OBSERVATIONS ON THE *CHOODAI* FISHERY OF MANDAPAM AREA

By K. V. Sekharan

(Central Marine Fisheries Research Station, Mandapam Camp)

Introduction

In the economy of the fishing villages around Mandapam, there is probably no fishery of greater importance than that for sardines, locally called *choodai*. Beginning in late March or early April, the fishery extends up to October or November and is confined mainly to the inshore waters of Palk Bay, where specialised methods are employed for catching the juveniles. Devanesan (1932) has given a brief account of the food of *Sardinella gibbosa*, one of the species yielding the fishery; the bionomics and fishery of the same species have also been referred to in a note by Chacko (1946). Panikkar (1949), discussing the biology of the pelagic fishes of the world, has remarked on the occurrence of shoals of *S. gibbosa* on the South East coast of India. And recently, Prasad (1953) reporting on the swarming of *Noctiluca* in the Palk Bay, observed that this was responsible for the set-back experienced by the *choodai* fishery early in the 1952 season. The salient features of the fishery, however, are as yet little understood, and this investigation, taken up at the suggestion of Dr. N. K. Panikkar, includes a study of the methods of fishing, the biology of the main species contributing to the fishery and the fluctuations in their abundance.

In this paper the results of preliminary observations conducted during the seasons in 1952 and 1953 are reported. First, a survey of the fishing centres between Dhanushkodi and Panakulam (a distance of about 50 miles) was undertaken, and this account deals only with this section of the Palk Bay. Samples of commercial catches, obtained usually once a week, were analysed into the main species represented; the length measurements of the major species were also recorded for a study of their rate of growth and the age-composition of the catches. Only the standard length (from tip of snout to the end of the silvery area on caudal peduncle) has been taken into account here. Maturity stages were determined following the standards defined by the International Council for the Exploration of the Sea. For determining the frequency of spawning, the diameter of ova taken from mature fishes was measured.

Fishing Centres

As the catches are mostly dried and exported to the interior, fishing centres are situated near localities where facilities are available for drying the fish quickly. In some places the sandy beach serving this purpose is low-lying and covered with sea water from October or November to February, and when the water recedes, the sand contains a good proportion of salt, which is an additional advantage for drying the fish. The fish-landing places at Dhanushkodi, Rameswaram (partly), Munakkad, Thedai, Pullamadam and Irumeni are situated near such localities. The other centres are Thangachimadam, Uchippuli, Attankarai and Panakulam (Fig. 1).

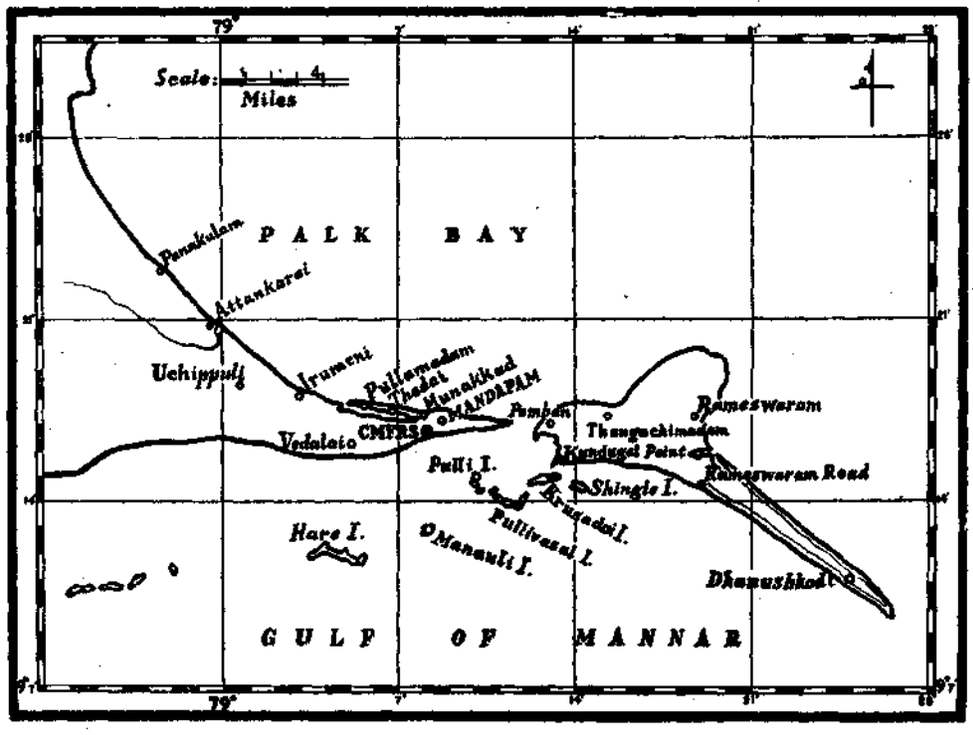

FIG. 1. Sardine Fishing Centres of Mandapam Area.

Gear used and the methods of fishing

Three main types of gear are used in the fishery: 1. Shore-seines, 2. Hand-nets (along with torches). 3. Gill-nets.

Shore-seines.—The most commonly used gear is the shore-seine which is operated in inshore waters, 1½ to 2 miles from shore. These nets, many of them specially designed for the fishery, are equipped with fine-meshed

bags at the beginning of the season, when the population available consists mostly of very small fishes. Later, however, when there is a dearth of young fishes, the meshes are enlarged. The mesh-size of the bags together with the approximate period of their use is given below.

Size of stretched mesh	Approximate time of use
0·3″–0·4″ (7·6–10·2 mm.)	March and April
0·5″ (12·7 mm.)	May
0·6″ (15·2 mm.)	From June onwards

The method of fishing is as follows: first, an experienced fisherman goes out in a scout boat, and when a shoal is sighted, a signal is given to others watching from the beach. Immediately the boat with the net is taken out and the shoal surrounded. The net is pulled from shore, 10 to 15 men helping on each side. The bulk of the shoal is trapped in the bag, while others get entangled in the meshes at the sides. Fishing is done mostly at night from April to about July, after which day-fishing is also resorted to.

