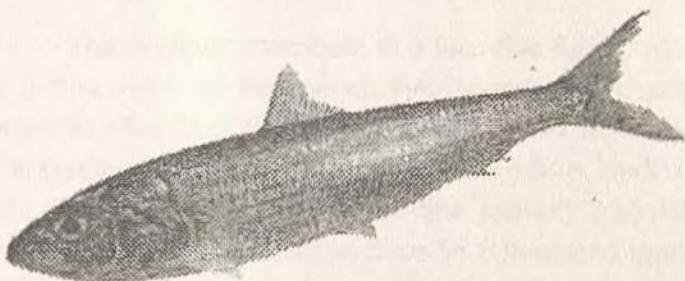




TRENDS IN WORLD SARDINE FISHERIES AND INDIA'S STATUS



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TREND OF FISHERY

The world sardine production (av. 1997-01) was 2.93 million tonnes. However, the production of 3.27 million tonnes during the year 2001 showed a clear lead of 12.7% over the previous year. In India, on an average 3.57 lakh tonnes of sardines are landed annually which contribute 12.2% to the total sardine production in the world. Important species contributing to the total sardine production are *Sardina pilchardus* (European pilchard 33.6%), *Sardinops coeruleus* (California pilchard 17.2%), *S. melanostictus* (Japanese pilchard 12.8%), *Sardinella aurita* (Round sardinella 13.9%), *S. longiceps* (Indian oil sardine 10.8%), *Sardinops ocellatus* (South African Pilchard - 6%) and *Sardinella gibbosa* (Goldstripe sardinella 5.7%).

The sardines contribute to a lucrative fishery along the Indian coast. All the species that belongs to the genus *Sardinella* other than oil sardine are called lesser sardines or other sardines. Out of 3.57 lakh tonnes of sardines landed in India during 1997-01, the oil sardine formed 2.56 lakh tonnes (72%) and the lesser sardines 98.8 thousand tonnes (28%).

The Indian Oil sardine (*Sardinella longiceps* Val.)

Taxonomy / Identification

Body fusiform, elongate and subcylindrical; belly rounded, with low keel of scutes. Head more than greatest width of body unlike in other *Sardinella* spp. Fins devoid of spines. Only one dorsal fin and placed before mid-point of body. Gill opening with two fleshy outgrowths posteriorly.
Gill

rakers numerous, 150-255 on the lower limb of the first gill arch compared to other sardines. No lateral line. Scales cycloid. Maximum length reported 272mm. The species are known as Mathi/Nalla mathi in Malayalam, Boothai in Kannada., Tarli/Haid in Marathi, Nonne-kavallu in Telugu, Nolali/Paichalai in Tamil; Tarli in Marathi and Hindi; Nna Kavala, Disco kabala in Oriya.

Distribution

Arabia, Mombasa, Seychelles, Iran, Pakistan, India (east and west coasts), Sri Lanka, Java, Bali Straits and Philippines.

Seasons of abundance

Oil sardine is very capricious as to its arrival and departure. The fishery is characterised by wide fluctuations on a seasonal, annual and decadal scale. The successful years of the fishery bring as much prosperity to the coastal community as its failure a major economic setback. The species, though distributed along both the coasts of India, supports a fishery of considerable magnitude along Kerala, Karnataka and Goa (8° N and 16° N) coasts. The production trend was exceptionally good during 1923-24 season (57,000 t) along the west coast after which it showed declining phase for subsequent 22 years with catches reported at less than 500 t during the forties. Revival of the fishery was noticed from 1950 and the landings improved tremendously. During the last five decades the all India landings varied from 14,000 tonnes in 1952 to 3 lakh t in 1968 and later to 3.67 lakh tonnes in the year 2000 contributing on an average 15% to the total marine fish production in the country.

Until the eighties, Kerala and Karnataka along the southwest coast accounted for nearly 95% of the total oil sardine production. However, there has been steady decline in the catches along the Karnataka coast where its contribution to the total fish landings decreased from 33% (1980's) to 7% (1990's). The production in Kerala came to a low of 4000t in 1994. Consequent on the decline of oil sardine catch from the west coast there has been a phenomenal rise in the landings from Tamilnadu, Andhra Pradesh and further north along the east coast. By late nineties, oil sardine has emerged as a major resource along the east coast.

The optimum temperature and salinity ranges for distribution and abundance of oil sardine is 27-28° C and 22.8-33.5 ppt respectively although occasionally they have been observed to enter the estuaries and backwaters along the south west coast. The fishery commences soon after the outbreak of monsoon in June and continues till March-April as in Kerala; and starts by September/October with peak fishing during October to January period in Karnataka-Goa. Along the east coast, the fishing season is from April to December with peak catches during January to March in Tamilnadu and July-October along the Andhra coast. The catch per unit effort of the pair trawlers operating from Rameswaram is as high as 3t or more during the season. The species caught here has a characteristic emaciated appearance with a large head and tapering body, the bones being more calcified, it tastes dull compared to its western counter part.

