

OBSERVATIONS ON THE FOOD AND FEEDING HABITS OF THE INDIAN OIL SARDINE, *SARDINELLA LONGICEPS* VAL.

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A STUDY of the food and feeding habits of fishes forms an important aspect of fishery biological investigations. Some work has been done in the past on the food and feeding habits of oil sardine, *Sardinella longiceps* Val. Hornell (1910) first published an account of the food of oil sardine and also emphasised the importance of undertaking the study in greater detail. Hornell and Nayudu (1924) gave a brief account on the food of oil sardine along with a note on the plankton off West-Hill, Calicut. Subsequent studies on the food and feeding habits of this fish have been made by Chidambaram (1950) and Nair (1953) and brief references by John and Menon (1942), Nair and Subrahmanyam (1955) and Subrahmanyam (1959). Thus, some amount of reliable information is already available on the food and feeding habits of the oil sardine. The results published so far do not, however, include any observations north of Calicut, which is a fishing centre on the Malabar coast. The present account deals with some preliminary quantitative and qualitative observations made on the food of *Sardinella longiceps* Val., at Mangalore, an important fishing centre representative of the Mysore coast during the period February 1957 to January 1960.

MATERIAL AND METHODS

Samples were collected from fishing centres around Mangalore. In the Mangalore area, oil sardine are usually caught by the cast net, the gill-net (*Chalabale*) and the shore-seine (*Rampan*). During the 1957-58 season samples were available throughout the year; in the subsequent two seasons the oil sardine fishery was very poor all along the Mangalore zone, and so samples were not available for all the months.

Every week ten fish representing different length groups (total length) were taken for the study of gut inclusions. The maturity stage of each fish was noted and the gut inclusions were carefully washed into a petri-dish. The total volume of stomach contents was determined by displacement method. The stomach contents were made up to a known volume (10 c.c.)

and out of this 1 c.c. was taken by means of graduated pipette and examined in detail over a counting chamber.

The number method was followed in determining the relative abundance and importance of the various groups constituting the food. As the oil sardine is a plankton feeder and as the number method was found to be more convenient in this case than the points method described by Hynes (1950), the former method alone was followed in the present work. Each food item is counted in an aliquot sample and its relative abundance is expressed as percentage of the total number of items in the gut contents. After a comparison of different methods of the study of food of fishes Hynes (*op. cit.*) stated that "any of the commonly accepted methods of assessing the composition of the diet of the fish from the gut contents will give substantially the same result".

FEEDING INTENSITY

By feeding intensity is meant the average volume of stomach contents. This varied considerably from month to month as may be seen from Fig. 1. The feeding was moderate during February and March 1957, the average volume of stomach contents being 0.4 c.c., the size range of fish examined was 100–129 mm. During the next two months the size range was 115–145 mm. but there was downward trend in regard to the volume of stomach contents. Samples examined in May showed only sand particles. In July mature fish (150–184 mm.) entered the fishery and the feeding was found to be poor (about 0.3 c.c.). However, active feeding was observed from August to November period (average volume 0.5 c.c.) with the maximum volume of 0.6 c.c. during September; the size range of samples during this period was 110–174 mm. In December the feeding intensity was as low as recorded in July, but there was an increase in volume during January 1958 (size range 125–159 mm.). In February, only two samples were available having a size range of 125–160 mm. and they showed poor feeding with an average volume of 0.2 c.c. For the April–June period the fish ranged from 125–169 mm. in length and the average volume of gut contents was 0.3 c.c. In September and October 1958 the specimens varied from 125–159 mm. and 140–169 mm. respectively and the volume of stomach contents for these two months was 0.2 c.c. It increased to 0.4 c.c. in November (size range of oil sardine 145–180 mm.). From December 1958 to September 1959 there was no catch of oil sardine in the Mangalore area. In November and December 1959 the size range was 130–160 mm. and 130–174 mm. respectively and the feeding was found to be moderate, but in January 1960 (size range 135–139 mm.) green debris and sand particles were observed in the stomachs.

