

# THE FOOD AND FEEDING HABITS OF THE INDIAN OIL SARDINE *SARDINELLA LONGICEPS VALENCIENNES* AT KARWAR.

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## INTRODUCTION

*Sardinella longiceps* being a commercially important fish needs special attention and a study of its food and feeding is important. Some work has been done on this subject on the south-west coast of India as referred to by Nair (1952). Recently Venkataraman (1960), Kuthalingam (1960) and Dhulkhed (1962) have made some studies at Calicut, Madras and Mangalore respectively; and at Karwar nothing has so far been reported.

Stomachs of oil sardine landed at Karwar during 1961-64 were studied for the present report. Samples were collected from the landings of *Rampan* (shore-seine), *Yendi balae* (shore-seine) and *Veechu balae* (cast net). The organisms present in the stomach were arbitrarily ranked according to their relative abundance into absolutely abundant, abundant, plenty, good, some, poor, a few, rare and negligible. 'Some' was taken as the unit, 'good', 'plenty', 'abundant' and 'absolutely abundant' as two, five, ten and twenty times or above of 'some'; and 'poor', 'a few', 'rare' and 'negligible' as half, one-fifth, one-tenth and one-twentieth or below respectively. Points were given to these to calculate the percentage composition of the various groups of food constituents. For this calculation organisms were classed as diatoms, dinoflagellates, tintinnids, larval forms, cladocerans, copepods and fish eggs and fish remains; and the zooplankton elements which do not come under any of the above sections were grouped together as other zooplankton.

## FOOD CONSTITUENTS

### 1961-62

In 1961-62 oil sardine were landed in October-January and stomachs of 160 fish ranging in total length from 94 to 139 mm were studied. Percentage composition of the various groups of food items present in the stomachs during these months are given in Fig. 1.

Diatoms were sparsely represented in the stomachs during October, November and December; their respective percentages being 10.17, 14.04 and 11.59. *Coscinodiscus* sp., *C. jonesianus*, *Chaetoceros* spp., *Thalassiosira* sp., *Biddulphia*

sp., *B. heteroceros*, *Pleurosigma* sp., *Fragilaria oceanica*, *Triceratium favus*, *Navi-cula* sp. and *Tropedoneis* sp. were the diatoms present in the stomachs then. Among these *Coscinodiscus* sp. and *Chaetoceros coarctatus* appeared commonly. *Fragilaria oceanica* occurred only on one occasion in November. The occurrence of other forms mentioned above was poor. In January diatoms constituted an average of 36.79% of the stomach contents with *Coscinodiscus jonesianus* and *Chaetoceros* spp. (mostly *C. coarctatus*) as the common major items. Along with them *Biddulphia heteroceros*, *Coscinodiscus* sp. and *Thalassiosira* sp. occurred as minor elements.

Dinoflagellates were sparse except in November when they constituted 11.54% of the dietary. During other months they formed only 2.94 to 3.54%. The forms present were *Ceratium vultur*, *C. tripos*, *C. trichoceros*, *Peridinium* sp., *Dinophysis mile* and *D. homunculus*.

Tintinnids like *Tintinnopsis nucula*, *T. gracilis* and *T. radix* appeared in good quantity in October-December. Their percentages during October, November and December were 12.44, 11.71 and 22.85 respectively. In January, they were absent.

15.98% of the food in October was constituted by various larval forms. In November, December and January they were only 6.99, 5.40 and 3.82% respectively. Among them bivalve larvae occurred in good numbers in October and early November. Copepod and decapod nauplii, cypris larvae, decapod protozoa and mysis stages were present in small numbers in October and rare during other months.

A few cladocerans were noticed in October and November forming 3.20% and 1.31% respectively. In December they were only 0.34%. Of the two species, *Evadne tergestina* and *Penilia avirostris*, the former was more common.

In general, copepods formed the most important item of zooplanktonic food, constituting 55.27, 54.22 and 56.25% in October, November and January respectively. In December copepods contributed only 26.64% when the total zooplankton food was 84.87%. Among copepods *Acrocalanus longicornis* was most common. Others in the order of abundance were *Paracalanus aculeatus*, *Oithona plumifera*, *Oithona* sp., *Euterpina acutifrons*, *Corycaeus giesbrechti*, *Acartia erythraea*, *Acrocalanus gibbor*, *Temora turbinata*, *Pseudodiaptomus* sp. and *Oncea* sp.

Among other zooplankton, *Lucifer hanseni* was found in November and December. The item 'other zooplankton' was 29.64% of the stomach contents in December.

