THE DIATOM, *FRAGILARIA OCEANICA* CLEVE, AN INDICATOR OF ABUNDANCE OF THE INDIAN OIL SARDINE, *SARDINELLA LONGICEPS* CUV. AND VAL.*

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THE oil sardine fishery has contributed in no small measure to the economy of the fisherfolk of the West Coast of India, and apart from its food value, the fish has sustained prosperous oil and guano industries for well over a century.[1] The fishery, however, is subject to extreme fluctuations and its continuous failure during the forties extending over several years had disastrous consequences on the fishing industry. Factors governing these fluctuations have been the subject of investigations for over three decades.

Since the inception of the Marine Fisheries Research Station of the Government of India, sardine investigations have been actively pursued at the Sub-Station at Kozhikode, which was set up in 1948. Intensive studies on the biology and fishery of the oil sardine and related subjects have been in progress with the primary object of determining the causes responsible for the fluctuations encountered in the fishery One of the aspects of study related to the food and feeding habits of the different age groups of the oil sardine with special reference to the seasonal changes in the composition of its food, both in quantity and quality. Even during the early phase of this investigation, it became apparent that the oil sardine is a plankton feeder showing a special preference for phytoplankton, with the diatom *Fragilaria oceanica* forming a major constituent of its food. Further studies have revealed that *Fragilaria oceanica* constitutes the main component of the food of the juveniles which form the mainstay and bulk of the commercial fishery and also, occasionally, of the adult oil sardine.[2]

From the accounts so far published, it would appear that blooms of *Fragilaria oceanica* in the Indian waters are confined to the Laccadive Sea. This diatom is absent in other places, or if present, it occurs only in such small numbers as to be easily overlooked. Very rarely, a few numbers have been encountered on the Madras Coast.[3] It is interesting to note in this connection that large-scale shoaling of the oil sardine is confined to this region of the West Coast where the diatom also occurs in abundance.

Intensive studies on the qualitative and quantitative aspects of phytoplankton production and of the major constituents of the marine flora have been in progress simultaneously and these have shown that phytoplankton production attains its peak during the South-West monsoon months (June-September) and one of the major, if not the foremost, constituents of the peak is *Fragilaria oceanica*. This diatom, which forms flat, ribbon-like colonies, generally attains the height of its development between June and October, the intensity of its development fluctuating to some extent from time to time Continuous observations over a period of seven years have indicated that the diatom has an asexual vegetative phase in its life-cycle lasting from three to four years, after which it forms auxospores, presumably by a sexual process; this process rejuvenates the protoplast and large new cells are formed which multiply by repeated vegetative divisions. The presence of considerable numbers of chains composed of large cells at three to four year intervals permits this interpretation. It is well known that in diatoms, immediately after auxospore-formation, the rate of vegetative multiplication is rather fast and that this rate slows down gradually as the cells undergo repeated divisions until auxospore-formation again provides the necessary stimulus for renewed activity[4,5] Thus, in the present instance also, every four years or so, the *Fragilaria* bloom is more intense than during the in-between years. During the period of investigation in the present area two such blooms, one in 1949 and the other in 1953, were observed. These fluctuations in the bloom of *Fragilaria*, and thus its availability, seem to show an interesting relationship with those of the oil sardine fishery.

The oil sardine fishery commences along the West Coast with the onset of the South-West monsoon and the stock at this time is composed of active spawners,[2] These disappear with the cessation of the monsoon and the juveniles enter the fishing grounds in enormous shoals to contribute to the bulk of the

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commercial landings during the peak period of the fishery. As pointed out by Panikkar,[6] all previous workers are unanimous in ascribing the success of the oil sardine fishery to the abundance of the juveniles only. It is significant that the peak of the oil sardine fishery, when the juveniles dominate the catches, is reached during or immediately after the peak of *Fragilaria oceanica*. Further, a secondary maximum in the bloom of this diatom has also been observed during certain years accompanied by heavy landings of juvenile sardines. The influence of this diatom on the oil sardine was markedly noticed during the 1951-52 season when the fishery which was steady till October 1951, suffered a severe setback during the subsequent months owing to the scarcity of *Fragilaria* in the fishing grounds. The fishery revived with the reappearance of the diatom by the end of December 1951.

These investigations on the oil sardine and *Fragilaria oceanica* extending over seven years lead to the inescapable conclusion that one of the major factors governing the fluctuations of the oil sardine is the availability of *Fragilaria oceanica* which is its favourite food.[2] It was mentioned above that during the last seven years *Fragilaria* attained two outstanding peaks in the years 1949 and 1953 caused by the rejuvenation process in its life-history. It would appear that the bloom of 1949 may have helped the recovery of the oil sardine fishery which was a continuous failure for several preceding years. This progressive recovery of the fishery culminated in the exceptionally good 1953-54 season, which coincided with the second outstanding bloom of *Fragilaria* in 1953, when the heavy landings composed of juveniles contributed to one of the most successful fisheries during the last quarter of a century. It may be pointed out that the next outstanding bloom of *Fragilaria oceanica* is expected in 1956-57 and this surmise together with the expected good recruitment consequent on the abundance of the spawners in the fishery of the current season, *i.e.*, 1954-55, indicates a good oil sardine fishery during that season, provided the hydrological and other factors are also favourable.

Our thanks are due to Dr. N. Kesava Panikkar for his keen interest and valuable suggestions.

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CONQUEST OF SOLAR ENERGY

THE harnessing of huge amounts of energy now going to waste in the desert and arid areas of the earth was the topic of a symposium held recently at New Delhi under the joint auspices of UNESCO and the National Institute of Sciences of India.

One of the most striking papers presented was that of Professor V. A. Baum, Head of the Heliotechnical Laboratory at the G. M. Krzhizhanovsky Power Institute at Tashkent in the Soviet Union. With nearly a million square miles of arid lands, the use of solar energy is being treated as a major problem in the U.S.S.R.

In Tashkent, every square metre of land receives more than a million kilocalories of sun energy per year, and the Soviet scientists have succeeded in developing paraboloid reflectors ten metres in diameter which produce 100 lb of steam per hour at a pressure of 100 lb. per square inch. Such heaters have been used for the operation of canneries, for distilling water, operating refrigerators, and for heating the laboratory. In another application, solar heaters have been developed to make fresh water from salt. A practical still of this type has been used to make 75,000 tons of distilled water and 12,000 tons of ice a year.

The U.S.S.R. State Optical Institute has constructed a number of solar kitchens using aluminium mirrors 4 feet in diameter which can produce 6 quarts of boiled water per hour. Work is now continuing to develop a solar steam generator which can be used as a heating plant in winter and a cooling plant in summer for cinemas, hospitals and houses. The development of ice-making and of air-conditioning is considered especially important in those arid regions where the suffering of the population from heat in summer is as severe as that from cold in the winter.