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SOME OBSERVATIONS ON THE POSSIBILITIES OF CULTURE OF THE INDIAN SAND WHITING *SILLAGO SIHAMA* (FORSKÅL) IN BRACKISH WATERS

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Indian sand whiting, *Sillago sihama* (Forskål), forms a dominant species in the estuarine fish catches during the south-west monsoon when they are in great demand and fetch a high price as sea fishing remains suspended due to rough weather conditions.

The paper deals with preliminary observations on certain aspects of the biology of the fish related to its culture. The ability of the species to withstand very wide ranges of salinity makes it suitable for culture in both brackish and fresh waters.

Introduction

The Indian sand whiting, *Sillago sihama* (Forskål) is captured in large quantities from the estuaries in South Kanara District, Mysore State, during the southwest monsoon (June to September), when sea fishing remains suspended. At other times also the fish is available in the estuaries but not exploited to that extent. The catches of this species during the monsoon period consist of fishes in advanced stages of maturity and some males were found in the spawning condition also leading to the belief that it spawns in the estuaries. This observation suggested the possibility of breeding this species by hypophysation and therefore a study of certain biological aspects relating to the culture of the species was conducted during June 1971 to July 1972 and are presented in this paper.

Material and methods

Fortnightly samples of the fish, caught mainly by hook and line from the Nethravathy and Gangolly estuaries, were examined for size distribution, maturity, sex ratio and fecundity. A total of 1,002 specimens (40 to 323 mm in total length) were examined. Maturity stages were classified according to macroscopic and microscopic characteristics. Fecundity was estimated by the gravimetric method. Juveniles were collected from the estuaries by a special fry collection net, using scarelines. They were transported in oxygenated plastic bags. Live fish were maintained in aerated glass aquaria and plastic pools with periodical renewal of water.

Observations

Maturation

The maturation process was mainly studied by tracing the development of ova to maturity by ova-diameter studies and monthwise distribution of maturity stages according to size groups.

Development of ova to maturity

The size distribution of ova in various stages of maturity is shown in Fig. 1. The size of the ova varied from 2 oc.m.d. in stage I to 47 oc.m.d. in stage V (1 oc.m.d.=0.016 mm). Except in stages I and II, ova smaller than 5 oc.m.d. were not measured as these were the transparent, immature ova present in all the ovaries. The ova in stage I range in size from 1 to 6 oc.m.d., a great majority of them being in the size group 1 to 3 oc.m.d. The size of ova in stage II varies from 1 to 12 oc.m.d. The polygon for this stage indicates the withdrawal of a batch of ova with a modal size of 5 oc.m.d. to undergo maturation. In stage III, the maturing group of ova is well demarcated from the immature stock by the mode at 20 oc.m.d., the largest ova measuring 24 oc.m.d. In the same stage, a smaller group of ova with a mode at 8 oc.m.d. indicates the withdrawal of yet another batch for maturation. In stage IV, the mode of the advanced group shifts to 23 oc.m.d., the maximum size of ova in this stage being 30 oc.m.d. The second group of maturing ova indicated in stage III is, however, not distinct. In stage V, the maximum size of ova is 48 oc.m.d, and the mode of the advanced group shifts from 23 oc.m.d. (in stage IV) to 38 oc.m.d. These, obviously are the ova which would be shed in the ensuing spawning season. In this stage, a second maturing group of ova is seen with a mode at 23 oc.m.d., which evidently corresponds to the mode at 8 oc.m.d in stage III but not seen in stage IV. This second group of ova, with a distinct mode at 23 oc.m.d. in stage V, are not likely to be released along with the most advanced group, but develop further after the first batch is shed. This view is further substantiated by the fact that a similar size group having a mode at 20 oc.m.d. is present in the ova diameter frequency polygon of the spent ovaries (stage VII). In the absence of actual record of females in spawning condition (stage VI), the presence of a mature and a separate maturing group of ova which has undergone half the maturation process in the ovary of stage V, indicates that the same individual fish breeds more than once in a year and that at least two batches of ova are shed with some interval in between.

