SPAWNING PERIODICITY OF THE RIBBON FISH, *TRICHIURUS LEPTURUS* (F.), WITH A NOTE ON ITS RATE OF GROWTH

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ABSTRACT

The spawning periodicity of *Trichiurus lepturus* is briefly re-examined here in the light of certain recent observations. It is seen that this species spawns more than once in a year along the Madras coast and the two seasons are roughly around May-June and later in November-December. This fact also leads to a revision in the interpretation of the rate of growth of the fish. It is now estimated that the fish at the end of one year attains an average of 300 mm in length and that those above about 900 mm are just over four years.

Considering the importance of ribbon fishes in the marine fisheries of the east coast, it may be conceded that the amount of literature on the biology of this group is not adequate. While the recent publications, especially those of James (1959 and 61), Dutt and Thankam (1966) and Gupta (1967) concentrate more on the details of osteology or taxonomy of this group, the one account by Prabhu (1955) still remains the best discussion on the biology of the most important species of this area, viz. *Trichiurus lepturus* (*T. haumela*) and the latest monograph by James (1967) gives a fairly comprehensive treatment of the group as a whole. However, as already brought to our attention by James (1967), the reports of Prabhu (*loc. cit.*) and even those of Mahadevan (1950) , Vijayaraghavan (1951) and Sekharan (1955) dealing with the different aspects of the digestive system, food and muscle fat variations in this species from the Madras coast, cover only fish whose maximum length is less than 620 mm, whereas in the commercial catches of Madras *T. lepturus* of nearly a meter in length are not uncommon. Thus, there is some lacuna in the available information, especially as regards fish of the larger size, on the biology of this important species. Consequent on the more extended fishing operations up to about 16 km employing power boats and nylon gear in recent times the fresh material obtained has been utilized for a re-examination of some of the known aspects of the biology of this species.

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The discussion that follows is largely centred round the question of spawning periodicity of the species, based on data and observations gathered from the marine fishing centres in Madras City and immediate surroundings, during the period from June 1965 through May 1967.

Observations and Discussion

Spawning periodicity

It will be helpful to reiterate here the relevant points from the findings of Prabhu (*loc. cit.*) which briefly state that (i) the spawning is restricted to a short and definite period, probably at the end of June, and (ii) the young ones of this species measuring 7-9 cm in length are observed in large numbers only once a year towards the end of July. The single spawning theory has been based on the intraovarian egg distribution as well as on his collection of the young fish only once a year.

Some of our own observations and data collected from the same region lead to slightly different interpretations from those given above. In Madras and nearby regions, the ribbon fish fishery generally commences towards the close of July or early August and continues more or less steadily until late January. The length frequency distribution in a sufficiently large sample taken during the fishing season is of some interest. Each haul usually consists of fish comprising a wide range in length, including the juveniles of even 100 mm and upwards to the very large fish of about 900 mm. Such a sample covering the entire size range shows minor modes at approximate intervals of 150 mm. Unless a truly representative sample is measured (and this has many practical difficulties in a fish landing centre as in the Madras City) some of these modes tend to remain obscure and a true picture is not likely to emerge. While discussing the frequency modes in *Eupleurogrammus intermedius*, James (1967) has pointed out the same difficulty of how the identity of some of the modes is likely to be masked on account of the lack of a short and definite spawning period. Thus, the sampling methods and interpretations given by Prabhu appear to have led him to arrive at some erroneous conclusions, especially when the spawning periodicity of this species has not been satisfactorily ascertained.

Early juveniles — Early juveniles of less than 100 mm in length have been seen in our collections from shore seines during the period June-July and again in December - January. Fig. 1 shows the pattern of occurrence of these early juveniles between 45 and 200 mm in length. Each point (solid dots for 1965-66 and open circles for 1966-67) in the figure represents a single individual of that particular length. It may be evident that the very small sized fish are by no means abundant in these commercial catch nor have they been caught in the plankton hauls. In the absence of any special means of collecting these early stages, or knowing the actual place or depth at which they occur and in view of their tendency to escape capture by ordinary nets, we had to depend only on the stray individuals picked up from the general hauls. While this cannot give any realistic picture on the frequency of their occurrence, the figure will help to show clearly that the young ones of this species

occur along the Madras coast twice in the course of twelve months. During both the years of our observation, the season of occurrence has been more or less comparable although there is some inevitable disparity in the frequency of distribution of the different sizes for the two years.