Method of harvest / fishing

The artisanal fishing gears mostly boat seines and beach seines (Mathikolli, Thangu vala, Kollibale, Rampan), cast nets (Veesuvala) and small meshed

gillnets (Mathichala vala) were in operation till the 1970's along the southwest coast. These gears became obsolete with the introduction of mass harvesting gears like purse seines in the late 70's, ring seines in the late 80's and with the steady rise in the motorization of traditional fishing crafts. Along the east coast, traditional gears, mainly boat seines (Karavala, Peddavala) gillnets (Chalavalai) and bag nets (Edavalai) dominate. In Tamil Nadu the pair trawlers and the recently introduced ring seines exploit this resource from 12-16m depths during January to April off Pamban-Rameswaram area. The purse seines operate at 30-40m depths almost throughout the year except during the SW monsoon period. The ring seines, a simulative purse seine, though banned, carryout fishing throughout the year. Off late, during the ban period, the operation of large size ring seine units with inboard engines has been a matter of grave concern to the fishery managers.

Size composition

The life span of the species is about 2 ½ years. The growth in length of oil sardine at the end of successive years is variable from place to place and during different years. The average length attained at the completion of 1 to 3 years is 135mm, 170mm and 191mm respectively. '0' -year and 1-year old fishes dominate the fishery. Along the west coast, the length composition of catches ranges between 50-220mm. Off Karnataka, the spawners enter the fishery during July-September, while new recruits (100-120 mm) and juveniles (120-140 mm) dominate during August to October and October to February respectively. On the east coast, the size of oil sardine varies between 50-207 mm.

Large-scale destruction of juveniles of 50-90mm, which occurs

along with spawners, during May-July by the ring seines along the Kerala coast is common. Bigger units are being added to this fleet every year. The purse seines and ring seines exploit considerable quantities of spawners during April-June, with adverse impact on recruitment and economic benefits.

Breeding / spawning season

The fish attains maturity at about 150-mm size when they are just one year old. On the west coast peak spawning occurs during June-August, while on the east coast, it is during December-February, April to June and August to October.

Reproductive capacity and behaviour

Fecundity ranged from 70,000-80,000 eggs. Spawning, is influenced by lunar periodicity, and usually takes place at night, a few days before and after new moon. Spawning grounds have been indicated off Quilandy, near Kozhikode, Tanur-Tellicherry belt, Quilon and Mangalore at depths of 20-30 m and about 15 km from the shore. Planktonic eggs and larvae, indicating spawning sites off Chennai coast are also recorded. Seasons of feeble or severe rainfall cause recruitment failure, while a daily rainfall of 20-30 mm during June-August along the south west coast may indicate a good recruitment to the fishery.

Food and feeding habits

The oil sardine is a planktivore. The diatoms, dinoflagellates and copepods are the favoured food items. The diatoms include *Fragillaria*,

Biddulphia, Coscinodiscus, Thalassiothrix and Pleurosigma. The abundance of diatom *Fragilaria oceanica* is said to indicate abundance of oil sardine in coastal waters. The food of adults of Madras coast consisted of small sized crustaceans like copepods, ostracods, Lucifer and larval prawns; larval bivalves, polychaete larvae, sergestids and a few diatoms and algae. Food of post-larvae of oil sardine consisted of diatoms and algae.

Drug / medicinal value

Proximate composition

(g per 100g edible portion) - Moisture: 67.0,
protein: 19.4, fat:11.7 and ash: 1.8.

Amino acid composition of muscle proteins

(g amino acid per 100g protein) - Aspartic acid:
10.05, Threonine: 4.66, Serine: 2.89, Glutamic
acid: 14.33, Proline: 1.93, Glycine: 3.77, Alanine:
4.88, Valine: 4.75, Cystine: 1.63, Methionine: 2.8,
Isoleucine: 3.29, Leucine: 5.97, Tyrosine: 3.41,
Phenyl alanine: 3.93, Histidine: 5.57, Lysine:
10.64, Arginine: 6.47 and Tryptophan: 1.89.

Fatty acid composition of the lipids

(% by wt. of total fatty acids) Saturated: 40.2,
monounsaturated: 28.2 and polyunsaturated: 31.6

Role in food chain

The southeast Arabian Sea, with its annual cycle of upwelling

associated with the southwest monsoon, is one of the most productive areas of the world. The economic benefit of upwelling is the large concentration of commercially important fishes such as oil sardine, mackerel and whitebaits. Most of the aggregating fishes are clupeids with short food chains. The fishery of these fishes is entirely dependent on the blooms of phytoplankton and secondary production in the area. The fluctuations in oil sardine fishery are periodic and show a striking similarity to the 10/11-year periodicity of sunspot activity. These fluctuations have been closely related with change in environmental parameters like earth rotation, sunspot activity, and mean sea level and rainfall intensity. Based on these long term forecast of the fishery is possible.