Torches and hand-nets.—The habit of young clupeoids to gather around a source of light is exploited in this method of fishing. The fishermen usually go to a distance of 2 to 3 miles in search of shoals. When a shoal is sighted, the torch, usually made of dried palmyrah leaves, is lighted. The young fish gather around the boat and are baled out into the canoe with hand-nets. This method seems to lose its effectiveness as the fishes grow older, and hence is applicable only at the beginning of the season. Moreover, a minimum of 4 hours of darkness is essential for a successful fishing trip. About 27 tons of fish were thus landed by 12 boats operating at Munakkad in 1½ months during the season in 1952.

Gill-nets.—Small-meshed gill-nets (size of stretched mesh about 1″) operating over a distance of 5 to 6 miles offshore are also used in the fishery. These nets are said to have been introduced about fifteen years back as they were found suitable for catching the larger sardines.

The use of the gear mentioned above varies from place to place as shown in Table I.

Trends of production

Figures of production during 1952 and 1953, based on rough estimates of the landings at various fishing centres, are furnished in Table I. During very good years, the fishery is capable of yielding as much as about 2,500 tons of fish valued at over 5 lakhs of rupees. The season in 1953, however, was very poor, the catches having fallen very much below a profitable level.

TABLE I. *Number of Boats and Gear Employed in the* Choodai *Fishery and Figures of Production during* 1952 *aud* 1953

Place	No. of boats with torches and hand-nets	Gill-nets	Shore-seines	No. of men required to operate each combination	Estimated catch in	
					1952 (in tons)	1953 (in tons)
Dhanushkodi ..	..	..	20	20–30	104	90
Rameswaram* ..	100	..	25	6–7; 20–30	222	170
Thangachimadam ..	5	50	..	6–7; 5–6	40	30
Munakkad† ..	12	..	..	6–7	27	1
Thedai ..	..	..	5	20–30	100	17
Pullamadam ..	..	..	13	20–30	230	77
Irumeni ..	..	..	10	20–30	200	174
Uchippuli ..	..	..	15	20–30	190	83
Attankarai ..	..	..	10	20–30	110	60
Panakulam .	..	..	10	20–30	52	45
Total .	117	50	98		1,275	747
Approximate value in Rs.‡					297,500	193,670

* Figures of production at Rameswaram were not taken into account when calculating the catch per season, as separate figures for shore-seines and torch-hand-net combination were not available.

† Only 4 boats were operating at Munakkad in 1953.

‡ The average price obtained by the fishermen was Rs. 90 and Rs. 100 in 1952 and 1953 respectively, for about 860 pounds of fish.

This decline was evident even in 1952, while in 1950 and 1951 there were very good catches. An estimate of the catch-per-season for various boat-net combinations during 1952 and 1953 is given below.

	Catch per season in 1952 (in tons)	1953 (in tons)
Boats using torches and hand-nets ..	2·5	0·25
,, ,, shore-seines	11·9	6·6
,, ,, gill-nets	0·8	0·6

Species comprising the fishery

Sardinella albella (Cuv. and Val.) is the most abundant species contributing to the fishery, with *Sardinella gibbosa* (Blkr.) as the next in importance.

These two species together constitute usually 80 to 90 per cent. of the catches. *S. dayi* Regan, *S. sirm* (Rüpp.), *Hilsa* spp., *Anchoviella* spp., *Thrissocles* spp. and *Sardinella fimbriata* also occur frequently. Other fishes recorded in the catches were *Leiognathus* spp., *Caranx* spp., *Gerres* spp. and *Atherina* spp. Sometimes squids and prawns were also seen.

Growth of Young Sardines

Studies on the growth of the major species of *Sardinella* were based on random samples of commercial catches obtained, usually once a week, from Dhanushkodi, Thangachimadam, Munakkad, Pullamadam and Attankarai during the Palk Bay season. With a view to following the pattern of growth throughout the year, samples, when available, were also collected from Kundugal Point and Rameswaram Road on the Gulf of Mannar side, where fishing extends from November to about April. The hand-nets and shore-seines used on the Palk Bay coast are so efficient that only very small fishes measuring less than 18 mm. in length are allowed to escape, if at all they are present in the inshore waters. Later, in June and July, shore-seines with larger meshes are employed, and because of this, it is possible that after May the catches are more selective. However, as the main reason for enlarging the mesh is the dearth of small fishes in coastal waters, it appears safe to assume that the picture presented by the catches of these nets is, to a large extent, a correct version of the conditions existing in the waters fished.

Sardinella albella

Altogether 78 samples totalling 6,394 fish were collected between April 1952 and March 1954. This does not include a small percentage (less than 1% in April) of fish, less than 20 mm. in length, rejected because of the difficulty of correctly identifying them. The maximum length recorded was 125 mm. This size range, 20 mm. to 125 mm., was divided into 5 mm. intervals and the frequency in each length-group recorded. These are shown as percentages of the total in Figures 2 and 3.