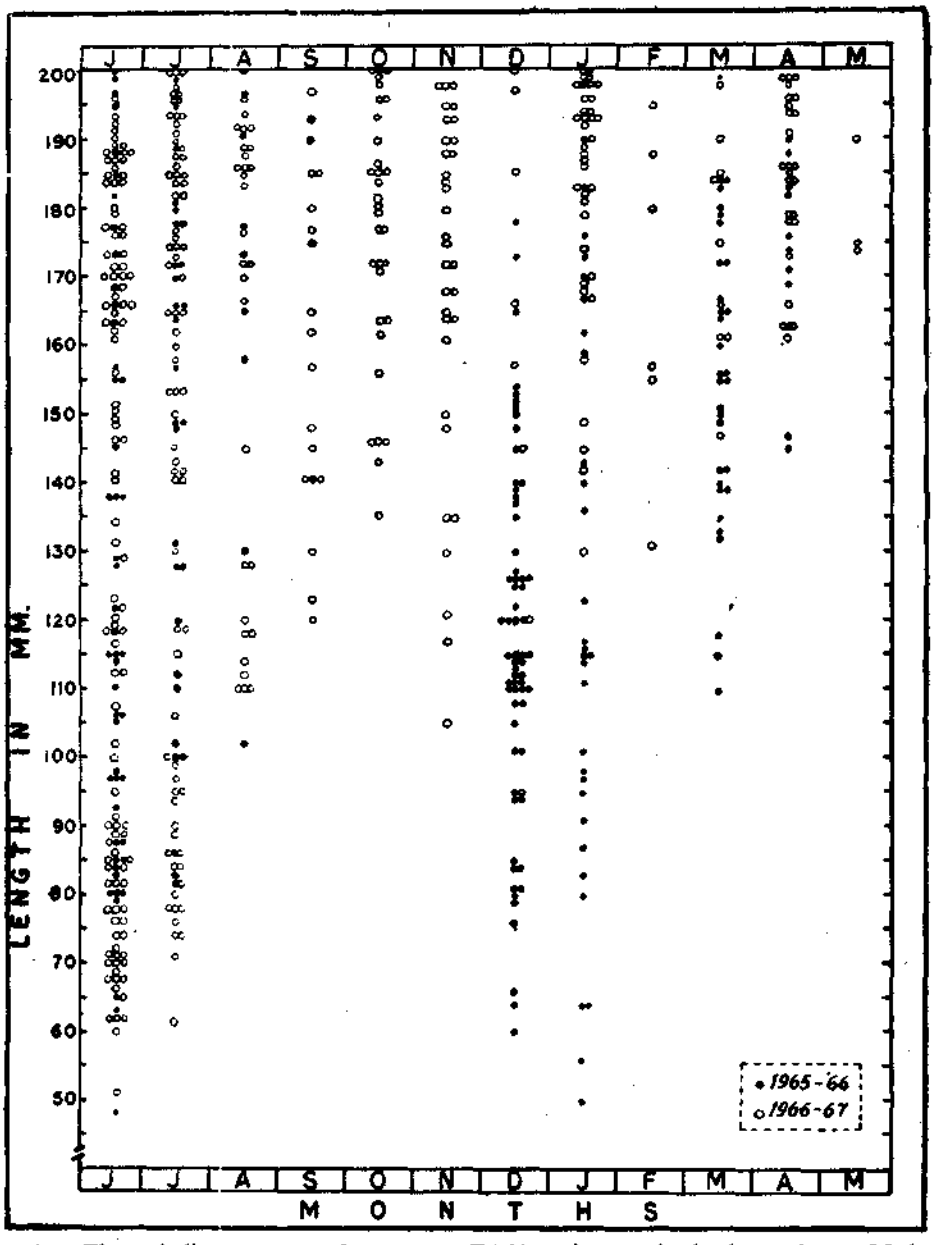


FIG. 1. The periodic occurrence of very young *Trichiurus lepturus* in the shore seines at Madras during 1965-'67.

Basheeruddin and Nagappan Nayar (1961) have collected juvenile fish of 80-100 and 130-270 mm from the same region during March to April, while Dr. K.V. Sekharan (personal communication) informs that *Trichiurus lepturus* of 55-100 mm have been obtained by him off the Chilka coast during the latter half of February. The smallest post-larva so far collected by us measured 47 mm and was obtained in June 1965. On account of the non-availability of the eggs and extreme paucity of the early stages in our coastal waters, it has been more or less conjectured that the fish spawns in the offshore regions. However, the repeated appearance of the early stages at almost half-yearly intervals would indicate two periods of spawning in this species.