Size at first maturity

For this study the fish were grouped according to a size interval of one centimeter and the corresponding maturity stages tabulated separately for females and males.

The data indicate, females were in stage I from 121 to 240 mm ; stage II from 161 to 290 mm ; stage III from 161 to 330 mm ; stage IV from 221 to 320 mm ; stage V from 191 to 310 mm ; stage VII from 211 to 290 mm in total length. Females in stage VI were not available for study. The smallest spent female fish recorded was 211 mm.

Males were in stage I from 111 to 290 mm ; stage II from 141 to 280 mm ; stage III from 151 to 240 mm ; stage IV from 161 to 260 mm ; stage V from 111 to 250 mm ; stage VI

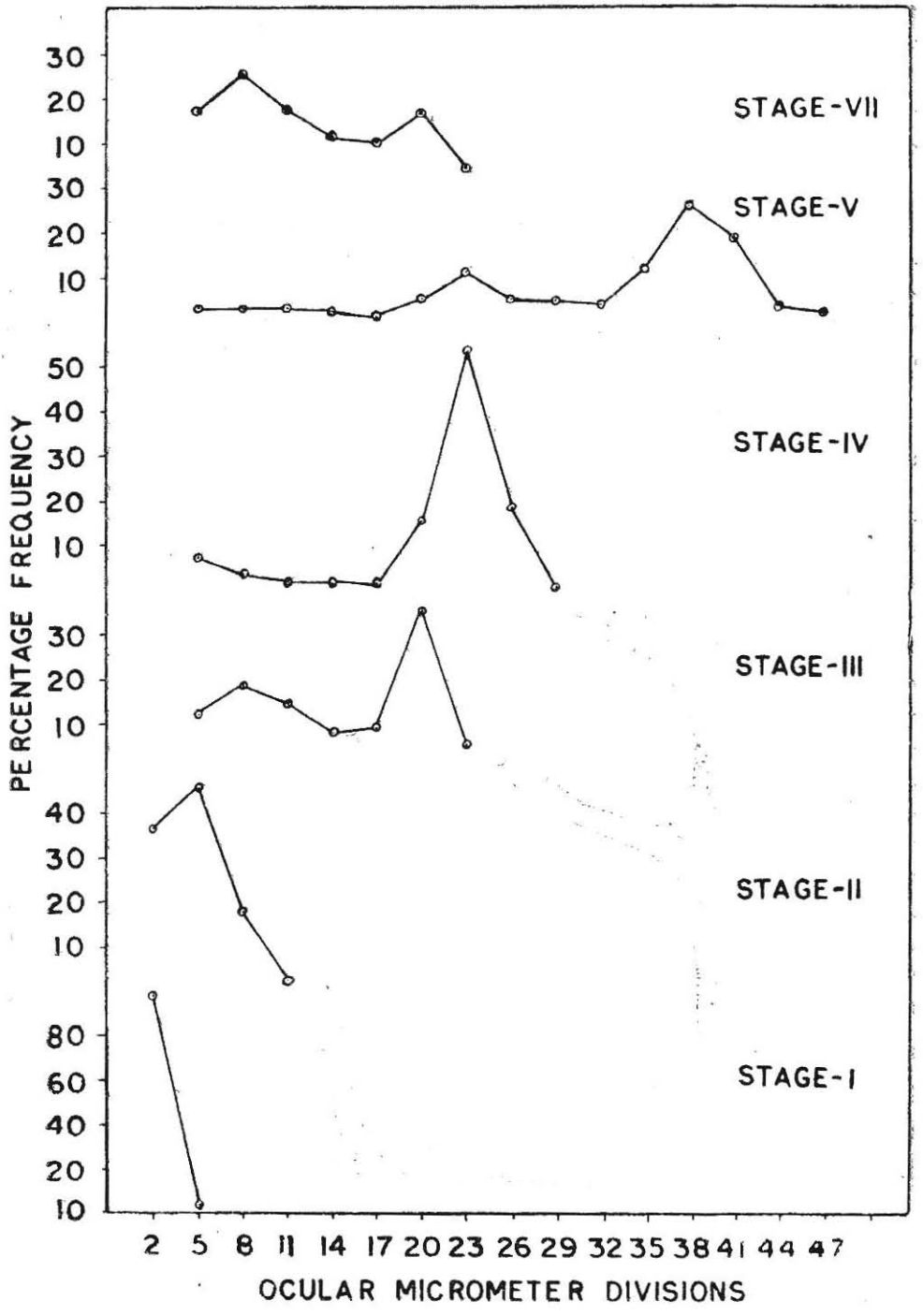

Fig. 1.—Ova diameter frequency polygons of ovaries of *S. sihama* in different stages of maturity.

from 151 to 260 mm in total length. No males in stage VII were recorded. The smallest male on record in spawning condition was 151 mm in total length.

The above observations also indicate that the males mature at a much smaller size than the females.

Spawning

Examination of the ova diameter frequencies of mature ovaries of *S. sihama* indicates that they contain three distinct groups of ova, namely, immature, maturing and mature. As the fish approaches the spawning season, the most advanced group of ova gets separated from the following maturing group which has undergone about half the maturation process. After the elimination of the first group (mature) the second group (maturing) obviously takes the place of the first group, by which time a second maturing group is expected to appear.