Fig. 2 (for 1952–53) shows two modes *a* and *b*. Mode *a*, which obviously represents the 0-year group, is at 37 mm. in April 1952. By the end of October 1952, it has shifted to 77 mm., indicating a probable growth rate of about 40 mm. in 7 months for the young fish. After October, the fishery on the Palk Bay side ceased; and sufficiently large samples could not be obtained from the catches on the Gulf of Mannar coast. In March 1953, however, gill-net operation commenced at Thangachimadam and a sample obtained from there showed the major length-group to be 107 mm., the size at which the mode *b* was seen during April, May and June 1952. The

mode *b* therefore, appears to represent the modal length of fish that had passed beyond the first year of their life. These one-year-old fish were seen in large numbers during April 1953 also (Fig. 3). The season in 1953 also showed two modes *a* and *b* for *S. albella*. The fishery started only in May and the major length-group for that month was 42 mm. represented by mode *a*. By September, when the fishery on Palk Bay side closed, this had moved to 87 mm., showing that the young fish had added about 45 mm. to their

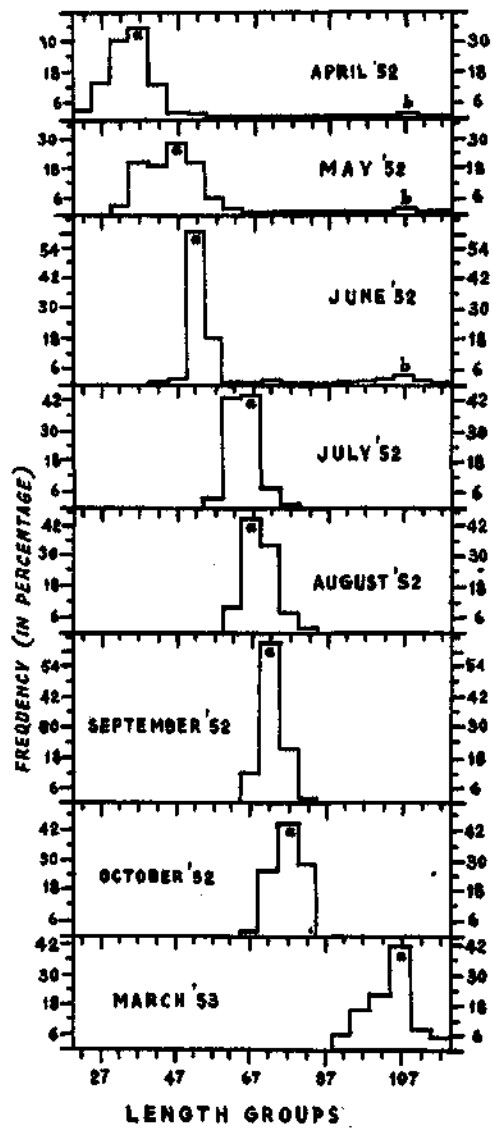

FIG. 2. Length frequency distribution of *Sardinella albella* during 1952–53.

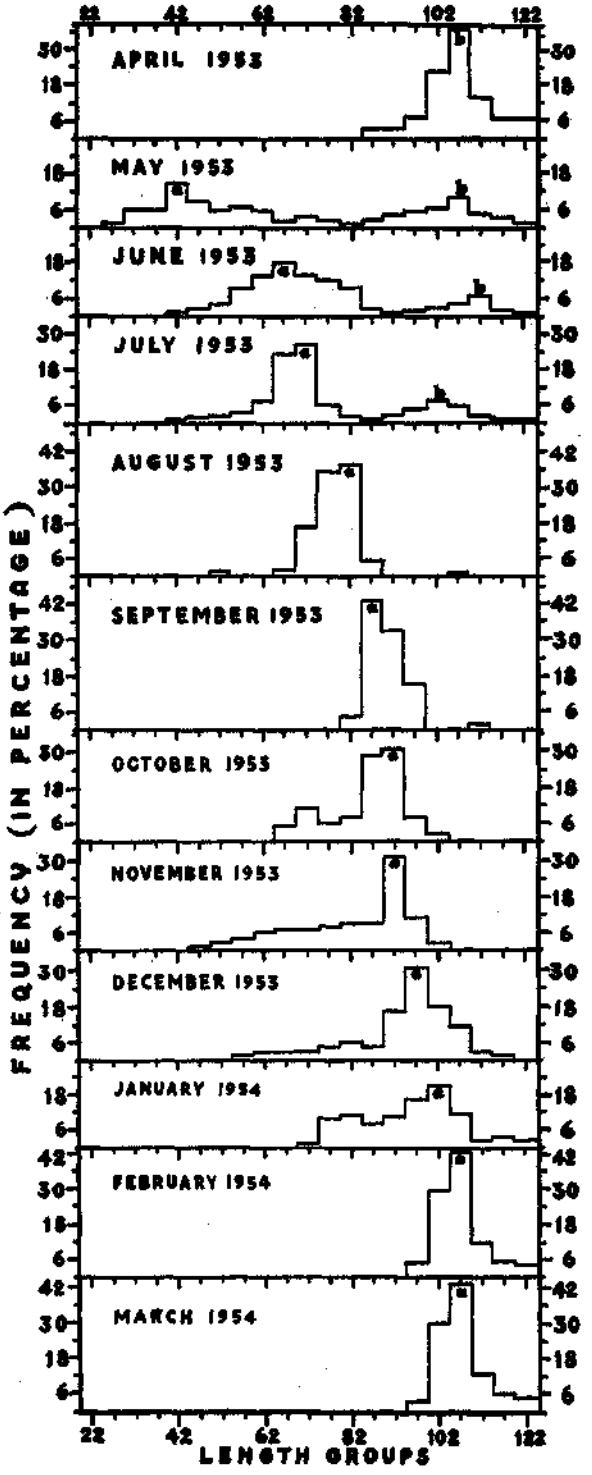

FIG. 3. Length frequency distribution of *S. albella* during 1953–54.

length in 5 months' time. The monthly increment in length during the fishing season in 1953 thus appeared to be different from what was observed in 1952. In March 1954, the mode *a* was at 107 mm., which may therefore be regarded as the modal size of one-year-old fish.