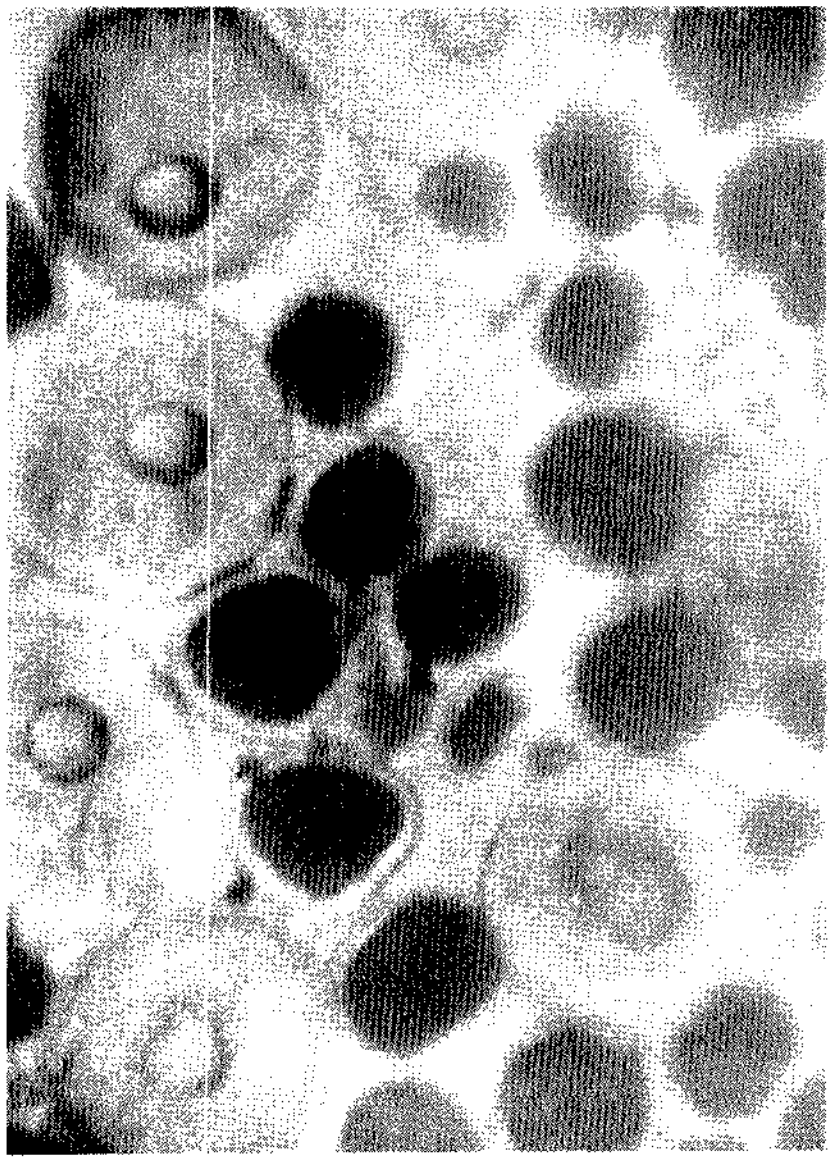
Intraovarian eggs— The pablo boat catches which usually include the larger size groups have been particularly helpful in the study of the gonadial condition of the fish. Fish with ovaries in fairly advanced stages of ripening were encountered in good numbers during April-May and again, to a lesser extent, in October-November. The intraovarian eggs in ovaries of the most mature fish were almost transparent with a diameter variation of 0.8-1.2 mm. Even these could not be regarded as of the oozing stage, although the eggs were seen to get readily loosened at the slightest injury to the ovarian wall. The estimated number of fully developed eggs and other relevant details in the case of seven such fish are furnished below:

S. No.	Length of fish (mm)	L. ovary (mm)	Ovary weight (g)	Total No. of eggs (0.8-1.2 mm dia.)
1	743	135	10.25	24,288
2	780	177	24.66	31,780
3	830	176	21.75	51,691
4	851	155	11.60	29,375
5	860	154	15.42	56,580
6	865	202	12.81	61,595
7	872	185	34.41	47,555

It may be seen from the above figures that the number of eggs in the mature ovaries is far in excess of the figures given by Prabhu, probably because the fish examined here are much larger in size than those examined by Prabhu. It is also not possible to extrapolate our values in his figures 7-9 depicting the ovary size and number of eggs of the fish.

