Studies on Some Aspects of Landings, Utilization and Export of Commercially Important Cephalopods

Thesis submitted to Cochin University of Science and Technology in partial fulfillment of the requirements for the degree of

DOCTOR OF PHILOSOPHY

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Certificate

This is to certify that the thesis entitled ***"Studies on Some Aspects of Landings, Utilization and Export of Commercially Important Cephalopods"*** *is a bonafide record of the research work carried out by Sri. John Mohan under my supervision and guidance in the School of Industrial Fisheries, Cochin University of Science and Technology in partial fulfillment of the requirements for the degree of Doctor of Philosophy of the Cochin University of Science and Technology and no part thereof has been presented before for any other degree.*

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Prof. Dr. M. Shahul Hameed
Supervising Guide

DECLARATION

This is to certify that the thesis entitled "Studies on Some Aspects of Landings, Utilization and Export of Commercially Important Cephalopods" is an authentic record of the research work carried out by me under the supervision of Prof. (Dr). M. Shahul Hameed, Retd. Director, School of Industrial Fisheries, Cochin University of Science of Technology in partial-fulfillment of the requirements for the Ph.D degree of Cochin University of Science and Technology and no part of it has previously formed the basis for award of any degree in any University

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CONTENTS

INTRODUCTION

Cephalopods consist of bilaterally symmetrical molluscs belonging to the class Cephalopoda with a well developed head that contains a circum-oral crown of mobile appendages that bear suckers and/or hooks except in Nautilus. Cephalopods first evolved 450 million years ago in the upper Cambrian period and represented by a single subclass, Nautiloidea. However, most of the species of this subclass became extinct during the Jurassic period. The subclass Coleoidea, comprising of present day cuttlefishes, squids, octopuses and vampire squids arose in the late Paleozoic era, about 330 to 400 million years ago. Most of its forms too became extinct by the end of the Mesozoic, about 150 million years ago. The living forms today have evolved in the upper Triassic and lower Jurassic periods Roper *et al* 1984. Around 1000 living species belonging to 43 families are distributed in all marine habitats of the world like benthic, epibenthic, pelagic and epipelagic in bays, seas, and the open ocean. They are distributed from surface to over 5000 m depths.

Cephalopods are soft-bodied animals with a cranium and mantle/fin support such as cuttlebone or gladius. An external shell occurs only in the primitive form Nautilus which is found restricted to the Indo-Pacific region. The mouth has chitinous beak-like jaws and a chitinous tongue-like radula. The eyes are well organized. Coloration with chromatophores and iridocytes, is variable depending on group and habitat. Locomotion is achieved by drawing water into the mantle cavity followed by its jet-like expulsion through the funnel and by crawling along the bottom on the arms. Fins on the mantle provide stability, steering, and secondary locomotion. Cephalopods except Nautilus are provided with ink-sacs in the body cavity which darts ink as a defence mechanism. The life expectancy of cephalopods is about one to two years in most forms, but larger species of squids and octopus, live for several years. Many species are known to die after spawning.

All cephalopods are dioecious and many of them exhibit external sexual dimorphism, either in structural or size differences. Females generally are larger than males. Males of many forms possess 1 or 2 modified arms called the hectocotylized arms which transfer the sperm packets from the male's mantle cavity to a locus of implantation on the female. Fertilization takes place in the female and the eggs are laid. The eggs are heavily yolked and development is direct, without metamorphic stages. At hatching, young animals often inhabit different habitats than the adults. Many species of oceanic cephalopods undergo diurnal vertical migrations, while shallow-living cephalopods are able to conceal themselves by chromatophore-produced colour patterns and chameleon-like colour changes, many deep-sea forms camouflage themselves by producing bioluminescent light from photophores. The role of cephalopods in the ecosystem seems to be that of subdominant predators. They are active predators on shrimps, crabs, fishes, other cephalopods and bivalved molluscs. In turn, cephalopods are major food items in the diets of toothed whales, seals, pelagic birds and both benthic and pelagic fishes.

The four groups of cephalopods such as squids, cuttlefishes, octopuses, and chambered nautiluses are easily distinguished by external characteristics. The squids have an elongate, torpedo-like body with posteriolateral fins. They have eight circumoral arms which are not connected at bases with a web. The arms usually have two rows of stalked suckers bearing chitinous rings running the entire length. Besides they possess two longer tentacles with two or more rows of suckers at the distal end.

The cuttlefishes have broad sac-like bodies with lateral fins. The members of family Sepiidae have narrow lateral fins that extend the length of the mantle. On the contrary, the individuals of family Sepiolidae have short, round and flap-like lateral fins. In either case, the posterior lobes of the lateral fins are free and are separated by the posterior end of the mantle. They have ten circumoral appendages with fourth pair being the longest. These tentacles can be retracted into pockets at the ventro-lateral sides of the head. The remaining arms have four rows of stalked suckers with chitinous rings without hooks. The eyes have eye lids and are covered with a transparent membrane. The shell of sepiid is thick, chalky and calcareous while the same of sepiolid is chitinous.

The octopuses have a short, sac-like body. They lack tentacles and have eight circumoral arms with bases connected by a membraneous web . The arms possess unstalked suckers, without chitinous rings, along the length of the arms.

The chambered nautiluses are characterized by an external, smooth, coiled, chambered shell. Males have sixty three circum oral appendages while females have as many as ninety four. The circum oral appendages are without suckers. They have simple eyes without lenses. Nautiluses are characterized by the absence of an ink sac.

Catches of cephalopods have been steadily increasing in most parts of the world. The world cephalopod landings during 1950 was a mere 0.58 million tonnes which rose to 3.77 million tonnes during 2004 (FAO,2004). The world catches of squids and cuttlefishes registered a phenomenal increase by 57% and 84% respectively during the seventies. However, a similar increase in the landings of octopuses could not be encountered during the same period. Cephalopod fisheries are unevenly distributed in the world's oceans. Cuttlefishes are taken mainly as a bycatch in trawl fisheries. The coastal squids are caught mainly with otter trawls, pair trawls, purse seines and by night-lightfishing methods. Oceanic squids are captured primarily by jigs and gillnets. Octopuses are taken by bottom trawls, pots, dragnets, hooks and spears. More than half of the total catch is taken in the northwest Pacific, the northeast and northwest Atlantic and the northeast Pacific, but a number of small scale fishing activities also exist in other areas.

Cephalopods comprising mainly squids and cuttlefishes form an important resource of world oceans and are of increasing economic importance. Of the 786 species of cephalopods in the world, large sized cuttlefish and squids belonging to families Sepiidae, Loliginidae and Ommastredphidae and a few octopods are commercially exploited presently (Hamabe *et al.*, 1976; FAO, 1976).

The world cephalopod production has grown from 1.55 million t in 1980 to 3.35 million t in 2001 (FAO/GLOBEFISH, 2003). In 2001, squids formed 67.01% of the landings, followed by cuttlefishes (15.93%), Octopi (9.48%) and other cephalopods (7.58%). India occupies ninenth rank in cephalopod production in the world with a production of 0.11 million tonnes. Japan is the leading cephalopod producing country with an average annual landing of 0.57 million tonnes (2001), followed by China (0.50 million t), Korean Rep. (0.41 million t), Argentina (0.23 million t), Thailand (0.17 million t), Morocco (0.14 million t) and Vietnam (0.13 million t). The other important contributors to cephalopod landings are USA, Mexico, Peru, Spain, Malaysia, Indonesia, Philippines, Russian Fed., Falkland Islands, New Zealand, Italy, France, Mauritania, Portugal and Uruguay (FAO/GLOBEFISH, 2003). The rapid increase in the landings of cephalopods was mainly due to increase in demand for this group in Japanese market and simultaneous increase in fishing effort to exploit this group all over the world using sophisticated methods, especially jigging for squids.

The fishing techniques for common squid in Japan has been greatly developed during the last 30 years through biological knowledge, the improvement of the fishing technologies including boats, engines, equipment; and particularly in jigging technology with light attraction, as well as better preservation of the catch for utilization and processing (Hamabe *et al.,* 1976). The Japanese common squid, *Todarodes pacificus* (Steenstrup) yields the largest catch of cephalopods in Japanese waters. Till the forties the *Todarodes pacificus* fishery had been only small-scale, exploited by non-powered boats of 1 to 2 GRT size and yielding less than 100,000 t per year. Powered boats of 10 to 30 GRT size, using more jigging lines and battery powered fishing lamps were introduced in the fifties for fishing in nearby waters. Later, in the sixties, 50-100 t boats equipped with motor-driven jigging machines, powerful lights run by generators, followed in the seventies by ocean going vessels of 100 to 300 GRT. Japanese squid jigging gear has been described by Yajima and Mitsugi (1976).

REVIEW OF LITERATURE

Earlier works on cephalopods of Indian waters are mainly confined to faunistic records and taxonomic studies. Silas (1968) has catalogued 201 species of cephalopods collected during the cruises of *R. V. Varuna.* The cephalopods collected by the research vessels which participated in the

International Indian Ocean Expeditions were reported by Filipova (1968). Several species of cephalopods were recorded by Oommen (1966, 1967, 1971, 1975, 1976) from the south west coast of India which included *Opisthoteuthis philippi,* is a new species from 275 – 365 m depths off Alleppey and three new species of octopodida viz. *Octopus varunae, Berrya keralensis* and *B.annae.* Sarvesan (1969) has listed 33 species of cephalopods from the Indian waters.

The occurrence of *S.trygonina* in Indian waters was reported by Sarvesan (1976) based on specimens of one male and one female collected from Gulf of Mannar off Tuticorin. The population structure and distribution of *Sepia pharaonis, S. aculeata, Sepiella inermis and Loligo duvauceli* of Visakhapatnam coast were described by Rayudu and Mohan (1982). The distribution of the cephalopods both in the coastal and oceanic waters of the Andaman-Nicobar Archipelago was reported by Sreenivasan and Sarvesan (1990). They described twenty-six species belonging to 22 genera and the most dominant species were found to be *Symplectoteuthis oualaniensis, Abralia andamanica, Onycoteuthis banksi, Sepia pharaonis, S. aculeata, S. prashadi, S. trigonina, Euprymna stenodactyla, Loligo duvauceli* and *Octopus sp.* A distinct pattern in the distribution of cephalopods according to the depth of the offshore areas off Gulf of Kutch was reported by Siraimeetan (1990). The cuttlefishes were mostly collected from the area 18 to 21^0N and squids were common in the area 22 to 23^0N. Nateewathana (1995) described two genera and 7 species of sepiids viz *Sepia brevimana, S.aculeata, S.pharaonis,* *S.recurvirostra, S.prashadi, S.arabica* and *Sepiella inermis* from the Indian Ocean. Among them, *S.prashadi* and *S. arabica* are new records from the Andaman Sea. Cephalopod resources in southeast and northeast coasts of India and Andaman-Nicobar waters were reported by Kripa *et al.* (1996). . The distribution and relative abundance of various neritic and oceanic group of cephalopods by area and depth are described by them. An account of the availability, species composition of octopuses along the southwest coast of India is given by Kripa *et al.* (2000). According to them, the major species of octopus in Kerala is *Octopus membranaceous* (Quoy and Gianard).

A new cuttlefish species *Sepia ramani.* collected from Tuticorin Bay is described by Neethiselvan (2001). Similarly, another new cuttlefish *Sepia prabahari.* collected from Tuticorin Bay is also described by Neethiselvan and Venkataramani (2002). Morphometric study on the squid, *Loligo duvauceli* from Mumbai waters was presented by Karnik and Chakraborty (2001).

Rao (1988) studied the length-weight relationship between males and females of *Loligo duvauceli* collected from Mangalore coast. The largest recorded male and female of this species recorded so far from Indian waters were 355 mm and 228 mm in length respectively. The length-weight relationship of *Sepia aculeata* collected from Mangalore was reported by Rao (1997), who observed significant difference in length-weight relationship between immature and mature male and female.

Food and feeding habit of the squid *L.duvauceli* obtained in trawl nets operated during the night were studied by Oommen (1976) and reported a carnivorous habit and cannibalistic behaviour in this species. Similarly, the food and feeding habits, morphology and histology of the gut as well as the physiology of digestion of *Loligo duvauceli*, *Sepia aculeata* and *Sepiella inermis* from west coast of India were also described by Oommen, (1977).

Sexual maturity, spawning seasons, sex ratio and fecundity of *Loligo duvauceli* of Mangalore coast were studied by Rao (1988). Morphometric measurements carried out in *Loligo duvauceli* indicated the degree of reproductive maturation along with the size at first maturity (Rahim and Chandran, 1988). They also reported the differentiation of the hectocotylised arm as an indicator of sexual maturity in *L .duvauceli*. Functional morphology and histology of the testis of the same species was reported by Rahim and Chandran (1984a, b). They also have reported the formation of spermatophore in *L. duvauceli* (Rahim and Chandran, 1994). Mohamed (1993) reported a non-semelparous reproduction in *L .duvauceli* as evidenced from low gonadosomatic index and tangible growth after reaching sexual maturity. According to him, two successive spawning congregations occurred along the southern Karnataka Coast during 1990 and 1991 which took place during the postmonsoon months (Sep-Oct). Spawning, sex ratio and fecundity of *Sepia aculeata* from Mangalore coast was reported by Rao

(1977). This study revealed that the major spawning season of this species is October to March. It attains first maturity at a dorsal mantle length of 86 mm and the fecundity ranges from 206 to 1,568 ova. Breeding biology of the spineless cuttlefish *Sepiella inermis* collected from Tuticorin waters was reported by Neethiselvan *et.al* (2002). This species is a prolonged breeder as mature and spent specimens were recorded almost round the year. However, two peak spawning periods, one in November and another in March were observed.

Population dynamics of the squid *Loligo duvauceli* in Saurashtra waters based on catch, effort and length frequency data collected from trawl net operations at Veraval, from 1979 to 1983 was reported by Kasim (1985). Menon (1988) studied the population dynamics of *Sepia aculeata* , along the Bombay coast. Similarly, the population dynamics and stock assessment of the cuttle fish, *Sepia pharaonis* (Ehrenberg) in Wadge Bank was studied by Philip and Ali (1989). They reported that a total biomass of 2060 tonnes from Wadge Bank and 74% of this biomass is supported by 20-50 m depth zone in the area. Stock assessment of *Loligo duvauceli* in Bombay waters was attempted by Vidyasagar and Deshmukh (1992). They reported further scope for the exploitation of *L. duvauceli* by the trawlers in Bombay waters. Rao *et al.* (1993) worked out the stock of the needle cuttlefish *Sepia aculeata* of both the coasts of India and opined that the present catches are optimal on the east coast but on the west coast there is considerable scope for increasing production. Similarly, stock assessment of the pharaoh cuttlefish *Sepia pharaonis* was attempted by Nair *et al.* (1993) and suggested that west coast has scope for increase in production. Stock assessment of the Indian squid *Loligo duvauceli* based on the data collected at different centres on both the coasts of India worked by Meiyappan *et al.* (1993) and reported that the present level of exploitation was at the optimum level on both the coasts. Population dynamics of the cuttlefish *Sepia elliptica* in Saurashtra waters was studied by Kasim (1993). Estimates of growth, mortality and stock of the Indian squid *Loligo duvauceli*, exploited off Mangalore was reported by Mohamed (1996). According to him, the maximum sustainable yield (MSY) of this species along Mangalore coast is 877.3 tons which could be achieved only by a 35% decrease in fishing effort. Similarly, the seasonal growth, stock-recruitment relationship and predictive yield of the same species exploited off Karnataka coast were studied by Mohamed and Rao (1997), which revealed that this species reaches a length of 181 mm at the end of first year. Stock assessment of *Loligo duvauceli, Doryteuthis sibogae, Sepioteuthis lessoniana, Sepia pharaonis, S. aculeata* and *Sepiella inermis* from Tuticorin coast was attempted by Neethiselvan *et al.* (2002). They reported overexploitation of four species viz. *Loligo duvauceli, Doryteuthis sibogae Sepioteuthis lessoniana* and *Sepiella inermis* off Thoothukkudi waters. The study recommended a reduction of 10% effort from the present level to sustain the stock of squids and cuttlefishes of this area. Growth and mortality of

Indian squid, *Loligo duvauceli* from Mumbai waters were studied by Karnik *et al.* (2003). They opined that a reduction in fishing effort is required to maximize the yield per recruit of *Loligo duvauceli* from Mumbai waters.

Details of catching methods of *Sepiteuthis*, *Loligo*, *Sepia* and *Sepiella* species are described by Sarvesan (1974). The cephalopod fishery of the Indian Ocean with respect to the Visakhapatnam coast was described by Rayudu and Mohan (1982). Of the 9 species of squid and cuttlefish encountered in trawl catches off the coast, *Sepia pharaonis*, *S. aculeata*, *Sepiella inermis* and *Loligo duvauceli* contribute 90% of the total catch. A brief account of the fishery aspects of squids off Mangalore coast is reported by Rao(1988). Sreenivasan and Sarvesan (1990) reported a wide distribution of the cephalopods both in the coastal and oceanic waters of the Andaman-Nicobar Archipelago and suggested adoption of suitable techniques such as light fishing with lift net. Area wise and depth wise cephalopod catches of the chartered fishing vessel off Gulf of Kutch was reported by Siraimeetan (1990). Catch statistics and status of exploitation of squids and cuttlefish in India was reviewed by Nair *et al.* (1992). According to them, *Loligo duvauceli* is the single species that constitutes the squid fishery on the west coast while *Sepia pharaonis* and *S. aculeata* mainly form the cuttlefish fishery. On the west coast of India, the post-monsoon season (September-February) is the best period for cephalopod landings accounting for an average of 63% of the annual production. According to Kripa *et al.* (2000) the total landing of octopus during 1994 was 630 tonnes.. Details of fishery of cuttlefish and squid resources off Tuticorin coast are well described by (Neethiselvan *et al*, 2002a). Cuttlefishes are also reported to contribute substantially to the cephalopod fishery of Tuticorin (Neethiselvan et al., 2002b).

In India, about 2,80,491 fishing crafts of various sizes and classes are under operation, consisting of 53,684 mechanized boats, 44,578 motorized crafts, 181,284 non-mechanised crafts. About 50 deep sea fishing vessels of more than 20 m LOA are operating along east coast, based at Visakhapatnam, particularly targeting shrimp resources in the north-east coast.

Both traditional and mechanized fishing crafts of medium and large size are operated in the country for exploitation of cephalopods. Fishing gears like hooks and line , jigging , surrounding nets, seines and traps are operated from traditional and small mechanized crafts, and bottom and pelagic trawls from medium and larger trawlers. Hand jigging methods adopted at Vizhinjam south west coast for cuttle fish is described by Nair (1986) with a brief description of the modern squid jigging method. An account of the experimental trawling and light fishing conducted at Vizhinjam is given by Nair and Omana (1986). The results of exploratory squid jigging with automatic squid jigging machines conducted from the vessel Matsya Sugandhi of Fishery Survey of India are discussed by Nair *et al* (1992). They have described the arrangements of jigging machines on the deck, the specifications of the jigging gear, lights and fishing operations. High opening trawl, high speed demersal trawl, bobbin trawl and hybrid trawl developed for deep sea operations are found very effective for exploitation of cephalopods and they are described by Panicker (1990), Kunjipalu *et al* (1994), and Kunjipalu (2003). About 85% of the cephalopods landed in India are caught as by-catch of trawl nets operated upto 100m depth (Meiyappan and Mohammed, 2003) The introduction of high opening bottom trawls resulted in rapid increase in cephalopod production. The semi pelagic trawl system developed by Central Institute of fisheries Technology has shown better catch rate for squids (CIFT,2006)

The distribution and abundance of squid and cuttle fishes along the east and west coast of India based on the exploratory surveys conducted by the Government of India Vessels are given by various authors.(Joseph *et al* 1976, Joseph *et al* 1987, Oommen 1980,1985; Sudarsan *et al* 1987 , 1988 ; Philip and Somvanshi 1991; Sulochanan and John 1982). The potential yield of squid and cuttle fishes were estimated by (Joseph 1985, Sudarsan *et al* 1990, Philip and Ali 1989) based on the catch rates obtained during the surveys. Potential yield of one lakh eighty thousand tonnes of cephalopods from the Indian continental shelf was estimated by George *et al* (1977), Gullan (1970) and Voss (1973) estimated the cephalopod resources of Indian Ocean as several hundred thousand tones. All these estimates indicate the scope for increasing the fishing effort for enhancing the production.

The prospects of developing cepholopods into products for internal and foreign markets have been discussed by Padmanabhan (1970) along with methods of processing and storage. The changes in nitrogen, proteins, non-protein nitrogen and total free amino acids of *Sepia aculeata* preserved in ice were studied by Sastry and Srikar (1982). The method for processing dried squid according to the quality requirements of the Japanese market is given by Shenoy (1985) . The mantle is the main edible portion of cephalopods, which are comparable in composition with low fat fish, and white meat of fish. Water, lipids and ash form the basic constituents in the proximate analysis (Love, 1970). Various biochemical properties of squid and cuttle fishes were studied by Lakhmanan and Balachandran (2000) and Lakshmanan *et al.* (1993) dealt with the quality of commercially frozen cephalopods products from India. Several studies have been reported on the storage characteristics of iced and frozen squid and cuttle fish. (Joseph *et al* 1977; Dananjaya *et al* 1987; Joseph and Perigreen 1988). Nazeem Beevi (2002) has found that temperature abused contaminated fish could act as a potent vehicle of food borne infections.

No specific literature is available on the export and marketing of Indian cephalopods except the periodic publications containing export statistics and reviews published by the Marine Products Export Development Authority Ministry of Commerce, Govt. of India and other International bodies.

OBJECTIVES OF THE STUDY

Though some information is available on the taxonomic, faunistic features and biological aspects of some of the commercially important species of Indian waters, very little is known about the handling and processing of cephalopods followed by the processing industry, trends in export and domestic markets and various factors influencing the cephalopod export. As such the present study is proposed with the following main objectives:

To get a clear picture of the cephalopod landing in India at different centers, the species composition, commercially important species and their share in the landings.

To assess the status of various mechanized and non-mechanized fishing crafts employed in the country for the exploitation of the squids cuttle fishes and octopuses and the fishing gears especially those developed targeting the cephalopods and to suggest suitable gears for the harvest.

To study various biological aspects like growth, mortality, maturation and spawning, food and feeding habit and stock of commercially important squid and cuttle fish of the south west coast and their influence on the fishery.

To evaluate various handling and processing techniques for cephalopods being followed by the fish processing industry and to suggest suitable methods to improve the quality of products and product diversification.

To study the present status of export of cephalopods from India, the shares of the top countries importing cephalopod products, the price offered by different countries, the total foreign exchange earnings and to formulate suitable ways to increase the export by expanding the international markets and diversifying the products.

Plan of study

In the present study two aspects of cephalopod fishery such as (i) landings and (ii) utilization including export of cephalopods from Indian are dealt with. Under the topic landings, craft, both traditional and mechanized and fishing techniques employed for capturing cephalopods are discussed. General trend in cephalopod landing in India and particularly south west coast, species composition, description and geographic distribution of important species of cuttle fishes, squids and octopus and the distribution and abundance of cephalopods along the continental shelf of the south west coast are also discussed. Some biological aspects like population parameters, maturation and spawning, food and feeding of the two representive species of cuttle fishes and squid viz, *Sepia pharaonis* and *Loligo duvauceli* are studied.

Under utilization, general handling and processing of various frozen cephalopods products for exports and commercial operation in a typical plant are studied. The export of cephalopod products since its commencement is studied in detail and market strategy for enhancing the export are suggested.

CHAPTER-1

CEPHALOPOD FISHERY-DESCRIPTION OF MAJOR SPECIES AND DISTRIBUTION ALONG THE SOUTH WEST COAST

CEPHALOPOD LANDING IN INDIA

The total cephalopod production in India has increased from 12300 tonnes in 1980 to 1,14,700 tonnes in 2001(FAO/GLOBEFIS, 2003). (Fig.1.1) About 80 species are recorded from Indian waters of which about a dozen are of commercial significance. Commercially important species are *L. duvauceli* (Indian squid), *Loligo uyii* (little squid), *Doryteuthis sibogae* (siboga squid), *D. singhalensis* (needle squid), *Loliolus investigatoris, Sepioteuthis lessoniana* (palk-bay squid), *Sepia pharaonis* (pharaoh cuttlefish), *S. aculeata* (needle cuttlefish), *S. elliptica* (golden cuttlefish), S. *prashadi* (hooded cuttlefish), S. *brevimana* (shotclub cuttlefish), *Sepiella inermis* (spineless cuttlefish), *Octopus dollfusi* (marbled octopus), *O. membranaceous* (webfoot octopus), *O. lobensis* (lobed octopus), *O. vulgaris* (common octopus) and *Cistopus indicus* (old woman octopus).

Region wise, 46.3% of the landings were contributed by north-west coast, followed by 41.0% by southwest coast, 12.1% by southeast and 0.6% by northeast coast (Srinath *et al.* 2003). Cuttlefishes account for about 51% of cephalopod landings along Indian coast, followed by squid (48%). Octopus landings are meagre but are showing an upward trend. Along the northwest coast, *Loligo duvauceli* contributes the entire squid

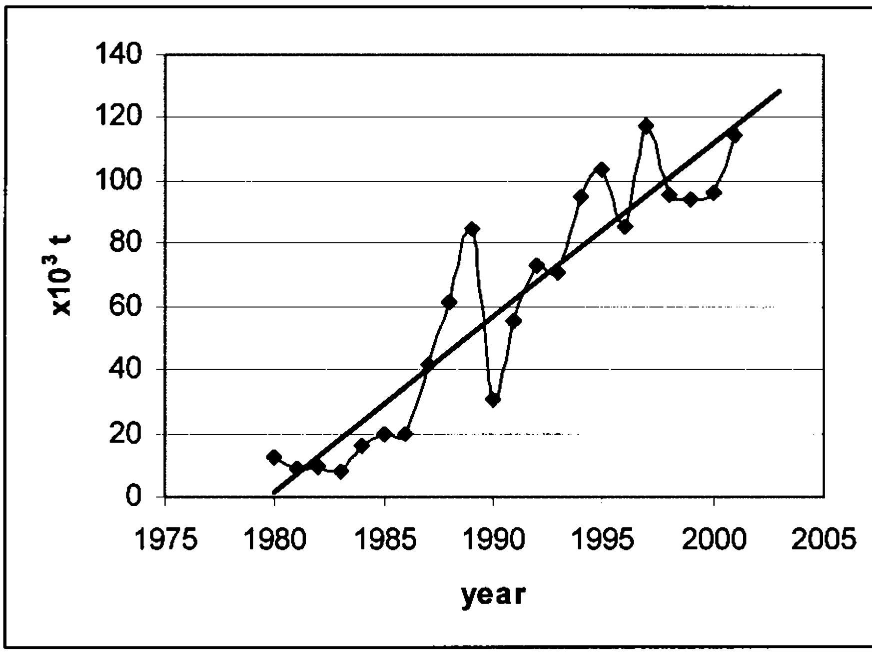


Fig. 1.1 Trend in cephalopod production in India

landings while *Doryteuthis sibogae* dominates in the southwest region. Cuttlefish landing of west coast is composed of *Sepia pharaonis* (27%), *S. aculeata* (16%), *S. elliptica* (2%) and *Sepiella inermis* (2%). Squid landings off east coast was constituted by *Loligo duvauceli* (24%), *Doryteuthis sibogae* (11%), *L. uyii* (2%) and *Sepeoteuhis lessoniana* (7%). The oceanic squids *Symplectoteuthis oualaniensis* and *Omastrephes bartrami* occur in this region. Due to the extension of fishing operations to the deeper water for shrimps in recent years along the south west coast certain unconventional species were landed by the trawlers (CMFRI, 2000) The diamond squid *Thysanoteuthis rhombus* was landed from 400-500m depth off Alleppey by the trawls operated from Munambam. The rare *Chiroteuthis* sp. was also caught by these trawlers.

Cuttle fish catch of east coast was contrituted by *S.pharoanis (*30%), *S. aculeata* (17%) and *S. inermis* (5%). Octopus recources are the least exploited in our country till recent years. It supports a subsistence fishery in Andaman and Nicobar and Lakshadeep islands. Attention is being paid on this recources owing to the high demand for octopus products in export market. Octopus spp. formed about 1% along the west coast and 21% of the cephalopod landings at Rameswaram Octopus catch of south west coast were composed of *Octopus dolfusi* and *Cistopus indicus* and off Cochin by *Cistopus indicus, Octopus dolfusi, Octopus membranaceus, O. lobensis* and *O. vulgaris*. No marked change in species composition were observed over the years (Meiyappan and Mohammed, 2003).

Among the various maritime states, Kerala has been ranking first in cephalopod production having an average production of 33242 m.t. during 1991- 2000 . The highest production of 37058 m.t. was reported during 1997. Cephalopods formed an average of 11.11% of the total marine landings of Kerala.Similarly Kerala state has contributed 36.73% of the total cephalopod production of India during 1991-2000. Gujarat and Maharashtra stand next to Kerala.The average landings were 22751 m. t. and 13568m.t. for Gujarat and Maharashtra respectively.These three states and viz Kerala, Gujarat and

Maharashtra together land 76.87% of the total cephalopod landing of India during 1991- 2000.

Potential yield of cephalopods has been estimated at 101,000 t.which is the same as the landings obtained during 2001(Srinath and Balan, 2003). Cephalopod form about 4 % of the total marine landings in India and contribute about 10% of the value of exported marine products exports (Meiyappan and Mohammed, 2003).

Description of commercially important species of cephalopods landed along the southwest coast of India and than geographical distribution are given below

Sepia pharaonis Ehrenberg, 1831

Synonyms: *Sepia torosa* Ortmann, 1888; *Sepia rouxii* d'Orbigny, 1839–1842; *Sepia formosana*Berry, 1912; *Crumenasepia hulliana* Iredale, 1926;

Common name – Pharaoh cuttlefish;

Diagnostic Features: Mantle is broad, wide and as long as mantle . Body is ovoid in shape and broadest at the middle. Tentacular club moderately long; protective membrane not meeting at the base. Eight suckers in traverse rows with five or six medium ones, the 3rd and 4th quite enlarged. The tentacles are moderate in length and not longer than the body, The stem is thick and triangular in cross section. The tentacular clubs are broad and about one fourth in dorsal mantle length. The oral arms are long with well developed keels and tapering ends. The suckers in all the arms are arranged in four traverse series. In male left arm IV is hectocotylised , basal 12 quadriserial rows normal, the next 10 rows with ventral suckers normal but the dorsal rows minute and separated from the ventral rows by a fleshy transversaly grooved ridge. The females are more robust than males. The mantle is comparatively narower in males. The bone is oval in shape, broad and elongated, the surface has three longitudinal ribs; yellowish brown in clolour on the dorsal side of the cuttle bone. The spine is short, stout and without keels. On the dorsal mantle and head vivid transverse tiger strips are seen, especially in males.

Distribution: Distributed along the Indo-Pacific, Red sea, Arabian sea, south and east China sea, northern and north-western Australia.

***Sepia prashadi* Winckworth, 1936**

Common name: Hooded cuttlefish

Diagnostic Features: Male and female arms subequal in length; protective membranes narrow. Arm suckers tetraserial.. Hectocotylus present on left ventral arm: 4 rows of normal size suckers proximally, 12 to 14 rows of reduced suckers medially, suckers of hectocotylus in 2 ventral series are displaced laterally, with gap between on proximal part of modified region, becoming closer together distally. Tentacular club short, oval; sucker-bearing surface flattened, with 3 to 5 suckers in transverse rows; suckers differ markedly in size: median 4 suckers extremely large, surrounded by moderately large suckers. Cuttlebone outline oblong; bone triangular, obtuse anteriorly; bluntly rounded posteriorly;. Chitin borders lateral and anterior margins of cuttlebone. Spine long, pointed, straight, directed dorsally, with dorsal and ventral keel. Dorsal mantle has transverse zebra stripe pattern in breeding males. Fins shorter than mantle.

Distribution: Western Indian ocean, Gulf of Eden, Eastern west coast of India and Srilanka.

Sepia aculeata **Orbigny, 1848**

Synonyms: *Sepia indica* d'Orbigny, 1848.

Common name – Needle cuttlefish

Diagnostic Features: Mantle broadly ovate, fins moderately broad extends the entire length of the mantle; head is large. Tentacular club long, with 10-12 minute sub equal suckers in each row across the club in the males, 13-14 suckers across in females; club protective membrane not united, extending proximately along oral face of the stalk as low ridges, the club suckers are minute, sub equal in size. There are 10-12 longitudinal series of suckers in males, the females posses 13-14 series of suckers; The oral arms are short, sub equal in length. The dorsal arms are rounded on the outer sides, the lateral arms are keeled and the ventral ones broad at the base with strong swimming membranes. The arm suckers are uniformly arranged in four rows and bordered by protective membrane on either side. Left arm IV is hectocotylized in males, there are about 12 rows of normal suckers proximally followed by 5 or 6 rows of very small suckers on the ventral longitudinal row. The cuttle bone is oval and elongated. There are three longitudinal ribs on the granular rough dorsal surface,the chitinous margin is very narrow. Anterior part of the ventral side is convex and striated and posterior part is concave. Spine is small and strong without keel . Dorsal side of the mantle is dark pigmented with gray or brown shades. Colour pattern is traverse and reticulate, there is a pale reflective line along the bases of fin.

Distribution: Distributed in the Indo – Pacific, southern India to south - China sea, East China and Japan. Occurs in the neritic region.

***Sepia brevimana* Steenstrup, 1875**

Synonyms: *Sepia rostrata* (in part) Férussac and d'Orbigny, 1848.

Common name – Shortclub cuttlefish

Diagnostic Features: Mantle is broadly ovate, dorsal margin acuminates its posterior end pointed due to the long spine. The narrow fins originate a little posterior to the mantle margin, the fin do not unite at the end. The acuminate contour of the posterior end of the mantle is distinctly sen on the ventral side. The eyes are prominent. The buccal membrane is seven lappetted. The short oral arms are subequal and measures half the length of the mantle. Their small arm suckers are quadric serial and small in size. The tentacular clubs are short with well developed swimming keel extending proximally beyond base Flat and elongate ovoid cuttle bone is rough on the dorsal side due to presence of numerous small tubercles forming three longitudinal ridges. The concave ventral side of the cuttle bone has a deep median groove on the striated zone. The long, thin spine is slightly keeled.