Sardinella gibbosa

The procedure adopted was the same as in the case of *S. albella*. A total of 64 samples comprising 5,886 fish were available for studies on the

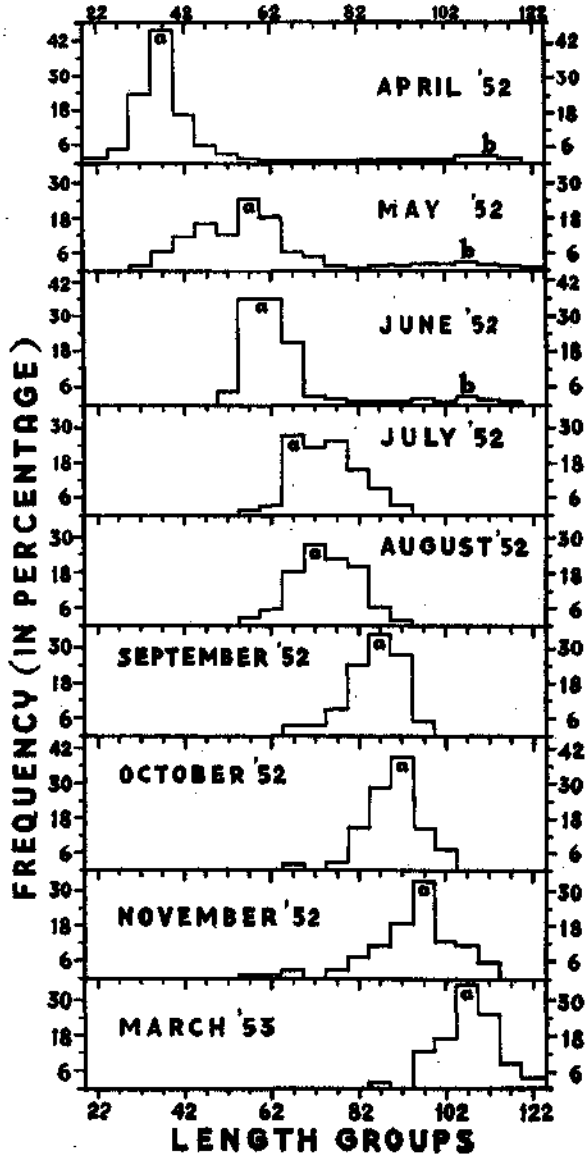

FIG. 4. Length frequency distribution of *S. gibbosa* during 1952–53.

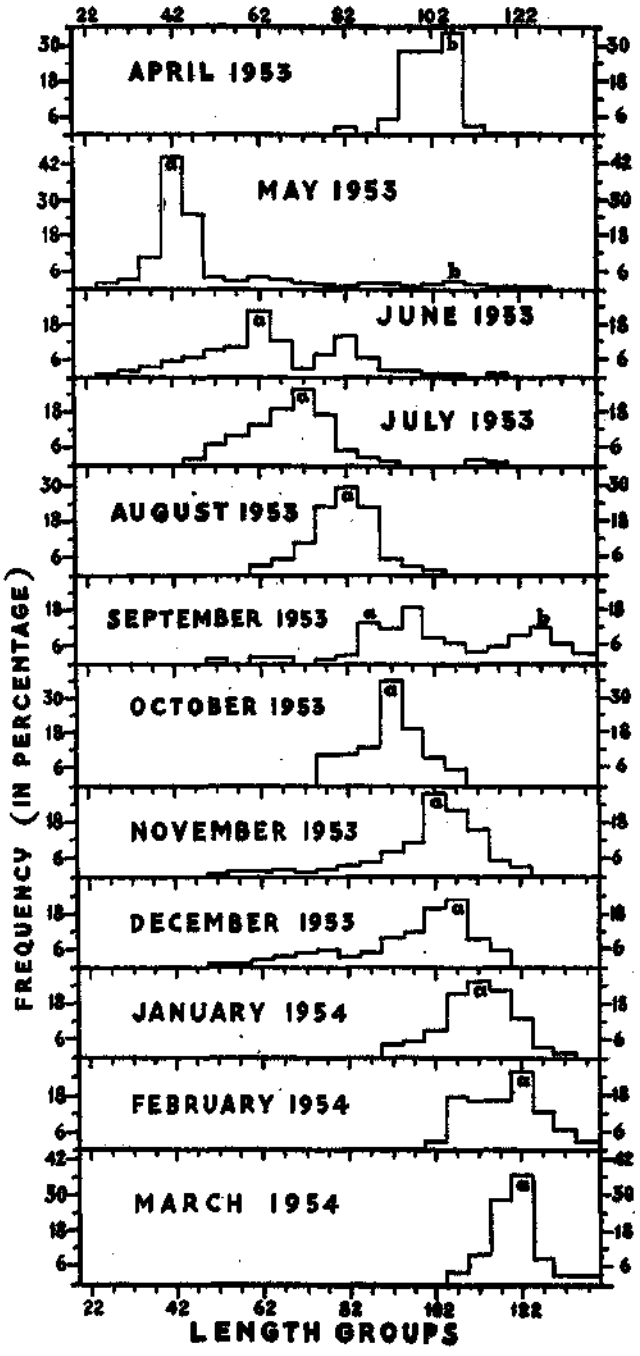

FIG. 5. Length frequency distribution of *S. gibbosa* during 1953–54.

rate of growth (Figs. 4 and 5). The maximum length recorded was 139 mm. (168 mm. in total length).

In April, May and June 1952, the length-groups entering the fishery varied from 22 mm. to 122 mm. A very prominent mode *a* is seen during these months, together with another probable, though not easily distinguishable, mode *b*. Mode *a* apparently represents the 0-year class and the progressive shift in its position from April to November may be regarded as showing the growth of juveniles. In May it was at 37 mm.; by November it was at 97 mm., indicating a growth of about 55 mm. in eight months. By March it had shifted to 107 mm., the size of mode *b* from April to June 1952. The mode *b* thus indicates the length of one-year-old fish during the period April to June 1952.