#### 1962-63

Oil sardine were landed in 1962-63 from May to March with a break in June. 300 stomachs collected from fish ranging in size from 54 to 184 mm were

studied during this year. Fig. 1 gives the percentage of the different groups of the food constituents that occurred in the stomachs during these months.

The diatoms *Coscinodiscus jonesianus* and *Biddulphia heteroceros* were rare in May (9.04%). During July, August and September diatoms constituted 88.99, 83.33 and 53.18% of the food. Plenty of *Coscinodiscus jonesianus* and a few *Coscinodiscus* sp. were found during these months. In late July the stomachs were almost full with *Coscinodiscus jonesianus*. In September some *Fragilaria oceanica* were also present. During October, November and December the percentages of diatoms in the stomachs were poor as they were only 25.15, 21.28 and 26.85 respectively. *Coscinodiscus* spp. were present in the stomachs in very small numbers. A good number of *Chaetoceros courcatus* occurred in early October and late December. Some *Thalassiosira* sp. appeared regularly in October and November. January marked a secondary peak (the primary one having occurred in July) in the occurrence of diatoms, the percentage observed being 46.35. During this month plenty of *Chaetoceros* sp. and *Pleurosigma* sp., a good number of *Tropedoneis* sp., some *Coscinodiscus* sp. and *C. jonesianus*; and a few *Thalassiosira* sp. occurred. In February and March, the percentages of diatoms in the stomachs were only 28.12 and 35.23 respectively. *Coscinodiscus jonesianus* and *Chaetoceros* sp. were the common forms. Other forms present were *Coscinodiscus* sp., *Pleurosigma* sp., *Biddulphia heteroceros* and *Thalassiothrix frauenfeldii*.

Dinoflagellates were present in the stomachs during September-December. They constituted 5.32% in September, 5.10% in October, 14.61% in November and 12.26% in December. The forms present were *Ceratium vultur*, *Peridinium* sp., *Dinophysis mile* and *D. homunculus*. As in the previous year the peak in their occurrence was in November.

Tintinnids were present in the stomachs in December-January, and March. In September, they were rare (0.08%) and in subsequent months they increased reaching a peak in December (16.82%). In January, again their percentage was 1.74; and in March they constituted only 0.51%. *Tintinnopsis gracilis* and *Codonella ostensfeldii* occurred in October, *T. nucula* in November, *T. nucula*, *T. gracilis* and *T. radix* in December; *T. radix* in January; and *T. dadayi* in March.

Several larval forms were present in the food. In May, September, October, November, December, January and March they contributed to 0.60, 14.05, 2.87, 0.27, 3.03, 5.08 and 11.64% respectively. In May gastropod larvae only were present. Later in first half of March they were found in good numbers. A number of bivalve larvae were seen in September, early October and beginning of January. Some cypris larvae were present from September to middle of October, a few copepod nauplii during September-January and March, and rarely decapod nauplii in mid-December. A few decapod protozoa and zoea of crab

were noticed in January and March; and mid-October respectively. In July, August and February, larval forms were not encountered in the stomachs.

*Evadne tergestina* were present in the stomachs in October—November and January—February, but they constituted only between 0.17 and 0.49%.

Copepods were abundant in May forming 90.36%, and 71.39% in February. In December and March they appeared in good quantities, the respective percentages being 33.75 and 36.76. In July, August, September, October, November and January the percentages of copepods in the stomachs were 11.01, 16.67, 23.21, 11.83, 27.04 and 17.42 respectively. *Acrocalanus longicornis*, *Paracalanus aculeatus* and *Oithona* sp. formed the most important items. A few *Acartia erythraea* were found in September—October and March. *Euterpina acutifrons* regularly appeared in the stomachs in small quantities during December—March. *Corycaeus giesbhechti* and *C. speciosus* were encountered in the stomachs in very small numbers in December—March. *Pseudodiaptomus* sp. occurred rarely in September and *Microsetella rosea* in few numbers in January.

Fish eggs and fish remains together formed 25.00% of the stomach contents in October, the former occurred negligibly and the latter in plenty.

Other zooplankton, mostly copepod eggs, were present in the stomachs during September—January and March. Pteropods occurred rarely in October. The percentage of other zooplankton in the stomachs during September, October, November, December, January and March were respectively 4.16, 27.76, 30.71, 7.29, 29.24 and 15.86.

#### 1963-64.

Oil sardine were landed this year during October—March and stomachs of 70 fish of 93 to 165 mm size range were studied for food.