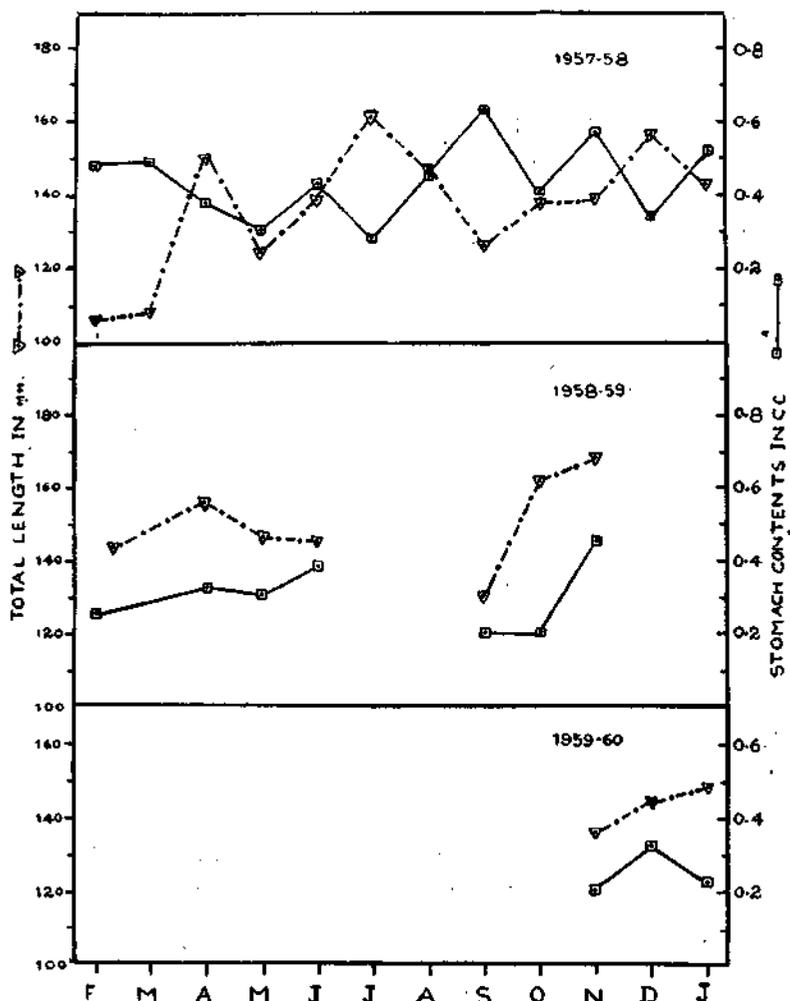


FIG. 1. Showing monthly average length and monthly average volume of stomach contents of oil sardine.

MATURITY CONDITION AND FOOD

In 1957-58 season, the samples obtained in February and March and again from August to November period consisted mostly of immature fish (Stages I and II); in April, May and June fish in Stages III, IV and V were obtained; and in December-January period fish were observed to be in Stage III. Maturity condition of oil sardine for April-June and August-November period of 1958-59 were same as recorded during the previous year. The samples of 1959-60 season comprised mainly immature fish.

In general, active feeding was noticed in oil sardine below maturity Stage V. Nair (1953) also observed active feeding in immature fish and also during the pre-spawning period.

