not grown further towards the close of the spawning season (February-March). These ova under the modes *a*3 and *a*2 are more likely to be shed in the next spawning season. The small batch of mature ova under mode *a* are likely to have developed from those under mode *a* in a partly spent ovary (Fig. J). As stated above these may be resorbed or shed.

Specimens in stage IV were encountered in trawler catches from August-September while those in stages V and VI from October onwards. Partly spent and completely spent ovaries were observed from December to March. The ova diameter frequency curves shown in Fig. I A to K represent the sequence in time of the growth and development of ova during the spawning season (September to March *vide infra*) and from the progression of the modes, it can be seen that at least five batches of eggs represented by the modes, *c*1, *c*, *b*1, *b* and *a*1 are likely to be shed during the spawning season. It can seen that there is a gradual reduction in the modal values for the ripe eggs from (*c*1 to *a*1) 82.5 to 57.5 m.d. This suggests that the size of the fully ripe ova at the time of shedding gets reduced towards the end of the spawning season.

Number of batches of eggs spawned: To know the number of batches of eggs spawned, the method adopted by Clark (1934) in the case of Pacific sardine, *Sardinops caerulea*, was followed. The ratio of maturing eggs (0.20 to 0.40 mm in diameter) to the mature and ripe eggs ($>$ 0.40 mm) was estimated for different months during the spawning seasons from the pooled ova diameter frequency data for ovaries in stage VI and partly spent condition, and presented in Table I. It can be seen from the table that the ratio of maturing eggs to mature eggs gradually declined from 1 : 3.9 in October to 1 : 2.0 in May and this lends support to the view that more than one batch of eggs (at least three batches) are spawned by *S. tumbil*. That the fall in the ratio of maturing eggs to mature and ripe eggs was not due to the decrease in the size (weight) of fish is shown by the average weight of fish in different months.

SPAWNING SEASON

The percentages of females in different stages of maturity in each month for the period from October 1963 to August 1967 are given in Table 2.

TABLE 1. *Ratio of maturing* (0.20 *to* 0.40 *mm*) *ova to mature and ripe ova* (> 0.40 *mm*) *in different months for ovaries of* S. tumbil *in fully ripe* (*stage VI*) *and partly spent condition.*

Month	Number of ovaries examined	Average weight of fish (g)	Maturing: mature and ripe ova.
October	2	615.0	1: 3.9
November	4	420.0	1: 3.8
December	5	381.4	1: 3.6
January	4	433.5	1: 3.5
March	3	500.5	1: 3.0
May	2	607.0	1: 2.0

Immature specimens in stages I to III were observed in all the months. Mature specimens (stage IV) were observed from August onwards and their percntage gradually increased, reaching the peak in December in all the years. From January onwards their percentage gradually declined. Specimens in stage IV were not observed from April to july in all the years, except 1964. Specimens in stage V were comparatively rare and were observed during October-December. Fully ripe specimens (stage VI) occurred in the catches from October to January. One ripe specimen was observed in the month of September in 1964. Partly spent gonads were observed from November to March, and in 1966 one specimen in partly spent condition was recorded in the beginning of May. This may be a stray late-spawner. Spent fish (stage VII) occurred during the period December-March. Ripe and partly-spent fish were not observed during the period October-January of the 1965-66 spawning season. One partly spent and one completely spent fish were observed in February 1966.

The cycle of events of maturation were more or less same during the four years (1963-1967). From this it can be inferred that the spawning season in this species is protracted extending from October to March, the peak period being November-December. From April to July mostly spent recovering and immature fish were encountered in the trawler catches. These events clearly show that April to July is the resting period; August to September the period of active maturation; and October to March the spawning period.