Diatoms (Fig. 1) formed 23.08, 12.83 and 7.93% respectively in October, November and March. In December, January and February, diatoms dominated in the stomachs, their respective percentages being 63.92, 71.54 and 66.33. The forms that occurred this year were *Ciscinodiscus* sp., *C. jonesianus*, *Thalassiosira* sp., *Chaetoceros* spp., *Biddulphia heteroceros*, *Thalassiothrix frauenfeldii*, *Nitzschia longissima*, *Navicula* sp., *Tropedonais* sp. and *Triceratium favus*. Of these, *Ciscinodiscus* sp., *Chaetoceros* spp. and *Thalassiosira* sp. contributed largely to the diatom dominance in December—February.

Dinoflagellates were present in the food in November, December, January and March and their percentages during these months were 22.85, 5.15, 16.76 and 6.71 respectively. The species noticed were *Ceratium vultur*, *C. trichoceros*, *C. breve*, *C. tripos*, *C. furca*, *Peridinium* sp., *Dinophysis homunculus*, *D. mile* and *Ornithocercas* sp. Dinoflagellates were absent in October and February.

Tintinnids constituted 4.41% of the food in November, the form present being *Tintinnopsis gracilis* only. In December, January and February tintinnids formed 10.31, 4.35, and 11.22% respectively. *Tintinnopsis gracilis*, *T. nucula*, *T. dadayi*, *T. tocaninensis*, *T. radix* and *Codonella ostensfeldii* were present in these months in varying numbers. In October and March, tintinnids did not appear in the stomachs.

The percentages of larval forms in the food were in November 22.05, December 10.31, February 10.20 and March 6.10. In October and January they were absent. In November, copepod nauplii appeared in plenty. They were rare in February and were few in March. Other forms present rarely were cypris larvae in December, and bivalve larvae in December and February.

Copepods were abundant in October, contributing 76.92% to the dietary, and it remained as unidentifiable partly digested matter. In November, copepods (*Oithona plumifera*, *Euterpina acutifrons* and *Paracalanus aculeatus*) constituted 33.45%. *Paracalanus aculeatus* alone was present in December forming 10.31%. Copepods contributed only 0.40% to the food in January and the form present was *Oithona plumifera*. During February and March, copepods formed 12.25 and 15.24% respectively. The forms present in February were *Acrocalanus longicornis*, *Paracalanus aculeatus*, *Oithona plumifera* and *Oithona* sp. As in October, the copepods in the food in March also was unidentifiable due to digestion.

Other zooplankton which contributed 4.41% in November, 3.95% in January and 64.02% in March were some copepod eggs in November, a few in January and a good number in March. Rarely *Lucifer hanseni* also occurred in March.

#### GENERAL OBSERVATIONS AND DISCUSSION

Oil sardine were found to feed exclusively on plankton, diatoms forming an important item at Karwar, as has been observed in Trivandrum (John and Menon 1942), and at Calicut (Hornell and Nayudu 1924, Devanesan 1943, Chidambaram 1950, Nair 1952, and Venkataraman 1960) and Mangalore (Dhulhed 1962). However, diatoms did not dominate always as has been noticed by other workers. They were abundant in the stomachs during July-September and December-February (Fig. 1). *Coscinodiscus*, *Chaetoceros*, *Thalassiosira*, *Biddulphia* and *Pleurosigma* were the most common feeds of the oil sardine.

*Fragilaria oceanica* was found to be the favourite food item of the oil sardine at Calicut and it has been recognized as an indicator species of a good sardine fishery there (Nair and Subrahmanyam 1955). There is no such correlation at Karwar. During the three years under study, the occurrence of *F. oceanica* in the plankton as well as the guts was negligible if not absent. In fact, the fishery was the highest ever recorded here with 382.51 m. tons catch



in 1962-63 (from Annual Report of the Central Marine Fisheries Research Institute, for the year ending 31st March 1963). On the other hand, when there were blooms of this diatom in the inshore area off Karwar in September 1959, oil sardine were absent. During 1960-61 also the fishery was poor though a good number of *F. oceanica* was present in the inshore plankton.

Unlike other places, at Karwar, copepods contributed plentifully to the dietary of the oil sardine and were equally important and dominating. The most common forms that occurred in the stomachs were *Paracalanus aculeatus* and *Oithona plumifera*. Other important forms that occurred in the guts were *Acrocalanus longicornis*, *Oithona* sp., *Euterpina acutifrons*, *Corycaeus* spp. and *Acartia erythraea*. Bigger forms like *Eucalanus* and *Centropages* were not encountered in the stomachs.