LENGTH AND FEEDING INTENSITY

In Fig. 1 are shown the monthly average volume and monthly average length of the samples examined. There was no apparent correlation between the two averages. In Fig. 2 feeding intensity is plotted against different length groups of the samples. Here also no definite increase in the volume of stomach contents with increase in length was noted. Undoubtedly, feed volume depends not only on length but also on the availability of food^d

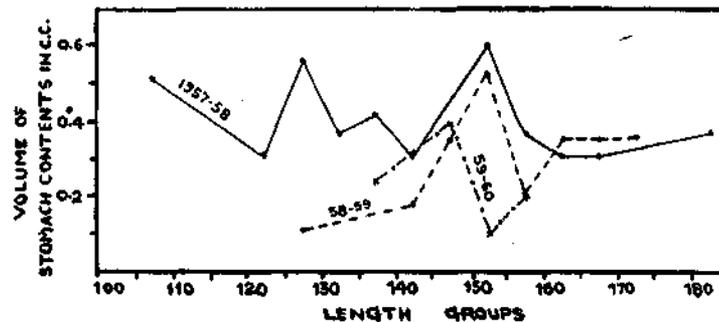


FIG. 2. Showing average volume of stomach contents against different length groups of oil sardine.

FOOD ITEMS

The various food items were identified up to genera and in some cases up to species. Figures 3 and 4 show variation of different food items of oil sardine expressed in terms of percentage. A few samples collected in May 1957, May 1958 and January 1960 contained sand particles in the stomachs and this may be attributed to the impounding of oil sardine caught in the shore-seine.

1. *Diatomaceae**

Diatoms formed the main food items of oil sardine and the following species were found to be more common in the gut inclusions.

(a) *Coscinodiscus* spp.—One of the most common species noticed in the stomachs during the study were *C. gigas* and *C. marginatus*. The feeding was observed to be high in March and April and again from June to September (except in July). It was found again in December-January

* Colony forms counted as a unit.

