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CEPHALOPOD BIONOMICS, FISHERIES AND RESOURCES OF THE EXCLUSIVE ECONOMIC ZONE OF INDIA

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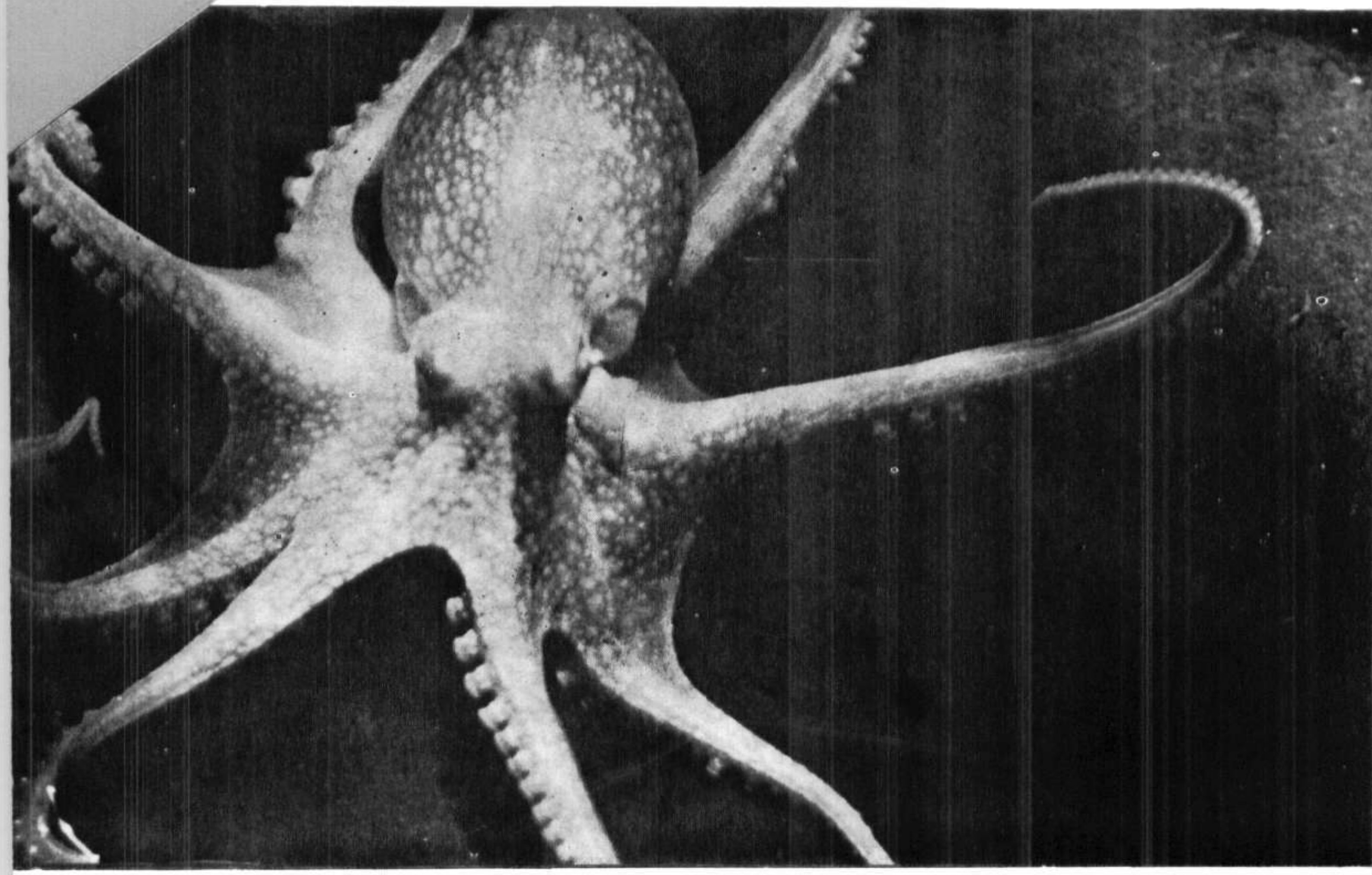

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CEPHALOPOD RESOURCES: PRESPECTIVES, PRIORITIES AND TARGETS FOR 2000 A.D.