Male and female differ in shape of cuttle bones. Generally dark coloured on the dorsal side and the ventral side, arm and sides whitish in colour.

Distribution: Distributed in the INDO- Malaysian region, along the northern cost of the Indian Ocean, west and east coast of India, in shallow coastal waters upto 30 m depth.

Sepiella inermis Van Hasselt, 1835

Synonyms: *Sepia (Sepiella) microcheirus* Gray, 1849; *Sepia affinis* Eydoux and Souleyet, 1852; *Sepiella maindroni* de Rochebrune, 1884

Common name : Spineless cuttlefish

Diagnostic Features: The mantle is broad and oval in shape. The dorsal margin is rounded and mid dorsal projection is not prominent . The ventral margin of the mantle is emarginated. A pigmented gland and a pore present at the posterior tip of the mantle ventrally, the tunnel is short and thick. The fin is broader posteriorly and narrower anteriorly and starts slightly behind the anterior margin of the mantle. The head is short and broad. Stout and laterally compressed arms , tapering to slender tips. Minute arm suckers are arranged quadriserially. The larger basal suckers are reduced progressively in size towards the distal end. Protective membranes of all arms are well developed . The suckers are provided with smooth-rings in females while in males strong dentate rings present. The left ventral arm is hectocotylized in males. There are ten rows of minute suckers in the proximal half of the arm. The distal half is narrow with quadriserially arranged normal suckers. Very long and slender tentacles have longer clubs having 16-24 equal sized minute suckers in traverse rows, swimming keel is shorter than club. Cuttle bone is oval and spineless. The dorsal surface of the bone is granulose with low mid-rib, the ventral surface is striated with distinct median groove.

Distribution: Indo-Pacific, Indian Ocean, southern Red sea, south of Aden to Andaman sea and southern China sea. Occuring upto the 40 m depth.

Sepia elliptica Hoyle, 1885

Common names – Ovalbone cuttlefish

Diagnostic Features: Mantle is broadly ovoid, not very much tapering at the posterior end. The mid-dorsal projection over the head is sharp and prominent. The head is short and broad with prominent eye lobes. The tentacles are short with clubs of moderate size. Clubs bear 12 travorse rows of minute sub equal suckers of uniform size, protective membranes, narrow, separate at the base extending along stalk as very low membranes ridges. Six or seven elongate, membranous, fleshy papillae along base of each fin.. The oral arms are short and stout. They are sub equal in length, about half in mantle length. Moderatley sized suckers are arranged in four uniform series in all the arms; sizes reduced towards the distal end. No teeth are provided on the horny rims of the suckers. Left arm IV is hectocotylized in males with five or six traverse rows of small sized suckers distal to the first five traverse rows of suckers. Cuttle bone is broad, thick and elliptical. The anterior part is acuminate and the posterior part is wide. Spine is thick, sharp and curved dorsally. Dorsal surface of the bone is smooth with three visible longitudinal ridges. The ventral surface two lateral ridges and three longitudinal furrows in the striated area. Pale grayish colour with traverse stripes on the dorsal side of the mantle, there is a white line along base of fins.

Distribution: Found in western Pacific, south and east Chinese sea, west and east coast of India.

Loligo duvauceli Orbigny, 1848

Synonymy : *Loligo oshimai* Sasaki, 1929; *Loligo indica* Pfeffer, 1884.

Common name: Indian squid

Diagnostic Features : Mantle is elongate and cylindrical, tubular with parllel sides upto the point where fins originate . The mid-dorsal projection of the anterior margin of the mantle is rounded. Fins are rhombic, broad, short and just over 50% of the mantle length. The middle point of the fin is the broadest and the anterior margin is nearly convex or straight. The oral arms are moderately long, laterally compressed and keeled along the length. The third pair of the arm is the broadest. Arm suckers of the females are of about equal size, on arms II and III rings smooth proximally, toothed with about seven broad, blunt teeth distally, the central one pointed. In males suckers of arm II and III are greatly enlarged with nine to eleven broad, truncate teeth in the distal two third of the tring, proximal one third is smooth, without dentition. The left arm IV is hectacotylized in males. The suckers are prominent in the modified portion. The papillae of the ventral row are larger than the dorsal row

, The distal papillae are devoid of suckers. Tentacles are long with expanded clubs. Large manus suckers have 14-17 short and sharp teeth on the ring. On each side of the rectum and ink sac an oval potophorc is provided. Numerous light brown chromatopheres are scattered all over the mantle, fins, head and arm. Chromatopheres are dense on the ventral side.

Distribution: Indo-Pacific, Indian ocean including Red Sea and Arabian sea, south Chinese sea and Philippines.

Loligo (Doryteuthis) sibogae, Adam 1954

Synonymy: Dorythethis sibogae, Adam 1954

Diagnostic features: Mantle very long and slender having the width nearly 1/5 of the length, mid-dorsal projection of the mantle is pointed interiorly whereas the ventral margin is emarginated . The fins are narrow and short having the length of about 45% of the mantle length. Head is small, longer than wide and eyes are large. The anterior free portion of the funnel reaching upto anterior margin of the eyes, deep funnel furrow. Arms are relatively very short. Arms are keeled and compressed. Suckers are arranged in two rows on all areas and bordered by protective membranes. Sucker rings are smooth proximally, there are seven to nine plate like, squared or truncate teeth distally.

Left arm IV is hectocotylized in males for 30 to 45% of its length by distal suckers. The stalks are modified into cone shaped fleshy papillae , those on the ventral row are the largest. Conical pedicels arranged in two rows along the margins of the arm. Arm gradually reduces in size anteriorly and very minute at the tip. Tentacles are short and slender. Clubs are short and slightly expanded with developed swimming membrane. Medial suckers on the manus are slightly enlarged and the lateral rows are small in size. The largest suckers bear 15-20 conical, sharp, incurved teeth around entire chitinous ring. Larger males have about 31-35 teeth on the club sucker rings; largest suckers from the club and arm III are about equal in size.

There are five ribs on the gladius, one median and two lateral, extending the whole length of the gladius. Females have wider gladius than males. A paired, bean shaped light organ is present around the ink sac. Mantle is whitish with dark brown chromatophores on the dorsal side. Chromatophores at the ventral side is centred in the middle are of the mantle.

Distribution: Western Pacific, Eastern Indonesia and China (Pescadores Islands).

Loligo (Doryteuthis) singhalensis Ortmann, 1891

Common name : Long barrel squid

Diagnostic Features : Mantle very long and slender, attains a large size for loliginids. Fins very long, up to 70% of mantle length; a ridge along ventral midline of mantle of males. Tentacles are moderate in length, stalks are stout and laterally compressed. Clubs short, slightly expanded; suckers in medial rows of manus only about 25% larger than those on lateral rows with 20 to 22 sharply pointed, curved teeth, some of which are quite reduced in size. Head is large , eyes are prominent , funnel is large and provided with prominent funnel valve. Arms relatively short; sucker rings with 7 to 9 long, slender bluntly pointed to truncate teeth distally, smooth proximally. Left arm IV hectocotylized in distal half with slender papillae, each bearing a minute sucker. A paired, bean-shaped light organ present around ink sac. Colour is darkish due to the presence of chromatophores, the ventral side less pigmented.

Distribution: Indo-Pacific; Eastern Arabian sea, Bay of Bengal, south China sea.

Sepioteuthis lessoniana Lesson, 1830

Synonymy : Sepioteuthis guinensis Quoy & Gaimard; 1832 Sepioteuthis lunulata Quoy & Gaimard, 1832; Sepioteuthis mauritania Quoy & Gaimard, 1832

Common name : Bigfin reef squid

Diagnostic Features : Mantle long, robust, its width about 40% of length. Fins very large, their length over 90% up to nearly 100% of mantle length, their width up to 75% of mantle length; tne grearest width occurs posterior to the midpoint of the fins. Tentacular clubs long, expanded; median manal suckers enlarged; rings with 14 to 23 sharp teeth. Arm sucker rings with 18 to 29 sharp, triangular teeth; tentacles long, robust; left arm IV hectocotylized along distal 1/3 to 1/4 of arm.

Distribution:Indo-Pacific, Read sea, Arabian sea, northern Australia, central Japan and Hawaii islands.

***Octopus dollfusi* Robson, 1928**

Diagnostic features: Elongated oval mantle, small head, well developed eyes but not conspicuous, no cirri over the eyes, long arms with subequal and stout basal portion. The first pair of arms are short with narrow inter- branchial membrane. Inter menbrane is well developed between all other arms. Cap like arm suckers are fleshy without chitinous rings, oral suckers are large at the base and become minute at the tip . in males the third right arm is hectocotylized and shorter than third arm. In ventral margin of the web is rolled into the form of a deep grove which series as the spermatophore groove. The male reproductive system consists of an elongate and slender penis and a large coiled diverticulum; moderate in size with a grayish brown in colour.

Distribution: Indo-China , Honkong and Indian Ocean.

Octopus membranaceus Quoy and Gaimard, 1832

Synonomy: Octopus tang siao Orbigny 1840

Mantle saccular to elongate, oval in shape and sculptured with small close-set tubercles or fine papillae. Tubercles present on the head and arms. Eyes are prominent and have two cirri or warts over each eye near the base. Arms are moderately long and stout. The web between the arms is very shallow. At the base of the second pair of arm there is a conspicuous dark ringed ocellus on the web. A groove on the arm, 7 or 8 filaments in outer demibranch of gill.

Distribution: Indo-Pacific, Indian ocean , China, Phillipines and Australia

Cistopus indicus Orbigny, 1840

Synonymy : *Octopus indicus* Orbigny, 1840;*Cistopus bursarius* (Steenstrup MS) Hoyle, 1886.

Common name: Old woman octopus

Diagnostic Features : Mantle elongate; neck constricted; head narrow. Arms long, slender, attenuate tips; dorsal arms (I) always longest and stoutest, IV shortest; dorsum covered with fine, low, widely-spaced warts; a small pouch occurs on each segment of the web between the bases of the arms; these 8 water pouches communicate with the sea water through small pores that open on the oral surface of the web; right arm III hectocotylized with a very small ligula (3% of arm length) that appears smooth and poorly developed; 10 or 11 lamellae on demibranch of gill.

Distribution:Indo- Pacific; Indo-Malayan Region, the Philippines, China , Bangladesh , India and Pakistan.

Distribution and abundance of Cephalopods along the South-West coast of India.

The survey data collected by the survey vessels of *M.F.V. Matsya Varshini* (36.5 MODL and 1160 HP) and *M.F.V. Lavanika* (24 MDAL and 500 HP) belonging to the Fishery Survey of India is used for this study. Matsya Varshini operated Expo-model fish trawl and Lavanika, 700 mesh fish trawl. The data for the period 1999 – 2003 of Matsya Varshini and 2001 –

2003 of Lavanika is used. Catch per unit effort obtained for cephalopod is taken as the index of abundance. In order to assess the seasonal availability, the data for the whole period is pooled and presented mnth-wise. Similarly the area-wise and depth-wise studies were also made by demarcating the area into 1^0 latitude and 30 – 50, 51 – 100 and 101 – 200m zones. As the gear used by these two vessels were different, the results are presented separately. Cuttle fish and squids are dealt together as there is no separate data for them.

The highest average catch per hour (44.2) was recorded during October from the 30–50m depth zone of the lat. 8^0N (Wadge Bank). In the case of 50-100m depth zone the highest catch rate was recorded in the month of July. Cephalopods were observed only during September, October and December in 101 – 200m depth zone and a comparatively high catch rate of 33.0kg/hr. was registered during October. As more fishing effort was in the areas 30 – 50 and 51 – 100m depth zones fairly good catch rates were registered in all the months with peak in October and July. In general, the period June, July and August was very good for cephalopod fishing.

In the lat. 9^0 N (the areas of Quilon and south of Cochin) the highest catch rate was observed from he 30 – 50m depth zone in the month of July. (Table 1.1). The months of October and November also registered comparatively high catch rates from the depth zone. Highest catch rates of 12.6 kg/ hr. and 12.0 kg/hr. were observed during the months of February and April. However, the period July to November yielded better catch rates from the depth zone. Cephalopods were caught only in three months viz. February, October and December and highest catch rate of 14.0 kg/hr. was noticed in December. Lack of adequate sampling in all the months may be one of the reasons for nil catch from this depth zone. Catch rates were comparatively poor in areas north of Cochin.

Cephalopods were not reported from this area in all the months from the shallow waters. Comparatively very low catch rates were recorded in the first half of the year except the month of March, which registered 10.0kg.hr. The months of October and December also recorded good catch rates from the 30 – 50m depth zone of Cochin. Cephalopods were present in the catches from the 50 – 100m depth zones only during the month of June – July and November - December with the highest catch rates in July and December. There were no fishing in areas beyond 100m depth in the areas off Cochin during the period under study by the vessel Matsya Varshini.

The catch rates obtained by the vessel Lavanika from areas off Cochin and north of Cochin are presented in Table 1.2. As the data available in respect of this vessel is only for a limited period, a very clear picture on the distribution of cephalopods is not available. However, as in the case of Matsya Varshini cephalopods were caught more from the shallow waters as compared to the other depth zones. The absence of cephalopods during certain months may be due to the lack of adequate sampling during these months. The highest catch rates were recorded during February and November form the shallow waters of southern part of cochin. However, the shallow waters of north of Cochin yielded comparatively gool catch rates by this vessel during July, June and November. Very limited fishing was carried out by this vessel in the Lat. 11^0N (off Calicut). Cephalopods were observed in two months, January and April from the area.

Table 1.1. Month wise catch rates (catch /hr) obtained from different latitudes and depth ranges by Matsya Varshini.

Month		Wadge Bank			Quilon Bank/South of Kochi			North of Kochi		
	Latitude	8^0 N	8^0 N	8^0 N	9^0 N	9^0 N	9^0 N	10^0 N	10^0 N	10^0 N
	Depth	30-50	50-100	100-200	30-50	50-100	100-200	30-50	50-100	100-200
January		0.7	0.6	-	2.2	7.4	-	0.9	-	-
February		1.9	17	-	5.3	12.6	3.5	-	-	-
March		1.2	4.8	-	3.3	1.3	-	10.0	-	-
April		1.2	1.3	-	2.0	12.0	-	1.5	-	-
May		4.5	7.8	-	1.1	5	-	-	-	-
June		20	13.5	-	7.3	6.6	-	0.3	4	-
July		21	23.4	-	16.9	10.8	-	7.3	6.3	-
August		29	12.8	-	2.4	7.0	-	-	-	
September		6.8	6.6	6.5	3.1	10.0	-	0.8	-	-
October		44.2	14.3	33.0	6.7	6.8	3.0	8.7	-	-
November		7.0	2.0	-	8.1	10.2	-	3.6	2	-
December		18	5.5	10.0	4.5	1.9	14.0	8.5	7.5	-

Some fishing effort was expended by this vessel in the 50 – 100m depth zones of Cochin. The highest catch rate of 18.4 kg/hr. was recorded from north of Cochin in the month of July whereas the month of June recorded the highest catch rate of 6.9 kg/hr from the same depth zone of southern part of Cochin. The period June – July and November showed good catch rates from this region.

Table 1.2 Month wise catch rates obtained from different latitudes and depth ranges by Lavanika.

Month		**Wadge Bank**	**Quilon Bank/ South of Kochi**		**North of Kochi**		
	Latitude	8^0 N	9^0 N	9^0 N	10^0 N	10^0 N	11^0 N
	Depth	50-100	30-50	50-100	30-50	50-100	30-50
January		-	-	-	-	-	3.3
February		-	4.5		-	-	-
March		-	2.4		-	-	-
April		0.5	3.7	2.9	1.3	1.6	4.3
May		-	-	-	-	-	-
June		-	-	6.9	6.8	2.9	-
July		-	1.2	-	13.3	18.4	-
August		--		-	-	-	-
September		-	3.4	1.5	1.3	3.3	-
October		-	1.4	-	2.4	1.3	
November		-	4.3	-	6.2	3.3	-
December		-	-	-	-	-	-

Table II Monthwise

Cephalopod fishery has become very important recently world over and therein considerable increase in the cephalopod landing as compared to other resources. Acceptance of cephalopods in the markets, where they were not proven appreciated resulted in higher production by increasing the fishing intensity and employing various technology advancements. In India also the cephalopod resources were neglected till early seventies. Landings move mostly incidental by the mechanical trawlers engaged in shrimps fishing along the coastal region and traditional crafts operating hook and line series in the central region. No specific gears were employed in India targeting Cephalopods except the hook and line fishing practiced along the South-west coast of India to the exploitation cuttle fishes. Recently some of the larger trawlers engaged exclusively in shrimp fishing along the north-east coast of India have been diverted for cephalopod resources modifying the gear when shrimping was not feasible during entire seasons. Apart from this experimental squid jigging was attempted by the Fishery Survey of India using modern squid jigging equipments along the South-west coast of India. An attempt is made in this chapter to study the species composition of economically important cephalopods of the south-west coast of India, their morphological features, spatial and temporal distribution of cephalopods along the south-west coast of India, Cephalopod fishery in India, capturing methods and some aspects of biology of the most abundant species of cuttle fish and squid.

CHAPTER: 2

FISHING TECHNIQUES FOR CEPHALOPODS

A wide variety of fishing crafts and gears are employed in Indian waters for the exploitation of cephalopods. Hook and lines, jigging, surrounding nets, seines and traps, trawls, light assisted lift nets and mechanized squid jigging are the main methods employed from the mechanized and non – mechanized fishing crafts. Cephalopod is often caught as a by catch of the shrimp and fin fish fishery. Nair (1986) has described hand jigging methods for cuttle fish at Vizhinjam along with a description of modern squid jigging. Nair and Omana (1986) also dealt with the experimental trawling and light fishing conducted at Vizhinjam for cephalopods. Nair *et al* (1992) has given a detailed account of the experimental squid jigging conducted by the Fishery Survey of India from the vessel *MFV Malsya Sugandhi* along the south west coast with details on the automatic squid jigging equipments and deck arrangements. Fishing crafts deployed for fishing in Indian waters range from simple catamarans, wooden canoes, and plywood boats and fiberglass boats equipped with or without outboard engines to well-designed mechanized crafts with inboard engines. An account of various fishing craft, both traditional and mechanized and fishing techniques employed for the exploitation of celphalopods directly and indirectly are described in this chapter.

Traditional crafts

Traditional crafts include catamarans, dugout and built up canoes, plywood and fiberglass boats which are either operated with or without outboard motors.

Catamaran

The catamaran (*kattumaram* or *theppa*) is a dominant traditional fishing craft, along the surf-beaten coast of India. This generally consists of a variable number of definitely shaped logs tied together to form a raft. It is usually made of 3-5 logs and occasionally 7 logs measuring about 3.6-7.5 m length (SIFFS, 1999; Srikrishna, 2002).

Wooden canoes

The simplest form of built-up canoes is the plank-built canoe. They are built with or without ribs inside. The planks are held together by tying with coir ropes and the gaps are caulked using cotton sprinkled with oil. The best type of built-up boats in India are seen on the west coast. Very large plank-built canoes are decked and fitted with inboard motors for operation of large seine nets, in recent years in India (SIFFS, 1999; Srikrishna, 2002; Edwin, 2006).

Plywood and fiberglass boats

Plywood and fiberglass boats are relatively new entrants into the artisanal fisheries sector. There are two types of plywood boats: decked boats and open boats. Decked boats are usually used for hook and line fishing, while open boats are used for large mesh gill net operations. Plywood and fiberglass boats of LOA up to 17 m are now being used by fishermen. Ring seines and mini-trawls are also operated from these boats (SIFFS, 1999; Srikrishna, 2002; Edwin, 2006).

Mechanized fishing crafts

Trawlers

A trawler is a specific boat type which is equipped to tow one or more trawl nets. They are provided with engines of sufficient power to tow the net at the appropriate trawling speed, and is fitted with trawl winches and equipment necessary to haul the net on board and lift the codend over the deck. In stern trawling, which is the most popular method of trawling in recent years, the warps are led from the trawl winch through two towing blocks attached to stern gallows. The wheel house is situated in the forward part of the vessel and the trawl winch is placed transversely, behind the wheel house. The fish hold is usually situated amidships.

Small scale trawlers

It is estimated that 43000 trawlers are operating in India, which form nearly 80 % of the small-scale mechanized fleet. The introduction of bottom trawling around 1950s was an important event in the capture fishery development of India.

In the initial phases of development of trawling, wooden crafts in the range of 8-9 m L_{OA}, equipped with 10-60 hp diesel engines, were used for trawling. (Kristjonsson, 1967). The overall size and installed horse power of trawlers have increased subsequently, over the years. Length classes of trawlers operating from Cochin range from 9.1 to 16.0 m with installed engine power ranging from 89 hp to about 156 hp (Boopendranath, 2001) and in recent years higher powered engines are used. Largest number of vessels were equipped with 106 hp engines (>50 %), followed by 99 hp, and 122 hp and 89 hp engines.

Other small scale mechanised crafts

Other mechanized crafts include, purse seiners, gill netters and liners. However, their contribution to cephalopod landings in India is very limited compared to that of trawlers.

Larger trawlers

A number of trawlers engaged in shrimping and fin fishing are some times diverted for cephalopods. The larger trawlers from the Sand Heads, Bay of Bengal were diverted to exploit other fishery resources like deep sea lobster and cephalopods when the shrimp fishery declined and became unprofitable. As the deep sea lobster resource is very limited, several large shrimp trawlers turned towards cephalopod resources, in view of its export value.

About 50 large shrimp trawlers have operated along the west-coast of India during the year 1993-1999. The details of the vessels are given in Table (2.1). Vessels varying in length between 28.0 and 31.39 m LOA, conducted stern trawling along the south-west coast during the off season for shrimps, especially during the period June-November which is the best fishing season for cuttlefishes. High opening two-seam trawls with a codend mesh was 40 mm, rigged with 'V' form or oval shaped otter boards of 450-680 kg, were used for operations. Each voyage was around 45 days with nearly 40 days of actual fishing. The depth of fishing varied between 50-100m. The catch varied from 25-60 tonnes per vessel per voyage depending upon the area and season. Average catch was about 900- 1500 kg. The cephalopods catch formed substantial portion of the landing, and in some cases contributing up to 60 tonnes (Personal Communication).

In all the vessels, processing and packing were done onboard. Depending on the weight of the cuttlefishes are graded as 11-50, 50-150, 150-300, 300-500, 500-700, 700-1000,1000-2000 and >2000. The cuttlefishes caught from the south-west coast (08°00'N to 13°00'N) were mostly weighing between 500-2000 g. This may be due to abundance of the largest species *Sepia pharaonis*. (Personnel communication).

Table 2.1. Specification of large shrimp trawlers modified for cephalopod fishing along the West Coast.

Overall length	31.39 – 28.0 m
Breadth	7.46 – 7.48 m
Draught	3.4 – 7.0 m
Gross tonnage	156 – 180
Net tonnage	35 – 79
Type of engine	Caterpillar, Yanmar, MAN
Horsepower	350 – 624 hp
Crew strength	12 – 15
Chill tank capacity	3.5 m^3
Fish hold capacity	60 – 110 m^3
Fish hold temp	18.0°C
Type of hull	Steel
Endurance	23 – 28 days
Fuel capacity	43.5 – 78.96 m^3
Type of freezer	Plate freezing, chill tank and IQF

Fishing Gears

Fishing gears deployed for catching cephalopods vary greatly in their structure materials used and principles of capture process and methods of operation. Fishing systems used for cephalopods are jigging, hooks & lines and trawling, seines and pots. Most widely used fishing systems fopr cephalopods are described in the following sections, following International Standard System of Classification adopted by FAO for fishery statistics (Nedlec,1982; Hameed and Boopendranath,2001)

Cephalopods are landed mainly as bycatches of bottom trawlers all over the world. Trawls are the most important fishing gear landing cephalopods in India. About 85% of the cephalopods landed in India are caught as bycatch of trawl nets, operated up to 100 m depth (Meiyappan and Mohammed, 2003).Trawl nets are conical bag nets with two wings and a codend where catch is concentrated, operated by towing from one or two boats. Based on the position in water column where they are operated, trawls are classified into bottom trawl and mid water or pelagic trawl. Depending on the number of boats used there are one-boat trawl or pair trawl.All trawls are basically funnel shaped, with their sides extending in the front to form wings to prevent the fish in front of approaching trawl from escaping. The modern bottom trawl is constructed generally from two panels of netting, top and bottom or from four panels, top, bottom and sides. Nets with two panels are known as two-seam and nets with four panels as four-seam trawl.

Trawls operated by small scale sector

Squid demersal trawl is known as *chooda vala*, in vernacular, is primarily targeted at squid, anchovies and ribbon fish resources. The gear is fabricated of machine made polyethylene netting, with a twine size of R370tex. The mesh sizes range from 120 mm in the wing and square sections, 120-30 mm in the net body, to 25 mm in the codend. The head rope length is typically 43.6 m. The wing-ends are connected to the otter boards by double bridles and a wooden danleno assembly, as for demersal fish trawl. This net is modified to catch anchovies by providing an inner liner of small meshed netting in the codend. Demersal cuttlefish trawl is known as *kanava vala*, in vernacular, is primarily targeted at cuttlefish resources. The gear is fabricated of machine-made polyethylene netting, with a twine size of R900tex. It is provided with larger mesh sizes in the front trawl sections. The mesh sizes range from 160 mm in the wings, 120-40 mm in the net body, to 25 mm in the codend. The head rope length is typically 41.6 m. The wing-ends are connected to the otter boards by double bridles and a wooden danleno assembly, as for demersal fish trawl.

Trawls operated by larger vessels.

High opening trawl, High speed demersal trawl, Bobbin trawl and Hybrid trawl developed by CIFT for deep sea operations have been found to be effective for harvesting cephalopods (Panicker, 1979: Kunjiplau, 2003; Kunjipalu et al. 1984). The semi pelagic system developed by CIFT has shown better catch rate for squid(CIFT,2006)

Semi-pelagic trawl system

Demersal trawls are generally non-selective and a large number of non-target species and juveniles are landed during trawling, in addition to its impact on benthic communities. Resource specific trawls for semi-pelagic resources have comparatively low impact on the benthic biota. CIFT Semi-pelagic Trawl System (CIFT SPTS-I) has been developed as an alternative to shrimp trawling in the small-scale mechanized trawler sector. The system consists of an 18 m four panel semi-pelagic trawl with double bridles, and high aspect ratio otter boards of 85 kg each. It is capable of attaining catch rates beyond 200 $kg.h^{-1}$ in moderately productive grounds and selectively harvest fast swimming demersal and semi-pelagic resources including cephalopods, which are mostly beyond the reach of conventional bottom trawls, currently used in commercial trawl fisheries in India (CIFT, 2006).

Hooks and Lines

Different types of hooks and lines are widely used for catching cephalopods, around the world using edible or artificial bait or lure which simulates the appearance and movement of the natural prey, and are finally held by the hook concealed in the bait or lure. The hook is connected to a line or snood. The squids and cuttlefishes are also caught by the piercing action of hooks or jigs passing nearby. Important types of hooks and lines which are pole and line which are either worked manually or mechanically; jig lines what are operated either manually or by powered jigging machines for squids attracted by light (Hameed and Boopendranath, 2000). Various types of handlines, long lines and troll lines are used with ripping hooks or jigs, for catching cephalopods.

Hand lines and pole and line jigging gears

The hand lines are operated on reaching the fishing ground with or without bait to entice the squids and jig them. The gear may consist of hand line with one or two branch lines. The stem of the jigs is made of wood, bamboo or steel and will have some weight to sink in water.

Simple hand lines are widely used for catching squid, cuttlefish and octopus. They can be similar to the normal hand lines, the pole and line fishing gear with two poles attached to a wooden handle or bifurcated pole with two lines (Gabriel et al. 2005). In deeper waters, a gear resembling the balance lines used for catching fish, is also in use.

In India, along Vizhinjam-Kanyakumari coast, hooks & lines are operated from motorized and non-motorized crafts to catch cuttlefish which account for the entire catch of cuttlefish from this region (Nair, 1986; Meiyappan and Mohammed, 2003).

Squid jigging

Squids are positively photo-tactic and aggregate close to the illumination. They are easily attracted to fast moving bait or a bait-like object. These principles are made use in squid jigging. A great variety of artificial jigs or lures have been evolved for this purpose. They consist of a stem made of a sufficiently flexible plastic with one to three rings of sharp, barbless hooks at the lower end. Stem and hook rings are held together by a steel rod or wire with eyes at both ends for the attachment of the line. One jigging line may carry up to 30 such jigs, which may be of the same or of different colour and shape. Adequate pull and hauling speed of the line are required to prevent the attached squid from disentangling its arms and tentacles from the barbless hooks. Hand operated line reels and later developed to automated squid jigging machines.

Hand line and pole & line jigging gears

Each fishing line carries several jigs instead of one, in fishing operations. The jigs are not baited and have two rings of hooks. The gear is lowered to the desired depth and jigged until a squid is caught. Immediately the line is hauled into the boat. Twenty to thirty jigs are arranged in line with about one metre distance between each other and connected with nylon monofilament and a sinker at the end. The wear and tear of a jigging line has an effect on the catching efficiency. Synthetic monofilaments are susceptible to abrasion on the outboard roller and on the line drum and they may have to be replaced.

Hand operated jigging reel

This is developed to increase smooth jigging and catching efficiency and for reducing labour. A winding gear or drum with a handle is used to unwind and haul back the fishing line and for jigging. This facilitates the operation of longer lines with more jigs reaching into deep water. A wire mesh frame with downward inclination toward the boat is placed between the out board roller and the rail to collect the squids which fall off the hooks and guide them into the boat.

Automated jigging machines

The automated jigging machine operates two drums one on each of the central power and steering unit. In order to simulate the jigging or jerking movement of line and jigs, the drums have elliptical or oval cross section. The power requirements for one jigging machine are about ½ hp (0.4kW). Electric drive with 220 volts or hydraulic drive also is used. The machine lowers and retrieves the lines from a desired depth at a predetermined speed. A wire mesh frame is positioned in such a way that the squid falling off the jigs after passing over the leading roller slide directly into boxes on deck or to a conveyer system which takes the to the hold for icing or freezing. The automated squid jigging machine enable considerable savings in crew and labour and are indispensable in larger vessels (Hameed and Boopendranath 2000). In Japanese waters, about 90 percent of Japanese common squid are caught by jigging and the rest by trawling, set-netting and other methods. The jigging boats range from 3 to 500 GRT. Jigging is of two types: (i) inshore , by boats smaller than 30 tons, and (ii) offshore by the bigger boats (Araya, 1976)

Light attracted jigging is a fishing method exclusively developed for catching squids.. Light attraction with fishing lamps is an essential feature of squid jigging. The light intensity and the respective size of the light attraction system depend on the size of the vessel. Fort he majority of the boats incandescent lamps of 4 kW are quite common (Ogura and Nasumi, 1976). The common squid (*Todarodes pacificus*) does not concentrate at bright light, but prefereably at the boundary between light and shade. According to echosounder observations, the squid concentrate in a narrow school under the vessel in 20 -25 m depth moving in from the bow or stern of the vessel. They attack the jigs from dark zone. At the dawn when the shade of the vessel due to the fishing has gradually fades, the squids disappear.

Squid jigging experiments in India

Nair (1982) and Nair and Omana (1982) have reported the light fishing experiments conducted in the Gulf of Mannar and Vizhinjam. Results of squid jigging operations conducted off southwest cost from *M.V. Matsya Sugunthi* (31.5 m OAL; 248.45 GRT; 650 BHP) and operations conducted to a limited extent along Gujarat coast from the 17.5 m *M.V .Meena Prapi* are reported by Nair *et al.* (1992) and Sivaraj *et al.* (2003).

During operations from *Matsya Sugunthi* two rows of halogen lamps (5 nos each) of 3 kW/220 V were provided on either side of the aft deck of the vessel. the squid jigging consisted of a main line of 2 mm dia monofilament attached with a number of jigs, connected in series, using jigging line of 0.5 mm to 0.9 mm dia monofilament according to the depth of operation. The thinner line with better transparency will render the line invisible and enhance jigging efficiency. The jigging line is attached to the mainline by means of a brass swivel. a spindle shaped lead sine is weighing 750 to 1000 g is tied to the lower end of the line to the keep the line vertical orientation. Two underwater luring lamps (1.5 V) of the same size as jigs were attached to the jigging line for luring the squid. The jigging line is In the jigging line, 20-30 jigs are attached in a series spaced 90-100 cm apart (Nair et al. 1992; Sivaraj et al. 2003). The squid jigging lines were worked from eight electric driven automatic squid jigging machine on the aft deck of the vessel.

Traps

Traps are passive fishing gears with enclosures to which the fish are lured or guided and from which escape is made difficult by means of labyrinths or retarding devices like funnels or constrictions. A wide range of traditional fishing gears is grouped here. Pots are cages or baskets made from materials like wood, wicker, metal rods, wire netting and reinforced plastic, designed to catch fish, crustaceans or cephalopods by enticing them with baits or shelter spaces. They are provided with one or more entrances of appropriate gape. They are usually set on the bottom singly or in series connected by ropes and position marked by buoys.

Octopus pots

Earthenware pots of different size and shape with or without handles are used in Japan, Korea, Italy, Malta and Hong Kong, for catching octopi. Octopi enter such pots for shelter and spawning. The earthenware pots are wither put singly or in series of up to 100 pots strung to lines (Pennington 1979). In some area such as Japan, Korea, Mexico and South India, large molluscan shells are used as octopus pots. In Palk Straits, large quantities of small octopus used to be caught by fixing as many as 700-900 shells on along line system which is hauled in each morning (Hornell, 1950). However, these pots have been later mostly replaced by more durable wooden boxes and plastic pots (Yamashita 1976).

Squid traps

Mid-water squid traps suspended from float and flag pole are used in Thailand for catching squids. Coconut leaves are used to cover the traps to provide shelter spaces (Hameed and Boopendranath, 2000; SEAFDEC, 1995a).

Surrounding nets

Surrounding nets are roughly rectangular walls of netting rigged with floats and sinkers which after detection of the presence of fish are cast to encircle the fish school. Purse seines are the predominant type of surrounding nets, in which the bottom of the net is closed after encircling the fish school, by a purse line which prevent fish from escaping downwards by diving.