Minimum size at first maturity

To determine the minimum size at first maturity, the percentage of maure fish in stage III and above in maturity scale were calculated for each size group and plotted against the mid points of the size groups in Fig. 2. Only immature

TABLE 2. *Monthly percentages of* S. tumbil *(females) in different stages of maturity. Data from the landings of Government of India trawlers.*

Year month	Stages of Maturity I	II	III	VI	V	VI	Partly Spent	Spent (VII)	No. of fish examined
1963									
Oct	74.3	2.9	11.4	5.7	5.7	—	—	—	36
Nov	25.0	12.5	21.4	33.9	—	5.4	1.8	—	56
Dec	8.3	—	8.3	50.0	—	33.4	—	—	12
1964									
Jan	—	—	—	—	—	100.0	—	—	1
Feb	8.7	21.7	30.4	26.1	—	—	—	13.1	23
March	21.4	21.4	10.7	10.7	—	—	28.6	7.2	28
April	75.0	6.3	6.2	—	—	—	12.5	—	16
May	81.3	—	6.2	12.5	—	—	—	—	16
June	60.0	6.7	20.0	13.3	—	—	—	—	16
July	34.2	18.4	34.2	13.2	—	—	—	—	38
Aug	28.6	19.0	14.3	38.1	—	—	—	—	42
Sept	13.3	6.7	15.6	60.0	—	2.2	2.2	—	45
Oct	11.8	17.6	17.6	41.2	2.9	8.8	—	—	34
Nov	—	12.0	52.0	16.0	4.0	16.0	—	—	25
Dec	—	—	10.2	59.0	2.6	15.4	7.7	5.1	39
1965									
Jan	—	—	14.3	28.6	—	14.3	28.3	14.2	7
Feb	11.5	11.6	26.9	34.6	—	3.8	11.6	—	26
March	49.4	13.0	18.2	15.5	—	—	3.9	—	77
April	71.4	21.4	7.2	—	—	—	—	—	42
May	72.4	20.7	6.9	—	—	—	—	—	29
June	97.5	—	2.5	—	—	—	—	—	40
July	75.0	25.0	—	—	—	—	—	—	4
Aug	73.5	8.8	14.8	2.9	—	—	—	—	34
Sept	81.6	10.2	4.1	4.1	—	—	—	—	49
Oct	28.6	33.3	23.8	14.3	—	—	—	—	21
Nov	25.0	32.1	17.9	21.4	3.6	—	—	—	28
Dec	—	—	15.8	84.2	—	—	—	—	19
1966									
Jan	17.4	—	30.4	52.3	—	—	—	—	23
Feb	22.2	5.6	27.7	33.3	—	—	5.6	5.6	18
March	39.1	21.8	30.4	8.7	—	—	—	—	23
April	100.0	—	—	—	—	—	—	—	8
May	79.2	8.3	8.3	—	—	—	—	4.2	24
June	75.0	18.7	6.3	—	—	—	—	—	16
July	84.6	15.4	—	—	—	—	—	—	13
Aug	66.6	22.3	11.1	—	—	—	—	—	9
Sept	65.6	18.8	9.4	6.2	—	—	—	—	32
Oct	45.5	13.6	13.6	27.3	—	—	—	—	44
Nov	30.0	10.0	26.7	26.7	—	3.3	3.3	—	30
Dec	8.7	10.9	28.2	30.4	—	8.7	13.1	—	46
1967									
Jan	16.7	—	16.7	66.6	—	—	—	—	6
Feb	37.5	3.1	28.1	28.1	3.2	—	—	—	32
March	60.0	10.0	30.0	—	—	—	—	—	10
April	100.0	—	—	—	—	—	—	—	2
May	75.0	25.0	—	—	—	—	—	—	5
June	100.0	—	—	—	—	—	—	—	5
July	80.0	—	20.0	—	—	—	—	—	5
Aug	75.0	—	12.5	12.5	—	—	—	—	8

fish were observed in size groups below 22 cm. Majority of the fish (57.3%) were mature in size group 30-32 cm. Since fish in ripe (stage VI) and partly spent condition were observed first in the length range 26-28 cm, the minimum size at maturity in *S. tumbil* can be taken as 26.0 cm in total lengh and the size at 50% maturity as 30.0 cm.