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ABSTRACT

Estimates of cephalopod resources of the Indian Ocean and the EEZ of India are discussed. Attention is drawn to major lacunnae in resource assesment. The importance of cephalopods also as forage, as bait, for neuro-physiological studies, behaviour studies and so on are discussed. The cephalopod potential and the prespectives and production targets for 2000 A.D. along with modalities of achieving the same are outlined.

INTRODUCTION

There is general consensus that cephalopods constitute potentially an important marine living resource where future exploitation to a high magnitude is possible. Estimates are that the present global production of 1.5 million tons can be increased many-fold. Nearly 70 per cent of the presently exploited resources of squids, cuttlefishes and *Octopus* come from the neritic waters where directed fisheries for this resource is sparse. While Cephalopods are considered a nonconventional resource in many areas, its high protein and low fat content can make it an important item of human diet. In fact, there has been a quantum jump in the cuttlefish and squid catches in the world during the decade 1970 to 1980 of 84 and 57 per cent respectively as against a growth of hardly 8 per cent of total world fish production. An FAO projection places this trend of production of cephalopods in the world fisheries to go up to about 2 million tons by 1990. Accordingly (Anon, 1983), the total world food requirements of cephalopods will be between 1.7-1.9 million tons by 1990, about 227,000 to 499,000 tons more than the present level. To maintain the present level of *per capita* consumption, the production should attain atleast the lower limit. The estimated projections given in Tables 1-3 will give an overview of the situation, especially for the countries viz., Japan, Republic of Korea, China, Spain, Italy, France, Mexico, Thailand and Philippines presently involved with the fisheries in a big way.

TABLE 1. *Projected Demand for Cephalopods in Japan 1990* (*After Anon*, 1983)

		1980 Esti-mated '000 tons	1990 Pro-jected live weight	1980 Esti-mated Per Capita kg.	1990 Pro-jected Per Capita kg.
FRESH/FROZEN					
Home consumption					
Squids/Cuttlefish	..	234.2	249.0	2.02	2.30
Octopus	..	43.3	48.0	0.37	0.44
Sub total	..	277.5	297.0	2.39	2.79
Institutional Catering					
Squids/Cuttlefish		85.3	130.0	1.22	1.54
Octopus	..	51.0	65.0		
Sub total	..	136.3	195.0	1.22	1.54
Processed					
Preparations	..	316.5	331.5	2.73	2.77
Others :					
Canned	..	5.1	4.0		
Dried, Salted & smoked	..	41.0	45.0	0.56	0.56
Salted fermented	..	18.6	22.0		
Sub total	..	381.2	402.5	3.29	3.33
Total Human Food	..	795.0	894.5	6.90	7.66
Bait	..	36.0	30.0		
Total Demand	..	831.0	924.5		

TABLE 2. *Actual supply and prospective deamnd for Cehalopods in 1990 in selected countries* (*After Anon.* 1983, *SCS/DEV/83/24*

Country		1980 *Per Capita* kg.	Total '000 tons	1990 *Per Capita* kg.	'000 tons
Mexico	..	0.39	27.0	0.41	38
Japan	..	6.82	763	7.08	895
Korea, Rep. of	..	2.16	110.6	2.63	118
Philippines	..	0.67	33.0	0.79	50
Thailand	..	0.83	26.0	0.97	56
France	..	0.28	14.6	0.32	18
Italy	..	1.57	89.1	1.85	108
Spain	..	3.50	132.0	3.73	151

TABLE 3. *General prespective for World Consumption of Cephalopods in 1990.* (*After Anon.* 1983. *SCS/Dev/83/24* ('000 tons)

		Approximate per cent consumption (1980)	Prespective consumption in 1990 Low[a]	High[b]
World Total[c]	..	**1447.6**	**1674**	**1946**
Africa	..	2.0	3	5
Latin America	..	32.0	43	53
Mexico	..	27.0	35	38
Other	..	5.0	8	15
Asia and Middle East	..	**1127.9**	**1314**	**1518**
Japan	..	795.0	845	895
Korea, Rep. of	..	110.6	129	157
Philippines	..	33.0	42	50
Thailand	..	18.3	48	56
Other Asian	..	171.0	250	360
Europe	..	**265.7**	**284**	**325**
France	..	14.6	15	18
Italy	..	89.1	91	108
Spain	..	132.0	142	151
Other European	..	30.0	36	48
Other Developed Countries		20.0	30	45

[a] Assuming no increase in *per capita* consumption.