In the 1953 season also the two modes *a* and *b* were seen, mode *a* shifting from 42 mm. in May to 87 mm. in September. But in February and March 1954 it was at 122 mm. The 1953 year-class of *S. gibbosa* thus appeared to have grown to about 122 mm. during the first year of its life, while the length attained by the 1952 year-class during the same length of time amounted only to about 107 mm. Thus, as in the case of *S. albella*, the rate of growth in *S. gibbosa* also would seem to vary from year to year, which in all probability is mainly due to changes in environmental conditions and density of population.

Devanesan (1932) reporting on the length of over 245 specimens of *S. gibbosa* collected from the Gulf of Mannar side for a study of their stomach contents, stated that it varied from 44 to 150 mm. As he was obviously referring to total length, there is close correspondence between his figures and the data given in the present paper. The absence of smaller fishes in his collections was probably due to the fact that he had not sampled the Palk Bay catches. Chacko (1946), however, states that specimens collected by him varied from 50 mm. to 160 mm. in length (apparently total length); he also observes that the smaller length-groups were abundant in April and May.

Age-Composition of the Catches

Figs. 2 to 5, based as they are on random samples of commercial catches, also throw light on the probable age-composition of *Sardinella* spp. entering the fishery. It is abundantly clear that the fishery draws its support mostly from the juveniles, *i.e.*, the 0-year class. The fluctuations in their abundance are therefore of the utmost importance to the fishery. One-year-old fishes also enter the fishery, but the observations conducted during the two seasons in 1952 and 1953 show that the contribution made by them is small. Besides these two, no other age-group could with certainty be regarded as supporting the local fishery.

SPAWNING SEASON OF *Sardinella* SPP.

As the fishery is based mainly on the 0-year-class, it is apparent that investigations with reference to the spawning time and the minimum size at first maturity of the main species concerned are of vital importance. No spawning specimens (stage VI) of *Sardinella* spp. could be collected from the commercial catches, but the time of appearance of the smaller length-groups and mature males and females served to indicate roughly the spawning season of the fishes under study. The youngest fishes were first noticed in April; and the percentage of males and females in the penultimate stage of maturity (stage V) were the highest in March and April. Mature fishes continued to appear in the catches until July. Hence it would appear that the spawning season in both fishes extends from February or March to June or even July.

Further evidence that the majority of individuals in both species spawn during a restricted season is afforded by Figs. 6 and 7 which are based on the measurements of the diameter of 3,000 ova collected from 6 specimens in each species. These fishes were not in the spawning stage, and hence the figures do not represent the size of ova of spawning fish. As far as they go, they show that there is only one mode for the diameter of maturing ova,

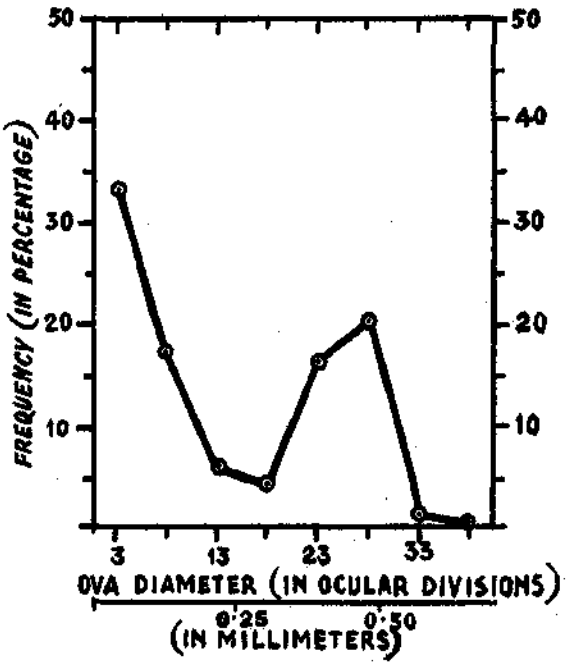

FIG. 6. Ova diameter of *S. albella.*

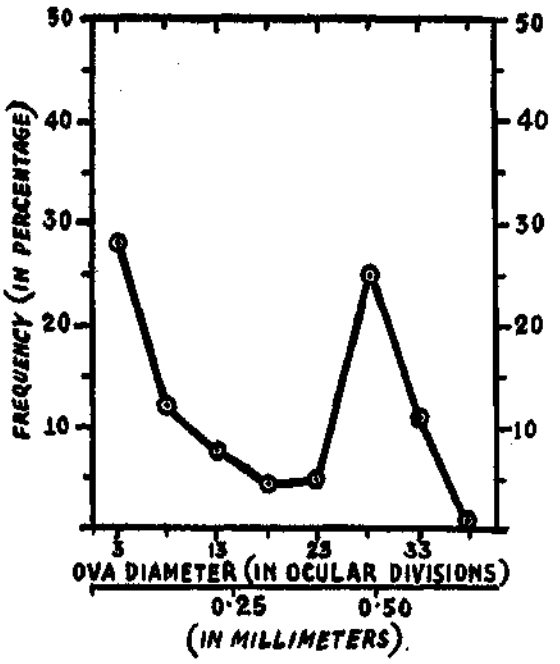

FIG. 7. Ova diameter of *S. gibbosa*.

the other mode being that of immature ova which will be spawned during the succeeding season.

John (1939) observes that *S. albella* on the West Coast spawns during May and June. The spawning season of *S. gibbosa*, according to Chacko (1946), is from September to February, although he states further that the young fish appear in abundance during April and May.

SIZE AT FIRST MATURITY

Fishes collected from March to June alone were taken into account for determining the size at first maturity. The appearance of stage III and above was taken as an indication that the individual would spawn during that season. The percentage of mature fish in each length-group is given in Figs. 8 and 9.

S. albella (Fig. 8).—The curve of maturity shows that fish less than 90 mm. in length were immature. Mature specimens were first observed in the 90–95 mm. group, of which about 33% were in stage III or above. 55% were mature at 97 mm., 70% at 102 mm., and 87% at 107 mm. Above this length all fish were found to be mature. It has already been shown that the average size of 1-year-old fish is 107 mm. Their maturation is undoubtedly of great significance to the fishery.