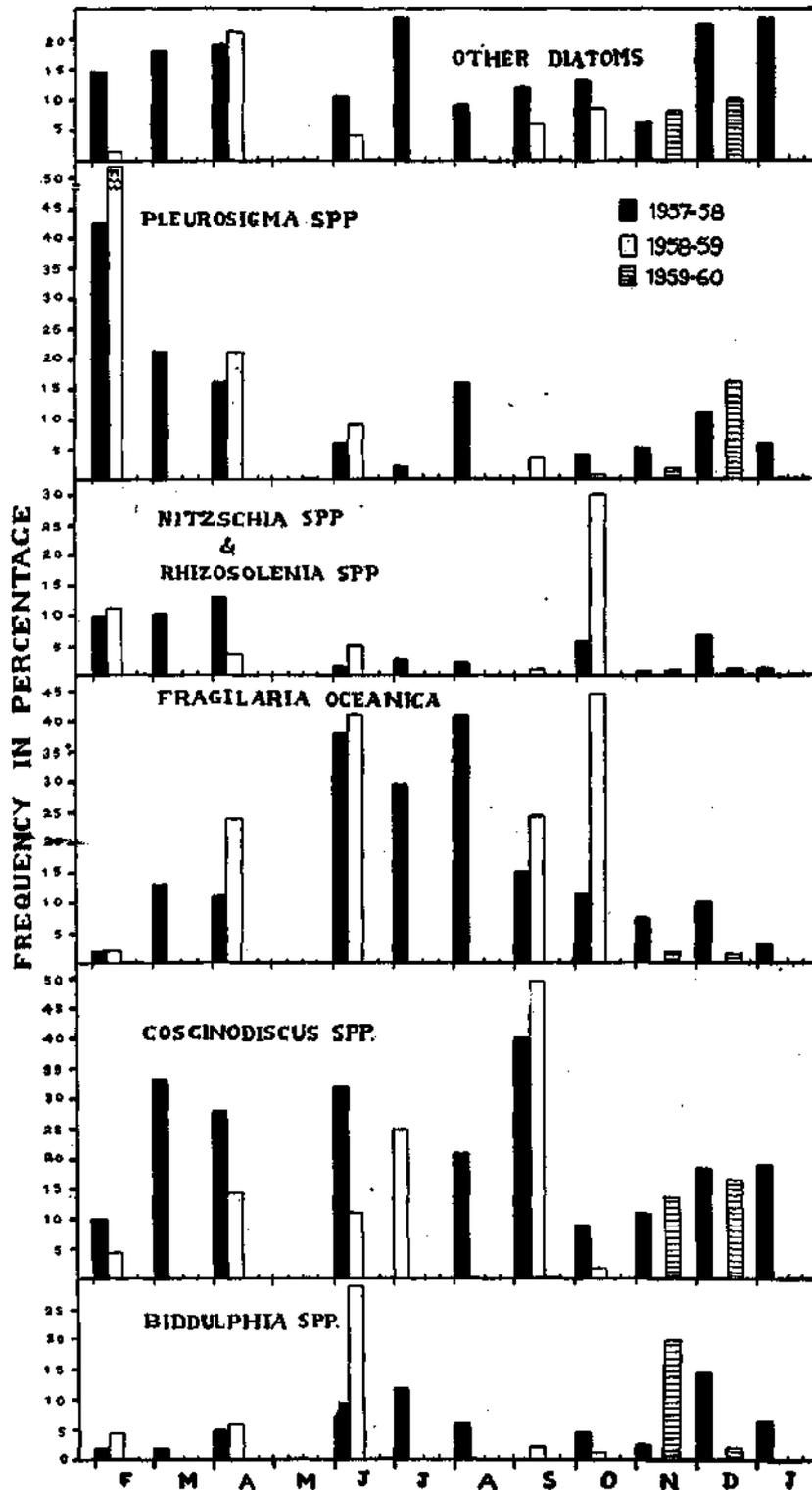


FIG. 3. Histograms showing fluctuations of different food organisms during the period 1957 to 1960.

1957-58. In the subsequent year also they were particularly abundant in April and September (Fig. 3). These two species constituted about 22.5%, 16.3% and 16.8% for the three years.

(b) *Fragilaria oceanica* which occurs in abundance during the south-west monsoon on the west coast formed an important food item of oil sardine. As regards this species Nair and Subrahmanyam (1953) stated that "one of the major factors governing the fluctuations of oil sardine is the availability of *Fragilaria oceanica* which is its favourite food". In 1957-58 it formed about 16.2% of the diatoms in the stomachs, whereas in the subsequent two seasons it contributed roughly about 27.2% and 1.6% respectively.

(c) *Biddulphia* spp.—*B. heteroceros*, *B. mobiliensis* and *B. sinensis* were the important species observed in the gut inclusions. The maximum feeding was recorded in June 1958-59 (about 30%) and also in November 1959-60 (20%). Their contributions towards gut inclusions for the three years referred to above were 5.8%, 8.5% and 2.4% respectively.

(d) *Pleurosigma* spp.—The common species met with were *P. elongatum* and *P. normani*. In 1957-58 they were recorded practically throughout the year and with the maximum value in February. During 1958-59 the maximum numbers were also recorded in February (71%). The percentage of these species in the stomach contents for the three years was 11.8%, 20.9% and 5.2% respectively.

(e) *Nitzschia* spp. and *Rhizosolenia* spp.—*N. closterium*, *N. seriata* and *N. sigma* and *Rhizosolenia alata*, *R. robusta* and *R. setigera* were other common diatoms observed frequently in the stomachs. In 1957-58 season they were recorded in large numbers from February to April and again in a few numbers from June to January period. During 1958-59 season the maximum percentage (30%) was noticed in October. In the subsequent year they were recorded in lesser numbers. Their contribution towards oil sardine food for the three years was 4.6%, 10.1% and 0.8% respectively.

(f) *Other diatoms*.—Other species of diatoms in lesser number were also noticed in the gut inclusions and the more common forms were *Asterionella japonica*, and *Bacteriastrum hylum* and species of *Ditylum*, *Hemidiscus*, *Planktoniella*, *Thalassiothrix* and *Triceratium*. The percentage of these in the gut contents was high in February-April and in July and also in December and January.