[b] Including the effect of income increases for all, and also for price effects in the case of Japan.

[c] Excluding bait (approximately 46,000 tons) and inventories

What is most revealing is that while the prespective consumption for 1990 (high) for the countries traditionally involved with Cephalopod fisheries is to the tune of about 264 thousand tons (100,000 tons for Japan), it is the senario for the 'Other Asian Countries' that is significant—a jump from 171.0 to 360.0 tons. While these may be only indicative projections, I feel, India has a vitally important role to play in filling up part of this gap of about 189,000 tons.

Today we are in a fortunate position to have many added facilities for our resources survey leading to constructive development programmes. With a fleet of large fishery exploratory survey vessels with the Fishery Survey of India and Sister Organisations of the Department of Fisheries and DARE of the Ministry of Agriculture and Rural Development, Government of India, and the acquisition of the Fishery Oceanographic Research Vessel SAGAR SAMPADA of the Department of Ocean Development, Government of India, we are uniquely set to carry out from the deeper neritic waters and our contiguous high seas resources surveys and evaluations as well as quite a lot of basic information that is required on the ecology, behaviour and stocks of cephalopods that are essential for sustained commercial operations. If we take the example of Thailand, great innovations are possible in the shallower neritic waters in our small scale fisheries sector and the continental shelf waters.

No development programme for cephalopods, a non-conventional resource for us can succeed unless we link it with a good internal marketing strategy. Thus there is an urgent need for a constructive product development and marketing programme even for the existing catch part of which is discarded. As introduction of specialised fishing methods are necessary to augment production from the present level of about 18,400 tons (Av. for three years 1982-84), largely taken as bycatch in the shrimp fisheries, what should be our strategy ? Upgrading the existing fisheries with innovations in light fishing with lift nets in the small scale sector and the establishment initially of joint venture programmes with buy back arrangements appear feasible propositions.

An expansion of the Cephalopod fisheries in India may throw up a number of problems and will also need special attentions in several areas including basic and applied research to support developmental programmes. I would like to touch on some of these before attempting a long term development projection for India.

RESOURCE ASSESSMENT

1. The expansion in cephalopod fisheries will involve tapping of new resources for utilization besides the traditionally exploited species. Proper species identification for developing resource management strategies is essential. Our species inventory, especially those from our oceanic waters is far from complete. Hence this basic element has to receive immediate attention through collection of samples and documentation from resource surveys and exploratory fishing for neritic, epipelagic and mesopelagic species. Identification of life-history stages is an equally difficult task. It is

imperative that we have identification aids or keys for larvae and juveniles so that recruitment monitoring of at least the commercially important species could be made more effective.

While living cephalopods number fewer than 1000 species (650 ?) belonging to 43 families, there are wide range of differences in their life habits, and behaviour ; some are benthic, others pelagic or pass through an early pelagic phase exhibiting ontogenic descent ; some solitary or as the oceanic squids, shoal in large schools. Size-wise they range from minute species hardly 2 cm to the giant squid *Architeuthis* sp. attaining over 20 metres in length and weighing well over a ton. However, most of the commercial species fall within the range of 30 gms to 2 kg in weight.

2. Use of Cephalopod beaks in species identification : A method for identifying beaks and on beak size estimating body weight and mantle length has been developed by Wolff (1984). Studies of this nature are very important since in many cases we get only the beaks from predator stomach and gut. Effective means of species identification thus becomes important and so also an estimate of the size of the prey. Perhaps this approach could eventually help in estimating prey biomass.