Fecundity

The estimated number of eggs with the data on the length and weight of fish and weight of ovary are given in Table. 3.

It can be seen from Table 3 that the fecundity of *S. tumbil* ranged from 337,569 to 2,14,981 eggs for fish of the size range 290 to 430 mm in total length. It can also be seen from the above table that fish of more or less the same length showed discrepancies in the ova count per gram sample, viz. two fish 41.5 cm in length have ova counts per gram sample of 5157 and 3051. Similarly a fish 42.0 cm in length has ova count of 2580 while another fish 42.2 cm in length has a count of 8102 ova per gram. This may be due to some individuals being ready for spawning for the first time while others may have spawned one or more batches of eggs. The small number of mature ova in a few cases may be due to the onset of recurring maturation with a fresh stock being developed for the next spawning season.

In Fig. 3 are plotted the ova counts per gram sample of the ovary of mature (stage IV and V) and ripe (stage VI) specimens of *S. tumbil* against the length of fish. The scatter of the points indicates that the ova counts fall into the following ranges (egg lines): (1) Individulas with ova count of 8000 or more per gram sample, (2) Individuals with count ranging from 4500 to 6500, (3) Individuals with ova count ranging from 2000 to 3500, (4) Individuals with ova count ranging from 1300 to 1750.

Fish with ova count of 8000 or more per gram are probably those which will be spawning for the first time in the season and which have these eggs as potential stock, which may be spawned in 3 or more batches.

Individuals with 4500 to 6500 eggs per gram may be those which have discharged one or two batches of eggs while those with a potential stock of 2000-3500 eggs per gram may have spawned 2 or 3 batches. Fish with ova count of 1300-1750 may be those which have spawned 3 or 4 batches and have yet one or two batches to be spawned before the close of the spawning season. From this it would appear that the number of eggs spawned in a batch gradually diminishes as the spawning season advances. The number of eggs per gram sample spawned in the first batch may be 3500 or more. In the second and third batches the number of eggs per gram sample spawned may be 2500-3000 and 700-1750 respectively and in the subsequent batches the number may be still less.

TABLE 3. *Estimated number of mature ova in* S. tumbil

Total length of fish (cm)	Weight of fish (g)	Weight of ovary (g)	No. of ova per gram sample	Estimated No. of ova in the entire ovary
29.0	182.5	9.423	3986	37569
32.8	249.0	27.763	2852	79179
33.0	258.0	24.113	2647	63828
33.1	258.0	20.573	3235	66554
33.8	312.0	30.743	2149	66067
34.1	298.0	30.273	2254	68235
34.6	357.5	58.055	1385	80384
35.2	363.5	16.178	2350	38018
35.5	349.5	28.593	3206	91669
35.6	347.5	48.323	1300	62820
36.0	425.0	28.613	2497	71447
37.5	433.5	82.503	2605	214981
37.6	384.5	26.973	3347	90278
38.3	428.0	29.303	2614	76598
38.4	428.0	24.304	3643	88539
38.5	523.0	12.523	6214	77818
38.5	456.0	19.543	5547	108401
39.0	527.5	67.463	2443	164812
39.3	503.5	22.473	4914	110432
40.1	500.5	40.073	1716	68765
40.2	567.0	33.903	2861	96997
40.7	575.5	23.313	5774	134609
41.0	589.5	24.673	4565	112632
41.1	641.0	36.703	3324	122000
41.3	545.5	22.993	5746	132118
41.5	588.5	30.373	5157	156634
41.5	615.0	50.823	3051	155061
42.0	681.0	65.743	2580	169617
42.2	581.0	11.123	8102	90118
42.7	686.0	25.863	6310	163196
43.0	621.5	15.783	6286	99212

In *S. tumbil* the opaque mature ova (0.40 to 0.90 mm in diameter) can be easily separated from the fully ripe translucent ova (1.0 to 1.4 mm). The fully ripe ova which are in a very advanced stage of development are likely to be