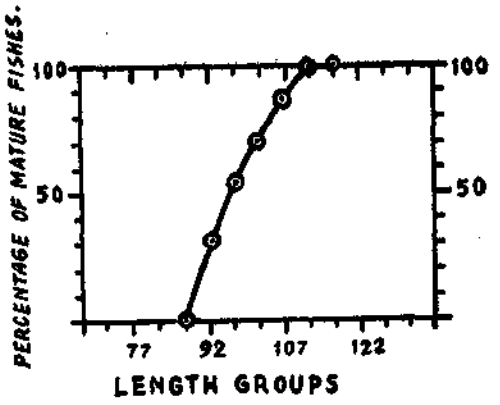

FIG. 8. Maturity curve of *S. albella.*

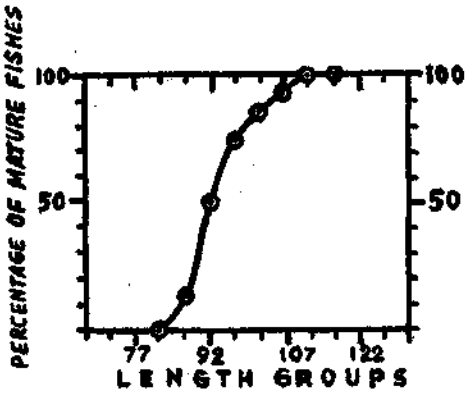

FIG. 9. Maturity curve of *S. gibbosa.*

S. gibbosa (Fig. 9).—In *S. gibbosa* all fish below 85 mm. were observed to be immature. A small percentage (13%) of the 85-87 mm. group was included among the mature group. The proportion of mature fish increases to 50% in 92 mm. group, 75% in 97 mm. group, 85% in 102 mm. group and 93% in 107 mm. group, individuals above this length being all mature. Thus one-year-old fish are seen to mature in the case of *S. gibbosa* also.

FEEDING HABITS OF *Sardinella* SPP.

The feeding habits of these fishes are under investigation. Preliminary observations show that their diet consists mainly of diatoms and copepods.

DISCUSSION

According to Russell (1942), "the wholesale destruction of undersized fish, when they are near the commercial size, is prejudicial to the stock and should be prevented". It is perhaps too early at this stage to state to what extent this recommendation may profitably be carried out with reference

to the *choodai* fishery of Mandapam, which, as will be evident from the observations reported above, is supported mostly by juveniles. For fisheries exploiting a number of year-classes or at least over one age-group of adults, protection afforded to the young fish might conceivably be of benefit, as it would lead to a biological improvement of stock. In the *choodai* fishery, however, there is only one important age-group which happens to be the 0-year class. The dearth of older fishes in the catches might be due either to a heavy mortality of one-year-old fishes after spawning, or to their migration away from the areas at present visited by the local fishermen. Therefore, if the object of protecting the small fishes from capture is to increase the proportion of older fishes, the fishery, as prosecuted at present, may not be very much benefited, for the improvement in stock, if any, may not occur in the coastal waters. The apparent failure of the regulation of the mullet fishery in Western Australia, where the imposition of an increase in legal minimum length did not result in an improvement of the stock in estuaries (Thompson, 1950), is a pointer in this direction. Whether other sections of the Indian coastline would derive any advantage from a restriction of the local fishery is a point which only further investigations will clarify.

However, the weight of the exploitable stock of juveniles (fishes less than one year old) could probably be improved, if a legal minimum length together with appropriate mesh-size regulations were enforced. But this presupposes that the rate of natural mortality of these young fishes would not be too high, for which there is no evidence at present. So also, there is room for considerable doubt as to whether the protected fish will maintain the present rate of growth. Besides these, there are other serious difficulties in the way of implementing a conservation programme. For one thing, the trade here does not impose any size limit for marketable fishes, although larger fishes of course fetch a better price than smaller ones. Hence the attempt has been, and continues to be, to catch as much as possible without regard to the size of the fish. Moreover, restriction of the capture of the smaller length-groups would almost certainly involve the prohibition of torch-fishing as well as a partial stoppage of shore-seine activity, which, in the present set-up, will not be countenanced by the industry. To introduce restriction of fishing until it can be demonstrated to be definitely advantageous would result in economic ruin to thousands of fishermen along the Palk Bay coast.

It has not yet been possible to collect reliable information as to when the local fishery actually started. From enquiries made in various quarters, it would appear that the fishery has been in existence at least for the past

100 years, with the vicissitudes observed in other fisheries as well. Mention may here be made of the observation recorded by Devanesan (1932), who, referring to *S. gibbosa*, stated that it is " the object of one of the most economically important fisheries in Palk Bay ". The fact that the fishery has been sustained over a considerable number of years, in spite of its dependance on young fish, may in itself be an argument against legislative intervention. Probably, this has been due, at least partly, to the following factors: (1) Only a narrow belt of the sea, 1½ to 2 miles from shore, is exploited by shore-seines, the gear used from the beginning to the end of the season. Even the other boats normally do not venture more than 5 to 6 miles offshore in search of shoals. Moreover, Palk Bay enjoys a respite from fishing during the period November to February, while sardine fishery is negligible on Gulf of Mannar side from March to about October. Hence it is quite probable that a good proportion of the juveniles escape destruction and reach the spawning stage. (2) *Sardinella* spp., forming the bulk of the catches, attain maturity at about the end of the first year of their life. Thus, what the fishery seeks is to exploit only part of the stock of young fish added to the population every year. The other part is allowed to escape, so that these fish may spawn and provide the stock necessary for the succeeding season. In other words, the fishery operates on a stock that is almost completely renewed from year to year.