Mercer *et al.* (1980) have gone one step further in using beak morphometrics of the Ommastrephid squid *Illex illecebrosus* in sex determination. The significance of cephalopod beaks and the possibilities of beak size—body weight estimations have been discussed by Clark (1962a, 1962b and 1966). Wolff and Wormath (1979) have used beak morphology for separating two morphologically similar species of ommastrephid squids.

A whole new area has thus been opened up for studies on species and sex identification as well as estimation on growth and predator prey relationship. It is hoped that some attention will be given to such studies and estimations in our waters.

3. Diel vertical migrations :

Spectacular diel vertical migrations are undertaken by many species of oceanic cephalopods. Roper and Young (1975) categorie a variety of patterns of vertical distribution of cephalopods as :

Near surface dwellers
First order diel vertical migration
Second order diel vertical migration
Diel vertical shifters
Diel vertical spreaders
Non-migrators
Vertical wanderers
Species associated with the ocean bottom ; and
species exhibiting ontogenic decent.

While we have carried out some studies on the Deed Scatting Layers (DSL) and the vertical migrations of macro-zooplankters (Silas, 1969), more work is needed in this direction specifically with reference to cephalopods for the following reasons :

(*a*) To understand the effect of temperature, light productivity and competitions in regulating or limiting the distributions of the species.

(*b*) In the Eastern Arabian Sea we have an oxygen minimum layer and the relationship of this with the occurrence of pelagic cephalopods, especially those associated with the DSL needs study.

(*c*) Determination of swimming layers of the commercially important species and the phases of feeding activity on the bait organisms in the DSL. From the north east Arabian Sea, Yamanaka (1976) has reported capture of the oceanic squid *Symplectoteuthis oualaniensis* with hand lines from a depth of 400 m during day and from near the surface attracted by light at night. This species is also said to avoid upwelling areas and during day time its swimming layer is said to correspond to the oxygen minimum layer (0.18-0.38 ml/1). Two DSL, one at 350-450 m and the second still deeper at 800-900 m have been reported from the Lakshadeep Sea (Silas, 1969) and the occurrence of cephalopods and their percentage composition in the DSL should be of considerable interest. The closing nets which could be operated at reasonably high speed is a must for quantitative studies on some of the mesopelagic squids. In a series of papers Clarke and Lu (1974, 1975) and Lu and Clarke (1974, 1975) have demonstrated the more effective use of two nets, namely the Isaacs Kidd Midwater Trawl with catch dividing buckets (IKMT) and a Rectangular Midwater Trawl (RMT) with good success.

We have facilities for use of such gear from our research vessels ; especially R. V. SAGAR SAMPADA and I hope constructive programmes will be developed for obtaining better quantified data.

Cephalopods as Forage

1. Cephalopods form forage to a wide variety of predators, viz., large perches, Tunas and tuna—like fishes including sword fish, sailfish and marlins, lancet fishes (*Alepisaurus ferox*), pelagic sharks and rays,

sea birds, dolphins and toothed whales. Clark (1979) 1980) estimates on the basis of beak of cephalopods in stomachs of sperm whales that the whales may consume squids as much as or more than the quantity harvested in world fisheries for squids. A proper evaluation of cephalopod as forage from our seas is necessary in order to understand whether excessive degree of preying on any particular species by predators would affect recruitment of any of the commercially important species. Besides it may be worth examining whether some of the forage species could be good indicators of aggregating areas of pelagic fish such as Tunas. Stomachs of lancet fishes caught in tuna longline fishery invariably contain fresh forage on which they would have fed and form excellent biological samplers. The importance of cephalopods as forage will be evident from the growing literature on the subject. A few pertinent references on prey-predator relationship are Krumholz and de Sylva (1958), Maksimov (1969), Dragovich and Potthoff (1972), Pervin, Warner and Fiscus (1973), Rancurel (1971, 1976), Clarke and MacLeod (1974), Mercer (1974), Imber (1975) and Toll and Hess (1981).