2. *Dinophyceae*

Next to diatoms *Dinophyceae* formed an important part of gut inclusions of oil sardine. *Dinophysis caudata* and *Prorocentrum micans* were conspi-

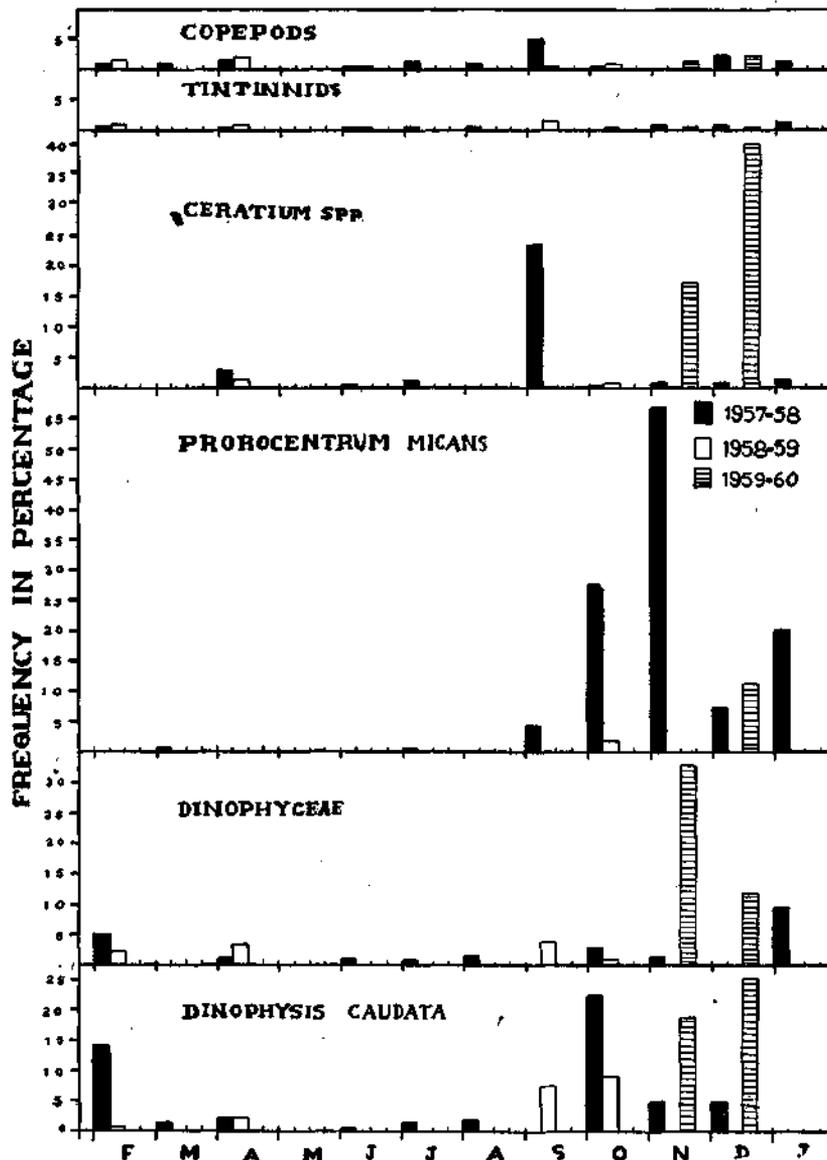


FIG. 4. Histograms showing fluctuations of different food organisms during the period 1957 to 1960.

cuus in the stomach. The former species was quite conspicuous in the guts during February and October 1957-58 and also during November and December of 1959-60. *P. micans* was dominant from September to January 1957-58 with a peak in November (Fig. 4). The percentage composition or the three seasons was 16.1%, 4.2% and 27.8% respectively.

Ceratium fusus, *C. furca*, *C. massiliense* and *C. tripos* were the important species of dinoflagellates observed in the stomach. The maximum percentage of these species was recorded during November and December 1959-60.

Species of *Peridinium*, *Pyrophacus* and *Ornithocercus* were represented in the guts in all the three years. In November 1959-60 the maximum was 33% (Fig. 4).