Theoretically, it is possible that an excessive removal of potential spawners would adversely affect this process of annual renewal and thus cause depletion. However, many fishery biologists believe that underreplacement, due to a reduction in the numerical strength of spawners brought about by fishing, is hardly likely to occur in marine fish stocks. There are others, of course, who do not subscribe to this view. Johansen (1930), for instance, found a correlation between the size of the spawning stock of herring and the resulting brood in Danish waters. Also, in Australia, " most fishermen and fisheries administrators think of stock management purely in terms of reproduction potential, and great importance is still attached to legal minima based on the lengths at which the fish first spawn " (Blackburn, 1950). Even if depletion could be brought about by a heavy mortality of would-be spawners through fishing, such a contingency is not likely to arise in the *choodai* fishery in view of its strictly inshore nature and the various other factors enumerated above.

It would therefore appear probable that the vicissitudes undergone by the fishery are primarily the result of natural fluctuations in annual renewal of the 0-year class which is the main exploitable age-group. Natural fluctuations in the year-classes of food fishes have been explained by Hjort (1914,

1926) as mostly determined by the hydrological and biological factors prevailing at the time of the critical stage of their larval period, when the food materials in the yolk-sac are exhausted and the young fish have to seek food from outside. He showed this to be true of the great fisheries of Northern Europe, and also stated that the number of eggs spawned is not of importance in this respect. Rollefsen (1930) suggested, as a contributory factor, the failure of eggs to develop normally due to disturbance caused by wave action at a critical phase; and Fish (1929), though he agreed with Hjort, indicated that storms had apparently caused a tremendous loss of cod eggs in Massachussetts Bay in 1924–25. Carruthers (1951) would regard the direction and velocity of wind as important factors influencing the strength of broods. But, the present view of most fishery biologists is in conformity with the essential features of Hjort's theory (Russell, 1942; Tomasevich, 1943; Tait, 1952); and researches undertaken by various workers have served to accumulate evidence in its support. Mention may here be made of the work of Graham, Carruthers and Goodchild (1926) who showed that the distribution of cod fry in the North Sea is very much subject to the influence of currents in the area and to that of Poulsen (1930 *a* and *b*) who, in addition to emphasising the strong correlation that existed between salinity and temperature and the abundance of cod fry in Danish waters, further proved that the latter was related to the number of young cod in demersal stage in the same and subsequent years. Thompson (1938, 1930) reporting on cod of the Western Atlantic and haddock of the North Sea was inclined to agree with the view of Hjort that hydrological and biological factors are of great importance in influencing the strength of broods. A similar opinion was expressed by Bückmann (1930) with reference to sole. The effect of currents on the drift of fry of herring was also recognised by Hodgson (1933). Again, Walford (1938) working on haddock of the Georges Bank, believed that the drift of water in the area contributed a great deal towards variations in the abundance of larvæ, and through this, to the success or failure of year-classes. Studying the early life-history of the Atlantic mackerel, *Scomber scombrus*, Sette (1943) also came to the same conclusion. Bjerkan (1930) pointed out that the immigration of young sprat into Norwegian waters depended on the strength of the South to North drift of water; during years of strong currents large quantities of young fish were transported from South to North, and this later gave rise to a good fishery, while weak currents during other years brought relatively smaller numbers of young fish which, later on, resulted in a failure of the fishery.

In short, workers who have studied the natural fluctuations in fisheries have stressed the importance of understanding the changes in the relative

abundance of the 0-year class, and even here attention is concentrated mostly on the fate of the smaller length-groups. That the fry of fishes are subject to the influence of currents is probably not disputed. The drift of water in the Mandapam area is from North to South from about August to March. During the rest of the year it is the South-to-North current that prevails (Bay of Bengal Pilot, 1940). This change takes place by about March (Sewell, 1929) and the fishery commences in late March or early April, thriving on an abundance of smaller length-groups. The occurrence of the latter during the initial stages of the fishery is probably due to their being drifted by currents into the waters of Palk Bay. This assumption gathers support from the fact that the proportion of mature fishes reaches its peak about this time and that spawning specimens have not so far been recorded from the local catches. Hydrological changes resulting in a deflection of the fry from their nursery grounds in Palk Bay might therefore have an adverse influence on the fishery. Moreover, the quality and quantity of food available to them during this period should be regarded as another factor influencing their survival and rate of growth. It may be noted here that Prasad (1953) attributes the failure of the fishery early in 1952 season to the swarming of *Noctiluca* in the inshore waters of Palk Bay. It would thus appear that the effect, if any, of hydrological and biological factors on the local fishery would be direct and immediate—a feature which distinguishes the *choodai* fishery from other fisheries where the fluctuations in the abundance of the 0-year class would be felt only when these fish grow to the size commercially exploited. The immediate problem, therefore, is to assess the effect of these factors on the fishery.

Summary

The *choodai* fishery of Mandapam area is essentially a fishery for small sardines, confined mainly to the inshore waters of Palk Bay.

Shore-seines, hand-nets (along with torches) and gill-nets are the main types of gear employed in the fishery. The methods of fishing are briefly described.

Sardinella albella and *S. gibbosa* constitute the bulk of the catches.

Studies on length-frequency distribution show that the fishery operates mainly on the 0-year class; the proportion of older fishes in the catches is small.

Both *S. albella* and *S. gibbosa* spawn at about the end of the first year of their life.

If the smaller length-groups are protected with a view to increasing the proportion of older fishes, the fishery, as prosecuted at present, may not be very much benefited.

Depletion due to reduction in reproduction-potential is not likely to occur in the local fishery, in view of its strictly inshore nature and various other factors.

The possibility is indicated that the fluctuations experienced by the fishery might primarily be due to variations in the annual replenishment of the 0-year class, which are largely governed by hydrological and biological factors.

ACKNOWLEDGMENTS

The author is greatly indebted to Dr. N. K. Panikkar, Chief Research Officer, Central Marine Fisheries Research Station, Mandapam Camp, for suggesting the problem and for the guidance and encouragement given during the course of this investigation.