When these nearly mature ovaries are examined[2] it is seen that in individual ovaries, besides the very advanced eggs having a diameter between 1.0 and 1.2 mm,

2. Small pieces of ovaries were hardened in seawater-formalin and the eggs slowly teased out free from one another into a counting chamber. The diameter of the intraovarian eggs were measured directly in millimeters from a Bosch & Lomb projection screen, where the magnification was conveniently calibrated. The diameter of all the eggs on the projection screen was read off in a horizontal plane. It was also verified by comparison that little changes in the diameter of these eggs took place from the fresh condition to the seawater-formalin preserved material. This method was found to be quick and satisfactory for counting and diameter measurements of a large number of eggs.



Photomicrograph showing the two principal size groups of intraovarian eggs in a very advanced ovary of *Trichiurus lepturus*. The opaque eggs measure 0.4 - 0.6 mm while the large translucent ones are 1.0 - 1.2 mm in diameter (ca. × 25).

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there is another distinct group of smaller eggs with an average diameter of 0.5 mm, possessing yellowish and opaque yolk (Pl. I). Their number represents 24-36% of the countable eggs in the ovary while the remaining are the very advanced eggs. These medium-sized eggs obviously represent another batch getting ready for spawning during the subsequent breeding season after the release of the largest group. The third category of the smallest size group (less than 0.2 mm) are unrecognisable to the naked eye and these are not included in the size frequency representations in advanced ovaries. It is from these oocytes that the eggs ripen periodically for each spawning. The pattern of size frequency distribution of the intraovarian eggs was found to be basically the same as represented in figures 3 and 4 of Prabhu and hence is not repeated here. Depending on the degree of ripening of the ova in individual fish collected in a season, the last mode may lie between 0.8 and 1.2 mm while the less advanced group tends to remain at a diameter between 0.4 and 0.6 mm (*cf.* with curve III, Fig. 4 of Prabhu, 1955).

While it has not been possible to state precisely whether these are ovaries that have matured for the first time, the number of medium-sized eggs present is far too many to be regarded as residual eggs in a state of resorption. In fact, the nature of the yolk and other structures clearly indicate that these are in the maturing stage. The early oocytes, on the other hand, have comparatively little yolk in them, besides being distinguishable by their smaller size. From histological structures the approximate condition of the different stages of the intraovarian eggs can be determined although the time taken for maturation of the eggs can only be conjectured in the light of actual observations on spawning periods or records of larval occurrence. The deposition of yolk in the dormant oocytes is a clear indication of the commencement of maturation process. In most of the tropical fishes the development of the eggs seems to progress uninterrupted when once the maturation process is initiated and it is unlikely that the progress is arrested after development has advanced nearly half-way through. Thus, judging from the structure of the intermediate group of eggs, it appears probable that these would attain full ripening within the next five or six months. Therefore, the presence of two distinct size groups of intraovarian eggs in the advanced ovaries and also the occurrence of late post-larval fish twice a year would indicate that the fish breeds on two different occasions in a year at approximate intervals of six months. The occurrence of early stages shows that these spawning seasons are once during May-June and again in November-December.

The sharp peak of advanced group of eggs which is clearly separated from the earlier group suggests that all the ripe eggs are being released at about the same period. The actual spawning of the individual fish thus seems to be completed within a short time as observed by Prabhu. However, that the population as a whole may take about four to six weeks to complete the spawning seems to be borne out by the comparative abundance of the very small fish in one or two succeeding months.

In this context the findings of James (1967) that the allied species of ribbon fish breed more than once a year is noteworthy. Dawson (1967) working on *T. lepturus* from the northern part of the Gulf of Mexico is of the opinion that the presence of young fish from May through July indicates a protracted spawning period of at least several weeks off the Louisiana coast. Tsukahara (1962), on the other hand, states that the absence of larger fish during late fall and early winter together with spring occurrence of planktonic post-larvae at deeper stations are indicative of winter spawning in this species at depths greater than 20 fathoms.

Fish of about 300 mm in length occur during the different months of the year, and more so during the fishing season, along with the larger size groups. During the months from February to June, this 300 mm size fish are seen only occasionally in the local catches when the whole ribbon fish fishery itself is unimportant. It is not known at present what happens to these fish during the summer months, but the occurrence of such medium sized juveniles even during the off season is of some interest as far as the biology and behaviour of the fish are concerned. In the absence of other positive evidence, it must be assumed that the fish move away from the coastal regions during the summer months. From the pablo boat catches which cover a wider range of distance and depth than the shore seines, it has been possible for us to obtain a limited number of fish of the 200-400 mm group at such times of the year when these fish were totally absent in the shore seine catches.