Markets, marketing channels and nature of product

Besides, being nutritionally rich, affordable and favoured table fish occurring abundantly almost throughout the year, it serves as a source for valuable by-products like sardine oil used in many industries and fish-meal for cattle and poultry feed. People in the maritime states of Kerala and Karnataka relish the oil sardine. On the east coast, the local consumption being very meager, most of the catch is marketed outside the state particularly in Kerala. During periods of glut, especially the pre-adults are sundried and supplied to manufacturers of poultry feed and as manure. Extraction of sardine oil was an activity more prevalent during the pre-independence era.

Resource potential and present status of exploitation

Potential yield 267,000 tonnes and present yield is 3.4 lakh tonnes.

Conservation / Regulation in harvesting

The average yield during the nineties was 0.13 million tonnes while the estimated maximum sustainable yield is 0.21 million tonnes. Fisheries of small pelagics like oil sardine is characterised by high inter annual and decadal variability making management difficult. There was an unprecedented failure of oil sardine fishery during the 40's which had disastrous effects on industries based on it, which provoked the British administration to introduce restrictive legislation in 1943 to prevent capture of juveniles and spawners. More recently, under the Marine Fishing Regulation Act (MFRA, 1986) passed by various maritime states, fishing by mechanized vessels, especially purse seines during monsoon is banned to protect spawners, but the implementation of the same is not uniform in all the states. A total and uniform ban on fishing during monsoon would be ideal. The present coastal fishery scenario demands responsible fishing by all sectors to sustain the fishery as well as to ensure the socio-economic well being of the fishermen.

Lesser sardines or other sardines

Lesser sardines comprise all the species of sardines (*Sardinella* spp.) other than Indian oil sardine. Except one species most of them grow to less than 200mm.

Taxonomy / Identification

Small, mostly silvery fishes. Body fusiform, laterally compressed, its depth variable. Belly with sharp keel, the number of scutes variable. Most of them could be identified from the number of gill rakers on

the lower arm of the first gill arch. Scales cycloid, no lateral line. Single dorsal fin, fins devoid of spines. Forked tail.

Distribution

They show wide distribution in the tropics and occur in the landings of all the maritime states of India, but contribute to a lucrative fishery along the southeast and southwest coasts. These shoaling species exhibit all the characteristics of tropical pelagic resources with annual and seasonal fluctuations. Of the 15 species of lesser sardines in the Indo-Pacific region, 12 occur in the Indian waters.

The species found in Indian Seas are: White sardinella, *S.albella* (Val.); Fringscale sardinella, *S.fimbriata* (Cuv. & Val.); Blacktip sardinella, *S.melanura* (Cuv.); Goldstripe sardinella, *S.gibbosa* (Bleeker); Sind sardinella, *S.sindensis* (Day); *S.dayi* Regan; *S.clupeoides* (Bleeker); Smooth belly sardinella, *S.leogaster* (Val.); and spotted sardinella, *S.sirm* (Walbaum); and *S.jonesi* (Lazarus).

Seasons of abundance

It constituted 4.2% of the landings during 1986-1990, 4.2% during 1991-1995 and 4.8% during 1996-2000. The average annual yields during the above periods were 78,553 t, 94,387 t and 1,22,243 t respectively registering a steady increase in production over the years. The highest production of 1,28,021 t was in 1995. The east coast contributed 65% with an average annual production of 67,172 t during 1986-2000. The annual production along the west coast was 35,449 t comprising 35% of the total annual production. Tamilnadu with an average annual landing of 42,263t stood first in lesser sardine production among the maritime states. It contributed 43% of the catch of the country. Kerala came next with a

contribution of 22% followed by Andhra Pradesh 17% and Karnataka 6%.

Fishing season and species composition

The fishing season, species composition and catch rates vary between and within regions. In W.Bengal, Orissa and Andhra Pradesh, the peak season is November to April-May while in Tamilnadu and Pondicherry, catches are available almost throughout the year. In Kerala the best catches occur from August to January/February. Along Karnataka coast, the fishery is erratic for most of the year with September-November witnessing better landings. Peak catches occur during September-February period along the Goa coast, while in Maharashtra it is between December and April.