Dinoflagellates, tintinnids, larval forms and other zooplankton appeared in the stomachs generally in the post monsoon months. Among dinoflagellates, species of *Ceratium*, *Peridinium* and *Dinophysis* were present. The peak in the occurrence of dinoflagellates in the food was in November. Tintinnids comprised largely of a number of *Tintinnopsis* spp. The larval forms that commonly occurred in the stomachs were copepod nauplii, cypris larvae and molluscan larvae. Decapod larvae were also found in lesser numbers. The important item in other zooplankton were copepod eggs and *Lucifer hanseni*.

As already stated diatoms and copepods form two important food items. Diatoms were comparatively less in 1961-62 forming only 18.15% (Fig. 2). In 1962-63 and 1963-64, they formed 41.75 and 40.94% respectively. Copepods were more in the first year, 48.09% and in the subsequent years they were 33.94 and 24.76% respectively. The item 'other zooplankton' was less in 1961-62 and became more in the succeeding years. Dinoflagellates, tintinnids and larval forms in 1962-63 were less.

The occurrence of cladocerans in the stomach was insignificant. In 1961-62 and 1962-63 their occurrence was limited to the post-monsoon months, forming only 1.21 and 0.12% of the food respectively (Fig. 2). Between *Evadne tergestina* and *Penilia avirostris* the former appeared more commonly in the stomachs. Cladocerans were absent in the stomachs in 1963-64. The occurrence of fish eggs and fish remains was not regular as they were found in the food in October 1962 only (Fig. 2). It is likely to be an accidental inclusion. Forms like *Noctiluca miliaris*, polychaetes, chaetognaths and appendicularians which were encountered in the local plankton were not found in the stomachs and, as in mackerel (Noble 1962), they are non-edible for oil sardine also.

All other workers except Kuthalingam (1960) observed phytoplankton to be the dominant food item. At Karwar, as shown in the inset histogram of Fig. 2, the phytoplankton had no such dominant role. In 1961-62, the percentages of

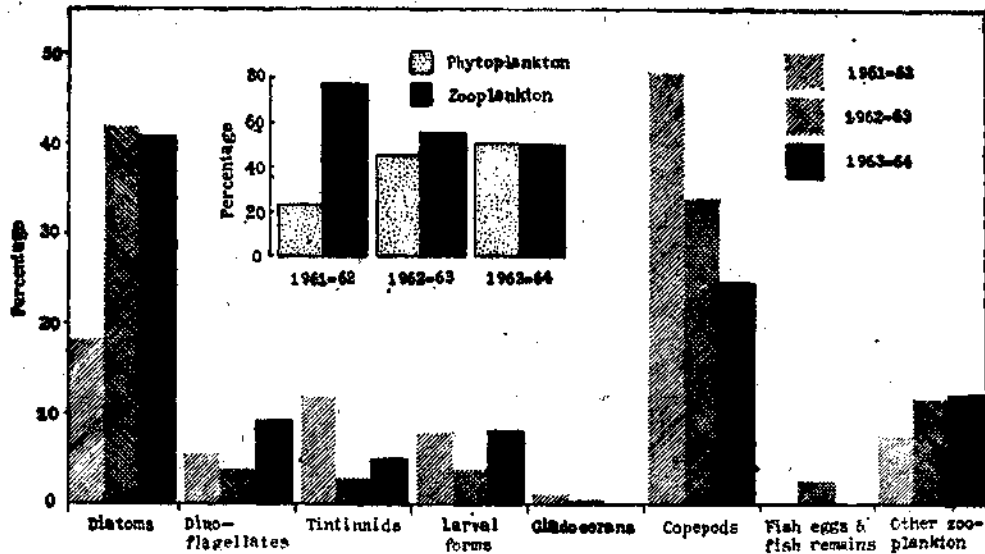


FIG. 2 Percentage composition of the different food constituents in the stomachs of the oil sardine at Karwar during the year 1961-62, 1962-63 and 1963-64. The inset histogram shows the percentage of phytoplankton and zooplankton in the stomachs during these three years.

phytoplankton and zooplankton in the food were 23.44 and 76.56 respectively. However, in 1962-63 and 1963-64, phytoplankton was 45.48 and 50.02%, the zooplankton being 54.52 and 49.98% respectively. Phytoplankton and zooplankton contributed almost equally to the food in these two years. Kuthalingam (1960) at Madras has observed the adult fish to be a zooplankton feeder.