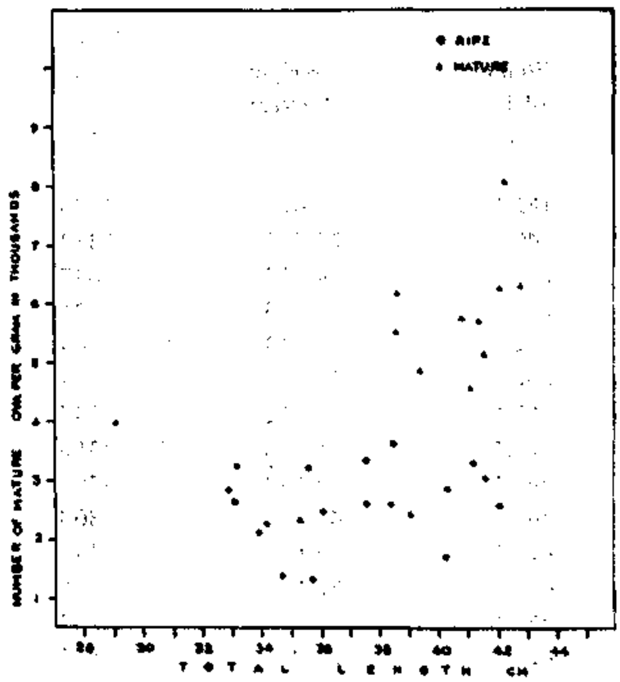

FIG. 3. Number of eggs per sample of ovary of *S. tumbil* at different lengths.

shed immediately or within a short time. The number of ripe ova per gram sample and for the entire ovary were estimated for 37 fish in stage VI and different degrees of partially spent condition according to the procedure already outlined. The data are presented in Table 4. In Fig. 4 the ripe ova count per gram sample are plotted against length of fish. The ova count ranged from 286 to 2689. The ripe ova count per gram sample of the ovary may be considered as the 'standing crop'.

It can be seen from Table 4 and Fig. 4 that the number of ripe eggs shd in a batch vary in fishes of more or less the same length. To cite an example, fish with total lengths of 40.0, 40.1, 40.1 and 40.2 cm show ripe ova counts of 286, 1176, 727 and 973 per gram respectively. Two fish of the same length (40.1 cm) show ripe ova counts of 1176 and 727 per gram.

Individuals with ripe ova count of 2689 per gram are probably those that have already shed one batch and getting ready to shed the second batch

TABLE 4. *Number of ripe ova (1.0-1.4 mm) per gram sample of the ovary and in the entire ovary in ripe (Stage VI) and partly spent ovaries of S. tumbil.*

S. No.	Total length fish (cm)	Weight of fish (g)	Weight of ovary (g)	No of ripe ova per gram sample	Estimated No. of ripe ova in the entire ovary
1	28.6	173.5	5.908	858	5069
2	28.6	173.5	6.953	1061	7377
3	29.0	175.5	13.793	864	11917
4	29.3	195.0	15.773	1382	21798
5	29.4	201.0	9.683	1652	15996
6	29.8	214.0	10.478	1063	11138
7	30.8	229.0	11.913	634	7553
8	32.1	268.5	21.293	1725	36730
9	32.7	255.5	16.353	1017	16631
10	32.8	249.0	27.763	997	27679
11	33.0	258.0	24.113	1288	31058
12	33.1	258.0	20.573	1103	22692
13	33.4	267.5	8.413	398	3348
14	33.6	323.0	13.083	935	12887
15	33.7	310.0	13.923	663	9231
16	33.8	312.0	30.743	697	21428
17	33.8	332.0	10.423	2639	28027
18	34.1	298.0	30.273	728	22038
19	34.5	357.5	13.423	1391	18671
20	34.6	357.5	58.055	655	38003
21	35.2	352.0	15.193	699	10620
22	35.5	349.5	28.693	1305	37314
23	35.6	347.5	48.323	629	30395
24	36.0	425.0	28.613	974	27869
25	37.2	380.0	7.953	1231	9790
26	37.5	433.5	82.503	924	76256
27	37.6	384.5	26.973	1178	31774
28	38.3	428.0	29.303	1545	45273
29	38.4	428.0	24.304	1116	27123
30	39.0	527.5	67.463	885	59705
31	40.0	459.5	14.053	286	4019
32	40.1	492.5	14.163	1176	16656
33	40.1	500.5	40.073	727	29133
34	40.2	567.0	33.903	973	32988
35	41.1	641.0	36.703	1359	49879
36	41.5	615.0	50.823	1219	61953
37	42.0	681.0	65.743	684	44968