3. Tintinnids

Tintinnid spp. were represented in the stomachs in a few numbers not showing any marked seasonal fluctuations and they accounted for 0.4%, 0.9% and 0.3% as gut inclusions for the three years respectively.

4. Zooplankton

Oil sardine were found to be mainly phytoplankton feeders. The zooplankters usually occurred only in a very small numbers. Among them the copepods were more important. Species of *Acrocalanus*, *Paracalanus* and *Oithona* and *Hapacticoids* were observed in the stomach.

The copepods were found in large numbers in the younger fish than in the large size groups.

On a few occasions *Evadne* spp., *Lucifer* sp., and larval bivalves were also recorded in the stomach.

GENERAL OBSERVATIONS AND DISCUSSION

Hornell and Nayudu (1924) stated that the oil sardine "feed upon immense quantities of unicellular plants (Phytoplankton) and animals". John and Menon (1942), Chidambaram (1950) and Nair (1953) observed that diatoms, dinoflagellates and copepods constituted food of oil sardine. It is to be noted here that these workers carried out their investigations at Calicut and south of this place. The present study has shown that in the Mangalore waters also the commercial size groups of oil sardine feed entirely on plankton, especially on phytoplankton. Nair and Subrahmanyam (*op. cit.*) have stated that the diatom *Fragilaria oceanica* is the favourite food item of oil sardine at Calicut. During this study it was also observed that the above diatom formed one of the most important items of the diet. Other important species of diatoms were those of *Coscinodiscus*, *Biddulphia*, *Pleurosigma*, *Nitzschia* and *Rhizosolenia*. Dinoflagellates were also met with in large numbers on a number of occasions. Tintinnids and copepods were also observed in the gut inclusions but in lesser numbers.

The diatom *Bellarochea malleus* though found in large numbers in the plankton samples collected at Ullal near Mangalore was never encountered in the stomach of oil sardine. Similarly, *Noctiluca* sp., radiolarians, polychaete larvae, decapod zoea and species of *Sagitta* and *Oikopleura* were not noticed in the gut inclusions.

As regards the availability of food and catches Panikkar (1949) stated that "in tropical waters a direct correlation between plankton and the abundance of pelagic fisheries composed of clupeids and mackerel should be possible". Again George (1953), working at Calicut, observed that "the principal season of the mackerel and sardine fisheries along this coast is from September to December. The plankton of this season is remarkable in that it is characterised by moderately abundant phytoplankton". During 1957-58 season, phytoplanktonic organisms were recorded in large numbers in the samples collected at Ullal almost throughout the year. It would be interesting to add in this connection that during the record 1957-58 season oil sardine were abundant in the coastal waters almost throughout the year. In 1958-59 season, the phytoplankton was poorer in quality and quantity as compared to the previous year, and the oil sardine fishery was of a lesser magnitude. During 1959-60 oil sardine fishery was good from October to December and during this period the phytoplankton was more abundant than during the preceding five months.

SUMMARY

Observations on food and feeding habits of oil sardine, *Sardinella longiceps* Val., were based on the weekly examination of the fish samples collected at Ullal and also at the other centres.

The volume of stomach was determined by the displacement method. The dietary elements were estimated by the number method. The various items were expressed in terms of percentage.

In general feeding activity was found to be more in fish below Stage V.

As observed by the previous workers at other centres oil sardine in the Mangalore area also feed mainly on diatoms and dinoflagellates. Tintinnids and copepods were the minor elements of food.

Noctiluca sp., radiolarians, polychaete larvae, decapod zoea and *Sagitta* sp. were not observed in the stomach though they were recorded in large numbers on certain occasions in the plankton samples.

In 1957-58 phytoplankton was present almost throughout the year in the plankton samples collected at Ullal and good catches of oil sardine were

landed during this year. During 1958-59 phytoplankton was comparatively poor and oil sardine yield was also less.

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