If the spawning period of the species is restricted, all the fish collected at any particular time are expected to belong to more or less the same stage of maturity. In the present case, a sample collected on a particular day contained fish in at least three different stages of maturity and in many months, advanced stages of maturity coupled with partially spent and spent stages were recorded indicating the absence of a restricted spawning period.

A total of 204 females and 343 males were examined for the determination of the spawning season.

The month-wise distribution of the maturity stages of female *S. sihama* is shown in Fig. 2. Stage V occurs from August to October and January to March and in some of these months spent fish (stage VII) also occur. There were no data for November and December, but it is expected that advanced stages (stages V and VI) would be found in these months also.

The distribution of the maturity stages in male is shown in Fig. 3. The data indicate that stages V and VI were available from July to September and January to April. Data were not available for November and December, but as in the case of female, the two advanced stages could be expected in these months also.

From the above observations, it appears that the spawning period of *S. sihama* is a prolonged one, extending over several months from August to April. Occurrence of juveniles in a number of months supports the above inference. The data also suggest that an individual fish releases the eggs in batches at different times, thereby indicating a prolonged breeding period.

Fecundity

Since the species spawns over a long period, with individual fish shedding the ova in batches, it is difficult to estimate the total number of ova that would be released by each

fish. Therefore, counts of the number of ova in the largest group present in the ovary at the time of capture of the fish were made to indicate the reproductive potential. The number of ova thus enumerated was observed to range from 11,304 to 1,00,593 in individuals measuring 207 to 317 mm in total length.