(Fig. 4). Fish with ripe ova counts of 1500-1800, 800-1400, 400-800 may represent individuals that have spawned 2, 3 and 4 batches respectively. Fish with a low count of < 300 per gram may be those that have spawned most of the ripe ova and may shed this last batch or these ova may distintegrate and get resorbed. Such disintegrating crumpled ova were observed in partially spent ovaries.

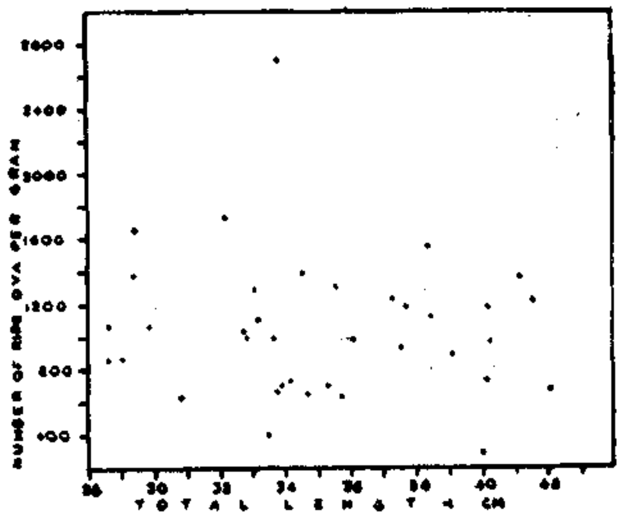

FIG. 4. Number of ripe eggs per gram sample of ovary of *S. tumbil* at different lengths.

Total length-fecundity relation: The fecundity values for 31 fish are plotted against total length in Fig. 5 A and it may be seen that relationship is that of a parabola. The relationship between total length and fecundity may be described by a formula of the type $F = AL^B$ where F = fecundity in thousands of eggs, L = total length in cm, A is a constant and B an exponent .In the case of *S. tumbil* the following equation was fitted for the total length-fecundity relationship.

$$F = 0.001142\ L^{3.1151}$$

By using the logarithms the parabolic equation can be expressed by the linear equation : $\log F = 3.1151 \log L - 2.9424$.

Fish weight-fecundity relation: In Fig. 5 B are plotted the fecundity values for 31 fish against the weight of fish. The relation between them is expressed by a linear regression equation of the form : $Y = A + BX$, where X and Y represent the weight of fish in grams and fecundity in thousands respectively, and A, a constant and B, the slope of the regression line (regression coefficient).

The equation expressing the relation beween the fecundity and weight of fish in *S. tumbil* was found to be

$$Y = 9.0003 + 0.2017 X$$

Ovary weight-fecundity relation: The fecundity plotted against weight of ovary does not show any relationship between them.