Cephalopods as Bait

Estimates are that nearly 46,000 tons of Cephalopods harvested, predominantly squids are used as bait in the global fishery activities. The demand is most for small sized squid of 150-200 gms for tuna long lining. Japan is esimated to use about 36,000 tons as bait in her distant water tuna long line operations. This demand for bait is likely to continue if not rapidly increase in the coming years as many of the developing countries may enter longline fishing and other types of line fishing where cephalopods may have to be used as bait. A decline in use of cephalopods (squids) as bait is predicted for Japan. A proper assessment of our requirements and the species suitable as bait needs study as we have made a start in exploratory surveys and joint ventures programmes in tuna long lining. In short the right species and the right size have to be decided and the size of the blocks in which they have to be frozen for easy transport and handling on board determined.

Cephalopod Behaviour

We have practically no studies on behaviour of cephalopods from our waters. An understanding of Cephalopod behaviour is equally important for the exploitation of the resources. We need information on the gregarious and non-gregarious habits of the species, existence of dominance hiearchies, feeding pattern ; degree of sociability, communication between arrivals by agnostic displays, territorial habits, protective adaptations to discourage perdators, escape behaviour, inking pattern, frequency and quantity and other antipredator behaviour, diel rythms, habitat preferences, swimming postures, ritualized reproductive behaviour and courtship patterns during sexual interactions, copulation and egg-laying ; ritualised colour patterns (light, dark, striped, bars and spots, dymantic or black spot display and other patterns such as zebra stripe, upward V-curves, longitudinal streaks and cryptic and defensive patterns) ; bioluminescence and its role in behaviour ; and semelparity.

Reproductive behaviour is of special interest. What triggers egg laying in a site ? According to Grimrpe (1926) in *Sepia officianalis*, the laid eggs may induce optical stimulation in spawning females in selecting an egg deposition site. In the case of *Loligo opalescens* an egg cluster is known to be a visual stimulus for females to attach freshly laid eggs to the cluster (Hurley, 1977). Confirmatory information for our tropical species is wanting.

The works of Wells (1962), Wells and Wells (1972), Young (1962), Moynihan and Rodaniche (1977, 1982) and Moynihan (1983) are but a few useful references which are indicative of the wealth of information that could be collected an aspects of the behaviour of the species, information on some of which are vitally necessary for managing the resource.

Neuro Physiological Studies

A good amount of effort has gone into the study of the giant nerve fibre system and the stellate ganglion of squids to understand the pathways of response transmission to enable split second body movements and reactions. The giant axon of the squids has thus been found to be important for neurophysiological and pharmacological studies (Rosenburg 1973). The basic processes connected with the nerve excitation and nerve conduction have been clarified by the study of squid giant axons (Hodgkin, 1964 ; Tasaki, 1968). More significant has been the outcome of the study of the nervous system of the *Octopus* by Wells (1962, 1966, 1978), Young (1971, 1977) and of the *Nautilus* by Young (1965).

We have made no use of such excellent material available in our waters for biomedical research.

Octopus Toxins as Pharmacological Tools

Some of the octopods secrete substances which may be lethal to prey invertebrates such as crustaceans (Ghiretti, 1960). Gage and Dulhunty (1979) while listing a number of instances and records of fatal bites of the Octopod *Hapalochilena maculosa* report the symptoms as '.......... respiratory distress, numbness