Shoals of squids are occasionally caught in purse seines along Mangalore-Malpe coast, in Karnataka state (Meiyappan and Mohammed, 2003).

Seine nets

Seine net is a long wall of netting with or with out a bag, supported by floats and sinkers, which are operated by surrounding areas of water with potential catch. The net is operated by ropes attached to the end of wings which are used for hauling and for herding the fish. Squids occasionally form a minor part of the catches of boat seines operated by motorised crafts in India. They are also deployed for catching squids in countries like Thailand and Malaysia (SEAFDEC, 1995a; 1995b).

Gill nets

Gill nets are rectangular walls of netting kept erect by means of floats and sinkers and positioned in the swimming layer of the target fish, which catch the fish by holding them in the mesh by gilling or entangling. Depending on method of operation gill nets are classified into drift gill nets, set gill nets and encircling gill nets. Gill nets are deployed for catching squids in countries like Thailand, Malaysia and Philippines (SEAFDEC, 1995a; 1995b; 1995c)

Lift nets

Lift net consists of horizontal netting panel or a cone-shaped bag with the mouth facing upwards, which are submerged and lifted either manually or mechanically to filter the fish in the overlying water column. There are shore operated lift nets which are operated from stationary installations along the shore and boat-operated lift nets which are operated from one or several boats.

Falling gear

Falling gear is cast over the area where fish is available, then gathered and lifted to collect the fish. Many of the artisanal fishing gears such as cast net, cover pot and lantern net belong to this category. The operation of cast net requires skill, but can be carried out by one man on a small boat, usually on a dark night, using a kerosene or electric luring light.

Large cast nets are deployed for squid fishing in Thailand and Malaysia (SEAFDEC, 1995a; 1995c). A modern squid cast net is 6-8 m deep and 15-20 m in circumference. The main net material is nylon 210Dx4x6 and 25-30 mm in mesh-size. A lead or iron chain is attached to the lowest meshes of the net. A heavy ring made of lead, 30-40 mm thick and 15-20 cm in diameter is used to block the escape of the catch. Apart from squid, the catch consists of cuttlefish and some fishes.

CONCLUSION

From the studies carried out to assess the present status of fishing crafts and gear employed for the capture of cephalopod resources it is found that a wide range of fishing crafts and fishing gears are used in our waters. However, there is no specific commercial gear targeting cephalopods, especially squid and cuttle fish. It is seen that the government agencies like Central Institute of Fisheries Technology & Fishery Survey of India are making attempts to develop suitable demersal and semi-pelagic trawl nets for cuttlefish and squid and popularize them. The experimental squid jigging for neritic and oceanic species conducted with the assistance of foreign expert was a new attempt to introduce ammercial riggin in Indian waters a very successful fishing technique elsewhere. . However the commercial viability of this fishing in Indian waters is yet to be established. The size of the squid caught by jigging is the main factor than the number caught for determining the commercial viability. The hook and line fishing at Vizhinjam is only a localized attempt which can be popularized and extended to other areas also.

It is seen that in Japan modified trawl gears are used to get better performance and avoid damage of catch. They use six panel trawl nets with an inside liner of 48mm mesh size for squid fishing. Countries like Italy, Spain and Portugal introduced specific trawling for squid. The success story of industrial trawlers from the east coast operated along the west coast for cuttle fish with modified trawl nets during the lean shrimping period is very encouraging. Encouragements should be given to such entrepreneurs attempting diversification.

In addition, efforts must be made to give a fillip to night fishing using light and jigging operations, which are good cephalopod catching methods.

CHAPTER 3

SOME ASPECTS OF BIOLOGY OF- *Sepia pharaonis* Ehrenberg *and Loligo duvauceli d'* Orbigny FROM COCHIN WATERS

Knowledge on the biological aspects like maturation and spawning, food and feeding habits, age and growth, length – weight relationship, fishing and natural mortality etc. is very essential for the exploitation and proper management of fishery resources. Studies on the maturation and spawning are essential for understanding and predicting the changes the population is likely to undergo during a year. The age and size at first maturity, time and duration of spawning, rate of regeneration of the stock, sex ratio, reproductive potential of the stock calculated from fecundity estimation are useful for the exploitation and management. Similarly food is an important factor influencing the growth, fecundity, migration and abundance of fish stocks. Knowledge on the age and growth is an essential pre requisite for understanding the dynamic features of the population. Such knowledge can give valuable information on stock composition, age and maturity, longevity, mortality, growth and yield of fish population.

Cephalopods of Indian waters have not received much attention as in the case of commercially important crustaceans and fin fishes as this resource was neglected till mid – seventies. The first work on biology is by Rao

(1954) on the squid *Sepioteuthis arctipinnis* of Palk Bay, which covered various aspects like age and growth, longevity, maturity and spawning, food and feeding etc. Unnithan (1982) studied similar aspects of the cuttle fish *Sepiella inermis* of Mandapam area Tamil Nadu. The functional morphology and food and feeding of the squid Loligo duvaucelli and cuttle fish *Sepia acueleata* and *Sepiella inermis* of the south west coast of India have been studied by Oommen (1977). The recent works on the biological aspects and stock assessment of squids and cuttle fishes are of Kasim (1985,1988,1993) on the population dynamics and stock assessment of the squid *Loligo duvaucelei* cuttle fish *Sepiella inermis* and *Sepia elliptica* of Sourastra waters, Karnik and Chakraborty (2001) on the *Loligo duvaucelli* of Mumbai waters, Kasim and Rao (1977) Rao (1988) Sunilkumar (1993,1996) along the Karnadaka coast, Rahim and Chandran (1988) along the south east coast. The fishery biology and stock assessment of *Loligo duvauceli* were studied by Meiyappan et al (1993) and *Sepia pharaonis* by Nair et al ; (1993) and *Sepia acueleata* by Rao (1993) based on the data collected from different centers along the east and west coast of India. An attempt is made in the present investigation to study some aspects of the biology and population parameters of two economically important species of cuttle fish and squid viz. *Sepia pharaonis* and *Loligo duvaucelli* of the south west coast of India.

Material and methods

Material for the study were collected at monthly intervals from the landings of survey vessels MFV *Matsya Varshini* and MFV *Lavanika* of Fishery Survey of India, Cochin Base, which operate demersal trawls along the south west coast and from the catches of commercial vessels landings at the Cochin Fisheries Harbour during the period January 2003 to December 2003. Altogether 756 specimens were studied for growth and mortality estimates, 332 specimens for maturity studies, 193 for food and feeding and 381 for length-weight study in the case of *Sepia pharaonis*. Owing to the large size, limited landing and high price of this species the availability of adequate number of specimens for examination was extremely difficult. In the case of *Loligo duvauceli* totally 2156 specimens, 1569 males and 587 females were examined for studying various biological aspects.

The sexes are separated and males are identified by the presence of hectocotylized arm, the organ for the transfer of spermatophores. In Sepia and Loligo, the fourth left arm is hectocotylized. The length of the mid-dorsal mantle (DML) is taken for length frequency analyses in both the species and it is measured to the nearest 1 mm and the wet weight to the nearest 0.1 gm. The length – weight relationship was worked out for males and females and compained separately using the formula.

$\text{Log}(Y) = \log a + b. \log(x)$

where $\log(Y)$ = weight and $\log(x)$ = length.

Population parameters were studied with the help of *NORMSEP* computer programme package FISAT II. which contains ELEFAN length frequency analysis module (Gyanilo *et al,* 1996). The value of $L\infty$ and K were computed from the length frequency data. The total mortality Z was calculated using catch curve method and the natural mortality M using Pauly's empirical formula (Pauly;1983).

The sex and maturity stages were determined by examining the nidamental glands, the accessory nidamental glands and the ovary in females. Maturity stages of only females are described following the scale followed by Gabr et al. (1998) which is a modified scale proposed by Mangold-Wirz (1963) in the case of *Sepia pharaonis*. In the case of *Loligo duvauceli* female maturity stages were determined following the universal scale for squid Lipinsky; proposed by(1979)

Length at first maturity was determined as the length at which 50% of the animals attain maturity. For estimating the fecundity ovary was weighed and a small portion was removed, weighed and ova were counted.

Stomach contents were analyzed employing point method (Pillay, 1952) and food items were identified up to generic or group level depending on the state of digestion and up to class level where identity could not be adjudged due to mutilation. The intensity of feeding was studied on the basis of fullness of the stomach and they are classified as full, ¾, ½ , ¼ and empty, To evaluate the importance of each food item the index of preponderance (Natarajan and Jhingran, 1961) was worked out using the formula .

$$\frac{Vi\,Oi}{\Sigma Vi\,Oi} \times 100$$

Where 'i' is the index of preponderance of food item and Vi and Oi are the percentage by volume and occurrence respectively.

Results

Sepia pharaonis **.Ehrenberg**

Length – weight relationship

The length of *Sepia pharaonis* used for the study ranged from 60 mm to 310 mm. Logarithmic regression equation derived for males and females using least square method for the species is as follows:

Male : In W = -7.01412 + 2.552432 x In L (r-0.9918)

Female : In W = -4.15146 + 2.015053 x In L (r-0.887497)

Combained : In W = -5.70869 + 2.30974 x In L (r- 0.947458)

The corresponding exponential formula can be expressed as

Male : $W = 0.000899\ L^{2.552432}$

Female : $W = 0.015741\ L^{2.015053}$

Combined : $W = 0.003317\ L^{2.30974}$

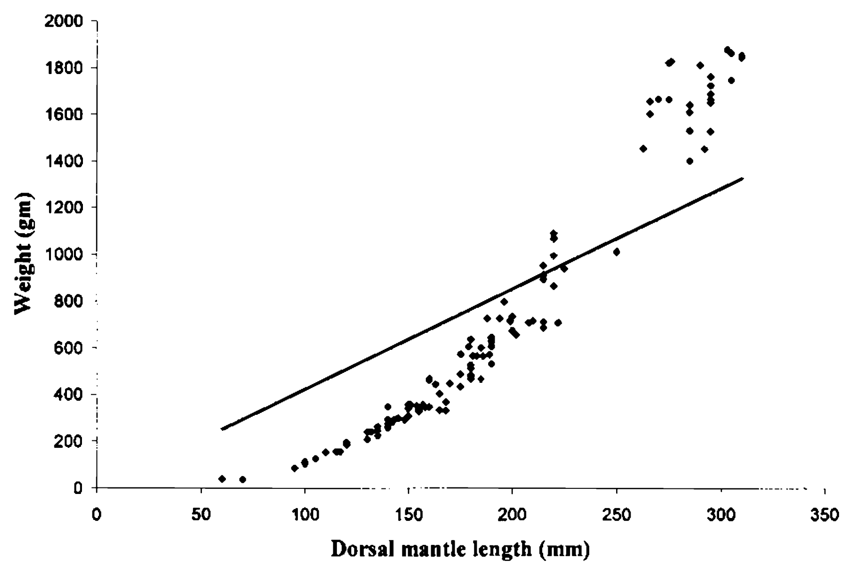


Fig: 3.1- Length weight relationship for male *S. pharaonis*

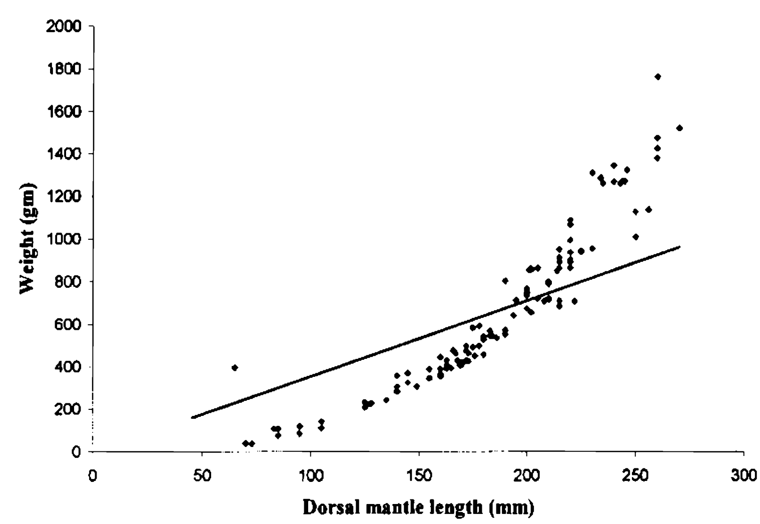


Fig: 3.2- Length weight relationship for female *S. pharaonis*

The values of observed lengths and corresponding weights are plotted in figure 3.1 and 3.2 and the regression line fitted indicates a straight-line relationship between the two variables.

Estimation of growth and mortality

The growth parameters were estimated with the help of FISAT II basing on modal progression analysis. The values of L∞ and growth coefficient (K) were calculated using Gulland and Holt plot were 381mm and 0.92 / year respectively. In order to get the complete growth curve, due to the limitation of data in respect of this species, the length frequency data for the entire year is repeated over and over for a period of three years and the growth curves up to L∞ was drawn (Fig 3.3). It is seen that *S. pharaonis* attains the L∞ at the age of 3.25.

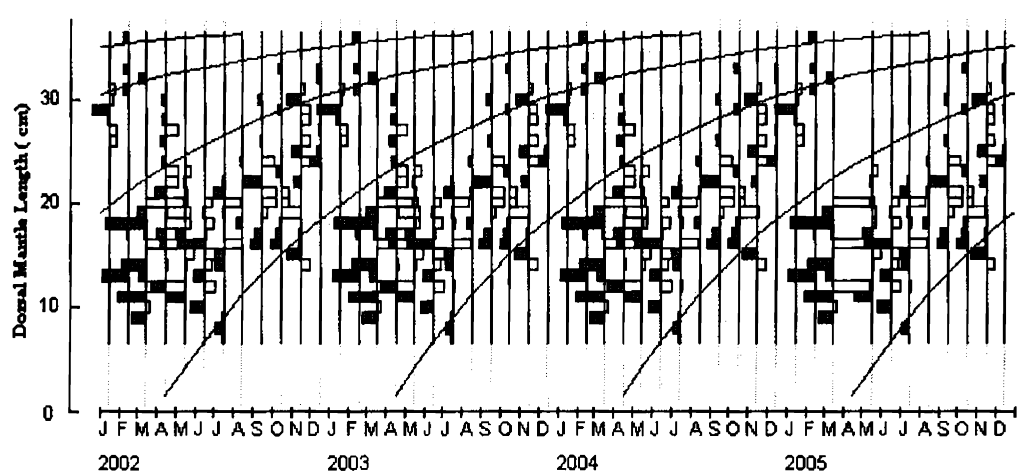


Fig .3.3 : Elefan generated von Bertalanffy growth curve

The mortality rates were calculated using the same package FISAT II basing on the length converted catch curve method. The total mortality Z was computed as 2.50 while calculating the Z value, specimens not fully recruited or nearing L∞ are discarded from calculation (Fig 3.4). The natural mortality (M) was estimated using Pauly's empirical formula as 1.36

and the fishing mortality as 1.14 subtracting natural mortality from total mortality.

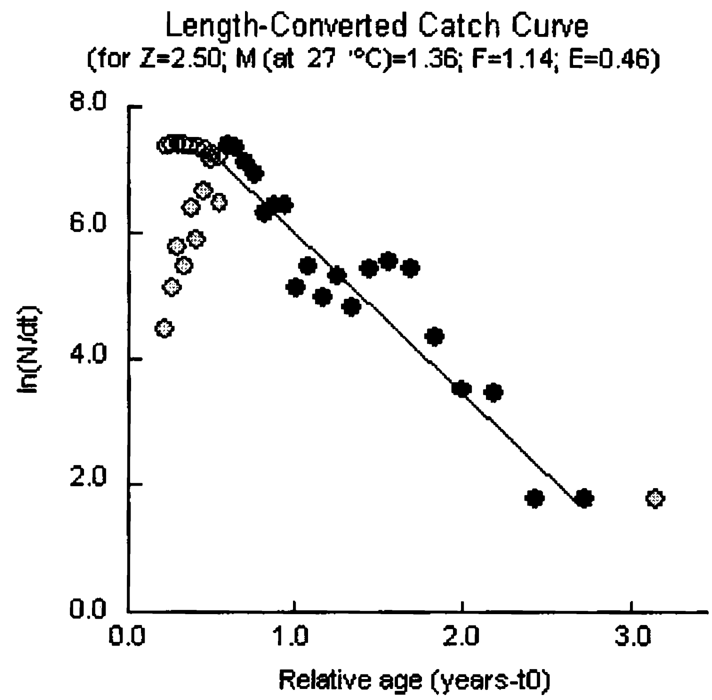


Fig.3.4: Length converted catch curve for estimation of total motality (z)

The exploitation ratio (E) estimated as per Gulland's equation from the length converted catch curve method was 0.46 for this species.

Maturation and spawning

Table 3.1, shows the monthly percentage of males and females obtained during this study. Males were comparatively longer than females with the length range of 60 mm to 310 mm and the females ranged from 65 mm to 210 mm in length. It is seen that during the months of January, February, June ,July, November and December males were predominant. Females dominated during pre monsoon months(March, Apriland May) and post monsoon months(August, September and October).

Table 3.1 : Monthly percentage of males and females of *S.pharaonis*

Months	Male	Female	Ratio
January	65	35	1.9 : 1
February	62	38	1.7 : 1
March	42	58	0.8 : 1
April	42	58	0.7 : 1
May	40	60	0.7 : 1
June	88	12	8:01
July	56	44	1. : 13
August	32	68	0.5. : 1
September	39	61	0.6 : 1
October	27	73	0.4 : 1
November	63	37	1.7 : 1
December	52	48	1.1 : 1

Five maturity stages are identified in the case of females depending upon the condition of the ovary, nidamental glands, accessory nidamental glands etc. The different stages are described as follows:

Stage I Immature — Nidamental glands are very thin and transparent, very small ovary. ova are not apparent.

Stage II Maturing — Thick and transparent nidamental glands which are visible clearly. The colour of the accessory nidamental gland is creamy white. Ovary is granular with small ova which are clearly visible and whitish in colour, few ova are reticulated.

Stage III Pre spawning The nidamental glands are white in colour. The accessory nidamental glands colour varied between yellow and orange. Small, medium and large reticulate ova are present in the ovary.

Stage IV Spawning The nidamental glands are swollen and white coloured. The accessory nidamental glands are pink. In addition to small, medium and large reticulate ova, large smooth transparent ova are present. Proximal oviduct is filled with mature eggs.

Stage V Spent. The nidamental glands and accessory nidamental glands are thin, less glossy and flaccid. The accessory nidamental glands turns to pink.

Matured females were observed from 140 mm onwards. Length and weight ranges, different maturity stages observed in different months during the study are given in Table.3.2.The length ranged from 70 mm to 320 mm and weight from 36gm to 2110 grms. The smallest specimens were observed during the months July and November. In general the period from March to September recorded small sized specimens.

Table- 3.2: Month wise distribution of Maturity stages of *S. pharaonis* during the period from January '2003 - December'2003

Months	Sample size	Length range	Weight range	Length mode	Male	Female	I	II	III	IV	Spent
January	20	22.5-31	942-1878	28.5	13	7	0	2	3	2	0
February	24	20.5-32	742-1978	28	15	9	0	0	2	7	0
March	21	12-26.8	111-1529	18	9	12	1	1	2	8	0
April	26	14-27	260-1645	17	11	15	0	3	5	7	0
May	32	11-29	100-1654	16.5	13	19	0	4	6	8	1
June	18	12.0-22.0	194-1067	18	16	2	0	2	0	0	0
July	30	7-21.5	36-892	10	17	13	5	6	2	0	0
August	22	13.5-20	240-797	16.3	7	15	2	19	2	1	0
September	23	13.5-30	244-1832	15.5	9	14	2	I	4	7	0
October	15	16.5-29.5	391-1528	22	4	11	0	2	0	7	2
November	30	7.5-27	38-1664	16	19	11	0	3	0	8	0
December	27	13-31	265-2110	26.5	14	13	2	2	3	5	1

Immature and maturing females were more during the period July – August and meturing females during July and August. Specimens with fourth stage of maturity were abundant during two seasons February - March and September - November. Spent specimens were very few and recorded in May, October and December . Length at first maturity was worked out in female and found 50% reaches maturity at185 mm length.(Fig 3.5)

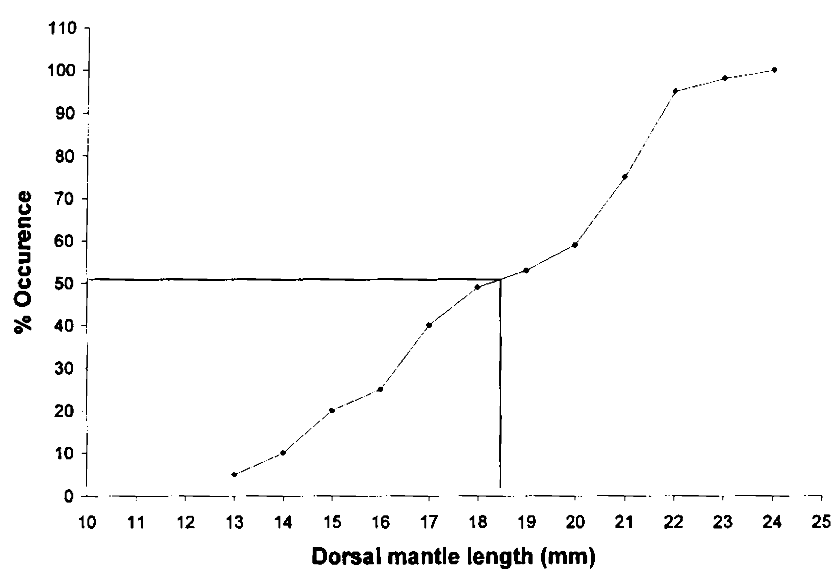


Fig 3.5 : Length at first maturity of *S. pharaonis*

Fecundity was estimated counting matured ova in the ovary of stage IV and found that the total number of ova ranged between 720 in female of 140 mm DML and 1150 in female of 215mm DML.

4. Food and feeding

Composition of food of *Sepia pharaonis* examined is shown in fig 3.6. The major component of the food was the teleost fish (37%), crab and shrimps formed 31% and 21 % respectively. Cephalopod and bivalves formed only a very smaller part of the food ie, 5 % and 2 % respectively. Of the 193 specimen examined 72.3% of males and 64.0% of females were with empty stomachs.

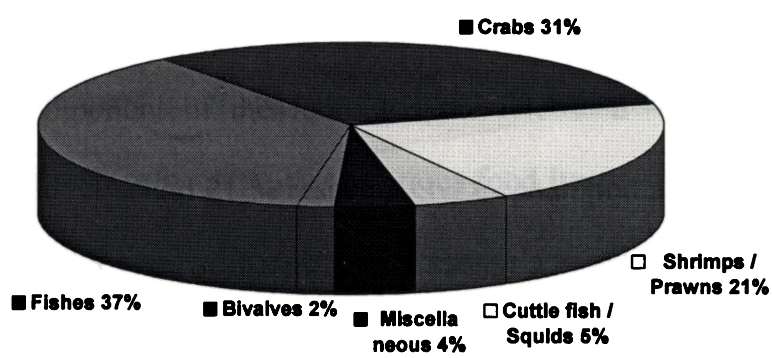


Fig 3.6 : Percentage Composition of food components in *S. pharaonis*

The stomach content of this species mostly consisted of fully digested matter and skeletal remains of teleost fishes and exoskeleton of crustaceans which made the identification of food items to the generic or species level very difficult

Table-3.3 -Degree of fullness of stomach of *Sepia pharaonis* in relation to sex and female maturity stages (percentage)

Sex and Stages of maturity	Degree of fullness in %					
	empty	poor	1 fourth	2 fourth	3 fourth	full
Male	70	17	6	4	1	2
Female I	71	15	14	0	0	0
II	55	10	28	7	0	0
III	60	20	0	20	0	0
IV	83	8	0	9	0	0
Spend	50	0	50	0	0	0

Feeding intensity was generally poor in both the sexes (Table 3.3) and only very few full and ¾ stomachs were observed during the study.

The percentage occurrence of various food items in different months is given in Table 3.4 . Fishes, crabs and prawns were present in almost all the months. Squids and cuttle fishes were present during January to July and totally absent during the remaining months. Bivalves were present only in three months viz. May, November and December.

Table-3.4: Month wise percentage occurrence of food components in the diet of *Sepia pharaonis*

Food components	Jan.	Feb.	Mar.	April	May	June	July	Aug	Sept.	Oct.	Nov.	Dec
Fishes	24.1	13.3	73.1	38	30.4	34	41.7	0	30	7.4	45	66.7
Crabs	36.4	76.7	3.4	32	11.9	37.5	9.4	46.7	30	37	17.5	8.3
Shrimps / Prawns	32.7	3.3	0	18	18.6	0	27.8	23.3	25	55.6	25	16.7
Cuttle fish / Squids	6.8	0	3.4	4	16.1	16	15.6	0	0	0	0	0
Miscellaneous	0	6.7	20	8	18.7	12.5	5.6	30	15	0	0	0
Bivalves	0	0	0	0	4.3	0	0	0	0	0	12.5	8.3

Loligo duvauceli d' Orbigny

Length weight relationship

The logarithmic regression equation in respect of length weight relationship for males and females both the sexes combined (Fig 4.-7 a & b) are as follows:-

Male:- 1n W = -6.188+2.149x In L (r- 0.818)

Female:- 1n W = -6.884 +2.309x In L (r- 0.8109)

Combined:-1n W = -6.389 +2.200x In L (r- 0.809)

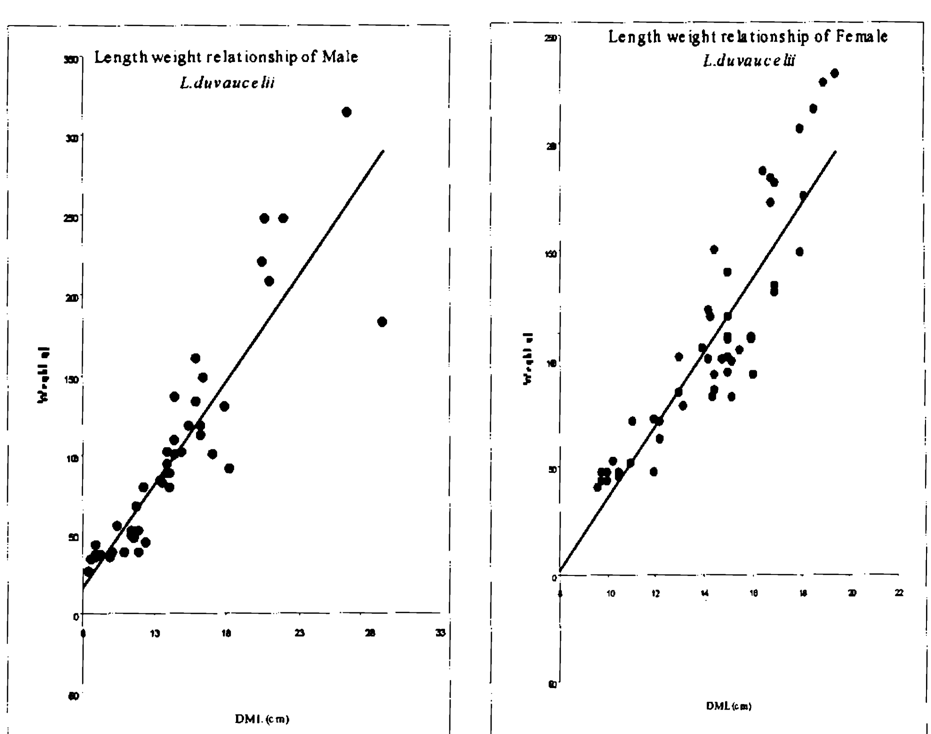
The corresponding exponential formula can be expressed as follows

Male W = 0.0020 $L^{2.149}$

Female W = 0.0010 $L^{2.309}$

Combined W = 0.00169 $L^{2.200}$

Fig: 3- 7 a,& b Length-weight relationship for male and female *L. duvaucelei*



Analysis of covariance indicated that there is no significant difference in the slope values of males, females and both the sexes combined.

Estimation of growth and mortality.

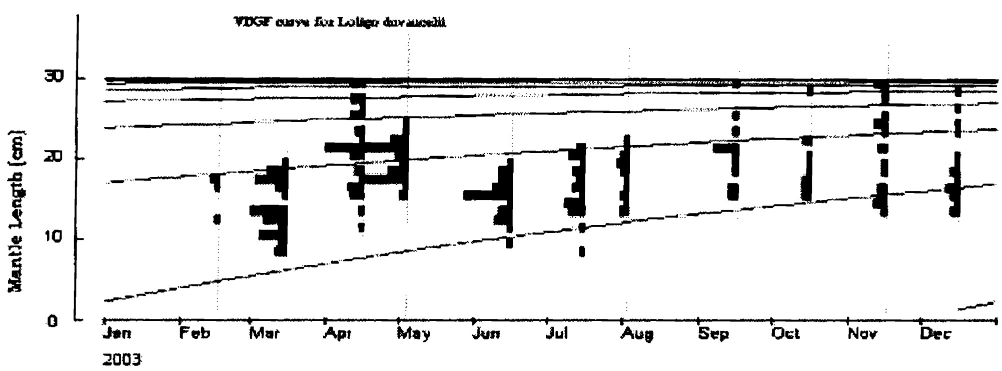


Fig .3.8 : ELEFAN generated von Bertalanffy growth curve

The month wise length class distribution and the growth curve tracing the modes of year classes is given in Fig 3.8. The sizes ranged from 65 mm to 291mm during the period of study and traceable modes were seen in different months

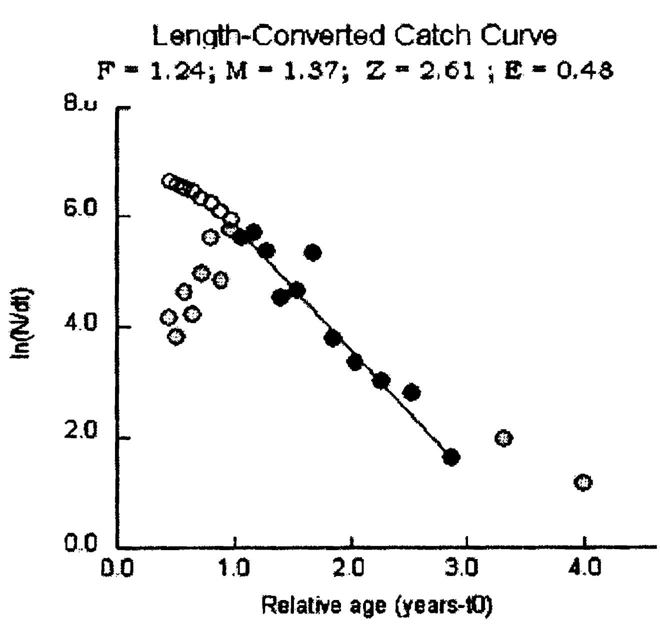


Fig .3 9: Length converted catch curve in *L.duvauceli* for estimation of total mortality (z)

Parameters of von Bertalanffy growth function for *L. duvauceli* were estimated as in the case of *S.pharaonis* using the FISAT II packages and $L\infty$ was 300 mm and growth co-efficient K was 0.75/ year. The Phi Prime Index estimated was 2.68 which falls within the permissible range of 2.51 to 2.97.

The total mortality Z was calculated using the length converted catch curve and it was 2.61 (Fig 3.9). The darkened quadrilateral in the figure represents the points used for estimating Z through least square line regression.The blank circles represent points either not fully recruited or nearing $L\infty$ and hence discarded from the calculation The natural mortality (M) was estimated as 1.37 using Pauly's (1983) empirical formula. The fishing mortality (F) was estimated subtracting of M from Z and it was found to be 1.24.

Exploitation ratio (E) estimated as per Gulland's (1971) equation was 0.48. As the exploitation ratio is below 0.5 it can be suggested that the stock of *L. duvauceli* in the south west coast is not under much fishing pressure.

Maturation and Spawning

Monthly percentage of males and females and sex ratio obtained during the study are given in Table 3.5. There was a female dominance at lengths below 160 mm and a sudden decline is noticed in the female proportion beyond 160 mm size. The month wise sex ratio revealed that male outnumbered female throughout the year, however the two sexes were almost equal during January.

Following the scale proposed by Lipinski (1979) for squids five maturity stages are described for females.

Stage I	The sexual organs are not clearly visible to the naked eye. Nidamental glands are transparent strips. Ovary is membraneous.
Stage II	Ovary small in size, the oviduct and nidamental glands are clearly visible as translucent or whitish strips. Ova not visible with the naked eye and embedded in tissue.
Stage III	Ovary is enlarged and occupies approximately half of the posterior body cavity. The nidamental glands are enlarged. Individual ova is clearly visible.
Stage IV	Ovary very prominent with plenty of translucent eggs in the oviduct and occupies entire posterior mantle space. Nidamental glands enlarged, whitish cream in colour.
Stage V	Oviduct almost without egg, Nidamental glands smallest, the body of the animal is slack.

Matured males occurred at the length of 65 mm and above. The males reached 50% maturity at 112 mm length and this can be taken as the size at first maturity for males Fig 3.10. In the case of females matured specimens appeared at 60 – 70 mm length range and reached 50% level at 102 mm which can be considered the size at first maturity for females. It seems that females reaches maturity earlier than males. Matured specimens were observed in the catch throughout the year

Table 3. 5 Month wise sex ratio of *L. duvauceli*

Months	Male	Female	Sex Ratio M:F
January	87	76	1 : 0.9
February	126	40	1 : 0.3
March	139	39	1 : 0.3
April	129	50	1 : 0.4
May	264	22	1 : 0.1
June	115	43	1 : 0.4
July	136	50	1 : 0.4
August	93	61	1 : 0.7
September	112	67	1 : 0.6
October	98	66	1 : 0.7
November	123	34	1 : 0.3
December	147	39	1 : 0.3

Examination of intra ovarian eggs revealed that there was only one mode around 1.3 mm indicating that ova may be released in a single batch during spawning. The largest egg observed was 1.62 mm in size.