An average of the three years data shows the phytoplankton-zooplankton ratio in the food as 2:3. Out of the 39.64% of phytoplankton (Fig. 3) diatoms formed 33.61% and the rest dinoflagellates. Zooplankton averages 60.36% during the three year period. In 60.36%, 35.60 were copepods, 6.50 tintinnids, 6.64 larval forms, and other zooplankton including cladocerans, and fish eggs and fish remains 11.62. Diatoms and copepods together make about two-thirds of the food; whereas all other items contribute collectively only one-third.

Oil sardine at Karwar were seldom found to abstain from feeding. Digested food was present in almost all the guts examined. Usually they feed at the surface as evidenced by their planktonic stomach contents. Occasionally they appear to feed at bottom, in which case their guts were almost filled with silt and sand. However, occurrence of sand alone need not necessarily imply bottom feeding as concluded by Devanesan (1943), for as in mackerel at Karwar (Noble 1962) the occurrence of sand in the stomach can depend upon the nets used and the methods employed for their fishing. For example, a number of sand grains occurred in the stomachs of sardine taken from *Rampam* catches. But in the sardine guts from *Yendi balae* and *Veechu balae* samples, sand occurred rarely.



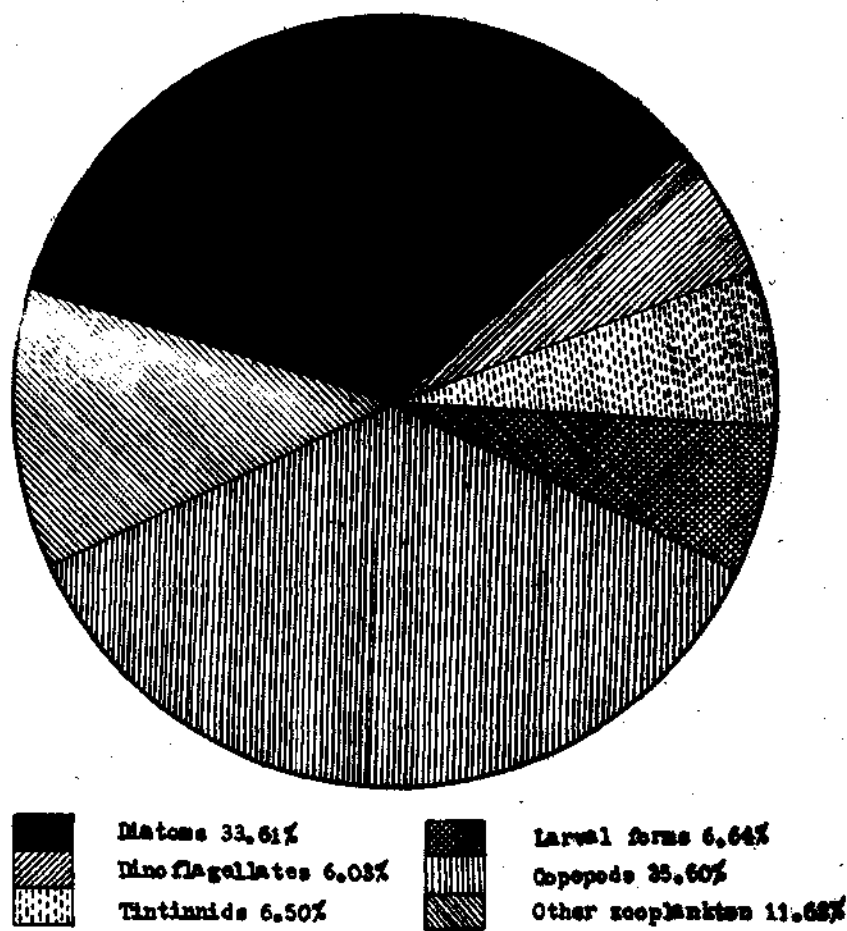


FIG. 3 Percentage composition of oil sardine food at Karwar.

The food of the oil sardine at Karwar as already seen differs from those studied by others at other places. Devanesan (1943) observed some variations in the food of oil sardines collected from different places in the west coast of India and suggested the possible existence of more than one race, and Devanesan and Chidambaram (1943) opined that the Karwar oil sardine is a separate race different from the oil sardine of other places.

#### SUMMARY

Diatoms form an important food item of the oil sardine and they dominate in the stomach contents once during July—September and then December—February. Copepods are equally important by their dominance during other times. Diatoms and copepods together form two-thirds of the total food, rest

being contributed by almost equal amount of dinoflagellates, tintinnids, larval forms and other zooplanktonic organisms.

The phytoplankton and the zooplankton in the food are found to be 2:3 in ratio, the zooplankton being dominant.

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