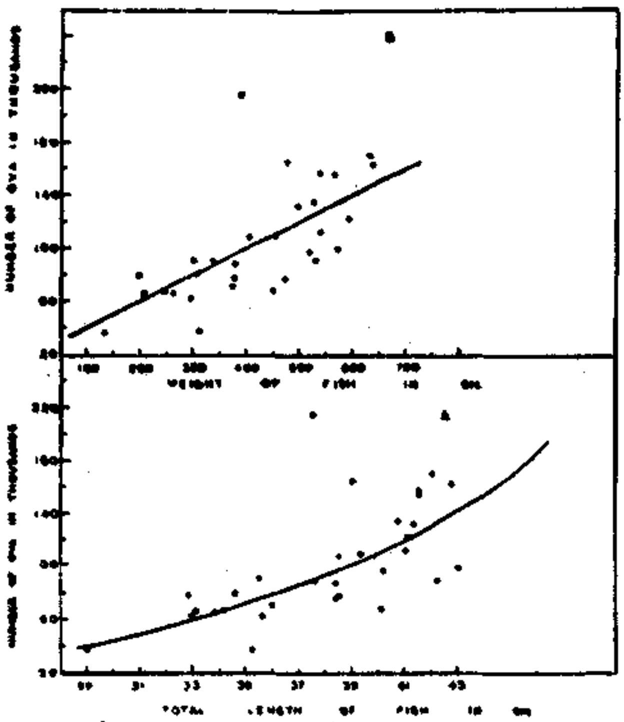

FIG. 5. Relation between fecundity and (A) length of fish; (B) weight of fish in *S. tumbil*.

Spawning ground and occurrence of post-larvae: The eggs of *S. tumbil* were collected in the plankton of inshore waters off Madras by Nair (1952) and Vijayaraghavan (1957) and from Waltair by Raju (1963). Ripe specimens were collected from inshore catches at Madras in December by Kuthalingam (1959) while Annigeri collected ripe specimens from catches off Mangalore. The present author has collected post-larvae 25-40 mm in the shore-seine catches at Waltair during November-March. Ripe and partly spent fish were collected from catches of trawlers which fished in 25-50 metres depth. The above observations clearly show that spawning may take placc in coastal waters, not far from the shore and that the eggs and larvae may enter the inshore waters during October-March period.

SAURIDA UNDOSQUAMIS

Female specimens in stage III and IV of maturity were observed during September to March while those in stages I and II were observed throughout the year. Fish in stage V and VI were not encountered. This indicates that spawning season in this species also may be form October to March with the peak in November-December. The eggs and larvae of this species have not been reported so far.

The ova-diameter frequency curve (fig. 6) shows two modes. Ova under these modes may undergo maturation and be shed in the same spawning season which may be protracted.

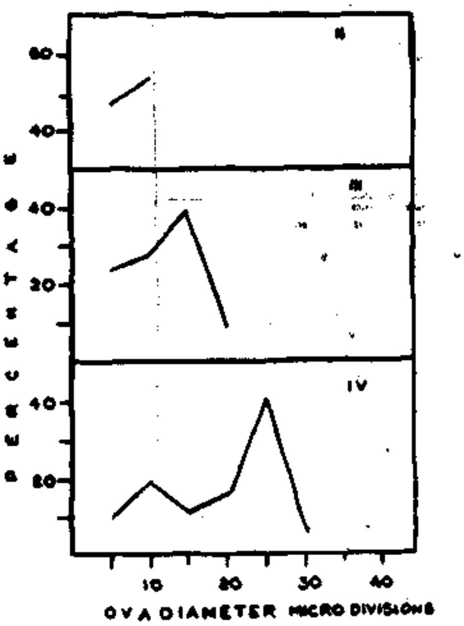

FIG. 6. Ova-diameter-frequency curves of ovaries of *S. undosquamis* in different sstages of matu. rity.

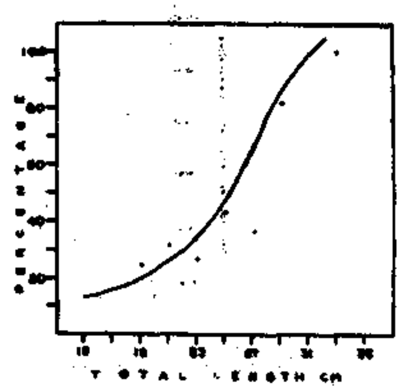

FIG. 7. Size at 50% maturity in females of *S. undosquamis*.