Table 3. 6 Month wise length range and maturity stages of *L. duvauceli.*

Months	Sample size (Nos)	Length range (cm)	Weight range (g)	Length mode	I	II	III	IV	spent
January	163	8.5-19	11.0-227	17	5	8	11	52	0
February	166	14-29	119-312	18	2	4	16	18	2
March	178	8.5-19	13-205	11	4	8	7	18	0
April	179	11.0-26	51-314	20	9	5	12	23	1
May	286	9.0-21	40-185	13	2	5	8	6	1

June	158	7.0-16	38-133	7	2	9	16	16	0
July	186	7.3-24	75-219	7.5	1	9	10	28	0
August	154	9.0-23	42-216	20	4	5	8	43	1
September	179	12.0-29.1	78-183	23	2	2	6	57	0
October	164	14.0-23.2	82-230	19	7	3	9	46	2
November	157	6.5-24.5	21-247	10	3	7	12	12	0
December	186	9.0-21.5	40-196	16	5	6	19	9	0

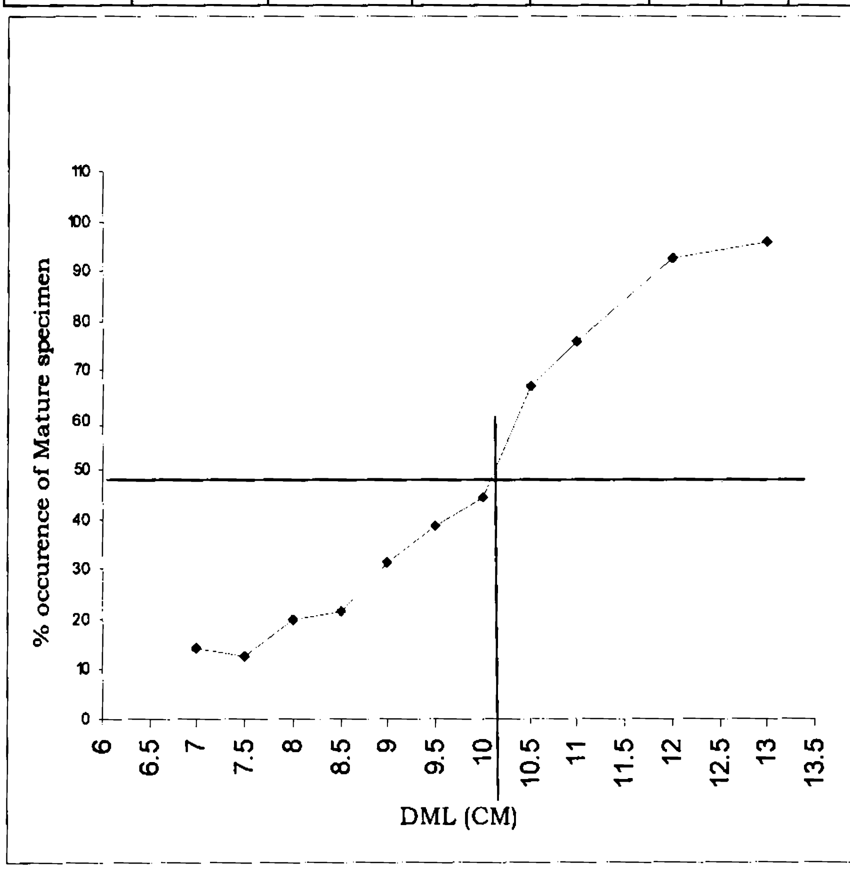


Fig 3.10 : Length at first maturity of *L. duvauceli*

The month – wise distribution of females with different maturity stages is given in Table 3.6 Immature females were more during January, April and October and females of third stage were dominant during July and August Specimens with fourth stage of maturity were abundant during two seasons

January and August to October. Spent specimen were very less and recorded during February and October.

The fecundity was estimated and the number of matured ova varied between 2104 and 10989.

Food and feeding habits

Major components of food items recorded during the study are given in fig 3.11. Myctofids and loliginids are the major components constituting 18% and 11% respectively. Other prominent components were pandalids, jelly fishes, trichurids, clupeids, engraulids and octopus. During March and April the feeding intensity was more compared to the other months. In general the feeding intensity was more during the period January- April and poor during September-October.

The percentage occurrence of various food items in different months is given in Table 3.8. Fishes, crabs and prawns were present in almost all the months.

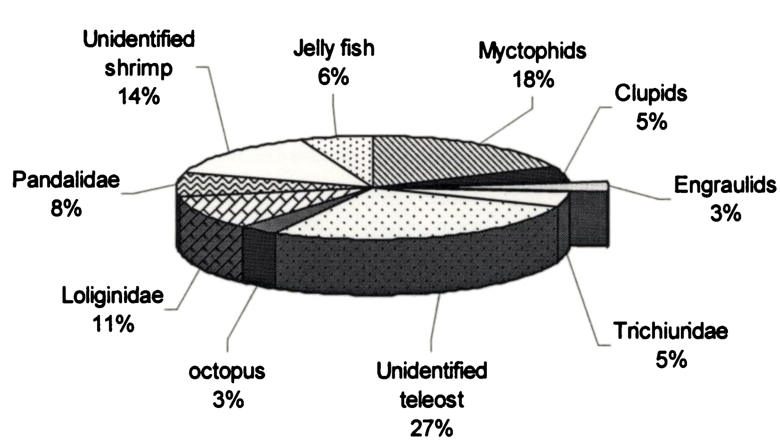


Fig 3. 11 Percentage composition of food components of *L. duvauceli*

Table 3.7 Month wise feeding intensity (%) of *Loligo duvauceli*

Months	Empty	1/4	1/2	Full
January	62.6	23.3	9.2	4.9
February	55.9	29.6	5.4	9.1
March	57.9	25.3	2.8	14.0
April	69.9	13.9	1.7	14.5
May	87.1	10.1	0.7	2.1
June	71.5	17.7	3.2	7.6
July	83.9	10.2	3.2	2.7
August	83.8	9.7	2.6	3.9
September	83.8	8.9	2.8	4.5
October	77.4	17.7	3.7	1.2
November	85.4	11.5	2.5	0.6
December	88.2	9.7	1.1	1.1

Table 3 . 8 Month wise % occurrence of food components in the diet of *L. duvauceli*

Varieties	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec
Fishes	24.1	12.1	73.1	39.6	30.4	34	41.7	0	30	17.9	49	66.7
Crab	36.4	68	3.9	31.5	21.3	17	9.4	46.7	30	37	16.9	8.3
Shrimps / Prawns	32.7	13	3.3	3.5	18	10.6	2	27.6	20.9	25	32	16.7
cephalopods	6.8	6.8	12	6.3	9	19.8	14	15.6	2	4.5	2	2.9
unidentified crustaceans	0	0	6.7	18.6	21.3	18.3	12.5	5.6	17	15.4	0	5

Percentages of fishes were the highest in March and December, crab in February and August

DISCUSSION

Studies on the biology and population dynamics of cephalopods of Indian waters gaubed attebtuib since the seventies. Prior to that Rao (1954) has studied some biological aspects of the Palk-Bay squid *Sepioteuthis arctipenis* from the south east coast. Some general information on the biology of different species of squids were given by Silas *et al* (1986) and cuttle fishes by Silas *et al* (1986 b) based on the data gathered from different centres of the east and west coast of India during 1976 – 1980. The food and feeding habits of squid *Loligo duvauceli* and cuttle fishes *Sepia aculeata* and *Sepilla inermis* of the southwest coast were studied by Oommen (1977). Stock assessment of *Loligo duvauceli* and pharaoh cuttle fish *Sepia pharaonis* were attempted by Meiyappan *et al.* (1993) and Nair *et al.* (1993). The results obtaind in the present study were discussed in the light of the results of the earlier studies on the biology of cephalopods along the Kerala coast and other centers of the west and east coast.

The length weight-relationship of *S. pharaonis* and *L. duvauceli* were worked out and the 'b' values were 2.01 for females and 2.55 for males and 2.30 for both the sexes combined in the case of *S. pharaonis*. The same values were 2.30 for females and 2.15 for males and 2.20 for combined in the case of *L. duvauceli.* In both the species the females and males have exponents (b) significantly different from 3 indicating allometric growth. The value of b in length – weight relationship is considered as 3 when growth is isometric. For an ideal fish which maintain diamention equality is metric 'b' value of 3 as has been occasionally observed (Allen, 1938). Slope value less than 3 indicates that fish becomes more slender as it increases in length while the slope greater than 3 denotes stoutness (Grover and Juliano, 1976). Deviation from this is often observed in fishes during growth and the value of b usually varies between 2.5 and 4.0 (Martin, 1949). In the case of *L. duvauceli* the slope values (b) males and females were 2.15 and 2.3 respectively and for *S. pharaonis* these values were 2.55 and 2.01 respectively which indicate sladerneus. The length weight relationship of *L. duvauceli* from the west coast was attempted by Silas *et al* (1986) and Meiyappan *et al* (1993) and observed that the rate of increase in weight in relation to length differed in males and females and they follow allometric growth. Similar observations were made by Silas *et al* (1986 b) and Nair *et al* (1993) in respect of the cuttle fish *Sepia pharonis* of the west coast.

The growth parameters L ∞ was 381mm and growth rate (K) was 0.92/year for males and females combined in *S. pharaonis*. In the case of *L. duvauceli* the L∞ and K value were worked out as300 mm and 0.75/year. *S. pharaonis* attain the L∞ at the age of 3.25 as per the present study. The Loo and k values were 320 mm and 0.72/year for males and 296mm and 0.82/year for females of *S. pharonis* of the west coast (Nair *et al,* 1993). In the case of *L. duvauceli* the corresponding values for the west coast were 360 mm and 0.80/year for males and 232 mm and 1.1/year for females (Meiyappan *et al*

1993). In an earlier study Silas *et. al* (1986) estimated the growth parameters of *L. duvauceli* of Cochin as 327 mm and 0.61/year for male and 205 mm and 1.19/ year for females. For *S. pharonis* from Vizhinjam the Loo and K values were 365 mm and 0.71/year for males and 342 mm 0.86/year for females. All these works were on the assumption that the growth in dorsal mantle length of cephalopod species follows von Bertalanffy's growth equation (VBGF). According to Jackson *et al* (2000) there are two views regarding the parameters of squid growth, the first one considers the squid growth asymptotic which can be described using the von Bertalanffy growth equation. The squid is considered as fish and describes squid growth using fin fish modeling techniques on the conclusion based on inferring growth curves from length frequency analysis (Long - hurst and Pauly, 1987; Pauly 1985, Jarre *et al* 1991). The second view considers squid growth different from that of teleost fishes and exhibiting non-asymptotic growth (Lipinski and Roeleveld, 1990; Rodhonse and Hatfield, 1990; and Jackson, 1994). Considering this view Meiyappan and Srinath (1989) suggested a modified growth formula in length while estimating the growth and mortality of *L.duvauceli* deviating from the classical form of the VBGF.

The total mortality rate (Z) was 2.50, the natural mortality (M) and fishing mortality (F) were 1.36 and 1.14 respectively for *S. pharaonis* in the present study. For *L. duvauceli* the natural mortality was 1.37 and the fishing mortality 1.24 bringing the total mortality 2.61. The mortality parameters observed in the present study are comparatively lower than the earlier studies. The Z value varied from 4.52 – 8.40 in males and 7.45-9.19 in female of *L.duvauceli* of Manglore coast during the year 1987-91 (Sunilkumar 1996) . In cuttle fish *Sepiella inermis* of Saurastra waters the total motality rates varied between 5.00 and 7.39 during the years 1979-'80 to 1982-'83(Kasim 1988).

The exploitation ratio (E) estimated for *Sepia pharaonis* and *Loligo duvauceli* were 0.46 and 0.48 respectively. According to Gulland (1971) the stock is supposed to be over fished if the exploitation ratio is above 0.5. As such both the species of the south west coast are not under much fishing pressure.

Cephalopods are rapid, active predators that feed on live prey like crustaceans, teleost and other cephalopods and play an important role in the trophic structure of the world's marine ecosystem (Nixon 1987, Rodhouse and Nigmatellin,1996) The feeding intensity was very poor in both the species. In *S. pharaonis* 72.3% of males 64.0% of females had empty stomachs. Teleost fish (53.0 %) formed the major component of food followed by crab (26.0%) and shrimp (19.0 %). Squid formed only two percent of the food. Intensity of feeding was found to be the highest during March and January with fin fish as the major component and during June- July with crustacean as the dominant variety.

The food of *Loligo duvauceli* consists of fin fishes, crustaceans, jelly fishes, and other cephalopods like octopus. The major portion of the teleost fishes were semi digested and could not be identified. Myctophids formed 18.0% lolignids11.0% and clupeids 5.0%. pandalids and shrimp's remaining together formed about 22.0% of the total stomach contents. Kore and Joshi (1975), and Oommen (1977)reported that the food of *L. duvauceli* of the west coast consisted of crustaceans, fish and squid. The crustaceans include portion of mysids, euphausids and ostracods. *L. duvauceli* being an inhabitant of column water there are chances of abundance of organisms present in the DSL (deep scattering layer) in the food. While studying the food and feeding habits of *L. duvauceli* of Cochin area Oommen (1977) has found 54.0% of squids with empty stomachs. Decreased feeding activity during the spawning season was observed (Kore and Joshi 1975) along the Ratnagiri coast.

Males were proportionaly more than the females during the period under study except the month of August in respect of *S. pharaonis*. They were comparatively larger than the females and ranged in length from 70 mm to 295 mm while the females ranged from 65 mm to 230 mm. Silas *et al* (1985) observed that females were generally dominant in the catches from hook and line fishing and males dominated in the trawl catches.

Very little is known about various stages of maturity of *S. pharaonis* and other cuttle fishes. Gabr *et al* (1998) have described four maturity stages viz immature (I), mature(II)pre spawning (III) and Spawning (IV) for *S. pharaonis* of Suez Canal modifying the maturity scale proposed by Mangold-Wirz (1963).No Spent stage is described by them in this case. In the present study four females appieared to the totally spent and they are assigned as spent stage in addition to the four stages followed by Gabr *et al* (1998). However this has to be studied further as the observations were only four and spent stages in cephalopods are not commonly recorded by many workers.

The spawning season appeared to be October to January when matured females were more in the case of *S. pharaonis* the size at first maturity was 140 mm in females. Silas *et al* (1985) observed the size at first maturity at 154 mm length in males and 157 mm length in females which is slightly higher than the present observation. According to them along both east and west coast this species spawns from October to April and in some areas up to August.

The fecundity estimates ranged from 720 in female of 140 mm to 1150 in 215 mm length. The fecundity estimated for this species of Suez Canal was between 517-1525 ova for females of 110-240mm mantle length. (Gabr *et al* 1998).

In the case of *Loligo duvauceli* dominance of females was noticed at length below 160mm and a male dominance above 160 mm length . The presence of female above 190mm was nominal during the study period.

The available information on the maturity stages of squids are scattered, fragmentary and frequently confusing (Arnold and William 1977) The scales proposed for one species of squid can be applied to other species of squids but not for cuttle fish or octopus (Burukovski,1977). A review of all information on squid maturity was made by Juanic (1985) and presented as a useful guide to applying maturity scales of squids. In the present study the maturity scales of females of *L.duvauceli* were described following Lipinski's universal scale which identify five maturity stages (Lipinski,1979). In males matured individuals occurred from 65.00 mm and above and reached 50% maturity at the length of 112 mm. All the males above 155 mm were in matured condition. In females matured specimen were observed at 60-70 mm size group and 50% maturity reached at 102mm length. Thus the females reaches maturity earlier than males. Mature specimens were observed in the landings almost throughout the year. An analysis of intra overion eggs showed only one mode around 1.3 mm indicating release of eggs in single batch during spawning. Dead or exhausted specimens were observed in the spawning grounds of *L. opalascens* and the Japanese flying squid *Todarodes pacificus* indicating post spawning mortality (Grieb, 1976; Grieb and Beeman 1978). Post spawning death process in *Todarodes pacificus* has been described by Hambe (1963) and Hayashhi (1971). At present there is no clear evidence of post spawning mortality in the speciaous. However the absence of matured females beyond 180 mm suggest post spawning mortality.

The number of matured ova varied from 2104 to 10989; Rao (1988) observed that the fecundity in *Loligo duvauceli* along the Mangalore coast varied between 1500 – 13156 and the present observation is comparable with this.

CHAPTER 4

PROCESSING OF CEPHALOPODS

INTRODUCTION

In recent years the processing of cephalopods has shown a rising trend due to greater world demand. About 24 – 26 seafood factories in Cochin process cephalopods and they account for 60% of the cephalopod processing in India. Cephalopods are considered a delicacy in foreign markets and high quality is the nrom especially in international trade. It is a remarkable feature that almost all the cephalopods processed are exported. Indian Standards Institution brought out standards for squid and cuttle fish in 1976(IS8076) outlining physical, sensory and bacteriological quality. The emphasis today is on high quality ensuring freshness of the material.

Studies have been made on storage characteristics of iced and frozen squid and cuttle fish (Joseph *et al*, 1977, Dhananjaya *et al* 1987; Joseph and Perigreen,1988). James and Iyer (1998) have evaluated the quality of frozen cuttle fish and squid by organleptic, microbiological and biochemical means.

Borgstrom 1965, Learson and Ampila (1977) Thrower and Thrower 1978 have found that cephalopods remain good in frozen condition up to eight months.

Lakshmanan *et al* (1993) have studied the quality levels of squid (*Loligo sp*) and cuttlefish (*Sepia sp*) for export in the sensory, biochemical and microbiological levels. Studies on iced and frozen quality of squid and cuttle fish have also been made by Raghunath (1984), Sastry and Sirkar 1985, Sanjeevan *et al* (1987), Lakshmanan *et al* (1993) and Varma *et al* (1985).

Sophia and Sherief (2003) indicate that treatment with 2% salt and 0.2% citric and improved quality of cuttlefish fillet and improved quality was observed up to eight weeks of frozen storage. Selvaraj *et al* (1991) found that ascorbic acid treated squid (*Loligo sp*) had improved quality and shelf life and no discoloration was seen even after nine months. Several studies have shown that ascorbic acid treatment improves quality of seafood in general.

Proteolytic degradation is probably the single most important characteristic affecting eating quality of cephalopods. Cephalopods are known to have short life spans of two to three years. Some grow rapidly and die after spawning. For rapid growth an active proteolytic system for protein turnover must exist. Active proteinases are found in the visceral and mantle portion of cephalopods. On death it is assumed that they enter a state of uncontrollable protein degradation from natural and bacterial sources. Rough handling and pressure of icing and storage probably releases proteolytic enzymes resulting in faster degradation.

Though cephalopods can be processed in dried, canned, smoked and other forms, in India freezing is the predominant method especialy specially for the export market.

Cephalopods have good nutritive value with the amino acid content almost similar to fish. The meat offers as many calories as white fish meat, has high biological value and rich source of B vitamins and phosphorous. They are fancied as a culinary delicacy in Japan, Spain, Portugal, USA and other countries. About 70% of the cephalopod body is edible forming the mantle, arms, tentacles and fin. And as such the most important use is as human food. In India the entire catch is exported mostly in the frozen form with very little of it is being consumed in the domestic market. A small portion is eanned or dried.

The high protein and low fat content make them suitable for human consumption (Roper *et al.* 1984)

While several products are made from cuttlefish, squid and octopus in various forms the dominant products are in the frozen form for export, Mainly forms an cuttlefish whole, whole cleaned, fillets etc. squids – whole, whole cleaned, tubes, rings etc. and octopus as whole, whole cleaned etc. An effort is made to study the handling and prossessing of various cephaloport products follwed by the industry and propose improvements to enhance the quality of products.

Materials and Methods

The material used for the study were the raw material available for processing at various seafood processing plants, processing cephalopods for export from Cochin. The main studies were at M/s Bhatsons Aquatic Products

Ltd, Aroor, Cochin. The company is a multi seafood product company dealing in frozen fish, shrimps and cephalopods mainly. It has steady supplies of raw material from suppliers and is operational round the year.

The company is a European Union Certified Company processing seafood products exclusively for export to the demanding international market. The operations of the preprocessing and processing lines and methods were closely monitored and recorded. The Company has in place a HACCP system to produce the finest quality material. Suggestions were tried to modify the processing operations and results evaluated.

Cephalopod processing

Maintenance of good quality begins with the fishing operations itself and the main factors for taking care of the good quality are listed below:-

1. Careful and speedy handling to avoid crushing and freshness of the material is an indispensable requirement for foreign market. Crushing will result in breakage of ink sacs and cause black colour spoiling the appearance.
2. Contact with dirty surface on board should be avoided and if frozen on board, must be kept cool before freezing and must be frozen quickly.
3. Fresh skin colour is an indispensable requirement and contact with warm air should be limited to the shortest time possible.

Trawling, jigging and gillnetting are the main methods of fishing. Squid jigging causes the minimum damage and it is the most appropriate fishing method for the Japanese market where freshest quality is required. Trawling can cause physical damage during the fishing operation and when the catch is hauled on to the deck. Netted squid often exhibits torn and spilt mantles. One of the causes of damage in trawl fishing is the presence of large amount of debris, especially mussel shells and other bottom wastes. This can be avoided to a large extent by the use of free hanging chains and floats that accentuate the lift of the net.

The unprocessed squid is cooled in chilled sea water and iced immediately for processing on the shore. Direct contact with sun is avoided by the use of plastic sheets, so that skin discolouration can be avoided. The squid are kept in plastic/polystyrene crates and iced with crushed block ice or flake ice for processing later. Care is taken to avoid direct contact of melting ice with the body of the squid. The squid caught by trawl net are immediately washed and sorted according to size and iced. In the case of onboard processing the squid are laid out evenly, according to size category tail by tail with tentacles folded underneath and along the squid.

Methods and equipment used in freezing the squid are same as that of fin fish. The product shape, product temperature, thickness of the layers in the freezing tray etc are some of the factors that influence the freezing time. Both squid and cuttle fish are processed as whole, fillets or tubes. Mainly the cuttle fish and squid are gutted in the factory only and it involves four steps. First the part of the head above the eyes and tentacles are cut off. This is followed by pulling away the head with the intestine. Then the mantle is spili and the inside is cleaned. For cutting rings the mantle is turned inside out and the remaining parts of the intestine are scraped off. The opened and eviscerated mantle is cleaned with potable water containing 5mg/kg available chlorine to remove all the impurities. The cleaned mantle is kept in iced water nearest to 0°C before freezing and the duration in iced water should not exceed more than two hours. This is because the contact with water has a protein leaching effect on the meat and hence excessive contact with water during the process must be avoided. The material is quick frozen at temperature of -40° C within four hours after filleting and dressing. It should not take more than 90 minutes to freeze the core of the material. The quick frozen material shall be stored in cold storage at -23° C or below. White appearance of the product is important for the market, especially for IQF products and to attain the white colouration and to avoid the rosy tint on the material, a bath in water containing citric acid and 3-4 Kg of salt per 100 liter is given. The result is that the tube is bleached with the citric acid and prevents the rosy tint while the salt firms up flesh.

The cuttle fish are laid on a table with central side down and the cuttle bone is removed first. This is followed by removal of viscera and cleaning of the mantle. The ink sacs, if required are kept for cooking. Skin is removed by making a cut on the neck and tearing it toward the tail end. The octopus are washed and the viscera is removed by holding the octopus on one hand exposing the inner parts and pulling out the viscera with the other hand. The viscera are then cut away at the throat and the body is thoroughly cleaned.

The main type of squid products are squid whole, squid whole cleaned, squid tube, IQF whole cleaned squid/ squid tubes, IQF stuffed tube, IQF rings with tentacles, IQF squid ring and squid tentacles. Size grades such as U/3,U/10,10/20, 20/40, 40/60, 60/80 and 80 up per kg are packed in 2 Kg blocks in waxed cartons. Ten such blocks form the master carton. The cuttle fish products are cuttle fish whole, cuttle fish whole, cleaned (cuttle fish fillets with tentacles), cuttle fish fillets, cuttle fish wing on, IQF whole cleaned, cuttle fish fillet rolled. The cuttle fish products are also packed in size grades starting from U/1 per kg and packed in 1 or 2 kg poly bags. Ten or twenty such poly bags forms a master carton.

Canning of cephalopods is of minor importance with only 1 to 2 % of the total landings in the world utilized in this way. However drying of squid are commercially practiced in Japan, other Asian countries and in Canada. The drying is thought to produce tasty and highly nutritious products. Tabashi (1905) maintained that sun drying induces particularly attractive flavour in the product. The sun drying takes about 3-5 days. The squids are hung over ropes with tentacles on one side and the fins on the other side. When the squid are about 70% dry, they are pressed between wooden boards or flattened by hand. This process is called shaping and the squid after shaping is placed in a tray with tentacles hanging from the tray. When the drying is completed with about 18-22% moisture, the shaping is done again.

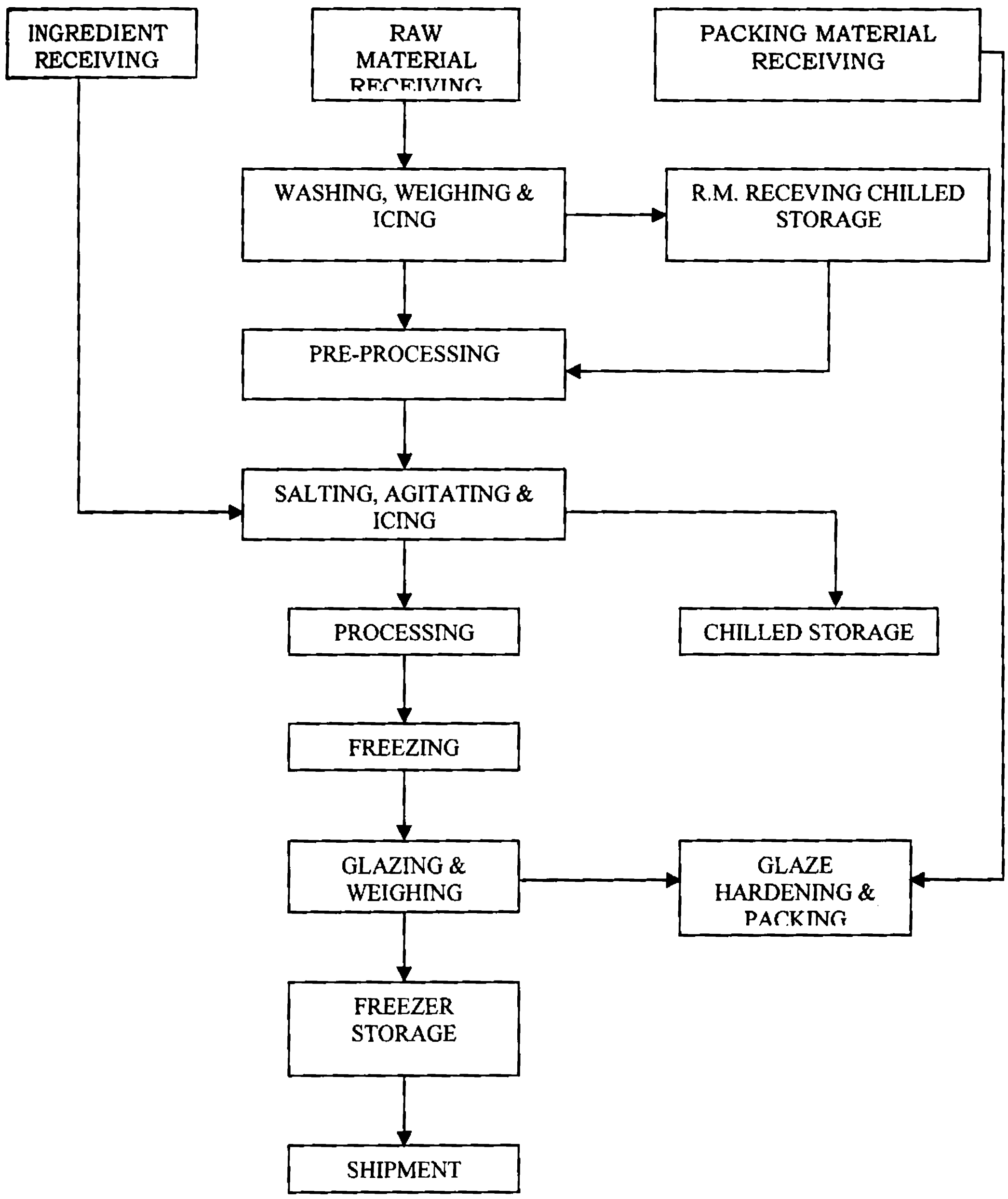
For smoking of squid and cuttle fish the cleaned mantle is soaked in hot water at 50-55°C for 2-3 minutes and skinned. This is followed by seasoning the mantle with dry seasoning material. The mantles are then piled in two or three layers on a table and pressed by weights in order to facilitate the penetration of the seasoning material for several hours. The seasoned mantles are smoked at temperature of 60-70° C for about 7-9 hours. The smoked mantle is cut in to rings of 1-2 mm width and seasoned with wet seasoning solution. Then the rings are drying in hot air and packed in plastic bags.

The value added products of cephalopods include battered rings and stuffed squid. For battering the squid rings are dusted with flour and dipped in batter mixture. The battered rings are then flash dried in hot vegetable oil at 180° C for about 20 seconds and rapidly frozen. The frozen, battered rings are packed in transparent polythene bags and stored under refrigeration. The stuffed squid comprises the tube of squid filled with stuffing, made basically from head tentacles and fins, seasoned according to the taste. The tube is not entirely filled and the filling mixture should be thick. The stuffed rings are put in to trays and frozen. Acelirated freeze dried products are also seen today.

The consumption of Cephalopods is mainly in traditional markets of East- South Asia and Europe. The market desires high quality products and the primary requirement is the freshness of the raw material. This is indicated by fresh sea weedy odour and firm, elastic texture of the frozen material.

The typical operations of processing under commercial condition in a typical seafood processing factory are described below. Some of the main frozen product of cuttle fish and squid are given with description of raw material selection, process operation, Hazard analysis and critical control point checks.

GENERAL PROCESS FLOW CHART FOR FROZEN CEPHALOPODS



STANDARD OPERATING PRODEDURE FOR RAW FROZEN CUTTLE FISH CFW, CFFT, CFFTW AND CFW/C, BLOCK FROZEN/IQF

Food Description

- Raw frozen cuttlefish –
- Block Frozen - 10X2KG AND 6X2 KG
- IQF - 10X1 KG, 1X10KG, 1X12KG
- Items - CFW, CFFT, CFTN

Incoming Materials :

Fresh cuttle fish whole are purchased directly from the landing center. After collecting the necessary information like time of catch, area of harvesting etc. from the suppliers, the raw material is inspected and satisfactory material are purchased. The purchased materials are kept in plastic containers with adequate quantity of ice at a temperature of <+5°c in chilled water and is brought to the pre-processing centre (PPC) in refrigerated trucks. At the PPC the materials are again checked for quality parameters. The raw material is d-eiced and organoleptic evaluation is done, for every 500 kgs, one sample is drawn to assess the quality standards. The observations are recorded in raw material evaluation register. Separate samples are taken from every arrival of raw material for testing the presence of any residues. If the test fails the material will be straight away rejected, they are within the quality parameters, it is received, weighed and given for pre-processing activities like deskinning, cleaning ice and removal of beaks tentacles, head etc, Separate raw material samples for bacteriological analysis are also taken.

The excess raw material received are kept in raw material chill room while the material received after the quality inspection are peeled (de-skinning), cleaned and graded before it is given for processing. The excess quantities of pre-processed materials are kept in plastic containers of 50 liters capacity with adequate quantity of ice in chill rooms and kept below + 5°c.

Packaging materials are delivered in clean, well maintained and covered vehicles. All the materials are checked for the prescribed quality. Only the material, which satisfies the quality standards are accepted. They are hygienically kept in dry storage rooms provided.

Processing :

The pre-processed materials are transported to the factory. The cleaned and graded material are weighted according to the product specifications and then placed in the freezing trays with enough chilled water added to obtain the proper glaze of the product. The weight and labelling instructions are put as per the buyer specification and is monitored by the production supervisors.

Care is taken to wrap the cuttle fish in polythene sheet after adding the glaze water to prevent any freezer burn on the product while freezing. The filled trays with product are then loaded into the horizontal plate freezer and ozen as blocks for a period of 60 minutes at – 40°c. If the product is IQF the aded material is fed into the IQF belt/plastics crates and after freezing anual glazing is done. The time and temperture are monitored by aintenance operator.

ackaging :

The frozen product is packed in master cartons according to the buyer pecification. The weight and labeling instructions are put as per the buyer rder and is monitored by the production supervisors.

Storage :

Packed products are kept in cold store below – 18°C in separate compartments according to the product type. The temperature of the store is recorded using a continuous thermograph indicator, and is monitored by Qualifty control (QC) supervisors. The QC technologists take one sample for microbiological analysis.

Shipping :

Shipment of the product is directly done from the store to pre-cooled containers without disturbing the cold chain. The stuffed containers are taken to the port for export to destination.

Table 4.1 Cuttle Fish whole Raw Material Specification

Sl.No.	Factors	Maximum Tolerance Limit in a Sample
1.	General Appearance and odour	Satisfactory
2.	Dehydration	Nil
3.	Discoloration	<2%
4.	Deterioration	Nil
5.	Broken/Damaged/Bruised Pieces	<5%
6.	Texture	Soft and firm
7.	Temperature	<5°C

FLOW DIAGRAM OF BLOCK FROZEN CUTTLEFISH WHOLE

CP -+7°c for 3 hours → WHOLE RAW MATERIAL

↓

WASHING

↓

GRADING

↓

WASHING IN MACHINE

↓

CHECKING (ON WHITE BACKGROUND)

↓

ICING (IN CRATE)

↓

TRANSPORTING TO FACTORY

↓

RECEIVING

↓

FILTH & SPRAY WASH ← WASHING ← 2 PPM chilled chlorine water

↓

SORTING & GRADING (WHITE BACKGROUND)

↓

WEIGHING

↓

CHECKING

↓

SETTING IN PAN 2 PPM chilled water

↓

CCP Temp. – 40°c → FREEZING

↓

PACKING ⟶ in master cartons at – 20°c

↓

STORING

↓

SHIPPING

STANDARD OPERATING PROCEDURE FOR RAW FROZEN SQUIDS SQW, SQT, SQW/C, SQT & TN. SQUID STUFED, SQTN, SQRG & SOFT, BLOCK FROZEN/IQF.