More than one species contribute to the lesser sardine fishery of any region and they form a fishery throughout the year. In the Goa-Karnataka coast, *Sardinella gibbosa*, *S. dayi*, *S. fimbriata* and *S. albella* are abundant. Along Kerala coast, *S.gibbosa*, *S.sindensis* and *S. sirm* dominate while *S. clupeoides*, *S. fimbriata*, *S.melanura* and *S. jonesi* occur occasionally. *S. albella* and *S. gibbosa* are dominant in the Palk Bay and the Gulf of Mannar regions while *S.sirm* is common in the peninsular tip between Vizhinjam and Tuticorin. Along the central east coast, *S.gibbosa*, *S. albella*, *S. dayi*, *S. sirm*, *S. clupeoides*, *S. fimbriata* and *S. gibbosa* are abundant.

Method of harvest

The traditional, motorised and mechanised crafts such as a variety of seines, gillnets and trawls are employed. Along the southeast coast, the

small meshed gillnet (Choodavalai) is meant for lesser sardine exploitation. The gear used to harvest the resource determines the size of the fish. Along the Konkan, North Kanara and Vizhinjam coasts, gillnets are used. The seines (shore seines, boat seines and ring seines) are popular along the southwest coast. The canoes and plankbuilt crafts with outboard engines operate the boat seines (Ranibale, Mattubale, Kotibale) and ringseines at depths upto 20 to 30 m. The purse seines are operated from the mechanised units at depth upto 60-m. The trawlers operating in the nearshore waters also land sardines as bycatch in considerable quantities along the Karnataka coast.

Size composition

The lesser sardines exhibit all characteristics of small pelagic tropical fishes like fast growth, short life span (2-3 years) and high natural mortality. Most of the species attain 70% of their maximum length in the first year itself. The length at age of 1 year is 125 mm to 135 mm for *S. albella*, *S. gibbosa* and *S. fimbriata* and 170 mm for *S. sirm*. The growth of these sardines in relation to their life span is fastest with a *K* value greater than or close to 1. The high values of natural mortality (*M*) for the stocks of *S. albella*, *S. gibbosa* and *S. fimbriata* are in tune with their fast growth in the first year of life and as a prey for most of the large predatory fishes. The 0 and 1 year classes mainly sustain the lesser sardine fishery. The total length of the different species constituting the fishery range from 4 to 20 cm.

Breeding season, reproductive capacity and behaviour

Most of the lesser sardine species mature in the first year of their life. In most species, fishes measuring above 120 mm in total length are found to be fully mature. *S. fimbriata* attains sexual maturity at a length of 135-185 mm and *S. dayi* at 140mm. They have protracted spawning period with a peak extending to one or two months. *S. albella*, *S. gibbosa* and *S. fimbriata* spawn once whereas *S. sirm* spawns thrice within the same spawning season releasing 3 to 4 broods per year. Fecundity varied from 26,000 to 73,000 in *S.gibbosa*, 121,500 to 132,900 in *S.sirm* and is about 60,000 in *S.dayi*

Food and feeding habits

Lesser sardines feed mainly on a variety of plankters. *S.gibbosa* feed on copepods, Mysis, Lucifer, larvae of prawns and crabs, fish eggs, Acetes, etc., while *S.albella* feed mainly on copepods, Lucifer, Acetes, Mysis, fish and bivalve larvae etc. *S.fimbriata* feeds mainly on phytoplankton and copepods and *S. dayi* thrives on prawns and other crustacean larvae, Acetes, molluscan larvae, etc.

Role in food chain

Sardines take full advantage of the primary and secondary production and constitute important linkage with higher carnivores in the food chain.

Marketing

Because of the small size and low market value, industrialists do not prefer them. It is relished both in the fresh/frozen as well as dried form.

When landed in good quantities, they are salted and sun dried and then sent to interior markets and to neighboring states and countries for consumption. The smaller sized fishes, which do not fetch a good price in the local markets, are dried for converting to fishmeal.

Conservation required / regulation in harvesting

The total annual stock of the lesser sardines is estimated to be 2,80,000t comprising 20,000 t in the Andaman waters, 30,000 t in the northeast, 140,000t in the southeast, 80,000 t in the southwest and 10,000t in the northwest coasts. The MSY was estimated at 1,40,000 t. The average annual catch of 80,328 t during 1986-90; 94,387 t during 1991-95 and 1,22,243 t during 1996-2000, though indicated an increasing trend is still below the estimated MSY. Studies on the stock assessment on *S. gibbosa* indicated that the yield along the southwest coast is considerably lower than the MSY and hence there is further scope of increasing the catch from this area. Along the southeast coast, the present yield is more or less steady. The exploitation of this small pelagic fish from the coastal waters is sustainable and that they are easily vulnerable to the traditional sector. As no single species is harvested continuously, there is no excess fishing pressure at present on the lesser sardine group on the whole.

How and where it stands in India vis-a-vis other countries

Sardine resource in India is multispecies unlike in other parts of the world. The resource is optimally exploited shows a decadal trend in its abundance. The stock is highly variable like any other pelagic resources of the world.