BIBLIOGRAPHY

Anonymous. 1940 .. Bay of Bengal Pilot. *Published by the Hydrographic Department, Admiralty*, London. 454 pp.

Bjerkan, P. 1930 .. Fluctuations in the stock of young sprat off the West Coast of Norway and its relation to the sprat population as a whole. *Rapp. Proc. Verb. Reunion*, **65**, 173–81.

Blackburn, M. 1949 .. The life-history of the Australian pilchard. Bulletin No. 242, Commonwealth Scientific and Industrial Research Organization, Melbourne, Australia, 86 pp.

———— 1950 .. Measures of abundance of pelagic fish. Bulletin No. 251, Commonwealth Scientific and Industrial Research Organisation, Melbourne, Australia, 74 pp.

———— 1950 .. The Tasmanian whitebait, *Lovettia seali* (Johnston) and the whitebait fishery. *Austr. J. Mar. Freshw. Res.*, **1**, No. 2, 155–98.

Bückmann, A. 1930 .. Fluktuationen im Seezungenbestande der Deutschen Bucht. *Rapp. Proc. Verb. Reunion*, **65**, 50–66.

Carruthers, J. N. 1951 .. An attitude on fishery hydrography. *J. Mar. Res.*, **10**, No. 1, 101–18.

Chacko, P. I. 1946 .. On the bionomics of the Indian sprat, *Sardinella gibbosa*. *Jour. Bombay Nat. Hist. Soc.*, **46**, No. 2, 407–08.

Devanesan, D. W. 1932 .. A note on the food and feeding habits of *Sardinella gibbosa*. *Jour. Madras Univ.*, **4**, No. 2, 159–64.

Fish, C. J. 1929 .. Production and distribution of cod eggs in Massachussetts Bay in 1924 and 1925. *Bull. Bur. Fish.*, **43**, 253–96.

Graham, M. 1948 Rational fishing of the cod of the North Sea, being the Buckland Lectures for 1939. 111 pp. Edward Arnold & Co., London.

Hjort, J. 1914 .. Fluctuations in the great Fisheries of Northern Europe. *Rapp. Proc. Verb. Reunion*, **20**.

———— 1926 .. Fluctuations in the year-classes of important food fishes. *Jour. Cons.*, **1**, No. 1, 5–38.

Hodgson, W. C. 1933 .. The natural history of the herring of the southern North Sea, being the Buckland Lectures for 1933. 120 pp. Edward Arnold & Co., London.

Johansen, A. C. 1930 .. On a correlation between the yearly catch of herring in the Sound and the abundance of herring larvæ in autumn. *Rapp. Proc. Verb. Reunion*, 65, 82–83.

Graham, M., Carruthers, J. N. and Goodchild, H. H. 1926 .. The distribution of the pelagic stages of the cod in the North Sea in 1924 in relation to the system of currents: with a section on the food of pelagic young cod. *Fish. Invest. Ser. 2, Sea. Fish., Min. Agri. & Fish.*, 8, No. 6. 31 pp.

John, V. 1939 .. On the food and spawning season of *Sardinella brachysoma Proc. 26th Ind. Sci. Cong. Abstracts*, 134–35.

Lea, E. 1930 .. Mortality in the tribe of the Norwegain herring. *Rapp. Proc. Verb. Reunion*, 65, 100–17.

Panikkar, N. K. 1949 .. A survey of the pelagic fisheries of the world, Part II. The biology of pelagic fishes. *Indo-Pac. Fish. Coun. Proceedings. First Meeting*, Singapore, 123–32.

Poulsen, E. M. 1930 *a* .. On the fluctuations in the abundance of cod fry in the Kattegat and the Belt Sea and causes of the same. *Rapp. Proc. Verb. Reunion*, 65, 26–30.

———. 1930 *b* .. Investigations of fluctuations in the cod stock in Danish waters. *ibid.*, 68, 20–23.

Prasad, R. R. 1953 .. Swarming of *Noctiluca* in the Palk Bay and its effect on the *Choodai* fishery with a note on the possible use of *Noctiluca* as an indicator species. *Proc. Indian Acad. Sci.*, 38, 40–47.

Rollefsen, G. 1930 .. Observations on cod eggs. *Rapp. Proc. Verb. Reunion*, 65, 31–34.

Russell, E. S. 1942 .. The overfishing problem, 130 pp., Cambridge University Press.

Sette, O. E. 1943 .. Biology of the Atlantic mackerel (*Scomber scombrus*) of North America. Part. I. Early life-history. *U. S. Department of the Interior, Fish and Wildlife Service, Fishery Bulletin* 38.

——— and Ahlstrom. 1948 Estimations of the abundance of the eggs of the Pacific pilchard (*Sardinops cærulea*) off Southern California during 1940 and 1941. *J. Mar. Res.*, 7, No. 3, 511–542.

Tait, J. B. 1952 .. Hydrography in relation to fisheries. 106 pp. Edward Arnold & Co., London.

Thompson, H. 1930 .. Fluctuations in the North Sea haddock. *Rapp. Proc. Verb. Reunion*, 65, 35–44.

———. 1938 .. Comparative studies of the fluctuations in the stock of fish in the seas of North and West Europe. Cod. *ibid.*, 101, 7.

Thomson, J. M. 1950 .. The effect of a period of increased minimum legal lenth of the sea mullet in Western Australia. *Austr. J. Mar. Freshw. Res.*, 1, No. 2, 199–220.

Tomasevich, J. 1943 .. International agreements on the conservation of marine resources. 297 pp. Food Research Institute, Stanford University, California.

Walford, A. 1938 .. Effect of currents on distribution and survival of the eggs and larvæ of the haddock. Bulletin No. 29. From *Bull. Bur. Fish.*, 49, Govt. Printing Office, Washington.