Food Description

- Raw frozen squids
- Block Frozen - 10X2 KG AND 6 X 2KG
- IQF -10X1 KG, 1X10 KG, 6X 1KG
- Items -SQW, SQT & TN, SQT, SQTN, SQFT, SORG

Incoming Materials :

Fresh squid are purchased from the landing centre. After collecting the necessary information like time of catch, area of harvesting etc., from the suppliers, the raw material is inspected and satisfactory material are purchased. (Table 4.2) The purchased materials are kept in plastic containers with adequate quantity of ice at a temperature of <+5°c in chilled water and is rought to the PPC in refrigerated trucks. At the PPC the materials are again checked for quality parameters. The raw material is d-eiced and organoleptic evalaluation is done. For every 500 kg one sample is drawn to asses the quality standards. The observations are recorded in a raw material avaluation register. Separate samples are taken from every arrival of raw material for testing the presence of Sulphite residues. If the test fails the material will be straight away rejected. If the materials are within the quality parameters, it is received, weighed and given for preprocessing activities like de-skinning, cleaning, removal of eye and beaks removal of tentancles, for beheading etc. separate raw material samples for bacteriological analysis are also taken.

The excess raw materials received are kept in raw material chill room. The material received after the quality inspection are peeled (de-skinned), cleaned and graded before it is given for preprocessing. The excess quantities of preprocessed materials are kept in plastic containers of 50 liters capacity with adequate quantity of ice in chill rooms kept below +5°c.

Packaging materials are delivered in clean, wwll maintained and covered vehicles. All the materials are checked for the prescribed quantity. They are hygienically kept in dry storage rooms provided.

Processing :

The pre-processed materials are transported to the factory. The cleaned and graded materials are weighed according to the product specifrications and then placed in freezing trays with enough chilled water added to obtain the proper glaze of the product. The weight and labeling instructions are put as per the order given and is monitored by the production supervisors. Care is taken to wrap the squid in polyethylene sheet after adding the glaze water to prevent any freezer burn on the product during freezing and storage. The filled trays with product are then loaded into the horizontal plate freezer and frozen as blocks for a period of 60 minutes at –40°c. If the product is IQF, the graded material is fed into the IQP belt/plastics crates and after freezing manual glazing was done. The time and temperature are monitored by maintenance operator.

Packaging

The frozen product is packed in master cartoons according to the buyer specification. The weight and labeling instructions are-put as per the buyer's order and is monitored by production supervisors.

Storage :

Packed products are kept in cold store at below – 18^0C in separate compartments according to the product type. The temperature of store is recorded using a continuous thermograph indicator, and is monitored by Quality Control (QC) supervisors. The QC technologists take one sample for microbiological analysis.

Shipping :

Shipment of the product is directly done from the store to precooled containers without disturbing the cold chain; the stuffed containers are taken to the port of discharge.

Table 4.2 Squid Whole Raw Material Specification

Sl.No.	Factors	Maximum Tolerance Limit in a sample
1.	General Appearance and odour	Satisfactory
2.	Dehydration	Nil
3.	Discoloration	<2%
4.	Deterioration	Nil
5.	Broken/Damaged/Bruised Pieces	<5%
6.	Texture	Soft and firm
7.	Temperature	<5°C

FLOW DIAGRAM OF BLOCK FROZEN SQUID - WHOLE

CP-+7^{0}C for 3 hours — HEAD ON RECEIVING

↓

ICING

↓

WASHING

↓

CLEANING

↓

GRADING

↓

WASHING IN MACHINE

↓

CHECKING-IN WHITE TABLE

↓

ICING-IN CRATES

↓

TRANSPORTING TO FACTORY

↓

RECEIVING

↓

FLITH & SPRAY ← WASHING ← 2 ppm chilled chlorine water

SORTING & GRADING – WHITE TABLE

↓

WEIGHING

↓

CHECKING IN WHITE BOARD

↓

SETTING IN PAN ← 2 Ppm Chilled Water

↓

ccp Temp. –40°c → FREEZING

↓

PACKING in master cartons at – 20°c

↓

STORING

↓

SHIPPING

FLOW DIAGRAM OF BLOCK FROZEN SQUID TUBE

CCP-+7OC for hours HEAD ON RECEIVING

↓

ICING

↓

WASHING

↓

PEELING

↓

SEPERATING HEAD AND BODY

↓

CLEANING

↓

GRADING

↓

WASHING IN MACHINE

↓

CHECKING-IN WHITE TABLE

↓

ICING-INCRATES

↓

TRANSPORTING TO FACTORY

↓

RECEIVING

↓

FILTH & SPRAY ⟷ WASHING ⟷ 2ppm chilled chlorine water

↓

SORTING & GRADING – WHITE TABLE

↓

WEIGHING

↓

CHECKING IN WHITE BOARD

↓

SETTING IN PAN ⟷ 2 ppm chilled water

↓

CCP Temp. – 40°c ⟶ FREEZING

↓

PACKING master cartons at –20°c

↓

STORING

↓

SHIPPING

Standard operating procedures for cooked products

From the in feed elevator the material passes into the cooking chamber through an in feed shaker, where it is blanched or cooked as per the requirement or product specification. The main difference between blanching and cooking is the temperature of processing and the duration of the treatment. Blanching is done for a shorter period of time and at a comparatively lower temperature than cooking. (Table 4.3)

Blanching is done based on the product description, but it is usually done for shrimps, squid rings, tentacles etc, whereas cooking mainly done for clams and mussels. Blanching or cooking time is based on the belt speed. Belt speed of the blancher/cooker is controlled by a motor and time of blanching is calculated by cycles of motor. The belt speed for cooking/blaching is calculated by cycles of motor. The belt speed for cooking/blanching depends on the material and grade.

The temperature in the blancher can be controlled by adjusting the rpm of the conveyor, by adjusting the level of the water in the blancher with water level controller and maintaining the hot water temperature by pumping water through a pneumatic controller.

The above control measures prevents the under/over cooking so that it will give even cooking and helps to maintain the yield of a product. In blanching the minimum temperature is 66°C for 15 to 75 seconds, which is necessary to destroy the human pathogenic organism. Blanching/Cooking controls enzymatic action.

Table 4.3 Blanching temperature for cooked product.

Grade	Critical Time	Operating
80/100	75°c	75-77
100/200	75°c	75-77
200/300	75°c	75-77
300/500	75°c	75-77
500/UP	75°c	75-77

Chilling

From the cooker the blanched / cooked material passes into the chiller through the conveyor. The material is chilled in water at a temperature of 2-3°C with 2ppm chlorination.

For continuous cooling of a blanched or cooked product fast cooling is recommended. Cooling ensures minimum weight loss while bringing the product to the requisite freezer check temperature. The product is fed from the blancher to the cooler.

Through a belt where it is immediately cooled by a chilled spray and carried into the cold-water bath. Just near the exit from the bath, another cold-water spray is directed on the product, there by achieving best freezer infeed temperature. The belt lifts the product out of water bath and drains all the surface water prior to freezer feed. Cooling time can be adjusted between 30 to 150 seconds.

Freezing

From the chiller the material passes into the flo freezer, via pre-cooler and the material is frozen at a temperature of -4°C for 10 to 15 min.

Flo-freezer is based on fluidization, which means fast, gentle, hygienic and individual (IQF) freezing of a wide range of products. Flo-freezer is fully continuous and integrated with the production line. The fluidization principle is that the product is exposed to an upwardly directed air stream that supports and conveys the product through the freezing without any need for a conveyor belt.

On its way through the Flo-freezer, each individual product particle is completely surrounded by air of sufficiently low temperature, suspended separately on a cushion of air the particles not only the freezes quickly but uniformly through out theproduct tray, it freezes with a minimum damage and clustering is minimized. This ensures complete individual quick freezing (IQF) and highest possible quality. The mass of product, which flows out of the freezer, is at the same rate as they are fed in.

Glazing

The frozen materials are surface glazed while passing through a glazer using chilled water at a temperature below 5°C chlorinated at 5ppm level.

The glazers are designed to provide each product a uniform protective ice coating. The product is fed to the vibrating screen of the glazer from the freezer through an adjustable angle chute.

The product is conveyed by the oscillatory vibrating motion of the screen and is sprayed with cold water from top and bottom by specially spray nozzles.

Glazing helps to prevent dehydration, it also enhances the shelf life of the product by reducing rancidity, it even prevents decomposition, gives a shining, desirable appearance. Over glazing causes clustering of product.

Glazing of the product depends on efficiency of the nozzle, movement of the product through conveyor, size of the product, temperature of the glaze water, time of exposure to water spray.

Glaze Hardening

From the glazer the glazed material passes into the Glaze freezer. The amterial is further frozen for glaze hardening at a temperature of -30 ro 35°C.

It is a fiber conveyor belt, which takes the glazed product directly to the glazo-freezer (Hardening freezer). It also helps to avoid clustering of the product after glazing.

Metal Detection & Filling

The glaze frozen product is channelised through a metal detector, which is sensitive upto 0.1mm diameter metal piece. On passing through that, the product is collected in the 10 kg. bulk cartoons and then taken for weighing.

Weighing

The filled cartons are now taken to the electronic weighing machine and their weights are made correct according to the glaze percentage.

Packing

Counted numbers of 10 kg master cartons are taken and put into tubs of 50 – 100 kg. capacity. Girls stand with small mugs of 50g capacity along with each tub and fill poly bags with desired product in declared proportions for Seafood Mix & if it's single product packing then they fill the bags with the same product & check their weight to the filling weight for the packs. The filled poly bags are heat sealed immediately and such bags are packed in a master carton of specified capacity.

The 10kg lots are bulk packed into aster cartons with polythene lining. The amster cartons are sealed and secured by taping by carton sealer.

Storage

Store is adjacent to the packing area. After packing the cases are stacked on trolley and are pulled to the storeroom through anteroom.

In storeroom the materials are grouped material wise, grade wise and packing wise separately.

The packed master cartons are stored at -18°c or below. The QC in charge ensures the correct flow of work and control of temperature. The thermo printer automatically records the cold storage temperature. The quantity of the finished material is recorded in the packing register. Each days production is identified by a day coding system (E.g. 3A16) and marked D or day shift and N for night shift and additionally A, B, C, etc. has subdivisions for each lot arriving boat wise to ensure traceability and enable recall procedure in case of non compliance.

Flow diagram : Cooked Products

RAW MATERIALS OTHER INGREDIENTS

↓

Receiving

↓

Weighing

↓

Storage

↓

Peeling

↓

Cleaning

↓

Soaking

↓

Feeding

↓

Cooking – CCP

↓ Packing

Chiling

↓

Freezing

↓

Glazing

↓

Glaze hardening

↓

Packing

↓

Metal checking - CCP

DETERMINATION OF CRITICAL CONTROL POINTS AT RECEIVING AND FREEZING AREAS

Preventive Measures

All the products are accepted only if the product temperature is below 5°C and free from decomposition.

Critical limit

Temperature :- +5°C

Decomposition :- NIL

Monitoring Procedures

The raw material arrives in plastic boxex. 25 boxes are considered as one lot and from such a lot one box is checked for decomposition and temperature by trained personnel. If there is any delay in processing, the material is re iced and held in the chill room to get the temperature below 5 degree C. This is done under the supervision of the trained personnel.

Corrective Action :

If there is any decomposition in the sample, then each box of that particular lot is checked and the boxes, which contain decomposed, materials are rejected and recorded in the corrective action format. If the temperature of the sample box is above the critical limit, then increase the number of sample boxes. From this the boxes, which are above critical limit, are re-iced. All corrective actions are recorded in the Corrective Action Format.

Chemical Hazards:-

Even though the chances of occurring of pesticide and heavy metal contamination is very less a competent external agency is engaged to conduct analysis on these factors and obtain the result once in three months, for antibiotics. All consignments are checked by an outside competent authority.

Preventive Measure

In the case of additional sulphite presence, daily check the raw material with Malachite green solution.

Corrective Action

If any Raw Material shows the presence of additional sulphite, reject that material immediately.

Critical Control Point (Freezing)

Hazards

Biological Pathogen

Preventive Measures

Checking the temperature and time of freezing by the technical person. After freezing the core temperature of product is checked.

The product is loaded into freezer only if it is pre-cooled for 15 minutes. A technical person supervises all these factors.

Critical Limit

Temperature : -40 degree C

Time : 90 minutes

Cire Temperature : 18 degree C or below

Monitoring Procedures

The freezer temperature, freezing time and core temperature of the frozen slabs is being carried out by a technical person for each load. All these data are recorded in the Time – Temperature Chart.

The temperature of the freezer is monitored by automatic temperature guage and the core temperature by Thermometer.

Corrective Action

If there is any fluctuations of the freezer temperature time, and core temperature of the slabs, then we will take following actions.

1. ***Freezer temperature and time :-***

   Rectify the defects and record in the corrective action format.

2. ***Core Temperature :-***

   If the core temperature of the slab is above – 18 degree C, then it will have to be refreezed and recorded in the Corrective Action Format. The lot which found to be defective is considered as a separate lot and subject to verification procedures in the lab and recorded in the Corrective Action Format.

Packing

Companies have high quality packing system, where separate storage, labelling and packing facilities are provide, the packing material are attractive and of good quality, so that they serve both the functions – consumer attraction and product quality maintenance. The products are packed in the required cartons as per the customer's demand.

Packing materials :

Polythene sheets : 30x30 size transparent polythene sheets are used for packing cuttle fish and squid.

Polythene bags:

Shrimps are usually packed in polythene bags 9x21 size transparent polythene bags are used for shrimp packing. 30x30 size transparent poilythene bags are used for covering 10 frozen blocks of shrimp.

1. ***Straps*** : Straps of 12mm width and 0.5mm thickness are used for strapping master carton.
2. ***Code Slip*** : It is a pieces of polythene paper containing details of product like, kind, style, count, date of production and expiry date printed on it. Date of production and expiry date are given at the time production it self by the production supervisors.
3. ***Duplex Carton*** : Duplex cartons are used only if the buyer specifies so. They are paper board cartons coated with wax to protect the contents

from loss of moisture. Usually scampi is packed in duplex carton.

4. ***Master Cartons*** : The finished products are packed in 10 wax coated corrugated fiberboard cartons. Usually 5 ply-corrugated cartons are used. Master cartons should be strong enough to withstand the vigorous practice of stuffing and unloading.

Specification on the pack;

1. Name of the product
2. Type of the product
3. Grade of the product
4. Processor's code
5. Year, month and date of processing
6. Net weight of the pack
7. Gross weight of the pack

NEW PRODUCT

A new products in the form of sea food mix with scphalopods was tried. The ratio cephalopods fish, shrimp, other sea food in the ratio 3:5:2:1 were tried and exported a sample consignments and the opinon of the buyers gathered.

HAZARD – ANALYSIS WORKSHEET

Product Description : BLOCK FROZEN SQUIDS

Method of Distribution and Storage: STORED AND DISTRIBUTED AS FROZEN

Intended Use and Consumer :

TO BE REPROCESSED BY THE IMPORTER

(1)	(2)	(3)	(4)	(5)	(6)
Ingredient Processing Step	Identify Potential Hazards introduced controlled or enhance at this step(I)	Are any potential food-safety hazrds significant Yes/No	Justify your Decisions for Column3	What preventive measures can be applied to prevent significant hazards	Is this step a critical control point (Yes/No)
RAW MATERIAL RECEIVING	Biological	Yes	Since there is no further step to reduce the hazards	Time and Temperature keep the temperature below+5 deg C for 3 hrs.	Yes
	Chemical		Source Control		
	Physical Foreign Matter	No	It can be removed during further step	Not applicable	No

HAZARD – ANALYSIS WORKSHEET

Product Description : BLOCK FROZEN CUTTLEFISH

Method of Distribution and Storage:

STORED AND DISTRIBUTED AS FROZEN

Intended Use and Consumer :

TO BE REPROCESSED BY THE IMPORTER

(1)	(2)	(3)	(4)	(5)	(6)
Ingredient Processing Step	Identify Potential Hazards introduced controlled or enhance at this step(I)	Are any potential food-safety hazrds significant Yes/No	Justify your Decisions for Column3	What preventive measures can be applied to prevent significant hazards	Is this step a critical control point (Yes/No)
RAW MATERIAL RECEIVING	Biological	Yes	Since there is no further step to reduce the hazards	Time and Temperature keep the temperature below+5 deg C for 3 hrs.	Yes
	Chemical		Source Control		
	Physical Foreign Matter	No	It can be removed during further step	Not applicable	No

DISCUSSION

All cephalopod processed is exported especially to the sophisticated markets of Japan, USA and Europe. The demand for quality products is exacting and stringent conditions are placed on the quality of the product. The Indian seafood processor even today has a bias towards shrimps and goes in for cephalopod processing only when there is a slump in shrimp catches (Personal communication).

It is a known fact that cephalopods undergo rapid proteolytic changes after catch. While the processing operations in the seafood plant are carried out under the regulations of the European Union which are addressed to in letter and spirit, it is observed that there is delay in product movement from raw material reception, preprocessing center and processing. If this time lag can be reduced it will result in better quality of end product. However it is observed that processing lines in operation have a bias towards shrimp processing and hence this problem arises.

Modification of the processing lines to expeditiously more cephalopods will result in better quality product. It was observed in the study at the plant that cutting operational tome by 10% resulted in products with better organoleptic properties.

Most of the plants process products of the traditional kind and there is a reluctance to innovate and try out non conventional and value added products.

The reason adduced is that there is no time to waste as there will be a time lag in the introduction and acceptance of the product in the export market.

Quality factor are self regulatory as producing the finest quality is incumbent on the discerning buyer demanding it. Quality today in a sophisticated and a global market is the norm of the day.

The plant in the study being Erupion Union compliant has in place quality systems and rejects are minimal or nil. It is suggest that all companies processing cephalophots follow the strict norms of the EU to obtain excellent quality product. The systems relatively provide stable end results. One products tride as sea foods with sephalophods and low value fishes was wel accepted by buyers in Europe. and further enquiries have come in. this should be sceen as a trend in the right direoctor as it will telp in export of low value items along with sephalopods insuring value addition and better revenue to the processor at low cost.

CHAPTER 5

UTILIZATION AND EXPORT OF CEPHALOPODS

UTILIZATION

Cephalopods have very high nutritive value as comparable to other quality fishes and crustaceans. The edible portion of the cephalopod body consisting of the mantle, fins, tentacles and arms form 60 – 80% of the total body weight, which is higher than the finfishes and shell fishes (Silas etal 1986). The high protein and low fat content make them suitable for human consumption. Consumption of cephalopods was not very common in India. They are very rarely included in the diet may be due to the conventional food habits and preferences to fishes and shellfishes. Though the production has increased due to the demand in foreign markets, their demand for local consumption is not very much. However an increase in domestic consumption is noticed they very recently, may be due to the searcity of quality fishes, Mainly consumption is restricted to coastal areas and they are sold in fresh conditions in the near by markets. The Japanese eat cuttle fish and squid raw with sauce and they have a wide range of culinary preparations out of squid, cuttle fish and octopus.

In long line fishery for tunas, billfishes, pelagic sharks etc cephalopods are used as baits. According to Silas and Pillai (1982) squids are the most important bait in the tuna long line fishery. Cephalopods have been used as bait in hook and line fishery along the Indian coast(Sarvesan, 1974; Rajagopal *et al* 1977; Silas and Pillai 1982)

The cuttle bones have a wide variety of commercial and industrial applications. Cuttle bones are used for preparing fine abrasives and dentifrices (Dees 1961). Powdered cuttle bones are used for cleaning glasses, the surface of wood works, motor vehicles etc. before painting. It is a good source of food for poultry and cage birds. A variety of fancy articles are made out of cuttle bone in Japan. The oil and liver extracts are used for human consumption and as food for live stock (Takahashi, 1965).Squid and waste from squid and other cephalopods are used as manure and converted as fish meal and poultry feed. The squid viscera, which is often discarded as offal by the fishing vessels or processing factories is used by Japan, Republic of Korea, Taiwan, China and Spain for manufacture of items like squid meal, soluble protein, squid oil and fermented salted products (ADB/ INFOFISH, 1991). The utilization of squid viscera has great potential in the light of the growing demand for the squid meal by the eel and shrimp aquaculture industry.

The ink of cuttle fish has been used by the artists as a natural pigment and it has got medicinal values.

Export of Cephalopods from India

Cephalopods have emerged in recent years as an important component of the marine products exported from India and has become now the third largest item . The export of frozen cephalopod products started in 1965 from a meagre 42 ton had a phenomenal growth. During the period 1998 – 2000 India exported an average of 74758 tons of cephalopods both frozen and dried, which formed 18.84% of the total marine products exported. Similarly cephalopods totally earned an average of Rs. 644.04 crores during this period which is 11. 18% of the total foreign exchange earnings from marine exports. Initially only few countries like Burma, Singapore, Japan, France, Italy, U K etc imported cephalopod products from India. The trade has grown up year-by-year and now cephalopod products are exported to more than 50 nations. Similarly the total number of products increased from few frozen cuttle fish and squid products to 57 products of frozen and dried cuttle fishes, squid and octopus during the year 2002.

Data source

Statistics of marine products exports published every year by the Marine Products Export Development Authority (Ministry of Commerce and Industry, Government of India) is used in this study. It provides all information pertaining to the products, countries, value etc. The export statistics ten years period from 1992 – 2001 is analyzed to find out the unit prices realized by various products, their yearly fluctuations both in quantity and value, shere of cephalopod in the total marine export, the important countries importing each product, prices offered by each item etc. during this period.

Brief history of cephalopod exports

Export of cephalopod products started in the year 1963 with the export of 421 kgs of cuttle fish bones to Burma valued Rs.11,139/-. In the year 1964 United States and United Kingdom imported 6 tonne and 1 tonne of cuttle fish bones respectively. In 1968 West Germany also joined by importing 650 kg. of cuttle fish bones valued Rs. 2740/-. The bones imported to Burma fetched Rs.21.31 per kg while rates of other countries were very low. During the sixties 69,452 kgs. of cuttle fish bones were exported valued at Rs.3,16,330. Burma, USA and UK were the regular. The contribution of cephalopod to the marine export was only 0.01-0.1% of the total import by quantity and 0.01-0.05% by value during the sixties.

During the year 1971 Sri Lanka, came into the picture by importing 2269 kgs. of cuttle fish bones valuing Rs.9550/- followed by Singapore in the next year with 3 tones valuing Rs.19830/- @ Rs.6.6/kg .In 1973 Belgium, France and Japan together imported 35.465 kgs. of cuttle fish bones. Initially cuttle fish bone was the only item of export from India, and it formed only a negligible part of the total export.

Export of products other than cuttle fish bones commenced from 1974 onwards when Australia, Belgium and Japan imported 49 tonnes of frozen cuttle fish at on average rate of Rs.10.84/kg which was the beginning of export of cephalopods as food item. In the same year 93 tonnes of frozen cuttle fish fillets were exported to Japan at the rate of Rs.15.74 per kg. In 1975 the countries like Australia, Belgium, France, Spain and USA together imported 46 tonnes of frozen squid for the first time at an average rate of Rs. 6.62 per kg. Till 1985 frozen cuttle fish, frozen cuttle fish fillets, frozen squids and cuttle fish bones were the only export items. There was a steady growth in cephalopod export since 1974. From 142 tonnes in the year 1974 the export reached to 4040 tonnes in the year 1983. The percentage contribution has also gone up from 0.09% in 1973 to 4.41% in 1978 and 5.12% in 1980 and 4.69% in 1983. There was a slight decrease in the export of cephalopods in the year 1984 contributing only 3.49%.

There was a significant increase in the export from the year 1985 onwards. In this year 7627 tonnes of cephalopod products forming 9.46% of the total marine export were marketed in various countries. It has gone up to 23947 tonnes in 1988 constituting 24.11% of the total export. In the year 1989 cephalopod formed 26.09% of the which was the highest contribution. Thereafter the share of cephalopods was between 18.62% to 24.74% of the Frozen octopus was added in the year 1989 by exporting 44 tonnes to Japan, Cyprus, Belgium and Spain. From the year 1990 onwards more and more value added products were added way year to meet the demand in the international markets.

Table 5.1. Export of cephalopods from India during the period 1965 - 2001

Year	Quantity (tonnes)	Cephalopods (tonnes)	% quantity of cephalopods	Total value Rs. 000	Value of cephalopods (Rs. 000)	%Value of cephalopods	Unit value per kg (Rs.)
1965	15457	8	0.05	69237	37	0.5	4.62
1966	19153	17	0.09	135246	50	0.04	2.94
1967	21764	3	0.01	199286	26	0.01	8.66
1968	24810	27	0.12	230846	98	0.04	3.63
1969	30584	11	0.4	330731	74	0.02	6.73
1970	37175	3	0.01	355359	20	0.01	6.67
1971	34032	13	0.04	391725	54	0.01	4.15
1972	38721	24	0.06	581317	123	0.02	5.13
1973	48785	46	0.09	795763	405	0.05	8.80
1974	46629	142	0.30	763127	1983	0.26	13.96
1975	53412	1072	2.01	1049063	29428	2.81	27.45
1976	62151	1164	1.87	1798620	19609	1.09	16.85
1977	64964	1744	2.68	1797374	24114	1.34	13.83
1978	77946	3439	4.41	2121574	49602	2.34	14.42
1979	92184	3476	3.77	2620292	63582	2.43	18.29
1980	74542	3817	5.12	2188756	55795	2.55	14.62
1981	75375	2831	3.76	2867128	48602	1.70	17.17
1982	75136	3260	4.34	3422429	76089	2.22	23.34
1983	86169	4040	4.69	3623231	72711	2.01	18.00
1984	89912	3141	3.49	3854983	70647	1.83	22.49
1985	80588	7627	9.46	3756683	135661	3.61	17.79
1986	89283	14305	16.02	4626841	290736	6.28	20.32
1987	89125	13073	14.67	4895540	281865	5.76	21.56
1988	99306	23947	24.11	5833819	565120	9.69	23.60
1989	103557	20014	26.09	6155533	773441	12.56	28.65
1990	133653	27983	20.94	8184110	847828	10.36	30.29
1991	162930	35092	21.54	12742383	1438936	11.25	41.00
1992	191314	44453	23.24	15814358	2357691	14.91	53.03
1993	239918	57742	24.07	22527980	3425894	15.21	59.33
1994	301278	67071	22.26	35655197	4588718	12.87	68.41
1995	289524	71641	24.74	33947003	5293013	15.59	73.88
1996	353676	81629	23.08	39800164	5986557	15.04	73.04
1997	398977	74303	18.62	46615846	5814098	12.47	78.24
1998	313503	70820	22.59	47095457	5874102	12.47	82.94
1999	327205	73448	22.45	47573910	6005566	12.62	81.77
2000	421075	73485	17.45	63965654	6292596	9.84	85.63
2001	424320	73101	1723	59172989	6112743	10.33	83.62

There was a slight decrease in the percentage contribution during the year 2000 and 2001 though the total marine export has gone up significantly. The percentage contributions were 17.45% and 17.23% respectively.

More or less similar trend was noticed in respect of revenue realized on account of the export. During the period 1965-1973, when cuttle fish bone was the only product the total revenue was only Rs. 8,87,000/- which was negligible compared to the total earning from seafood export. From the year 1974 onwards an increase in the share of revenue was inorded Cephalopods constituted 1.09 - 2.81% of the total sea food export earnings during 1975-1984. Substantial increase in the export earnings for cephalopods was noticed from 1985 onwards and in 1986 the quantity almost doubled . In 1988, 9.69% of the total export earning was on account of cephalopod, constituting one fourth of the total export. There was substantial growth in the export value as compared to the previous decades. The contribution of cephalopods ranged between 10.36% - 15.59% of the total export earnings. As happened in the case of quantity decline was observed in 2000 and 2001 in respect of percentage contribution export earnings though the amount realized was more in these year (Table 5.1).

With the commencement of export of frozen items from 1974 onwards the unit prices have also gone up steadily with slight yearly fluctuations. The unit prices ranged between Rs. 13.96 – 23.60 kg during the period 1974-1988 (fifteen years period). From 1989 onwards the unit prices have gone up steadily and the price has reached to Rs. 85.63 per kg. in the year 2000 which is the heigst during the study period. There were 52 items of cuttle fish, squid and octopus including the dried variety as per the data for the year 2002. They are listed below.

Cuttle fish:

Frozen cuttle fish whole, Frozen cuttle fish whole cleaned, Frozen cuttle fish tentacles, Frozen cuttle fish rings, Frozen cuttle fish roe, IQF cuttle fish, Frozen cuttle fish ink, Frozen cuttle fish wings, Frozen cuttle fish W.C (tray packed), Frozen baby cuttle fish, Frozen cuttle fish blanched, Frozen cuttle fish de-skinned, Frozen cuttle fish (meat trimmed), Frozen cuttle fish beak, Frozen cuttle fish strips, Frozen cuttle fish tips/ cones, Frozen cuttle fish fillets.

Squid :

Frozen squid whole, Frozen squid whole cleaned, Frozen squid tube, Frozen squid rings, Frozen squid tentacles, Frozen squid fillets, Frozen squid whole (peeled), Frozen squid (stuffed), Frozen squid roe, Frozen squid tubes / rings/ tentacles, frozen squid wings, frozen squid (tray packed), frozen squid blanched , frozen squid rings blanched, frozen squid neck, frozen squid tips/cones, frozen squid strips, IQF squid rings, IQF squid stuffed, IQF squid whole cleaned, frozen squid whole round, frozen baby squid whole round, frozen squid tentacles whole blanched, IQF squid stripes, IQF squid whole, IQF squid tubes.

Octopus:

Frozen octopus, Frozen baby octopus, IQF octopus tentacles, IQF baby octopus, Frozen octopus tentacles, Frozen octopus rings, AFD octopus and Frozen octopus whole cleaned.

Dried products

Dried cuttle fish, dried cuttle fish bone, dried squid and dried octopus.

Category wise study of important products during 1991 – 2001

The result of detailed study made on important products are presented.

Cuttle fish bone

As stated earlier cuttle bone was the only cephalopod product exported from India till 1973.

Export of cuttle bones started in 1963 with the first consignment and till 1973 altogether 153 tonnes of cuttle bones valued Rs. 8,87,000/- was exported. The countries like Burma, USA, and UK were the regular importers of cuttle fish bones.

Among the countries which imported cuttle bone, Burma gave the highest unit price. The unit values were between Rs.21.25 – Rs. 37.50. Next highest unit price of Rs. 13.80 was offered by Japan in 1973. Singapore offered Rs.6.61 per kg.. Though import was steady from USA and UK, the unit prices offered by them were only Rs. 4.61 and Rs.3.94 respectively. UK has imported 35.62% of the total cuttle bones from India while USA imported 30.03% and Japan 9.11%. The share of Burma was only 2.18%.

During the period 1974-83 totally 251455 kgs of cuttle fish bones were exported to various countries realizing Rs.2.53 million. USA and UK continued to be the regular importers of cuttle bones. West Germany and New Zealand were regular importers during 1976 – 1983.

During the period 1984-93 India exported 124039 kgs. of cuttle fish bones valued Rs. 2.63 million. Though the quantity is nearly half of last years export the value realized was more less the same due to the increase in unit price which was more than double of the previous years.

The export of cuttle fish bones has come down drastically during the period 1994-2001 (eight years). Only 26 tonnes valued Rs. 1.4 million was exported to two countries viz. UK and Japan. About 90% of the total export was taken by the UK. Average unit price for this period was Rs. 54.89 per kg. against Rs. 21.26 per kg. during the previous decade. Therewas no significant export of cuttle bones from the year 1999 onwards.

Dried cuttle fish bone

Though cuttle fish bone export has reduced drastically and almost stopped from 1999 onwards, another product viz. dried cuttle fish bone picked up the export market. This item was exported first time in 1995 to countries like Bahrain Islands, Hong Kong, Sri Lanka, USA and New Zealand. Bahrain Island imported 75.45% and Hong Kong 24.08% in 1995. China jointed the market in 1996 by importing 74 tonnes at the rate of Rs. 63.62 per kg. The countries like China, Bahrain Islands, Hong Kong and Greece imported the major part of this item. The unit price was very low in the year 1995, due to the very low price of Rs. 1.58 per kg offered by the Bahrain Islands. Then there has been substantial increase in the price and it has gone upto Rs.64.19 in 1997. However the exports of this commodity is dwindling year by year.

Frozen cuttle fish

Cuttle fish whole was the first frozen item of cephalopod exported from India. Totally 47. 9 tonnes of frozen cuttle fish value Rs.5.2 lakhs was exported to Australia, Belgium and Japan. In 1975 there was a remarkable increase in quantity and value. France and USA also joined the above countries and totally 381.1 tonnes valued at Rs. 10.1 million was exported. However the highest export was in 1980 exporting 926.3 tonnes valued at about Rs.18 million. Second highest export was in 1983, viz. 886 tonnes valued at Rs. 21.6 milliom. Countries like Netherland, Australia, Belgium, Italy, Spain, USA, UK etc. made regular imports.

The average unit price was Rs. 10.85 per kg. in the year 1974 and Rs.26.65 in the next year the price ranged between 19.03 and 24.42 during 1980 and 1984. Remarkable increase in the unit price is seen from 1992 onwards which recorded Rs.39.51 per kg. The year 1993 recorded Rs.52.93 per kg. and thereafter the unit prices gone up steadily and reached the highest unit price of Rs. 69.33 in the year 1997 with slight decline. The unit prices renged from Rs. 39.51/kg and Rs. 69.33/kg the highest price of Rs. 69.33/kg was obtained in 1997.