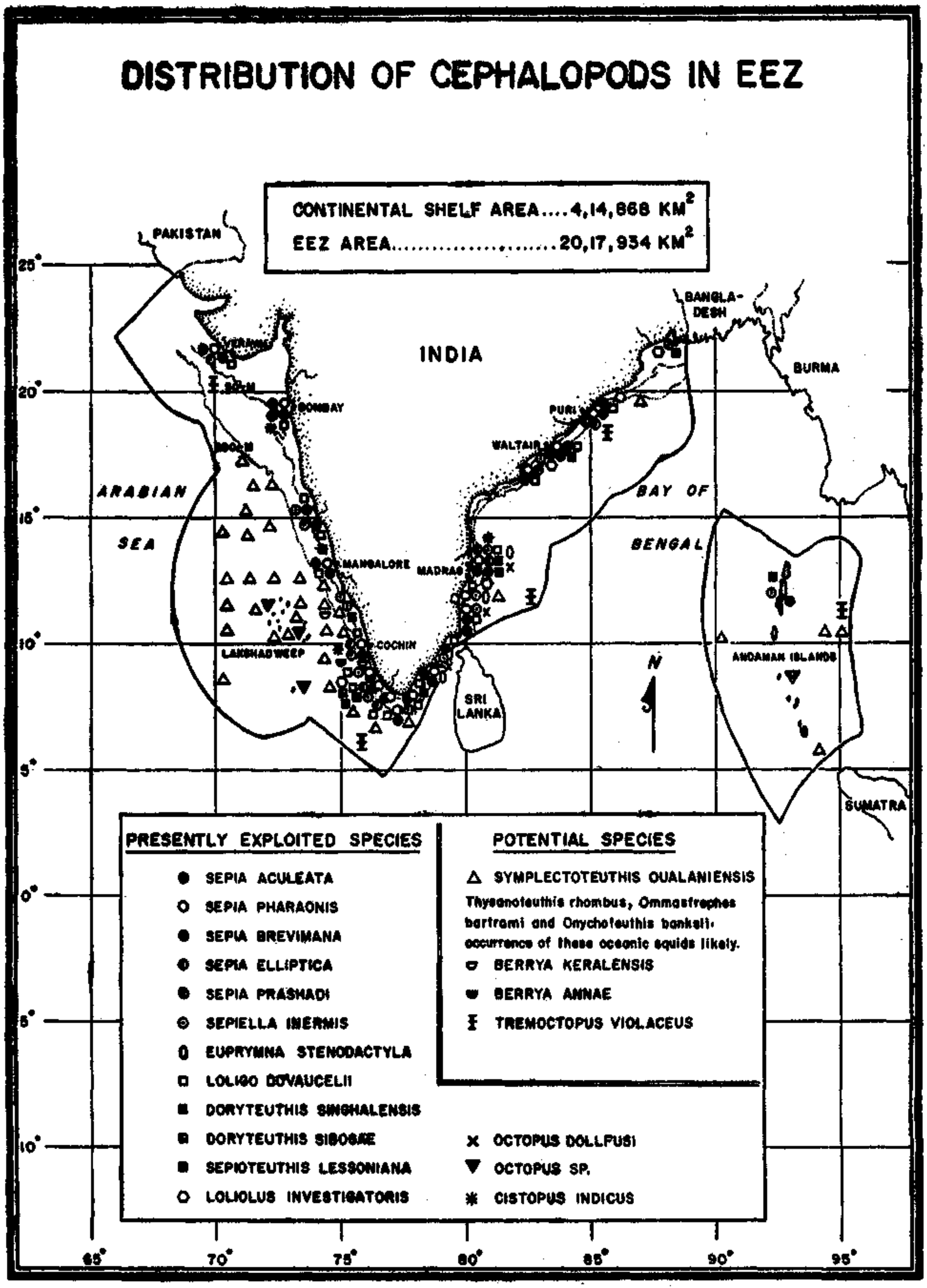


Fig. 1. Occurrence of exploited and potentially important species of cephalopods in the Exclusive Economic Zone of India.

of the mouth and tongue, blurring of vision, difficulty of speech and swallowing, loss of tactile sensation, ataxia and muscular paralysis ' followed by death. The toxin is identified as Maculotoxin which has pharmacological effects (Trethewie, 1965), akin to Tetradotoxin and Saxotoxin obtained from marine organisms. Since the death is caused by paralysis, the artificial ventilation of the victim is said to improve the chances of survival.