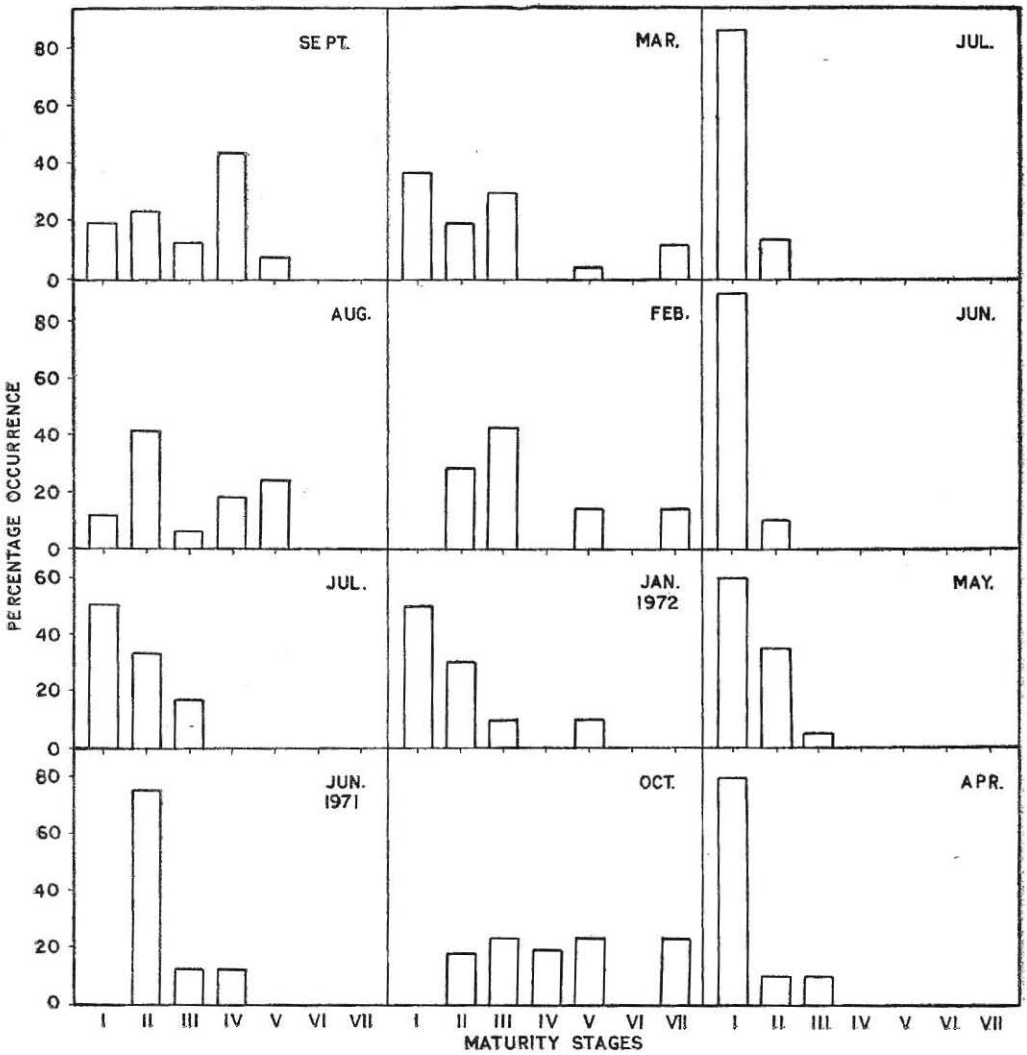

Fig. 2.—Month-wise percentage occurrence of maturity stages in females of *S. sihama*.

Observations on seed resources

Attempts to collect the naturally occurring seed of *S. sihama* from the Nethravathy and Gangolly estuaries were made once in a month from January to July, 1972.

The observations indicate that the young ones of this fish are available in good numbers in the Gangolly estuary. During the above period, only a few young ones could

be collected from the Nethravathy estuary, indicating the paucity of the same. Therefore, only the particulars of collection from Gangolly estuary are given in Table I. Juveniles of this species are abundant in January and February as compared to other months upto July. There were no observations for the period August to December. Young ones could be effectively collected at low tide than at high tide. The areas of collection are close to the mouths of the rivers, extending about 3 km upstream. Young ones were observed to congregate in shallow water (about a metre in depth) around exposed sandy areas at low tide. Scaring the fish with the help of scare lines and production of sound into the bag of the net appears to be the best method of collection. After collection, if young ones were kept crowded in containers even with change of water, it led to heavy mortality. In the present study, transportation of 30 fish in 6 litres of water contained in an oxygen filled plastic bag over a distance of 100 km was found successful without any mortality.