Table 5.2 Year wise export details of Frozen cuttle fish whole

Sl no	Year	Quantity Tonnes	Value Rs. 000	Unit value RS.
1	1992	6011.5	237531.3	39.51
2	1993	10371.6	548988.3	52.93
3	1994	16505.3	1016419.7	61.58
4	1995	11413.2	640213	56.1
5	1996	17982.4	1231607.8	68.49
6	1997	22990.4	1593913.2	69.33
7	1998	18694.8	1152054.5	61.62
8	1999	14905.5	901997.2	66.51
9	2000	15333.4	927108.2	60.46
10	2001	10492.1	656262.5	62.55

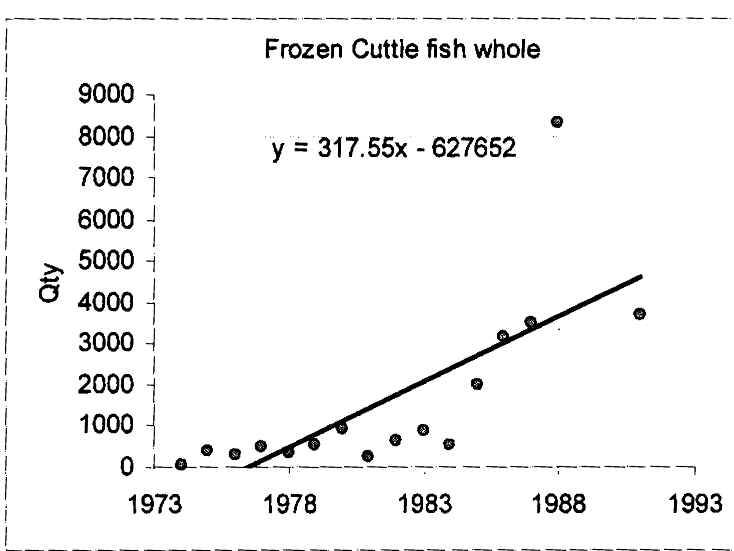


Fig 5.1. Yearly growth rate of Frozen cuttle fish whole

The details of export of frozen cuttle fish to the major importing countries during 1992-2001 are given in table 5.2. and Fig. 5.1 Considerable growth in the export of this commodity is observed from 1992 onwards. During this year 6011.5 tonnes was exported to various countries. The highest export was in the year 1997 and 1998 with 22990.4 tonnes and 18694.8 tonnes valued Rs.159.4 and Rs.115.2 crores respectively. During this period China bought 37.08% which was the highest. Thailand and Spain imported 16.25% and 15.66% respectively. Hong Kong and Portugal contributed 7.83% and 5.27% respectively.

Japan offered the highest average unit price of Rs. 83.97 per kg. and the next highest rate of Rs. 64.76 per kg by Greece. Singapore and Spain also offered Rs. 64.0 per kg. The lowest prices of Rs. 40.83 per kg. and Rs. 48.00 per kg. were offered by Portugal and Hong Kong respectively. (Table 5.3).

Table 5.3.Frozen cuttle fish whole country wise export

Country	Quantity	Value Rs. 000	Unit value Rs. Per kg	% of Export
China	49759.3	3059054.8	61.48	37.08
Greece	1275.6	82612.7	64.76	0.95
Hongkong	10514.5	504543.96	48	7.83
Italy	2699.7	151100.5	55.97	2.01
Portugal	7066.4	288524.1	40.83	5.27
Singapore	2433	153560.6	63.9	1.79
Spain	21018.1	1337935.6	63.66	15.66
Thailand	21815.3	1324341.3	60.71	16.25
U.A.E	5528.8	339485.3	61.4	4.12
Japan	4852.3	407449.4	83.97	3.62

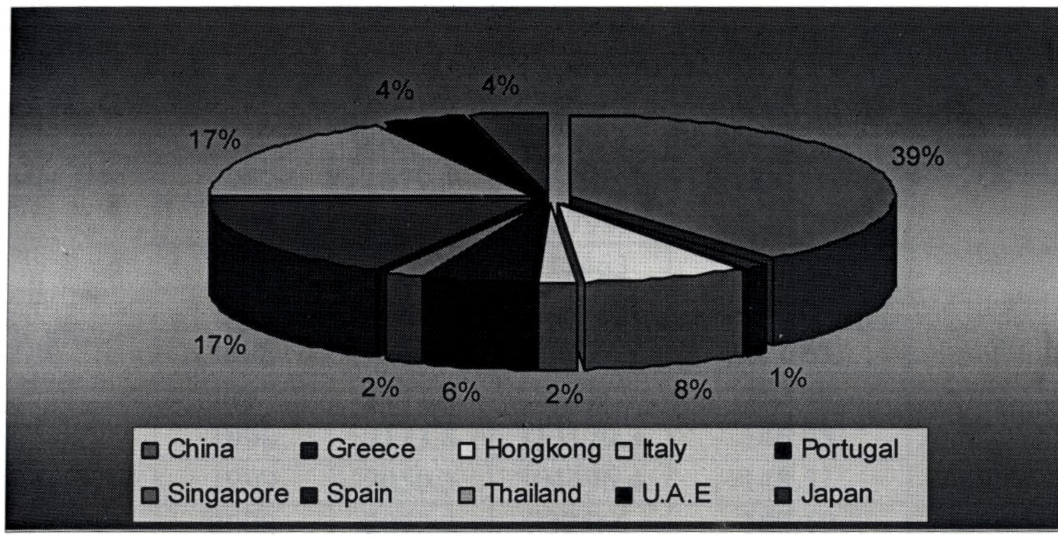


Fig 5.2.Frozen cuttle fish whole country wise export

Cuttle fish fillets

The export of cuttle fish fillets commenced in 1974 by exporting 92.7 tonnes to Japan which valued Rs.14.6 lakhs. In 1975 Japan imported 625.1 tonnes of fillets valuing Rs. 1.88 crores. Countries like Australia, Belgium, Netherlands and Denmaek also imported for the first time in small quantities. During the first decade of export totally 10 countries have imported cuttle fish fillets from India. The countries like Algeria, Saudi Arabia and Nepal have imported only once during this 10 years period.

Table 5.4 Frozen Cuttile Fish fillets exports year arise.

Year	Qty. Tonees	Value Rs.000	Unitvalue Rs per kg
1992	1679.5	145825.4	86.83
1993	1323.5	146794.2	110.91
1994	1852.9	315463	170.25
1995	2634.1	374069.7	142.01
1996	2656.7	349653.7	131.61
1997	2177.5	332037	152.49
1998	2133.8	313129.3	146.75
1999	2050.3	304496.4	148.51
2000	2072.2	332566	160.49
2001	1007.9	133475.7	132.43

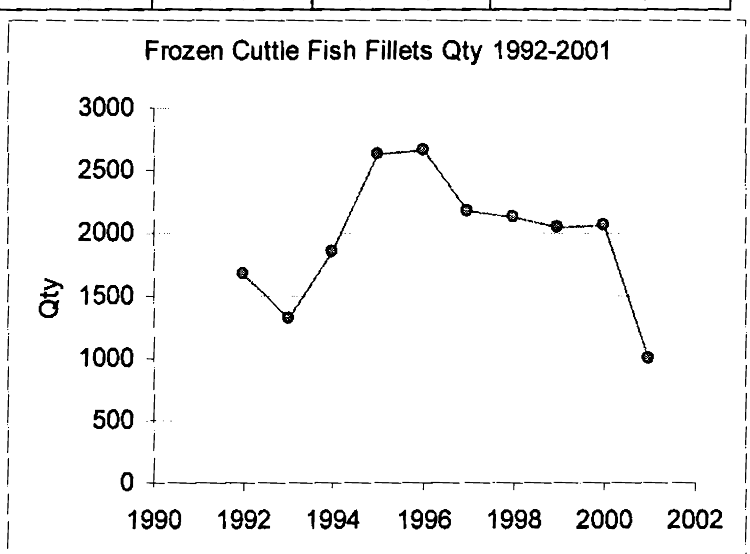


Fig. 5.3 Year wise export of frozen cuttle fish fillets (Qnantity)

The details of export of cuttle fish fillets during the period 1992- 2001 are given in Table 5.4. and Fig. 5.3 Significant fluctuations are noticed in the quantity exported and value realized. The export was declined in 1997 to 2177.5 tonnes and it was steady till the year 2000. In 2001 the quantity has reduced to 1008.0 tonnes, less than half of the previous years. Similar fluctuations are noticed in the total value and unit prices realized. The highest unit price of Rs. 170.25 per kg. was recorded in the year 1994 and the second highest of Rs. 160.50 per kg in the year 2000. The year 2001 recorded a relatively low price of Rs. 132.42 per kg. Totally 28 nations have imported cuttle fish fillets from India during this period. Contributions of top 12 countries are shown in figure 5.4. Japan stands first with 9534.0 tonnes constituting 48.67% of the total export from India. Singapore was the second with 2429.7 tonnes forming 12.40%. Thailand imported 8.44%. The contribution of China, Hong Kong and France are also significant. The highest average unit price of Rs. 201.88 per kg. was offered by USA. Thailand and Singapore offered the next highest average prices of Rs. 194.14 per kg. and Rs. 191.89 per kg. respectively. The lowest average unit price of Rs. 48.12 per kg. was offered by UAE. The countries like Spain, France and Italy also quoted comparatively very low prices. In general the South- Eastern countries offered more rates than the European countries **(Fig. 4.5.)**

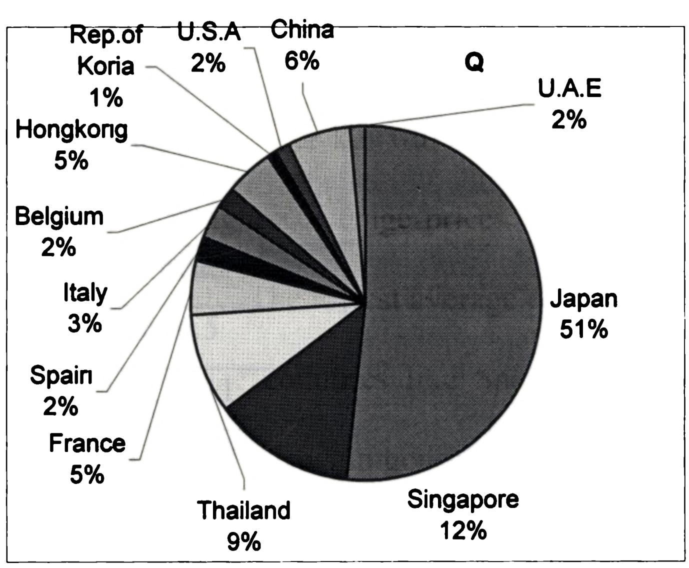


Fig 5.4 Frozen Cuttile fish fillets country wise

Frozen cuttle fish whole cleaned

Information on this commodity is available from 1991 onwards only. In this year 4464.1 tonnes were exported. In the next year the quantity was 9234.8 tonnes, i.e. more than double of the previous year. In 1994 export of this variety has declined drastically and reached 6208.2 tonnes. The very next year the export was nearly double of the previous year. The export market has picked from 1998 onwards after a decline in the previous two years. During the period, 1998-2001 the export was over 10,000 tonnes per year. The highest quantity exported was 12106.7 tonnes in the year 1999. In the year 1991 the average unit price was Rs. 50.62 per kg. There was gradual increase every year and the highest unit price of Rs. 109027/kg was recorded in the year 2001 Table 5.5.

Table 5.5 Frozen cuttle fish whole cleaned year wise export

Year	Quantity (Tonnes)	Value (Rs. 000)	Unit Value (Rs. Per kg)
1992	9234.8	630130	68.23
1993	8092.4	637812	78.82
1994	6208.2	541922	87.29
1995	11602.7	1003714	86.51
1996	8646.5	772526	89.08
1997	6176.11	656646	106.32
1998	11380.6	1212988	106.58
1999	12106.7	1220611	100.82
2000	10292.7	1072101	104.16
2001	11158	1219215	109.27

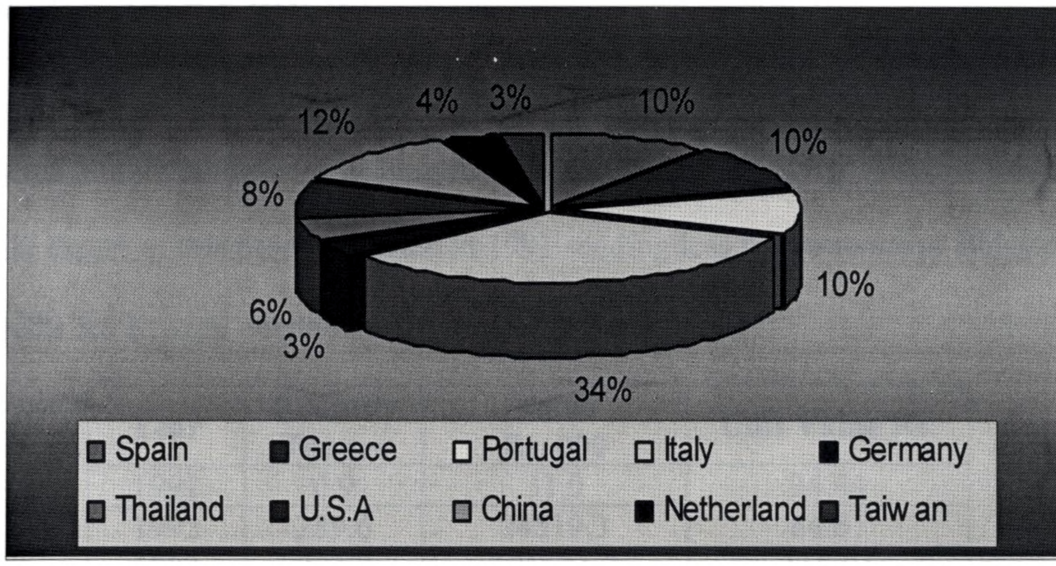


Fig 5.5 Frozen cuttle fish whole cleaned country wise exports

Altogether 41 countries have imported this commodity from India. Countries like Iraq, Las Palmas, Canary Islands, Lebanon, Maldive Islands etc. made one or two imports during the period 1992-2001. Spain dominated by importing 4002.6 tonnes which constituted 47.77% of the total export from India (figure 5.5). Italy was the second with 15.16% and China occupied third place with 5.55% in the credit. Greece and Portugal also imported nearly five percent. Japan was the lowest contributor but offered the highest price of Rs. 106.18 per kg. Next highest rates of Rs. 105.60 per kg and Rs. 103.60 were offered by Taiwan and Netherlands respectively. The lowest unit price was offered by Italy (Rs. 79.64 per kg). The unit prices received from countries like China, Thailand and Portugal were comparatively low.

Frozen cuttle fish IQF

This product has attained significance in the export market and in quantity and value it is next to cuttle fish whole and cuttle fish whole cleaned. The export of this product started in 1991 sending less than a tonne to Belgium

Table 5.6 Frozen cuttle fish I Q F year – wise export

Year	Quantity Tonnes	Value Rs. 000	Unit Value Rs.
1991	0.9	31.0	34.44
1992	289.6	24519.3	84.67
1993	853.8	101521.2	118.91
1994	1604.4	185611.8	115.69
1995	2454.6	247219.0	100.72
1996	3506.2	389042.1	110.96
1997	2628.1	320131.5	121.81
1998	2796.3	302511.7	108.18
1999	3703.7	372474.8	100.57
2000	4204.7	439749.6	100.59
2001	6339.8	635219.8	100.20

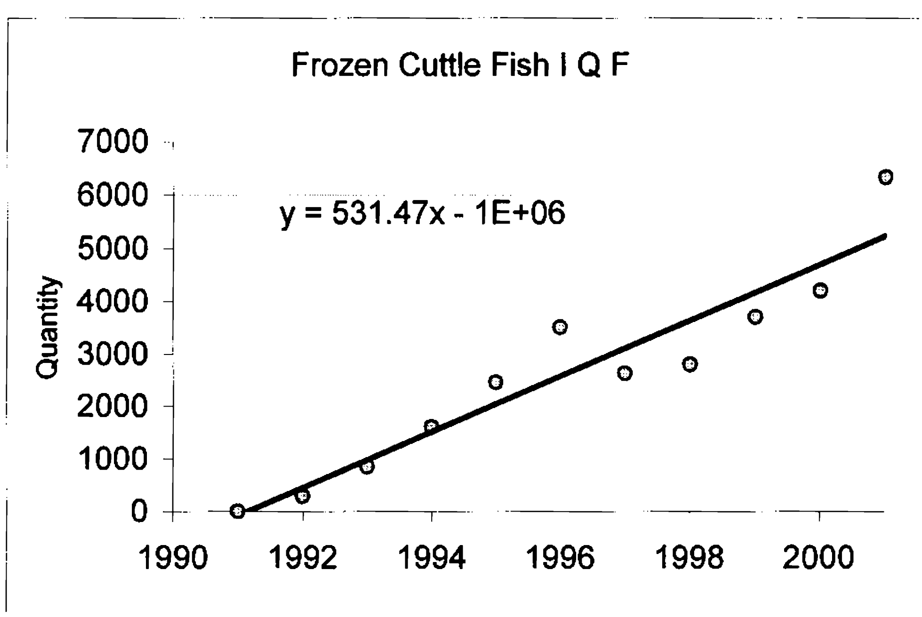


Fig. 5.6 Grwoth of frozen cuttle Fish I Q F products

The trade has picked up well from the next year onwards and fast growth is observed till 1996. The total quantity reached upto 3506.2 tonnes in the year 1996. The export declined drastically in the subsequent two years. The demand has gone up again since 1999 when the export was 3703.7 tonnes. It has reached to the highest figure of 6339.8 in the year 2001. (Table 5.6 and fig. 5.6)

The highest average unit price (Rs. 121.81 per kg.) was registered in the year 1997 when there was decline in the export. The next high rates of Rs. 118.91 per kg. and Rs. 115.68 per kg. were recorded in the years 1993 and 1994 i.e. in the initial years. Slight decrease is noticed in the unit prices in the later years.

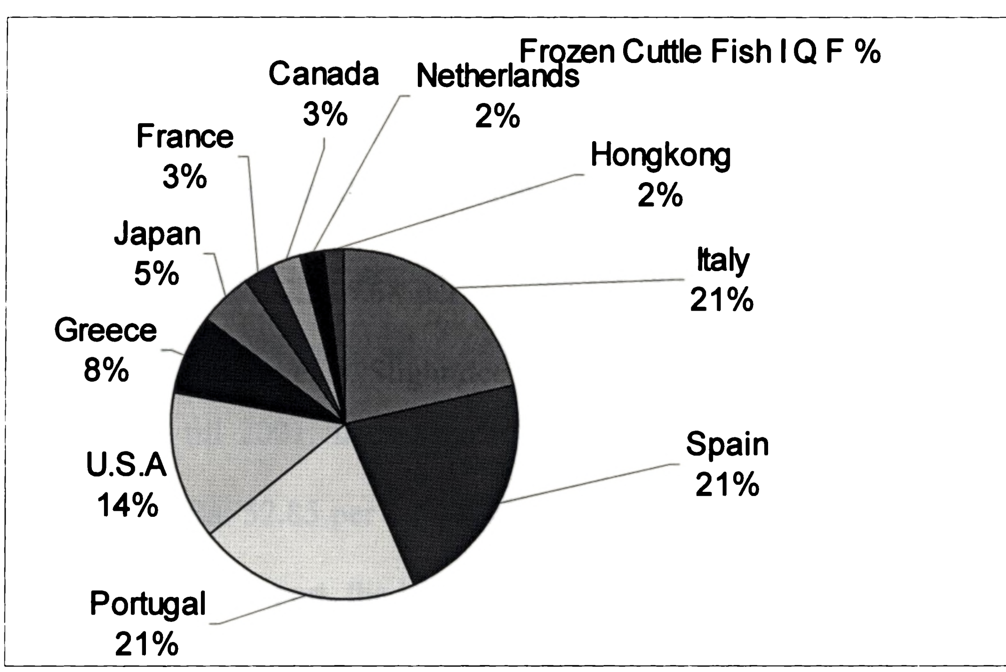


Fig. 5.7 Frozen Cuttle Fish I Q F - Countrywise

Altogether 29 countries have imported this item from India during the period 1992-2001. Some countries like Lebanon, Malta, Mauritius, Republic of Korea, Las Palmas etc. imported only once during this period. The details of import made by 10 leading countries are given in fig. 5.7. Italy was on top with 19.98%, Spain and Portugal were also in the top with 19.77% and 18.89% of the total export from India. These three countries imported 58.64% of the total export. USA was in the fourth position with 12.79%.

Japan has imported 999 tonnes during the 10 year period and usually high average unit price was offered by this country i.e. Rs.248.17 per kg. The next highest rate (Rs.112.45 per kg.) was offered by Canada. The price received from Japan was more than double of the second highest price. The lowest unit rates of Rs. 91.88 per kg. and Rs. 92.19 per kg. were offered by Hong Kong and Portugal.

Frozen cuttle fish wings

The export of cuttle fish wings commenced from 1996 onwards. Totally 71.6 tonnes was exported to countries like Japan, Taiwan, Italy and Germany at an average unit price of Rs. 78.80 per kg. This was the highest price obtained till 2001. In the next year 136.4 tonnes was exported at an average rate of Rs. 52.85 per kg. (Table 5.7) From 1998 onwards there was a downward trend in export, the lowest export was 37.1 tonnes in the year 2001 and realized the lowest unit price of Rs. 45.39 per kg. The year 2000 recorded a comparatively high price of Rs. 77.51 per kg (Fig. 5.8). This was due to the high price of Rs. 226.97 per kg. offered by Hong Kong. The important countries involved in the trade of this commodity were Japan, Taiwan, Italy, Singapore, France, Germany, Hong Kong and China. Total quantity exported during the period 1996-2001 was 567.8 tonnes. Japan imported 35.40% of the total quantity. Taiwan stood second with 24.48%. Italy and Singapore imported 8.19% and 6.87% respectively. The share of remaining countries ranged from 5.23% to 3.15% . The highest unit price of Rs. 123.00 per kg.was offered by Hong Kong. The next highest prices of Rs. 52.57 per kg. and Rs.82.43 per kg. were offered by France and Italy respectively. Japan and Singapore offered the lowest prices of Rs. 45.83 per kg. and Rs. 44.09 per kg. respectively.

Table 5.7 Cuttle fish wings year wise export

Year	Quantity	Value	Unit Value
1996	71.6	5642.2	78.8
1997	136.4	7208.9	52.85
1998	120.1	5672.7	47.23
1999	98.8	5044.3	51.06
2000	103.8	8045.8	77.51
2001	37.1	16841.1	45.39

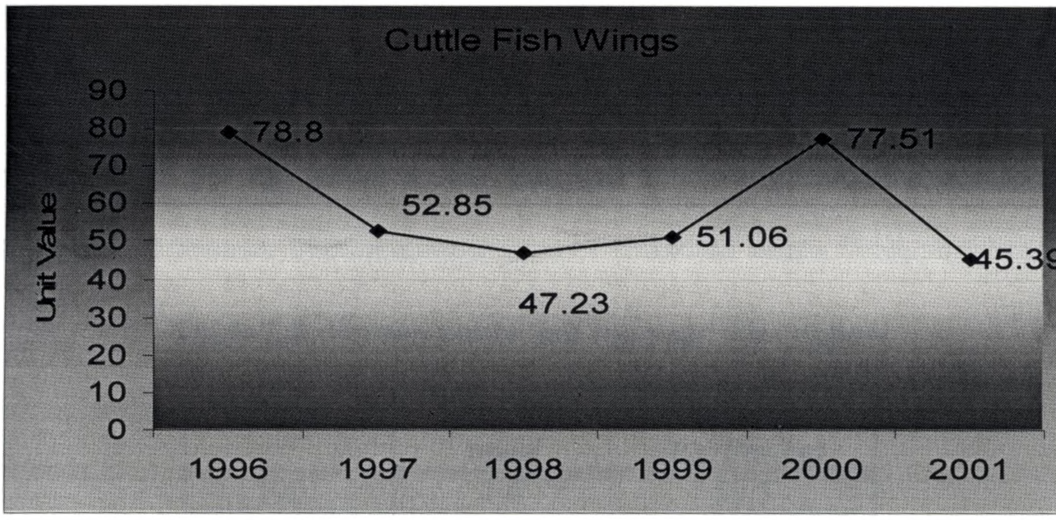


Figure 5.8. Cuttle fish wings (year wise unit value)

Frozen cuttle fish roe

Export of this product commenced in the year 1991 by exporting 1.4 tonnes to Spain. In the year 1993, 103.0 tonnes was exported which was the highest quantity exported during the 10 years period (1992-2001) with 101.0 tonnes in 1996 which was the second highest. The highest unit price was recorded in the year 2001 (Rs. 156.3 per kg). The years 1995, 1998, 1999 and 2000 recorded comparatively high prices. The lowest rates were in 1991 and 1994 (Table 5.8, fig. 5.9).

Altogether 17 countries made import of this item during 1992-2001. Spain imported 55.90% of the total quantity and imported substantial quantity every year. Japan and Italy were regular buyers and imported 8.68% and 7.64% respectively.

Japan has offered the highest average unit price of Rs. 153.87 per kg. Portugal and Netherlands offered the next highest rates of Rs. 116.05 per kg.

and Rs. 115.90 per kg. respectively. Saudi Arabia which made purchase only in the year 2000 has quoted Rs. 112. 74 per kg. Belgium quoted the lowest rate of Rs. 62.95 per kg. which is less than half of the highest price quoted by Japan.

Table 5.8. Frozen cuttle fish roe year wise export

Year	Quantity tones	Unit value (Rs. Per kg)
1991	1.4	59.5
1992	21.5	88.22
1993	103	86.88
1994	30.2	73.65
1995	96.6	125.36
1996	101	91.27
1997	79.5	77.01
1998	73.1	120.27
1999	57.9	124.92
2000	89.2	123.32

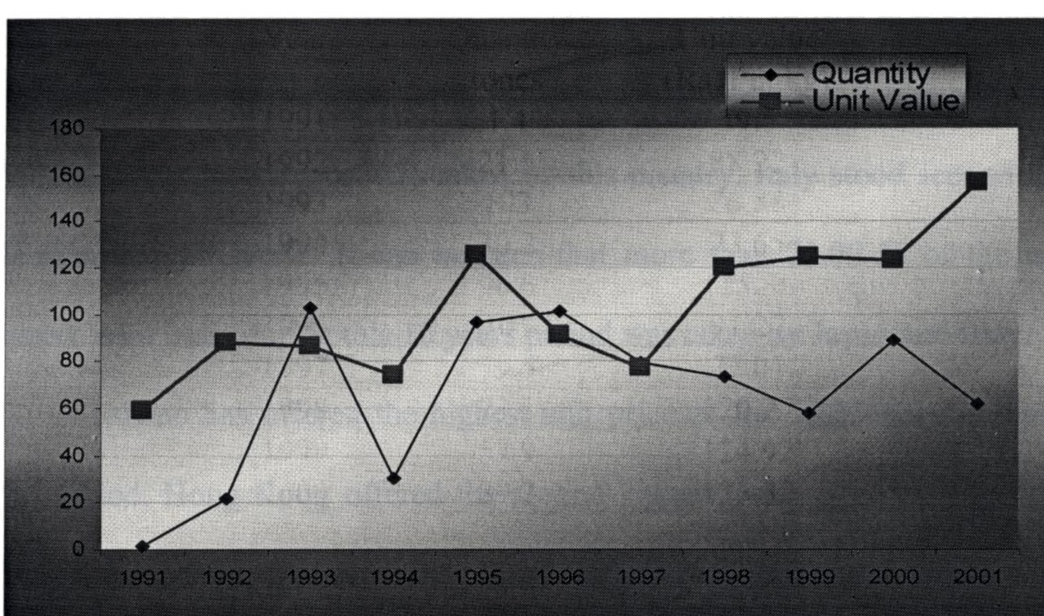


Fig.5.9 Frozen cuttle fish roe (quantity and unit value)

Frozen cuttle fish tentacles

In 1991 India exported 441.2 tonnes of cuttle fish tentacles. But in 1992 the quantity has come down to 288.2 tonnes. Again the market has picked up slowly and reached 1035.9 tonnes in 1995 which is the highest quantity exported in a year. A declining trend with fluctuations is noticed from 1996 onwards and in 2001 only 563.3 tonnes was exported from India.

Cuttle fish tentacles fetched low prices as compared to other items. The lowest unit price of Rs. 19.02 per kg. was received in 1991. Thereafter the average unit price has increased steadily with slight variations and reached Rs. 57.53 per kg. in the year 1997. The highest unit price of Rs. 59.45 per kg. was obtained in 2001.

Altogether 18 countries have imported cuttle fish tentacles from India. Countries like Ireland, Russia and Australia made one or two imports during the period 1992-2001. Japan was leading in importing this commodity and 54.93% of the total export was taken by this country. Italy stood second with 21.62% in their credit. It can be seen that more than 75.00 % of the total export from India during this 10 years period was taken by Japan and Italy.

Taiwan has offered the highest unit price of Rs. 79.35 per kg. during this period. Hong Kong offered the second highest price (Rs. 55.61 perkg.). The lowest average unit price (Rs. 23.30 per kg) was given by China.

Frozen cuttle fish rings

First export of this item was in 1992 to Singapore, Thailand and Australia. In 1992 totally was exported 36.4 tonnes. and in the next year it has gone down to 2.6 tonnes as the requirement was very less. In 1994 export has gone up to 47.6 tonnes and the maximum quantity of 107.5 tonnes in 1995. Again there was decline in 1998 when only 2.0 tonnes was exported to Spain. The market has picked up again in 2000 and 2001 and 92.6 tonnes and 93.8 tonnes respectively were exported in these two years period.

As in the case of frozen cuttle fish tentacles the average unit prices were low. The highest average unit price of Rs.71.86 per kg. was recorded in the year 2000. The prices were below Rs. 30/- per kg in the year 1992 and 1993. In all the remaining years the average unit price ranged between Rs. 44.0 per kg. and 52.0 respectively.

Frozen cuttle fish rings was exported to 14 countries during the period 1992-2001. Japan imported 39.47% of the total export from India. Taiwan was second with 6.05%. Countries like Portugal, Singapore and Hong Kong imported little above five percent of the total. It is observed that no country has imported this item regularly. Most of the countries imported once or twice during this 10 years period.

Portugal and USA have given the highest average unit prices of Rs. 88.15 per kg. and Rs. 87.41 per kg. respectively. France has quoted the next highest rate of Rs. 61.19 per kg. Japan, with nearly forty percent of the share has quoted Rs. 48.20 per kg. The lowest rates of Rs. 21.67 per kg. and Rs. 27.90 per kg. were offered by Thailand and Singapore respectively.

Frozen baby cuttle fish

This item has been introduced in the market in the year 1998. The first export was to Canada and UAE and the total quantity was 85.5 tonnes. The highest quantity of 935.8 tonnes was exported in the year 2000 of which 330.2 tonnes was the share of Hong Kong. As in the case of other items of cuttle fish, a decline in the export is noticed in the year 2001 when the quantity declined from 935.8 tonnes to 267.9 tonnes (Table 5.9)

Only six countries have imported this item from India. Of this Republic of Korea and China imported only once UAE has imported 1151.1 tonnes which formed 70.48% of the total export from India. Hong Kong was the second with 26.30% (430 tonnes). Both the countries together imported 97.0% of the total quantities .

The average unit value was Rs. 40.49 per kg. There was a steady increase in the unit rates and reached the highest rate of Rs. 56.96 per kg in the year 2001. (Fig. 5.10) Hong Kong has offered the highest average unit rate of Rs.145.6 per kg. and the second highest rate (Rs. 68.56 per kg.) was by Republic of Korea. The lowest rate of Rs. 47.90 per kg was quoted by China.

Table 5.9. Frozen baby cuttle fish

Year	Quantity	value	Unit value
1998	85.5	3461.5	40.49
1999	344	17862.3	51.93
2000	935.8	51705.6	55.25
2001	267.9	15258.7	56.96

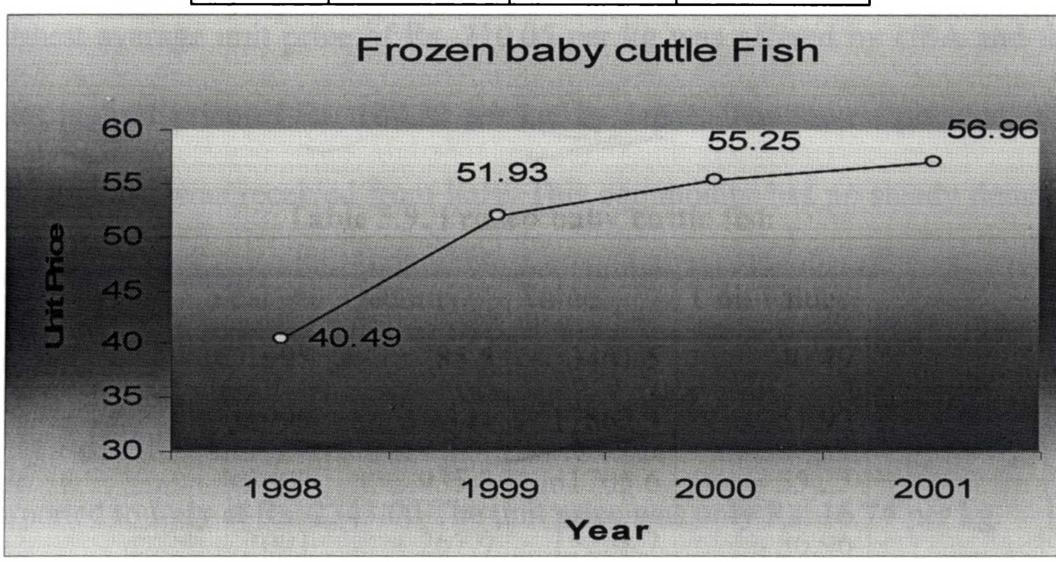


Figure 5.10. Frozen baby cuttle fish (unit price)

Frozen cuttle fish ink

Export of cuttle fish ink has started only in the year 1994 and continued in 1995 and 1996. In the first year Japan and Spain together imported 2.6 tonne valued Rs. 1.91 lakhs. In the subsequent year Japan, Italy, Spain and USA continued the import of this item in small quantities. Thereafter there was a break of three years and in 2000 Italy and Republic of Korea imported 16.9 tonnes. There was no trade of the product in 2001.

In the first year the average unit price was Rs. 73.65 per kg. and in the next year (1995) it has gone up to Rs. 91.62 per kg. In 1996 a very high price of Rs. 225.60/kg was recorded. This increase in price was due to the offer of high rates from USA and Japan. The rate has gone down to Rs. 95.36 per kg. in the year 2000.

Italy has imported 20.7tonnes (29.83%) during the period of study. Republic of Korea and Spain stood next 22.62% and 22.91% respectively. The highest average unit price of Rs. 210.05 per kg was offered by USA and the next highest price of Rs. 167.20 per kg. by Japan. The lowest price of Rs. 84.30 per kg was received from Italy. This commodity has no steady demand in the world market.

Cuttle fish beak

This item was exported first time in the year 2001. Only 140 kg. was exported to Italy at Rs. 2343.00 The unit price was only Rs. 16.74 per kg.