It will be worthwhile to understand the mechanism by which *H. maculosa* protects itself from its own toxin. It has been observed to squirt saliva from its beak into the water above the prey organism (crab) and move away and wait for the prey to die before approaching it again to feed on. The possibility of synthesising new and more effective anesthetic agents need study, in short, the therapeutic uses of Maculotoxin. For more information on the use of Maculotoxin reference is also invited to Flecker and Cotton (1955), Freeman and Turner (1970) and Dulhunty and cage (1971). *Haplochelaena maculosa* occurs in our waters and is occasionally caught in trawl operations along Tamil Nadu Coast. We have hitherto no reported cases of fatalities due to the bite of this species from our waters, perhaps as fishermen instinctively know it from its distinctive colouration and know that it is an undesirable species to handle. Lot of basic research needs to be done on the toxin of this and other cephalopods.

Life Cycle and Biology

A major lacunae as of data is that we lack information on the complete life cycle, biology and connected sequence of growth processess of even a single species of cephalopod from our waters. Information on semelparity or high post-spawning mortality is suspected for some species, males outlasting females in many, but confirmatory data is lacking from our waters. Some of the species are harvested in the 0-year class, I-year or II-year beyond which there is no information. In most species sexual maturity is rapid and a large body size is attained within a short time of less than a year. This is a reflection of the highly predatory habit and ability to forage on diverse orgnaisms. Canibalism has been observed of larger individuals preying on smaller ones of the same species.

The shorter generation time is probably compensated in numbers, some species occurring in very large aggregations. In short, our knowledge about the extrinsic and intrinsic factors that affect cephalopod mortality if fragmentary. Semelparity and abbreviated life span (1-3 years) of species are important information for the commercial exploitation and management of species.

Some species of squids and cuttlefishes attain sexual maturity at different sizes, but an adequate explanation is wanting. There is a need for understanding the factors responsible for such variations in body size at maturity in natural populations. Similarly the factors accelerating gonadial maturity also needs study.

Summers (1983) discusses the spawning—induced mortality in a terminal spawner *Loligo pealei* and the problems connected there with. There are other species which have intermittent spawning since ' spent ' animals have also been observed in commercial catches. Whether successive spawnings is a quick or slow process needs study. In *Octopus*, many females are semelparous and die after caring for their eggs through the embroyonic development, but males outlive females.

As earlier mentioned, aging in cephalopods is still a problem and the use of beaks, statoliths and length frequency studies are feasible, but have their drawbacks as well. Age markers, however, need proper identification. For example, in the case of *Loligo opalescens* this has been attempted on the basis of population statistics, statolith ring counts and laboratory rearing experiments, each giving different interpretation (Hixon, 1983).

Mesh size and type of gear operated introduce bias in sampling from commercial catches where immature and juvenile stages are bond to be left out. Sampling of planktonic stages themselves have great short comings in methodology and types of gear used. In many species, the breeding areas and spawning may be spatially seperated. Refinements in sampling methods have to be adopted for more precise populations estimates.

There is hardly any information on the effects of macro and micro parasites on natural populations of cephalopods. Our species have not been critically screened for parasites.

Transportation of live squids to be kept in captivity for research on aspects of physiology and behaviour are gaining ground. Some of the problems connected with live transportation and maintenance are discussed by Matsumoto (1976).

Cephalopod Mariculture

The culture of cephalopods (*Octopus*, squids and cuttle-fish) has been attempted and is technically feasible. However, in view of the large untapped resources yet available in capture fisheries aquaculture of cephalopod will continue to have a low priority except for selected species which may be need for bio-medical research or as choice food for a limited market.

In the context of a long range programme, the economic viability of culture of some of the commercially important species should be attempted. The factors in favour are the availability of spawners and eggs in inshore waters, the rapid growth and short generation period and hardiness of some of the species. Rapid decline in population under heavy fishing pressure of some commercial species may encourage attempts at mariculture of the species.

CEPHALOPOD FISHERIES

It is known that for any effective fisheries management, efforts are necessary for an understanding of the gaps in our knowledge on the commercially important species, viz. their life span (rate of growth, maturation and mortality); change in seasonal distribution and abundance, migration and stock discriminations. For the estimates of biomass of squids, acoustic surveys combined with underwater video measurements of the density of the population has been suggested as an effective tool (Caillict and Vaughan, 1983).