It may also be added here that while no special effort was taken to search for the early post-larvae of this species, the paucity of eggs and larvae in the inshore collections examined hitherto can indicate that the breeding of the fish takes place outside our collection range and the larvae may actually occur at some depth from the surface as had been remarked by both Tsukahara (1962) and Dawson (1967). For similar reasons, perhaps, fully mature oozing stages of the adults also have not been obtained from the local fishery. The most advanced stages of eggs liberated from a mature ovary are spherical, with an average diameter of 1.2 mm, and nearly transparent, except sometimes for a slightly granular opaque zone near the centrally placed oil globule which has a diameter of about 0.4 mm. Ribbon fish eggs as described by Delsman (1927) have never been obtained from the plankton hauls in this area. While these mature ovaries are not infrequent during the spawning season, later stages had not so far been met with. What we consider as a freshly spent ovary was seen only in one fish of 1120 mm caught in November 1967. The length of the ovary was comparable to a mature one, while it was slender, flabby and typically blood-shot all over, particularly near the posterior end. After a gross examination it was found that all the mature eggs had been liberated and the ovary contained only the opaque medium-sized ova (0.4 - 0.6 mm diameter) throughout. These would represent the batch to ripen within the next six months.

Similarly examination of the gonadial condition of the fish in the local fishery through the different months reveals that while a good many of the fish are in the

early stages of maturity, there is a progressively increasing percentage of maturing individuals from May to June when the local fishery itself is rather poor. Again we come across a large number of individuals of late maturity stages during the close of the fishery by about November and December. As pointed out earlier, it has not been possible to obtain many specimens which could be regarded as in the actual spawning or spent condition which would have helped us to pinpoint our hypothesis. But the period of occurrence of these advanced maturing fish just before the appearance of the early post-larval stages is a clear indication of their spawning activities by about June and December.

Rate of growth

Another point of significance is the growth rate of the fish which, according to Prabhu (1955, p.141), is that "....the post-larvae of *T. haumela* grow to a size of 7-9 cm in length within a period of a month and a half." This seems to be a reasonable estimate for a carnivorous fish with a linear accent on body form and growth. But at this rate it will be somewhat hard to reconcile with his subsequent estimate of growth rate, viz. ".....the first-year class specimens attain a length of 18 cm, the second-year class 30 cm, the third-year class 46 cm and the fourth-year class 54 cm" (p.145) indicating thereby a growth of only 18 cm for the entire first-year class (obviously referring to fish at the end of one year's life) and a further increase of only 12, 16 and 8 cm respectively during the second, third and fourth years. As explained earlier, a multiplicity of modes is evident in the length frequency distribution of an adequate sample covering the full range of 200 to about 1000 mm size fish. At least four modes are present in samples collected during the fishing season, the earlier modes at approximate intervals of 150 mm, while towards the last two, the gaps tend to become less. A similar condition seems to exist in Fig. 5 given by Prabhu himself, although this covers only the size up to about 560 mm. From the monthly length frequencies of fish from all depths given by Dawson (1967) it would appear that the maximum rate of growth of fish entering the I-year class is approximately 400 mm while those for the II-year class is about 700 mm. The findings of Tsukahara (1962) based on otolith studies, on the other hand, indicate that the total lengths at the ages 1, 2 and 3 are 240, 568 and 824 mm respectively. According to him the apparent variation in length of two and three year old fish might show significant differences in growth rates between the Gulf of Mexico and Japanese populations or might merely reflect differences in methods of analysis. In the allied species of ribbon fish *Eupleurogrammus intermedius*, James (1967) estimates a growth of nearly 210 mm during the first year, and a further increase of 120 and 100 mm respectively during the second and third years. While at this stage our data do not permit a fuller discussion on the growth pattern for *T. lepturus* in these waters, we have reasons to believe that each of the modes in a truly representative sample indicates half-yearly growth intervals. We are therefore inclined to make a tentative revised estimate in the growth of this species and to state that the fish at the end of one year would measure on an average 300 mm and that the largest size

group over 900 mm in length would have completed at least four years' growth. Thus, as James (1967) has rightly pointed out, if the life span of this species is more than four years the rate of growth in the different years of life is also likely to be different from that estimated so far.

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