Cuttle fish blanched

The first export was 3.6 tonnes to UK in 1998. In 1999 France imported 5.3 tonnes and there was no trade in 2000. Italy imported 7.0 tonnes in the year 2001. Altogether 15.9 tonnes were only exported to these three countries. The average unit price was Rs. 72.31 per kg. Italy has offered the highest unit rate of Rs. 77.09 per kg.

Cuttle fish de-skinned

The first export of this item was in 2001 only. Only two countries viz. Hong Kong and UAE have imported this item. UAE has imported 18.75 tonnes and Hong Kong 2.07 tonnes making the total 20. 82 tonnes . The average unit rate was Rs. 44.52 per kg. UAE has offered Rs. 46.16 per kg. and Hong Kong Rs. 29.73 per kg.

Frozen cuttle fish tray packed

This commodity has been introduced in the market in 1997. Three countries viz. Italy, Japan and Portugal have altogether imported 28.5 tonnes. There was no import by any of these countries for the next three years. In 2001 Italy imported 10.5 tonnes. Thus the total export was only 39.0 tonnes valued at Rs. 56. 22 lakhs with average unit price of Rs. 144.07 per kg. Japan has taken 56.40% of the total export and Italy 43.08%. Both the countries together contributed 99.48% of the total export. Share of Portugal was only 0.52% Japan offered the highest unit price of Rs. 190.64 per kg and Italy Rs. 84.26 per kg. The rate offered by Portugal was very low (Rs. 47.96 per kg.) as compared to these two countries.

FROZEN SQUID

Export of frozen products of squid commenced in 1975 one year after the commencement of frozen cuttle fish. Initially there was only one commodity viz. frozen squids, as all the times of squid are shown under one head. From the year 1991 onwards information is available regarding all the products of squids There was 16 varieties of products excluding the dried squid in 2001. The details regarding export of these items are followed.

Frozen squid

During the year 1975 India exported 46.1 tonnes of frozen squid valued Rs. 3.0 lakhs. There was considerable hike in the export of this item in the next year as the export reached 496.8 tonnes. From 1979onwards there was decline in export with slight fluctuations in the quantity and value and this trend continued till 1984. Initially frozen squid was exported to countries like Australia, Belgium, France, Italy, Japan, Netherlands, Spain, USA and UK.

During this 10 years period 68497 tonnes of frozen squid was exported to various countries. Altogether 34 nations have imported frozen squid from India on various occasions during this period. While countries like Belgium, Australia, France, Greece, Netherland, Italy Spain, Germany etc. made regular imports from India, the countries like Brazil, Bahrain Islands, Borneo, Turkey, Qatar etc. made import only once or twice in small quantities. Among the top ten countries France was in the first position with 30.00% of the total export of frozen squid from India. Spain and Greece occupied the second and third position with 21.91% and 21.57% respectively. Italy imported 6.27% and Belgium 3.77% of the total export. Though there were regular exports to the remaining countries, their contributions were meagre.

Japan has quoted the highest unit price of Rs. 44.39 per kg. The second highest rate (Rs. 31.30 per kg.) was offered by Australia, Spain and France which together imported more than fifty percent of the total quantity have offered Rs. 20.85 per per kg. and Rs.20.01 per kg. respectively. The lowest rate (Rs. 15.88 per kg) was offered by Greece.

Frozen peeled squid whole

Export of this item started from the year 1991 onwards, by exporting 87.7 tonnes to Japan and Italy. In 1992 Italy purchased 8.3 tonnes and there was no export in 1993. The highest quantity of 248.5 tonnes was exported in the year 1994 (Table 5.10). The entire quantity was taken by Italy. Sharp decline in the export of this commodity was noticed till 2001 except the year 1999 when the total export of this products was 128.8 tonnes. In 1997 only 4.0 tonne was exported and the lowest quantity (3.4 tonnes) was exported in 2001.(Fig. 5.11)

The unit rate was Rs.83.31 per kg. in the year 1991 and low rates were noticed till 1995 (Table 5.10). The year 1996 registered Rs. 89.53 per kg. There was an unusually high price of Rs.279.08 per kg. in the year 1997 which was offered by Japan for the entire quantity of 4.0 tonnes exported. The price has gone down to Rs. 86.00 per kg. in the year 1999. However price rise was noticed in the next two years and the second highest unit rate of Rs. 129.15 per kg. was registered in 2001.

Among the various countries which imported this commodity during 1992-2001, Italy was the main consumer. They have imported 289.3 tonnes which is more than 50.00% of the total export (Fig. 5.12). Portugal was in the second position with 10.42% and France in the third position with 7.23%. The contribution of Japan was also significant. Countries like UAE, USA, Taiwan etc. made import of this products in single year. Japan offered the highest average unit price of Rs. 156.12 per kg. The second highest rate of Rs.95.46 per kg.was quoted by UAE in 1998. Taiwan also quoted comparatively good rate. The lowest rates, Rs.64.37 per kg. and Rs.67.87 per kg. were offered by Netherlands and Italy respectively.

Table 5. 10 Frozen Peeled Squid whole (1992-2001)

	Quantity in Tonnes	Value in Rs. 000	Average Rs. Per kg
1992	8.3	502.9	60.59
1993	-	-	-
1994	248.5	16087.9	64.74
1995	87.6	6785.4	77.46
1996	34.8	3115.5	89.53
1997	4	1116.3	279.08
1998	39.8	4231.2	106.31
1999	128.8	11077.4	86
2000	14.8	1481.4	100.09
2001	3.4	439.1	129.15

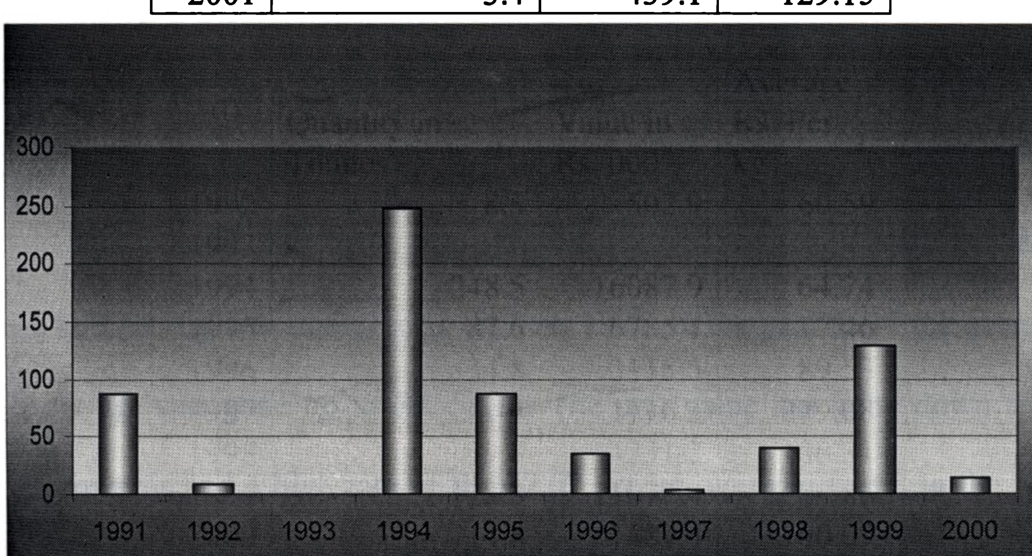


Fig 5.11 Peeled squid whole year wise quantity export

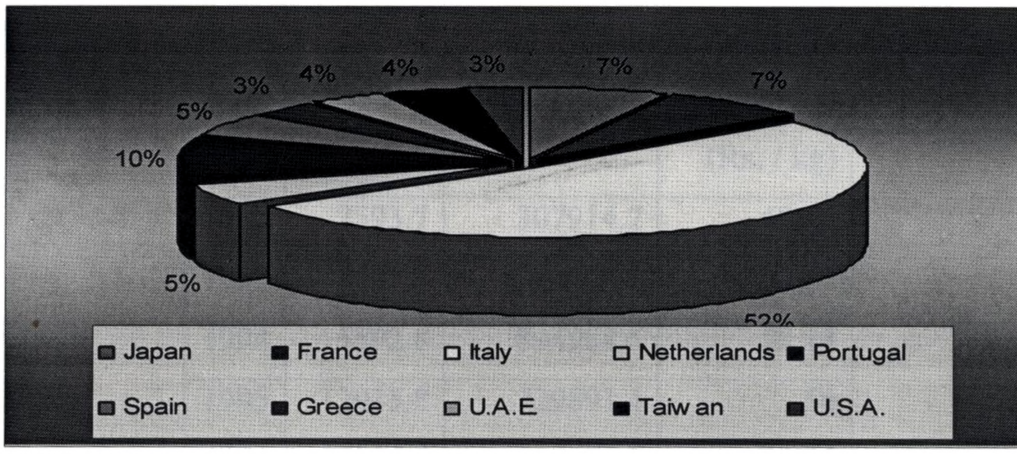


Fig 5.12 Peeled squid whole (Country wise)

Frozen whole squid (Baby squid)

In the year 1991 India exported 8412 tonnes of Baby squid valued at Rs. 28.9 crores and there was a slight drop in the next year when the quantity has reduced to 7594 tonnes but the value has increased to Rs. 30.8 crores. Thereafter significant increase is observed in the trade of this product and in the year 1996 totally 16317 tonnes was exported. From the year 1997 onwards decline in quantity is observed with slight yearly fluctuations. However the highest quantity of 17908 tonnes was exported in the year 2001 realising Rs.117.6 crores (Table 5.11).

The average unit value also showed fluctuations. The lowest value of Rs. 34.33 per kg. was observed in the year 1991. In the year 1994 the average rate per kg. was gone up to Rs. 58.14. The unit value has gone down from 1995 onwards and a high rate of Rs. 62.07 per kg. was registered in the year 1998. The highest unit value of Rs.68.58 per kg. was recorded in the year 2001.

Table 5.11. Frozen whole squid (Baby squid) year wise export

year	Quantity (tonnes)	Value (Rs)	Unit value (Rs. / kg)
1992	7593.7	307914.2	40.55
1993	12583.7	657763	52.27
1994	15392.8	894984.5	58.14
1995	13035.8	729891.4	56
1996	16316.5	806873.3	49.45
1997	12788.2	670304.9	52.42
1998	10470.7	649871.6	62.07
1999	13483.5	882414.2	65.44
2000	12053.1	826544.9	68.58
2001	17907.7	1176044.2	65.67

Nearly fifty countries had imported this item from India during the period 1992- 2001. The details of export to 10 major countries which imported one percent are shown in Table 5.12. Leading ten countries together imported 9% of the total export from India. Spain was in the top which imported 31.04% of the total import from India. Greece was in the second position with 19.74% and Thailand in the third position with 18.82%. The countries like Italy and UAE imported about five percent of the total quantity.

Japan has quoted the highest unit value of Rs. 100.13 per kg. and Hong Kong has offered the second highest rate of Rs.72.80 per kg.. The countries like Italy, Spain and France offered rates between Rs.60-70 per kg. The lowest rate of Rs.42.44 per kg. was quoted by Thailand and the next lowest of Rs.46.90 per kg. by UAE.

Frozen whole cleaned squid

A total of 2991 tonnes of whole cleaned squid was exported in the year 1991 valued at Rs.13.5 crores. There was substantial increase in quantity and value in the next three years. However there was a decline in quantity in 1994 but there was no decrease in value. On the other hand there was an increase of more than one crore rupees than the previous year, due to the increase in price. The maximum quantity (10632.7 tonnes) was exported in the year 1995 realiz Rs.76.9 crores which was the highest value realized in respect of this commodity. A gradual decline in quantity was observed from 1996 onwards and in the year 1999 the export was only 693.7 tonnes. Improvement is noticed in 2000 and 2001 when the export was 8557.8 tonnes and 8373.5 tonnes respectively (Table 5.12).

Tabel 5.12 Frozen whole cleaned squid 1992-2001

Year	Quantity	Valaue	Unit
1992	4831.9	276940.2	57.31
1993	7721.8	453968.7	58.79
1994	7008.9	464224.8	66.23
1995	10632.7	769042.5	72.33
1996	9758.9	680992	69.78
1997	8918.1	690534.4	77.43
1998	8146.8	704615.4	86.49
1999	6931.7	577721.3	88.34
2000	8557.8	716934.1	83.78
2001	8373.5	678464.3	81.03

The highest average unit price of Rs. 86.50 per kg. was observed in the year 1998. The years 1999 and 2000 registered more or less same prices viz.

Rs. 83.39 per kg. and Rs. 83.78 per kg. respectively. The year 2001 recorded slightly lower price (Rs. 81.03 per kg.) than the previous years. The lowest price of Rs. 57.31 per kg. was registered in the year 1992.

Altogether 47 countries have imported this item from India. The details of import made by the top 10 countries are given in table 5.13. During the period 1992-2001 these 10 countries have imported 92.71% of the total quantity exported from India. Greece reached the first position by importing 27.94% of the total quantity. Italy stood second with 19.04%. United States of America imported 16.66% of the total quantity. The share of Spain was 11.58%. The contributions of Portugal, Canada, Netherlands, Germany etc. were between five and one percent.

Table 5.13 Country wise exports whole clean squids

Country	Quantity	Value	Unit value	Shere %
U.S.A.	13478.3	1022550.5	75.87	16.66
Greece	22597.5	1631095.4	72.18	27.94
Spain	9366.2	710915.4	75.9	11.58
Portugal	4663.5	322588.8	69.17	5.77
Italy	15403.4	1104536.5	71.71	19.04
Canada	3362.4	278306.9	82.77	4.16
Netherlands	1955	163309.3	83.53	2.42
UAE	1242.3	101450.6	81.66	1.54
Germany	1881.4	146936.9	78.1	2.33
U.K.	1029.6	79064	76.79	1.27

Netherlands offered the highest unit price of Rs.83.53 per kg. Canada has quoted the second highest rate of Rs.82.77 per kg. The lowest price of

Rs.69.17 per kg. was quoted by Portugal. There was no wide variation in the average prices offered by the countries for this commodity.

Frozen squid tube

Maximum exports took place in the year 1991 and 1992 by exporting 8662.7 tonnes and 8132.6 tonnes respectively. From 1993 onwards there is a declining trend in the trade of this commodity with slight upward signs in one or two years. In the year 2001 the trade was low as compared to the previous years and 4068.6 tonnes was exported during this year. Similar declining trend was not seen in the price. Growth in the value is observed when there is a decline in quantity.

The lowest average unit value(Rs.44.96 per kg) was realized in the year 1992. A gradual increase in the average unit price was observed till 1995 when the price reached to Rs. 76.92 per kg. with a decline in the next two years. The average price has gone upto Rs. 78.53 per kg. in 1998. Comparatively good prices were registered in the last three years and the price was above Rs.85.00 per kg in these years (Table 5.14).

Totally 48 countries have imported this item from India during 1992-2001. Australia, Ireland, Cyprus, Borneo, Malaysia, Namibia, Mozambique etc. had trade with India only during the period 1992-1995. There was no import of this products by these countries after 1995. Similarly some countries like Bahrain Islands, Brunei, Denmark, Israel, Vietnam, Peru etc. entered the market only from 1996 onwards. During this 10 years period 14 countries have made single purchases only.

France had imported 17479.6 tonnes of squid tube which constituted 31.11% of the total quantity of this products exported from India. USA and Belgium stood next with 20.41% and 14.33% respectively. Italy and Spain imported around five percent of the total quantity. Japan has offered the highest average rate of Rs.111.87 per kg. and USA was the second with Rs.84.86 per kg. Germany offered the third highest rate of Rs.81.81 per kg. France and Italy offered the lowest rates of Rs. 55.78 per kg. and Rs. 55.56 per kg. respectively (Table 5.15)

Table 5.14 Frozen Squid Tube 1991-2001 year wise export

1992	8132.6	365654.1	44.96
1993	7494.1	342065.1	45.64
1994	6541.7	390256.8	59.66
1995	5996.7	461286	76.92
1996	6158.1	395366.3	64.2
1997	4153.1	294357.9	70.88
1998	4796.3	376642.6	78.53
1999	4459.5	395844	88.76
2000	4377.4	385288.6	88.02
2001	4068.6	350751	86.21

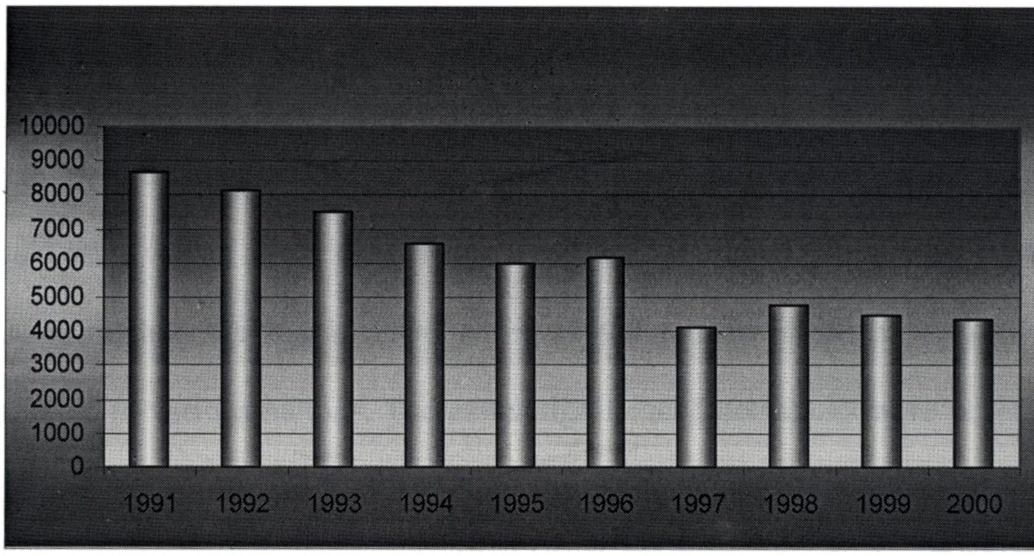


Fig. 5.13 Frozen squid tube year wise export

Table 5.15 Frozen squid tube country wise exports

Country	Quantity (Tonnes)	Value (Rs. 000)	Unit value (Rs)	% shere
France	17479.6	975009.5	55.78	31.11
U.S.A.	11468.7	973225.6	84.86	20.41
Belgium	8049.9	494454.6	61.42	14.33
Italy	3096.8	172047.3	55.56	5.51
Spain	2589.4	170709	65.93	4.61
Netherlands	1944.7	132189	67.97	3.46
South Africa	1467.3	101806.2	69.38	2.61
Japan	1306.7	146175.9	111.87	2.33
Singapore	889.3	55668.2	62.6	1.58
Germany	890.7	72869.4	81.81	1.59

Frozen Squid Rings

Information regarding the export of frozen squid rings are available from the year 1991 onwards. Twelve nations imported 1478 tonnes of frozen squid rings valued at Rs. 6.33 crores. There was a gradual increase every year and it reached the top in 1996 when 2789.9 tonnes of frozen rings were exported to various nations. Thereafter significant fluctuations were observed in the export of this product. As regards value, the highest export earning was in the year 2000 when the export was 2519.8 tonnes in quantity and Rs. 29. 99 crores in value. (Tables 5.16)

Table 5.16 Frozen squid rings exports

Year	Quantity (tones)	Value (Rs. 000)	Unit value
1992	1814.6	100214.8	55.23
1993	2182.5	126000	57.73
1994	2327.5	159538.9	68.55
1995	2537.3	219570.1	86.54
1996	2789.9	237337.1	85.07
1997	1660.8	169947.6	102.33
1998	2666.7	292558.9	109.71
1999	1906.7	206608.3	108.46
2000	2519.8	299870.5	119.01
2001	1876.1	200424.5	106.83

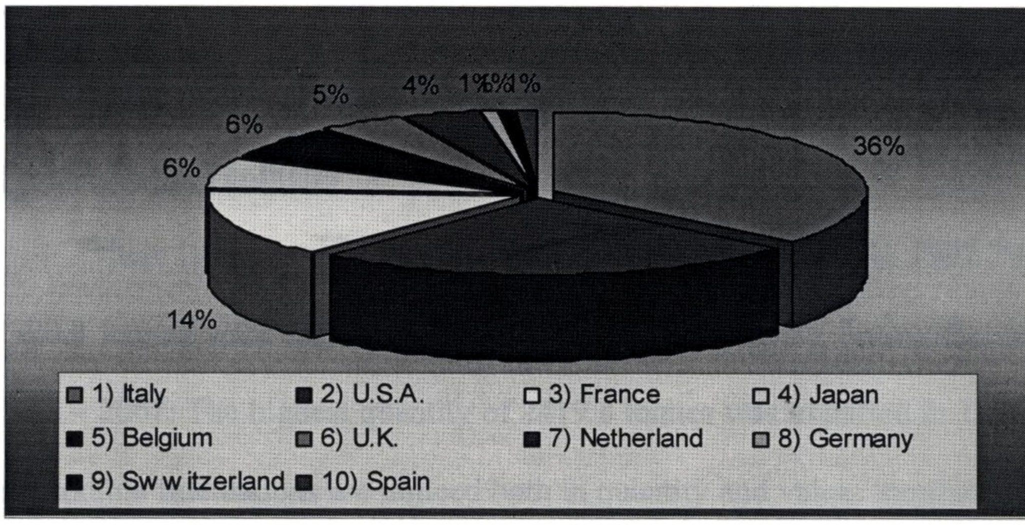


Figure 5.14.Frozen squid ring (countrywise)

The highest unit price was recorded in the year 2000 (Rs119.01/kg) and the lowest in the year 1991 (Rs 42.84/kg). Gradual increase in the unit price was observed from 1991 onwards and it reached to Rs 109.71 per kg in 1998

During the period 1992 – 2001 more than 30 countries imported this item from India. Italy was in the top importing 7736 tonnes valued at Rs. 523.30 million rupees. It formed 34.72% of the total export from India. United States and France stood in the second and third positions with a share of 24..59% and 13.44% respectively (Fig. 5.14). Countries like Australia, Oman, Cyprus, Singapore, Canada etc. made only single purchases during this period.

Average unit price offered by the top ten nations are given in table 5.16. The highest unit price of Rs. 124.76 per kg was offered by U. S.A which shares 24. 59% of the total export. The next highest price Rs. 120.59/kg was offered by Japan which imported about six percent of the total quantity. The lowest prices of Rs. 67.65/kg and Rs.68.24/kg were offered by Italy and Spain respectively. The very low price quoted by Italy has affected the total value as Italy was the main importer of this commodity.

Frozen Squid Tentacles

There is no specific trend in the export of this product. In 1992.Totally 1320.8 tonnes were exported which is the lowest quantity during the period 1992 – 2001. The highest quantity of 2419.8 tonnes was exported in 1995 and remarkable fluctuations are noticed both in quantity and value. Similar trend is noticed in the yearly average unit prices also. The lowest price of Rs. 27.26 per kg was registered in the year 1992 and the price went up to Rs.54.96/kg in 1995. with a fall in 1996 (Rs 44.26/kg) the price gone up in the next few years and the highest price of Rs.68.89/kg was recorded in 1999. (Table 5.17).

Table 5.17 Frozen squid tentacles

Year	Quantity (Tonnes)	Value (Rs. 000)	Unit value
1992	1320.8	35998.6	27.26
1993	1916.5	54023.5	28.19
1994	1661.7	66998.1	40.32
1995	2419.8	132987.2	54.96
1996	2190.3	96901.8	44.24
1997	1369.6	75667.2	55.25
1998	1534.9	88382	57.58
1999	1526.9	105181.6	68.89
2000	2162.5	138574.1	64.08
2001	1517.2	84838.8	55.92

Table 5.18. Frozen squid tentacles (country wise)

Country	Quantity (Tonnes)	Value (Rs. 000)	Unit value (Rs. /kg)	% share
Italy	4934	243037.1	49.26	28
France	4226.5	150656.8	35.65	24
Japan	2426.3	136917.5	56.43	13.77
Belgium	1677.1	72401.4	43.17	9.52
U.S.A.	165.4	94190.5	80.82	6.61
Netherland	1132.8	64187.3	56.66	6.43
Thailand	557.7	20902	34.48	3.17
U.K.	338.5	15120.7	44.67	1.92
Switzerland	124.7	6842.3	54.87	0.71
Hong kong	136.3	10908.4	80.03	0.77

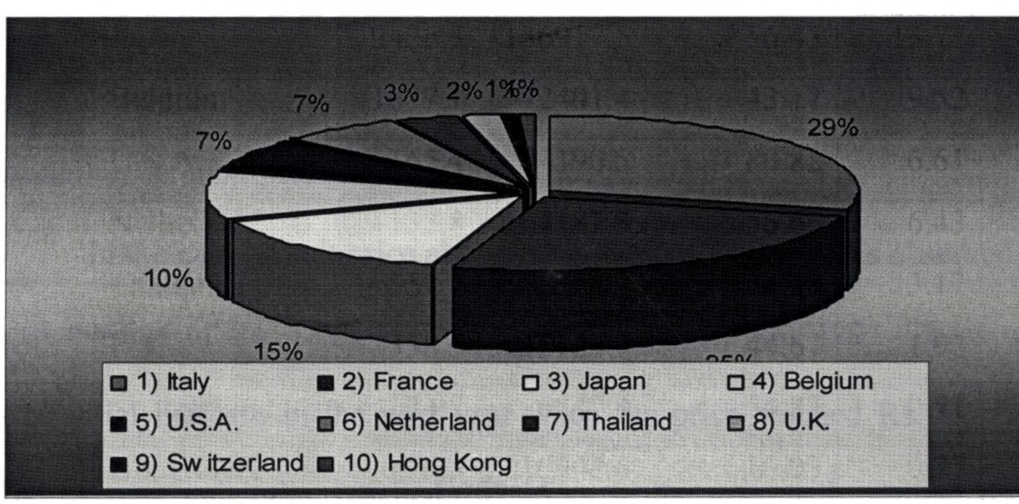


Figure 5.15 Frozen squid tentacles

Details of import of this commodity by the top ten countries are given in the Table 5.18. Italy was in the top which imported 4934.00 tonnes valued at Rs. 243.03 million. Which constituley twenty eight percent of the total quantity imported by Italy. France stood next with 24.00% and Japan in the third position with 13.77%. (fig. 5.15)

The highest unit price of Rs. 81.00/kg and Rs 80.00/kg were quoted by United States and Hong kong respectively. The lowest price of Rs. 35.65/kg was offered by France which imported 24.00% of the total imported 28.00% was also comparatively low.

Frozen Squid Fillets

Export details of this commodity was shown separately from 1991 onwards in which year 645 tonnes valued Rs. 55.94 million was exported.Gradual growth is observed yearly the total quantity reached 2219 tonnes in the year 1996 after which there was fall in export from 1997 onwards and in the year 2000 a sudden rise is recorded with the highest export of 2636 tonnes. There was a steep decline in quantity to nearly half (1454.00 tonnes) in the next year.(Table 5.19)

In the case of unit price also no steady yearly increase is observed. The lowest value of Rs. 135.04/kg was recorded in the year 1991. There was a substantial increase in the next year when the price reached Rs. 135.00/kg. The average unit price reached 202.06/kg in the year with a small drop in 1995. The highest rate of Rs. 207. 65/kg was recorded in the year 2001 with slight fluctuations between 1996 and 2001.

Table 5.19 Frozen Squid fillets (1991-2001)

Year	Quantity (Tonnes)	Value (Rs. 000)	Unit value
1992	767.9	103694	135.04
1993	770.2	121976	158.37
1994	686	131251	191.33
1995	1346.9	255767.5	189.89
1996	2219.1	448382.9	202.06
1997	1823.4	361058.3	1998.01
1998	1608.6	322997.2	200.79
1999	1731.8	309520.1	178.73
2000	2636.2	508065.8	192.73
2001	1454	301917.2	207.65

Japan imported 12001 tonnes valued Rs. 253.71 crores. Japan shared nearly 80% of the total export from India. Thailand was the next country, which took five percent of the total quantity. Republic of Panama imported 3.58 % and United States 2.61 % respectively. The contributions of all the remaining countries are negligible.(fig. 5.16)

Japan offered the highest price of Rs. 211.40/kg, which is three times more than the lowest prices i.e. Rs 65.60/kg and 68.36/kg offered by France and Italy respectively. The average unit price paid by Rep. of Panama and United States are also comparatively high and their contribution to export is reasonably good. Hong Kong offered the second highest price of Rs. 197. 73/kg but their share is very negligible.

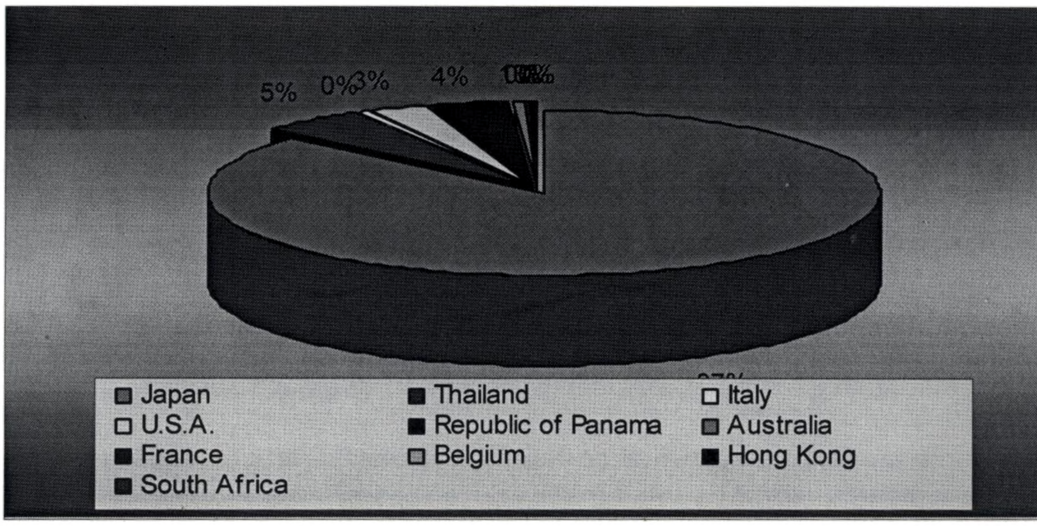


Figure 5.16. Frozen squid fillets (Country wise share)

Frozen Squid Wings

Export of frozen squid wings started in the year 1996. There is no visible trend in the trade of this commodity and a lot of fluctuations are noticed. In the first year 42.70 tonnes of squid wings was exported and in 1997 the export has gone up four times to 172.0 tonnes which is the highest quantity so far exported. The export of this product has drastically come down and it reached to the lowest figure of 16.0 tones in 2001.(Table 5.20)

Table 5.20 Frozen squid wings

Year	Quantity tones	Value (Rs. 000)	Average Unit Price (Rs. / kg)
1996	42.7	1418	33.21
1997	171.9	13611.6	79.18
1998	57.67	1698.9	29.46
1999	30.92	1721.6	55.68
2000	45.84	1804.4	39.36
2001	16	831.9	52

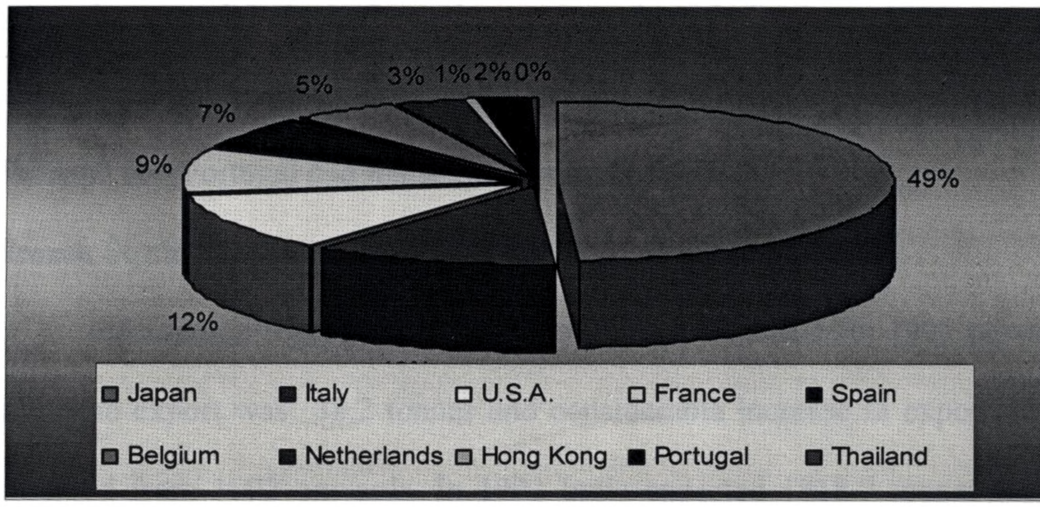


Figure 5.17. Frozen squid wings (Country wise share)

The highest unit price of Rs. 79.18/kg was obtained in the year 1997 when the export was the highest. . This was due to the good price offered by U. S. A which made importing in 1997 and there was no trade with U. S A in respect of this commodity thereafter. The lowest price of Rs.29.46 per kilogram was recorded during the year 1998 whereas in the first year i.e 1996, the price was Rs. 33.21/kg.

The details of export of this product to the top ten countries during the period 1996 – 2001 is given in fig. 5.17. As in the case of many cephalpod products, Japan imported 47.83% of the total quantity exported from India. Japan was followed by U. S. A and Italy with 11.70% and 11.64% respectively.

The highest unit price of Rs 101.76/kg was offered by U. S. A, in the year 1997. . The second highest rates of Rs. 81.81/kg and Rs. 70.73/kg were offered by Belgium and Portugal respectively. The lowest rates of Rs. 34.21/kg and Rs. 39.51/kg were quoted by Spain and Italy respectively.

Japan and Italy had regular imports from India from 1996 onwards without any interruption. The countries like U. S. A, Belgium, Hongkong, Thailand and Portugal had made very limited imports.

Frozen Squid / Tubes / Rings / Tentacles

Information regarding this commodity is available from 1991 onwards when the export was 38.2 tonnes and considerable increase in exports were observed from 1992 onwards. In 1992 India exported 1818.9 tonnes tonnes valued at Rs. 96396.2. It has reached the maximum of 4919.8 tonnes in the year 1996 and slight fluctuations are observed in the subsequent years and 4105.1 tonnes was exported in the year 2001.