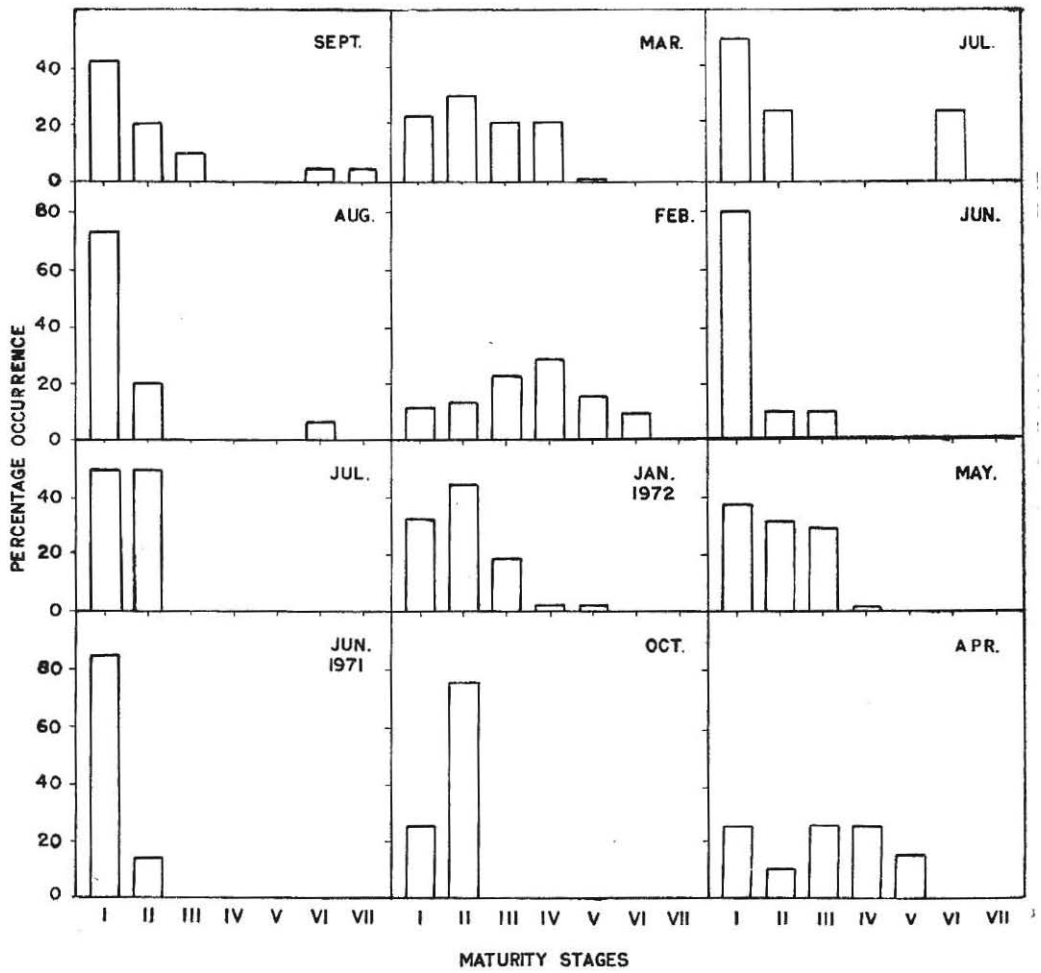

Fig. 3.—Month-wise percentage occurrence of maturity stages in males of *S. sihama*.

TABLE I

Particulars of collection of juveniles of *S. sihama* from the Gangolly estuary

Date	Duration of collection (minutes)	No. of fish collected	Size range (mm T.L.)	Salinity (‰)
11.1.72	60	100	61-151	—
4.2.72	90	323	40- 93	29.02
22.4.72	60	28	45- 86	24.74
25.5.72	120	26	85-114	29.16
19.6.72	60	10	34-115	20.29
29.7.72	90	29	75-172	3.85

Acclimation

Juveniles and young ones of the fish collected from the estuaries were acclimated from brackishwater to freshwater under varying conditions. Direct transfer of fish from brackishwater to freshwater led to mortality. Transfer from brackishwater to water which was made up of 50% brackishwater and 50% freshwater was also found to affect the fish. Gradual transfer from brackishwater to freshwater by stages spread over at least a week appeared to be the best method of acclimation. The observed values of percentage survival through acclimation were 30 (7 days) ; 55 (23 days) and 60 (24 days) in experiments conducted in aquaria in a water temperature range of 24.5 to 33.5°C. The atmospheric temperature during the period varied from 26.0 to 31.0°C. Though the fish could be acclimated to freshwater, its survival in the same needs further study. The maximum period of survival in fresh water during the present study was about 70 days.