The percentage of mature fish (stage III and IV) in different size groups are shown in Fig. 7. Since nearly half were mature in the size group 24-26 cm, the minimum size at maturity can be taken as 24.0 cm.

The fecundity estimates for fish (25.7 to 32.0 cm in total length) in stage IV of maturity ranged from 16542 to 78942. The ova count per gram sample of the ovary ranged from 3143 to 8939.

DISCUSSION

S. tumbil from Mangalore (west coast of India) and Viskhapatnam (east coast) differ with each other in respect of size of ova and many other characters The ova diameter were measured at the same magnification as Annigeri (1963). The size range of intraovarian eggs was found by Annigeri (1963) to be 1 to 48 m.d. whereas the present author has found the size range for specimens from Visakhapatnam to be 1 to 90 m.d. which is nearly double that for the Mangalore specimens. Annigeri (1963) has observed that the fully ripe ova which were about to be shed had a modal value of 35-38 m.d. whereas in specimens from Visakhapatnam region ova of this modal value were still opaque (mature) and not yet started ripening. He found that the fully ripe ova were translucent or semitransparent. In specimens from Visakhapatnam region also translucent ova were observed, but they were >50 m.d. in diameter. These ova had not become fully ripe, while the fully ripe ova were 55-90 m.d. (1.10 to 1.80 mm) in diameter, completely transparent and showed the characteristic hexagonal markings on the egg membrane (sculpture). Annigeri does not mention about these markings on the egg membrane while others (Vijayaraghavan 1957; Kuthalingam 1959; Raju 1963) have observed these markings. Kuthalingam (1959) found the average diameter of fully ripe egg to be 1.12 mm while according to Okada and Kyushin (1955), the diameter of fully ripe ova in *S. tumbil* from East China and Yellow seas ranged from 0.96 to 1.50 mm.

Another important difference is the presence of a pinkish-yellow oil globule (3 to 7 m.d) in ripe eggs of *S. tumbil* from Mangalore while in the ripe ova of *S. tumbil* from Visakhapatnam region an oil globule is not present. Vijayaraghavan (1957) and Kuthalingam (1959) did not find an oil globule in ripe ova from Madras, while Raju (1963) also did not find an oil globule in the eggs of this species collected from plankton off Visakhapatnam.

The frequency curve for a stage VI ovary presented by Annigeri (1963) resembles that of a stage IV ovary of specimens from Visakhapatnam wherein two groups of ova could be seen. The ova diameter frequency curves for ripe ovaries (stage VI) of specimens from Visakhapatnam show three groups of ova which undergo maturation (Fig. 1) and they may be shed in five or six batches as shown already. According to Annigeri, only two batches of eggs are shed, in case the second batch is not resorbed. It has been pointed out by the present author earlier that it is difficult to dintinguish a partly spent ovary from those in stage IV to VI.

It may be possible that what Annigeri considered as stage VI ovary (his fig. 4) was a partly spent ovary. The translucent ova with a modal value of 35-38 m.d. may be ripening eggs differentiated from the mature eggs after one or two batches of fully ripe (completely transparent) ova were shed. It, threfore, seems desirable to examine more specimens from Mangalore regarding the size of the intraovarian eggs and the ripe eggs, presence of oil globule and other characters before confirming the differences noted above in specimens from Mangalore and Visakhapatnam. In the characters considered above, *S. tumbil* from the East China and Yellow seas appear to be closer to those from the northwestern part of Bay of Bengal.

ACKNOWLEDGEMENTS

I am grateful to the late Dr. K. V. Sekharan, former Head of the Fishery Biology division, Central Marine Fisheries Research Institute, Cochin, and to Dr. J. P. Thapliyal, Professor of Zoology, Banares Hindu University, for guidance and help. I am thankful to Dr. E. G. Sials, Director, Central Marine Fisheries Research Institute, for offering valuable suggestions for improving the manuscript.

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