The lowest unit price of Rs. 33.00/kg was quoted in the year 1991. There was a steady increase in the price since 1991 and it reached the maximum of Rs. 93.60/kg in the year 1998.Thereafter steady decline in price was recorded and it has reached Rs 83.60/kg in 2001.

Ten countries imported about 92.00 % of the total export from India. France was in the first position which has taken 28.79% of the total trade followed by Italy (15.25%). Spain and Portugal shared 11.36% and 11.25% respectively. The lowest contribution was by South Africa whose only 1.89%. All these countries except South Africa had regular imports.

Frozen cuttle fish (Meat trimmed)

This product was for the first time exported in the year 2001. Only one country viz Italy imported this commodity. The total export was only 2380 kilogram Rs 39829.00 with an average value of Rs 16.73 per kilogram. There was no trade of this product in the year 2002. Compared to other products of cuttle fish the price quoted by Italy is very low.

Frozen cuttle fish beak

The trade of this product was very negligible and for the first time exported in the year 2001. when only 140 kilograms valuing Rs. 2343.00 was exported to Italy. The average unit price was our Rs 16.73/kg which is the exact price offered by Italy to cuttle fish meat trimmed. There was no export of this product in 2002.

Octopus

Export of octopus commenced in the year 1988 by exporting 19 tonnes of wet cleaned octopus valued Rs 1.63 lakhs to Greece. Thereafter octopus was exported only in frozen condition. Regular export of frozen octopus was started from the year 1989 onwards. Totally 44 tonnes of frozen octopus was exported to countries like Japan, Cyprus, Belgium and Spain in this year. Prior to that a very meagre quantity of 72 kgs of frozen octopus was imported by Japan in 1988 which was the first import of this commodity from India. In the year 1990 the total quantity of export reached 329 tonnes valuing at Rs 48.69 lakhs and countries like Sri Lanka, France, Italy, Portugal, Fed. Rep. Of Germany etc. later joined the group. As in the case of other cephalopod products diversification of products also started in the course of time .A brief description of export of various products of octopus during the period 1992 – 2001 is given below.

Frozen Octopus

As stated earlier the export of frozen octopus was started from the year 1989 onwards and there was a steady increase in export. It reached the maximum in the year 1997 when the total export of this commodity was 4286 tonnes (Table 5.21). Thereafter no increase was observed and fluctuations are noticed.

The unit value showed fluctuations. The lowest value (Rs.28.15/kg) was registered in the year 1992 and the highest value of Rs. 65.89/kg in the year 2001.

Table 5.21 Frozen octopus year wise export

Year	Quantity tones	Value (Rs. 000)	Unit value (Rs. / kg)
1992	381.9	10750.4	28.15
1993	307.1	9336.6	30.4
1994	1776.6	83501.3	47
1995	1805.1	81741.5	45.28
1996	2450.5	109653.1	44.75
1997	4286.4	217285.4	50.69
1998	2421.2	129354.4	53.43
1999	3512	195752.6	55.74
2000	2477.5	113064.8	45.64
2001	2177.1	143440.5	65.89

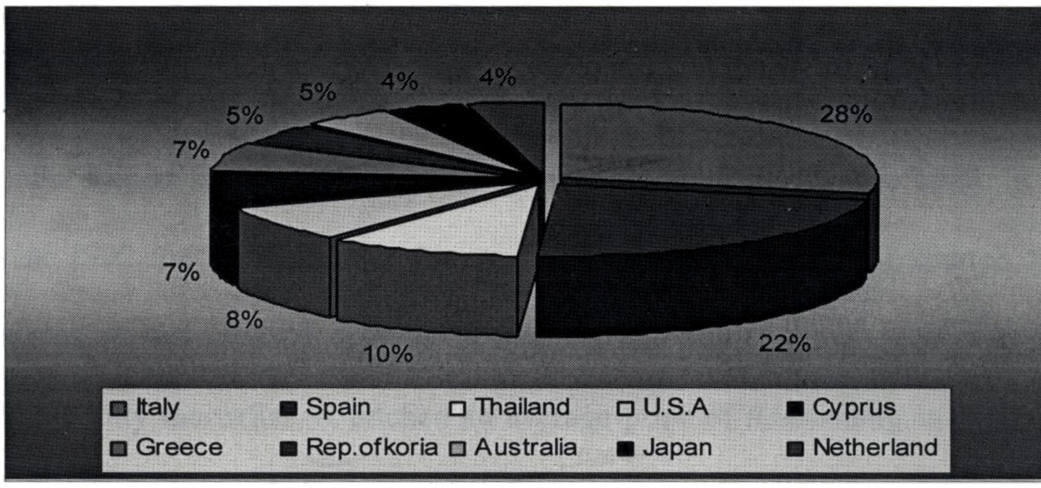


Figure 5.18. Frozen octopus country wise export

Though Greece was the only country to import this commodity in the year 1989 there were 37 countries in the year 2001. Export informations to leading ten countries during the period 1992 - 2001 are given in the fig. 5.18. During this period Italy topped with 5128.6 tonnes constituting 28.00 % of the total import. Spain was the next nation with 4002.3 tonnes forming 22.53% of the total export. The percentage contributions of the remaining eight countries ranged between 3 and 8 percent. All the ten countries together imported about 83% of the total frozen octopus from India.

The highest average unit price of Rs 86.04/kg was offered by Australia followed by Rs 73.03/kg by Japan. The lowest price of Rs 40.86/kg was quoted by the United States of America. Thailand and Cyprus also offered comparatively high rates i.e above Rs60.00/kg the countries like Italy, Spain and Rep of Korea quoted very low prices.

Wet Cleaned Octopus

Wet cleaned octopus was the first product of octopus exported from India. Export started with nineteen tonnes to Greece in the year 1988. In the year 1992 the countries like Japan, UAE and Italy together imported 10.3 tonnes of wet cleaned octopus from India and there was no export of this commodity thereafter. It fetched an average price of Rs41.60/kg in 1992 and Rs 8.36/ per kg in 1988.

Frozen baby octopus

This product was first time introduced in the export market by India in 1998. Totally 257.4 tonnes of baby octopus valued Rs102.31 lakhs was exported to different countries. The average unit price realized was Rs 39.75 per kg in 1998 and it gradually increased to Rs. 47.75 per kg in the year 2001. The highest export of 1547.3 tonnes was made in 1999 and there was drastic drop in the year 2000 which registered only 370.5 tonnes. Again the export of this product has gone up to more than double in the next year. (Table 5.22)

Table 5.22. Year wise export of baby octopus

Year	Quantity tones	Value (Rs. 000)	Unit Price (Rs. / kg)
1998	257.4	10231.4	39.75
1999	1547.3	68987.3	44.59
2000	370.5	16918.9	45.67
2001	761.9	36382.9	47.75

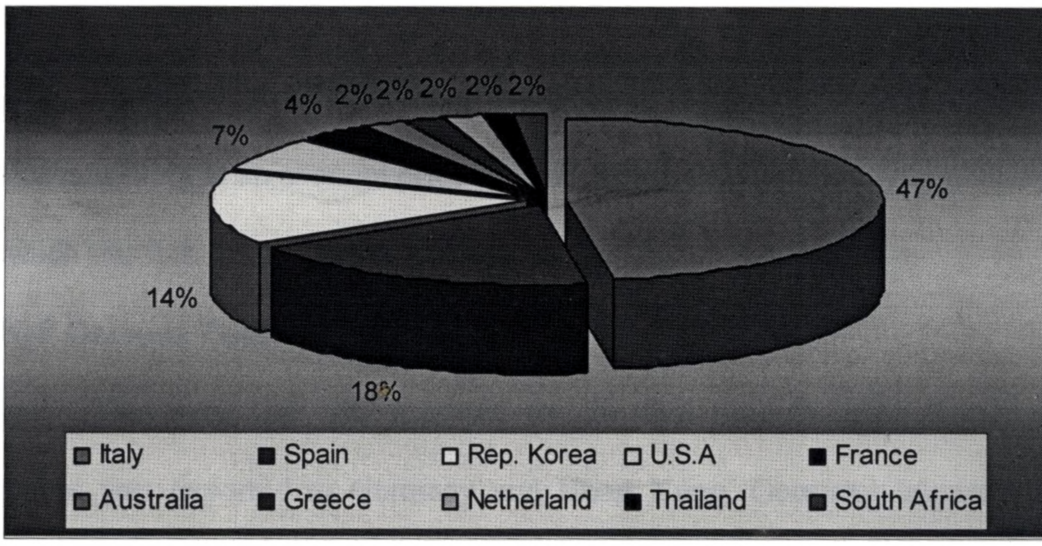


Figure 5.19 Baby octopus country wise export

Italy was in the top importing 1310.6 tonnes dduring 1998 – 2001. It formed 46.62% of the total ex[ports from India.. Spain was in the second position with 511.7 tonnes forming 17.42%. The third position was occupied by Republic of Korea with 400 tonnes and 13.62 percent. Contributions of other countries like U. S. A, France, Australia, Netherland, Greece etc are nominal. Altogether 25 countries imported baby octopus from India during this period. Among these, Spain, Italy, Republic of Korea, South Africa, Netherland and New Zealand made regular imports from India (Fig. 5.19).

The highest unit price of Rs57.48/kg and 50.05/kg recorded were from Netherlands and South Africa respectively. However their share in the import is only three percent. Third highest unit price (Rs 49.26/kg) was offered by France. Italy which imported 44.6% of the total quantity offered an average unit price of Rs 45.27/kg.

IQF Baby Octopus

Export of this item started first time in the year 2001 exporting 20.7 tonnes to Italy at an average price of Rs49.84/kg. Italy was the only country to which this item was exported.

IQF Octopus Tentacles

This item also was exported for the first time in 2001. Totally 3.3 tonnes was exported to Germany and Hong Kong. Germany imported two tonnes at the rate of Rs82.10 per kg and Hong Kong imported 1.3 tonnes at the rate of Rs61.25/kg. The average unit price was Rs. 73.90/kg.

Product introduced in 2002

The following products were introducted in 2002 and exported to various countries.

Frozen Cuttle Fish Strips : A very meagre quantity of 168 kilograms of cuttle fish strips was exported to France which fetched Rs. 11014.00 with an average price of Rs. 65.58/kg

Frozen Cuttle Fish Tips / Cones Totally about 23 tonnes of cuttle fish tips/ cones were exported to Belgium, Italy and Taiwan and earned Rs. 10.16 lakhs at an average price of Rs 44.25/kg. Taiwan imported 65.34% of the total quantity and Italy 28.12 %. Italy and Belgium offered more or less similar rates i.e Rs 89/kg and Rs 88.74/kg respectively whereas Taiwan offered a very rate of Rs. 20.27/kg which is very low.

Frozen squid neck: Totaly 6 tonnes was exported to france @ of Rs. 56.50/kg

IQF Squid rings : 11 countries have imported this item and total quantity was 287.7 tonnes @ Rs. 107.13 France and Italy were main Importers.

*IQF Squid Tentacles :*Totally 77.9 tonne was exported to 8 countries @ Rs. 78/kg. Italy, France, and Belgium were the main countries.

IQF squid stuffed : Only Two countries vis France and Spain imported 500 kg @ Rs. 76.67 per kg.

IQF Squid whole cleaned : Totally 117 tonnes was exported to six countries @ Rs. 105.76/kg

Frozen squid whole round : Two countries imported 27 tonnes @ 47.73/kg. Thailand was the main importer.

Frozen Baby squid whole round : Six countries have imported this item. Totally 425 tonnes was exported @ Rs. 54.5/kg.

Frozen squid tentacles blanched : Five countries have imported 46.7 tonnes @ Rs. 82.5/kg. France & Italy were the main importers.

*IQF Squid striped :*Only 0.9 tonnes was exported to France @ Rs. 58.42/ kg.

IQF squid whole : Totally 14 countries mostly Europian have imported this item. They altogether imported 1123 tonnes @ Rs. 108.5/kg.

IQF squid tube : Totally 98 tonnes was exported @ Rs. 138.50 to countries like USA and Belgiom.

Products Started in 2002

Certain value added products of octopus were introduced in the export market for the first time in 2002. The details of these products are given below:-

a) Frozen Octopus Tentacles

Two countries viz U. S. A and Germany imported this item and the total export was 17.3 tonnes at the rate of Rs67.29/kg. U. S. A imported 3.2 tonnes at the rate of Rs42.47/kg and Germany 14. 1 tonnes at the rate of Rs65.60/kg

b) Frozen Octopus Rings

Only one country viz Germany imported 6.9 tonnes of frozen octopus rings from India valued at Rs5.19 lakhs with a unit price of Rs74.88/kg.

c) AFD Octopus (Accelerated Feeze Dried

Though three countries viz Germany, Greece and Netherlands imported this item the total quantity exported was 3.8 tonnes valued at Rs 4.4 lakhs. The average price per kg was Rs 117.11 which is high as compared to other products of octopus. The share of Germany and Netherlands were very nominal 30 and 150 kg only. Greece imported 3.6 tonnes and has offered only Rs 62.60/kg only while Netherlands offered Rs1231.40/kg and Germany questedRs1051.63/kg.

The rates rates offered by these two countries are extremely high. Though the quantity imported by these two countries is very little the average unit price realized during 2002 is comparatively high due to very high price offered by these two countries.

d) <u>Frozen Octopus (whole cleaned)</u>

Frozen octopus was the main product till 2002. Frozen octopus (whole cleaned) was first introduced in the export market in the year 2002 only. Totally 437.0 tonnes of frozen (whole cleaned) octopus was exported to 11 countries during the first year of introduction itself. An amount Rs 257.3 lakhs was realized with an average unit price of Rs 58.88 per kilogram.

Among the countries Italy imported 184.3 tonnes constituting 42.17% of the total Export followed by Greece with 18.72% and Spain with 17.25%. Other countries like Australia, U. S. A, France and Cyprus imported less than ten percent of the total export from India.

The highest price (Rs92.81/kg) was offered by Greece and second highest (Rs64.14/kg) by Cyprus. The lowest price (Rs45.01/kg) was quoted by France and the next lowest of Rs51.62/kg by U. S. A

All the four products mentioned above are introduced in the export market in 2002 and future trend will be known only after scrutinizing the data of the next few years after publication.

DISCUSSION

Cephalopod resource is regarded as one of the most promising sea food resources because of high sales value supported by strong demand. The world cephalopod production has gone up to 36 million tones in 2000, the growth in production was the result of growth in the output of two main producing countries Japan and China. India stands in the 10^{th} position with 91,900 tones.

The growth of cephalopod export from India from 1974 is very significant. The percentage share has gone upto 26.09% of the total quantity and 15.59% of the total export earning. Certain countries like Japan, France, Spain, Italy, Thailand etc regularly exported different products and most of the countries made occational imports from India. No consistency was noticed in the export pattern as fluctuations are seen in the demand and price. Countries like Japan, USA, France, Spain etc., generally offered high rates while the Asian countries, UK, Italy etc. offered comparatively low rates. The prices depends upon the domestic demand and production.

Argentina is the leading exporter of fish and frozen cephalopods exporting nearly 17% of the world cephalopod. Morocco is the second main exporter of cephalopods in the world. India is in the 9th position in cephalopod exports, exporting more than 80% of the cephalopods landing of the country. As stated earlier now India is exporting 57 products of frozen squid, cuttle fish, octopus and dried products to over 50 nations in 2002.. Moderate growth in demand can be expected from the Asian markets like Japan, Republic of Korea and Taiwan. southern European markets like Spain, Italy and France and significant growth from the US market. All these nations have registered increase in cephalopods consumption. As such future expansion in trades should be to cater to the new and growing markets by increasing the production, the harvesting unexploited resource and introducing new processing technology. In north European countries, North America, New

Zealand and Australia cephalopod consumption is going up where new markets can be opened by developing special value added products. The established markets like Japan, Spain, Italy and France could be penetrated with new product development. Demand for cephalopods is expected to increase in developing countries because of rising income and population growth. Due to the changes in life style demand for easy to prepare and use products will increase and cephalopods are among the most promising alternative to conventional sea food products. The high nutritive value, low fat content, etc makes cephalopod a healthy food.

Countries like China, India, Indonesia , Taiwan, Malaysia etc export their surplus while Japan, Spain, Italy, France, Greece, UK etc import to meet there deficit. The cephalopod industry in India , Thailand and Vietnam is fully export oriented.

There has been increase in the flow of products from Asian countries particularly India and Thailand to European markets. Many products from Asian countries are very attractive in prices and many species have good taste and texture acceptable to Europeans. Constant promotion of products to participation in Trade Fairs, advertisement and sales visit to markets is required to penetrate the European markets. European markets prefer bulk packed frozen products and value added products. The increase in the consumption of cephalopods in European countries necessitates imports from other sources.

In Australia and New Zealand consumption of cephalopods increased noticeably and it is likely to expand further. As there domestic production this less, increase in imports are expected from these countries. Opportunities in a limited scale is available in African markets to cater to the demands of higher class hotels, tourists resorts , restaurants, ships etc.

Prices of cephalopod products rose steadily with occasional fluctuations which have been the result of over supply or shortage. Prices vary greatly from market to market with product difference. When cuttle fish fetch the highest price in Italy, octopus gets the highest price in Greece and Spain. All products of Tunisia, Mauritania and Morocco are highly priced than the Asian products due to the quality of species available.(ADB/INFO FISH 1991).

There is a strong relationship between domestic production and import prices. When there is over production and market is over supplied with domestic products there is quick fall in import prices. Prices vary according to species product form and country of origin./ Frozen or fresh cuttle fish and octopus fetched higher prices than squid . Dry squid is highly priced than fresh or frozen squid.

Marketing Strategy for Export Promotion

The present cephalopod production in India is from the coastal waters as by catch of shrimp and fin fish fishing. Their is no targeted fishing for cephalopods except the localised hook and line fishing and the jigging. The attempts made by industrial trawlers to introduce cephalopod fishing along the west coast during the lean shrimping season is very encouraging.

Several estimates of potential yields of cephalopods of the Indian Ocean are made by many workers (Voss, 1973 ; George et al 1977; Joseph 1985; Gulland 1970; Chikuni 1983, Sudarsan *et al* 1990) all these estimates of potential from the Indian ocean indicate the scope for increase the production many times from the present level. The exploitation of oceanic squid on commercial basis is not at taken up by India . It is the only way to increase the production as the coastal and inshort areas are under fishing pressure.

The cephalopod export can be expanded by i) increasing the production and ii) developing more value added and specialty products. Many nations like Japan, China, USA, France, Thailand, Netherlands etc import cephalopods from India and at the same time exporting products to other countries. They may be re-processing the imported frozen product in bulk and exporting as various value added products in commercial packs.

The Indian export industry should take a typical look at our own existing marketing frame work as competition from other countries has come in almost every product category. The emphasis should be shifted to looking for new users, new uses and more usage of the existing product. Keeping this in mind, the Indian industry may focus on plugging every inches in the market through product innovation and improved penetration levels. "The future lies in servicing large numbers. We have to change our communication track in keeping with our strategy to address specific segments. A consumer does not buy a brand (product) because it boasts a global heritage, but because of the perceived intrinsic value and benefit it offers." (Kotler 19). Any product, Indian or global will prove relevant to the common man only if it satisfies needs and wants that are locally relevant. The existing companies would have learnt to move faster and upgrade their offerings to retain consumers.

India has a reputation as the reservoir of the worlds most talented and skilled man power. However only of this reservoir of talent is housed and raised to international standards, can we make a marked difference to innovation, technological development and customer orientation – the troika for creating a sustained competitive edge in the global market place (Rao and Rao,1999)

With new product offerings and entry into new geographical locations, market reach can be extended further to augment export earnings. The growth in export revenues and net profit should be driven by new order execution, continued focus on keeping costs in check and efficient working capital management. In general a company prefers to enter countries (i) that rank high on market attractiveness (ii) that are low in market risk and (iii) in which the company possess competitive advantage (Kotler, 2000)

One of the best ways to initiate or extend export activities is by participating at an overseas trade show to exhibit the products and meet the customers . With the world wide web it may not be even necessary to attend trade shows to show ones products to overseas buyers or distributors. The internet has become the effective means of everything from gaining free exporting information and guidelines, conducting market research and offering customers a secure process for ordering and paying for products.

The marketing concepts holds that consumer needs vary and that marketing programmes will be more effective when that marketing programmes will be more effective when they are tailors to each target group. This also applies to foreign markets where economic, political and cultural conditions vary widely.

Rather than assuming that its products can be introduced and marketed as in one country to another country, the company should review the following adaptation elements and determine which would add more revenue than cost (i) Product features (ii) Brand name (iii) Labelling (iv) Packaging (v) Colour (vi) Materials (vii) Price (viii) Sales Promotion (ix) Advertising themes (x) Advertising Media (xi) Advertising Execution.

Significance of Consumer Behaviour in Promotion of New products in International Marketing

Consumer behaviour is an important factor that determines the success while introducing new products in the international markets .Because consumer's perceptions are highly subjective and consumers can be quite unpredictable. Because of the complex nature of consumers an understanding of consumer behaviour is imperative for promoting new products in various international markets. The cultural and psychological approach and social concepts of consumers may vary and it should be well understood before approaching them. Also the success of a product is greatly affected by whether its target customers are properly motivated . As such, it is important to identify specific motives relevant for marketing purpose.

The success or otherwise of a product depends significantly on how it is perceived by the customers. A marketer should provide some views about a product in order to aid consumers in perceiving the products in the deceived manner. It is not unusual for consumers to categories countries (eg: rich , poor, developed, developing etc) and use these categories to classify products. There is evidence of country – category effect in that sense that customers use stereotyping in typing product classes and brands (Syed Saad , Andaleef,1995)

At a more specific level, consumers may use country of origin as a guide to product quality. Consumers have general images about the products made in those countries. In general products from less developed are less favorably received than those from Industrial countries . But even for high-risk products from less developed countries, consumers are still willing to buy them as long as they carry known brand names, indicating the power of a brand name to moderate the negative influence of a country's negative image(Victor, 1993) In addition attribute claims become more creditable when the products are distributed through a prestigious retails (Paul Chao, 1989) Consumer preference is thus a product – category match. Consumer willingness to buy a countries particular product increases when country's image is an important characteristic for that product category. Because the consumers continuously merge product information with country image and their quality control procedures. The industry and the government should interact on quality standards and provide such incentives as tax free and subsidies to exporters who meet the standards while penalizing those who do not by imposing export taxes or withdraw of export licenses.(Sak and John,2002)

An international marketer should pay attention to the relationship to the country of origin and the perception of product quality. Country of origin important than price and brand information is affecting product quality assessment.(Marjorie et al ,1991)

When consumers seek a product with superior tangible attributes and when the product with superior tangible attributes and when the financial risk is high, they are more wary of products from least developed countries (LDC), Naturally LDC need to solve this marketing problem(Victor,1991) Many countries including the United States require proper origin certification in the form of a tag, label or other identification means before importing the foreign products.

It is worth mentioning here that certain Indian Companies made attempt to develop new value added products such as cuttle fish, diamond cutt, battered squid, Kebab, squid 'v' cut, barbeque cuttle fish and squid, sea food mix and popularize them in the international market.

SUMMARY

General characteristic features of the cephalopods are discussed in the introductory part. It also contains the review of the work done in various aspects in India and the objectives of the study.

The chapter 1 gives the general trend of the Cephalopod landings in India, composition of commercially important species, and distribution of cepahalopods in the continental shelf of the southwest coast of India. Description of important species are given . Out of the eighty species , about a dozen are economically important which are *Sepia pharaonis, S.acculaeta, S.elliptica, S.prashadi, S.brevimana, Sepiella inermis, Lloligo duvauceili , L.uyii, Doryteuthis sibogae, Loliolus investigatoris, Sepiateuthis lessoniana, Octopus dollfusi, O.membranaceous , O.lobensis, O.vulgaris and Cistopus indicus.* The northwest coast contributes 43.3%, southwest coast 41.0%, south east coast 12.1%, and 0.6% by the north east coast. Cuttle fishes accounts for about 51% of the total cephalopod production followed by squid with 48%. The contribution of Octopus is nominal. It supports a subsistence fishery in Andaman and Nicobar and Lakshadweep islands. Along the north west coast the *L.duvauceili* contributes the entire squid catch while, *D.sibogae* dominates in the south west region. The oceanic squids *Symplectoteuthis oualaniensis* and *Omastephes bartrami* occur in this region. Kerala stands first in the cephalopod production contributing 36.73% of the total cephalopod production in India (1991-2000). Gujarat and Maharashtra stand next and all these three states together land 76.87% during the period. The characteristic

features and geographical distribution of five species of cuttle fish , four species of squid and three species of octopus are described. Based on the average catch rates (catch per hour of trawling) of cephalopods obtained by two demersal resources survey vessels along the south west coast, the distribution pattern is studied.

Chapter 2 deals with various fishing crafts and fishing gears employed for capturing cephalopods in India. Major portion of the cephalopod catch are brought as by catches of shrimp and finfish fishery. The fishing gears like hook and line, light assisted loft nets and automated jigging are being exclusively used for cephalopods. The fishing crafts deployed for fishing include traditional crafts like catamarans, wooden canoes and plywood and fibre glass boats with or without out board engines, small scale mechanized crafts engaged in trawling and other fishing methods like gill netting, lining, purse – seining etc. and well designed and well equipped larger trawlers engaged in trawling. All these medium and larger trawlers conducting the demersal and column water trawling are landing the major part of the cephalopod catches. During the period 1993 – 1999 about 50 vessels ranging from 28.0 – 31.39m LOA large shrimp trawlers operated in the north east coast of India are diverted for cephalopod resources of the west coast when shrimp fishing was not economical. These vessels recorded very good catches of cephalopods especially cuttle fishes. Among various fishing gears employed for cephalopods demersal trawlers of different types and sizes operated from the medium mechanized and larger trawlers are the main-stay of the fishing gears. Semi pelagic trawlers are also introduced aiming at fast swimming demersal and semi pelagic resources including cephalopods. The specifications, accessories and mode of operations are discussed. Hooks and lines, hand line pole and line jigging gears are used for capturing cephalopods. Along the Vizhinjam. Kanyakumari coast hooks and lines are operated from motorized and non – motorized crafts to catch the large sized cuttle fish *S.pharoanis* which account for the entire catch of cuttle fish from this region. Squid jigging is a technique to capture squids which are positively photo-tactic and aggregate close to illumination. They are attracted to a fast moving bait or bait like objects. Hand line and pole and line jigging gears from boats and after reacting to the ground mostly manually. Hand operated jigging reels are developed and used to reduce the labour and the winding gear or drum is used to unwind and haul back the line. Automated squid jigging to catch the squid increase the efficiency. Squid jigging methods underwent radical changes and subsequently automatic squid jigging from factory vessels of 300 – 500 GRT and more are introduced for distant water fishing. The results of experimental squid jigging conducted from M.V.Matsya Sugandhi and the mode of operation are discussed in detail. Traps and pots are being used for capturing octopus and squids inhabiting shallow waters. Purse seines is a surrounding nets occasionally gets shoals of squids along the Karnataka coast. Seine net operated in the shallow waters get squids and cuttle fishes in limited quantities. Similarly the gill nets, loft nets and cast nets operated by the artisanal sector lands cephalopods along with other varieties.

The third chapter deals with biological aspects of two commercially important species viz *Sepia pharaonis* and *Loligo duvauceli* of Cochin water which represent the cuttle fishes and squids. Knowledge on the biological aspects like maturation and spawning, food and feeding habits, age and growth, length –weight relationship, fishing and natural mortality etc is very essential for the exploitation and proper management of these resource. The samples for this study were collected from the landings of the survey vessels of Fishery Survey of India and the landings at the Cochin Fisheries Harbour during January to December 2003. In the case of *Sepia pharoanis* 756 specimens were studied for growth and mortality, 332 for maturity studies, 193 food and feeding and 381 for length- weight relationship. Altogether 2156 specimens 1569males and 587 females were examined in respect of *Loligo duvaucelie.*

The length-weight relationships in respect of both the species were worked out. Length-weight relationship of males and females of both the species are as follows.

S.pharaonis Male: $W=0.000899\ L^{2.552}$

Female: $W=0.015741\ L^{2.015}$

L.duvauceli Male: $W= 0.0020\ L^{2.149}$

Female: $W= 0.0010\ L^{2.309}$

In both the species the males and females have the exponents (b) significantly different from 3 indicating allometric growth. The value of (b) in length-weight relationship is considered '3' when growth is isometric as observed in ideal fishes. The growth parameters , mortality rates etc were worked out with the help of computer programme package FISAT II for males and females together . The Loo and growth coefficient (k) were 381 mm and 0.92/year for *Sepia pharaonis* and 300mm and 0.75/year for *L. duvaucelie*. It is seen that; *S. pharaonis* attains the L∞ at the age of 3.25. The total mortality calculated basing on the length converted catch curve was 2.50. The natural mortality was 1.36 and fishing mortality 1.14 for *S. pharaonis*. The total mortality (z) was 2.61, the natural mortality 1.37 and fishing mortality 1.24 in the case of *L. duvaucelie*. The exploitation ratios were 0.46 for *S. pharaonis* and 0.48 for *L. duvaucelie*. According to the present study both the species of the southwest cost are not under much fishing stress. The maturation and spawning of both the species have been studied. Maturity stages, spawning seasons, seasonal distribution of various maturity stages, size at first maturity fecundity and sex ratio of both the species have been studied. Maturity stages were quantified only in the case of females. Five stages were identified in both species based on the condition of ovary, nidamental glands and accessory nidamental glands. Matured females of *S.pharaonis* were observed from 140mm onwards and length at first maturity was at 185mm. In *L. duvaucelie* matured females appeared at 60 – 70mm length range and reaches first maturity at 102mm. Females were dominant during pre monsoon and post monsoon months for *S.*

pharaonis, but in *L.duvaucelie* males were predominant in all the months. The fecundity was estimated and it ranged between 720 – 1150 in *S. pharaonis* and 2104 – 10989 in *L. duvaucelie.* Feeding intensity was less in both the species. In *S. pharaonis* 72.3% of males and 64.0% of females were with empty stomachs. The major components of food were telecost fish (37%) crab and shrimps (21%) respectively. Very few full and ¾ full stomachs were observed. In *L.duvaucelie* myctofids and loliginids are the major components constituting 18% and 11% respectively. Other prominent components were pandalib, jelly fishes, clupeids, trichunids etc. During March and April feeding intensity was more in the species as compared to other month. In *S. pharaonis* and *L. duvaucelie* it was very difficult to identify the food contents to the species and genetic level as bulk of the content was in semi digested condition.

The fourth chapter contains the handling and processing methods. Cephalopods were throwaway material with very little value in the early sixties when the shrimp processing industry started gearing up for exports on a large scale. They were consumed by people in the coastal areas and no consumption was observed in the interiors. The advent of cephalopods as an export commodity in the early seventies led to attention of cephalopods processing as an alternative to shrimp processing.

Squid has a major share in cephalopod processing as squid landings are higher in comparison to cuttle fish and octopus forms a minor part.

The most prevalent and common method of cephalopod processing is by freezing and other methods are only of a very minor nature. The methods of commercial processing and the steps involved in processing the important products of cuttle fish and squid are given in detail along with a process flow charts, standard operating procedures and HACCP plans in operations are given in detail.

Most of the cephalopod processing plants operate under the highest standards of quality assuring consumers finest quality. Rigorous quality control and food safety measures attributable to European Union Standards are in place as plants need to be approved if they are to export to any European Union Country. The plants being export oriented and HACCP is implemented with standard operating procedures, good manufacturing practices. The products produced by these plants studied were reasonably good and nil or very little complaints were received from the overseas buyers. However there is some scope for improvement. Time lag is noticed between the raw material being received in the processing plant and production into finished product. This is especially observed when there is heavy input and raw material is queued up for production. A reduction in queuing time resulted in finished products with better organoleptic qualities.

Efforts must be taken to ensure conversion of raw material into finished products in the shortest possible time to ensure the finest quality.

Cephalopod processing is not taken up by plants exclusively and production lines are often used for shrimps, fin fishes, etc. This can cause cross contamination and it would be preferable to have exclusive cephalopod processing plants.

The emphasis or over dependence on the traditional products of frozen cuttle fish, squids and octopus should be overcome by diversifying into value added products like battered products , kebabs etc. One product that can go a long way is seafood mix. In the case of cephalopod seafood mix which can and needs to be encouraged, a core of cephalopods surrounded by other low value seafood items results in value items that would otherwise not be used.

The utilization of cephalopods including the export is dealt in the fifth chapter. The high protein and low fat make them suitable for human consumption. Cephalopods are used baits in long line fishing for tuna, billfishes, pelagic sharks etc and hook and line fishing. The cuttle bone has a wide variety of commercial and industrial application. Powdered cuttle bone is used for cleaning glasses, and wood works and as source of food for poultry. The oil and liver extracts are used for human consumption squid meal, squid oil and soluble protein are made from squid viscera. The cuttle fish ink is used by artists as a natural pigment and it has got medicinal values. Export of frozen cephalopod commenced in 1973 and there was a phenomenal growth there after. During 1998-2000 an average of 74758 t. of cephalopod products realizing average value of Rs.644.04 crores was exported from India. It formed 18.84% by quantity and 11.18% by value. Initially, Burma, Singapore, Japan, Italy, U K, etc were the importers. Now more than 50 countries import various products from India. The growth of cephalopod export from 1963 onwards is given. The export has grown from 421kgs to 73101tonnes in 2001. Earlier cuttle bone was the only item for export. Since 1973, export of frozen products of cuttle fish squid has started and frozen octopus was added in the year 1989. In the years 1989 and 1995 a shares of export of cephalopod were 26.09% and 24.74% respectively . Year after year products were diversified and the year 2002 altogether 57 products frozen and dried products of cuttle fishes, squids and octopuses were exported . The year wise export data containing the products, quantity, value, countries etc for the period 1992 to 2001 were analysed . The unit value obtained for each product year wise, the rates offered by the important countries and their share in the export, fluctuations in the price rise are presented. The reasons for country wise fluctuations are discussed. It is seen that many of the countries importing frozen products from India are reprocessing them and marketing in their country and also re-exporting as consumer packs adding value to the products. The marketing strategy to be followed for enhancing the export are discussed. It is suggested that the export can be increased by enhancing the production and developing more value added and specialty products. The significance of consumer behaviour in promotion of new products is elaborated. The factors like country of origin, brand name, packing, the advertising etc influences the consumers.

Summary is followed by references.

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