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 cephalopods 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. aculaeta, S. elliptica, S. prashadi, S. brevimanu, Sepiella inermis, Loligo duvauceli, L. uyii, Doryteuthis sibogae, Loliolus investigatoris, Sepiateuthis lessoniana, Octopus dollfusi, O. membranaceus, O. lobensis, O. vulgaris and Cistopus indicus. The northwest coast contributes 43.3%, southwest coast 41.0%, southeast 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. duvauceli 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 pharaonis* 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 1569 males and 587 females were examined in respect of *Loligo duvauceli*.

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 $L_\infty$ 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 $L_\infty$ 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 coast 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 ¼ 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 73101 tonnes 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.