During the course of the experiments on acclimation, a variety of artificial feed was offered to fish of all sizes. They included chopped fish meat, prawn pulp, fresh water worms, maggots, earth worms, small freshwater snails, blood clots, freshwater plankton and pelleted feed. The fish did not show any attraction to these foods. Smaller fish (upto 100 mm in total length), however, accepted prawn pulp which larger fish refused. The larger fish readily accepted polychaetes. Fish in advanced stages of maturity do not appear to feed. These observations indicate certain selectivity in feeding, which also seems to vary with age.

Discussion

The only earlier study which includes some of the aspects of the biology of *S. sihama* reported in this paper was that of Radhakrishnan (1957). The samples for his study were obtained from the Palk Bay and Gulf of Mannar in the region around Mandapam, thus based on fish available at sea unlike the estuarine fish samples investigated here. It is noteworthy in this connection that while this species contributes to commercial catches from the sea in the Palk Bay and Gulf of Mannar, in the South Kanara region it contributes to

commercial catches from the estuaries. In the sea off this coast, the species is caught only as stray specimens which are usually not more than 120 mm in total length whereas in the estuaries fish upto a size of 323 mm are caught. Krishnamurthy (1969) also reported the occurrence of larger fish in the Pulicat Lake.

According to Radhakrishnan (1957), the ripe ova range in size from 0.417 to 0.517 mm but in the present study, the mode of this group of ova was found to be at 0.608 mm with a maximum size of 0.768 mm, while the mode for mature eggs reported by him corresponds with that stated in the present study. Since a good difference in size has been found between the modal sizes of mature and ripe groups of ova in stage V, individual fish appears to spawn more than once in a year. The conclusion however, in both the studies, points to a prolonged spawning season for the species. Spawning season according to Radhakrishnan (1957) extends from about August to February with peak in October. In the present study also it was found to extend from August to April.

Chaudhuri (1923) as quoted by Radhakrishnan (1957) suggested that spawning of *S. sihama* takes place in the mouths of rivers and that the fish, a permanent inhabitant of Chilka Lake, goes out to the sea or the mouth of the lake for breeding. The present study which includes large fish from the estuary in advanced stages of maturity and spawning condition supports the above view, specially since the samples from the sea do not include any mature or large fish as also stated by Radhakrishnan (1957) in his study.

The food of *S. sihama* from Pulicat Lake was studied by Krishnamurthy (1969). He concluded that there are three trophic phases in the life of this fish. The fry feed mainly on copepods and the adults on polychaetes. The fingerlings have a mixed diet of polychaetes, copepods and other crustaceans. In the stomach contents of fish from sea, there was predominance of prawns and other crustaceans while polychaetes occupied an insignificant place in the food of the fish from this environment. In the experiments on artificial feeding during acclimation from brackishwater to freshwater, it was found that fingerlings accepted prawn pulp and polychaetes readily, while adults fed only on polychaetes which is in agreement with the observations of Krishnamurthy (1969). Fishermen report that the fish in the spawning condition do not take bait on hook.

The size at first maturity has been stated to be 130 m by Radhakrishnan (1957). In the present study, however, males were found to mature at 151 m and females at 191 m. This difference could be explained as due to difference in the nature of material in the two cases.

The present study therefore confirms earlier observations made on the species in other regions regarding its maturity, spawning and food habits and indicates the possibility of hypophysation of the species because of the availability of mature and running fish in the estuaries in the region. Preliminary attempts at hypophysation indicated that while chances

to obtain males in proper condition are more, chances for obtaining females simultaneously are limited. This necessitates building up a stock of brood fish for the purpose of hypophysation.

References

Krishnamurthy, K. N., 1969. Observations on the food of the sandwhiting *Sillago sihama* (Forskål) from Pulicat Lake. *J. Mar. biol. Ass. India*, **11** (1 & 2) : 295-303.

Radhakrishnan, N., 1957. A contribution to the biology of Indian sand whiting, *Sillago sihama* (Forskål). *Indian J. Fish.* **4** (2) : 255-83.

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