Established fisheries in some areas indicate periodic cycles of abundance (Shin, 1982). In capture methods we have no information from our waters about the reactions of squid and cuttlefish to our trawl gear nor any idea about escapement. Yet, the bulk of our landings are from shrimp trawling operations, where cephalopods from only a small proportion of the catch. No large scale jigging or light fishing or trap fishing are in vogue except in very localised situations.

Cephalopods, especially squids are considered to be opportunistic species which evince an explosive increase in population size when there is a depletion in other species due to intensive fishing. The best examples are the Thai trawl fisheries (Gulf of Thailand), the trawl fisheries in the northwest Atlantic and the northwest coast of Africa. We have never critically looked into this aspect in our inshore trawl fisheries, where, with increased effort the catch rates of some of the traditionally important fish and crustacean species have been known to decline. Whether the incidental catch of squids and cuttle-fishes have thereafter increased in specific fishing grounds may be examined from past data. This information may also be necessary for developing directed fishery for squids and cuttlefishes in the small scale fisheries sector. Such explosive increase may have to be supported and sustained by an abundance of forage organisms for squids and cuttlefish among other factors. An *in toto* study of such a problem in our water is necessary and I can think of no better place for such a critical exercise as the south west coast (Kerala) of India.

The conventional methods of yield-per-recruit may be difficult to apply to cephalopods on account of the high post-spawning mortality. One suggestion is that (Anon, 1982) estimates may have to be made for two or more phases such as, pre spawning phase of moderate mortality and high mortality during and after spawning. I would refer workers to the excellent exposition by Caddy (1983) on the methods of assessment of squid stocks; analysis of catch and effort data and its use; estimation of recruitment of short lived species; tagging; and short and long-term management measures for cephalopod stocks. He has suggested specific regulatory measures for cephalopod fisheries some of which may have relevance to our situation.

There is also an urgent need to further streamline monitoring of our multispecies fisheries and data acquisition system for cephalopods and other components which may prey on cephalopods from our coastal fisheries for the timely detection of changes in population abundance.

PRESPECTIVES AND TARGETS FOR 2000 A.D.

Gulland (1971) estimated the global biomass of cephalopods to be anywhere between 2-100 $\times 10^6$ t. Voss (1973) estimated the potential world catch of cephalopods from the neritic and continental slope areas to be around 8 to 12 million tons of which only about 1.5 to 2 million tons are being harvested. The world potential of oceanic species (Oegopsids) was estimated by him as anywhere from 8 to 60 times those from neritic shelf resources—about 500 $\times 10^6$ t globally. These are theoretical estimates based partly on feeding rates of sperm whales on predominantly oceanic squids when sperm whale populations were optimal. In fact, Kawakami (1980) estimated the weight of squids consumed by sperm whales to be to the order of 100-320 $\times 10^6$ t. Indirect evidence of abundance of squids is seen in some areas from the very hevy concentrations of the beaks of oceanic squids in benthic deposits. Chikuni (1983) estimated the potential yield of neritic cephalopods from the Indo-Pacific Region to be about 1.1-1.4 million tons as against a catch of 0.3 million tons.

It is evident that some of these estimates greatly exceed today's world fish production of about 76 million tons. While these optsimistic estimates point to a high magnitude of cephalopod biomass, the harvesting of the resources may have to be considered in the light of the high energy (fuel) costs ; predator-prey relationship as besides the sperm whale and other marine mammals, cephalopods are also choice food of a wide variety of fishes (Lange and Sissenwine, 1980, Dong, 1981). Nevertheless the fact remains that large resources of oceanic squids are yet to be tapped. According to Caddy (1983) '.... the high productivity/ biomass ratio of cephalopods (predicted on their high rate of populations turn over or natural mortality rate), may mean that the standing stock that could produce the above production may be significantly lower than for a fish stock of corresponding productivity, so that in fact the proportion of the standing stock found at high enough densities for harvesting to be economically feasible is probably quite low'.

It is also estimated that when good fishing for cephalopod exist as in the North West Pacific and the North West Atlantic, they constitute about 4.7 and 4.0 per cent respectively of the total fish catch from the region (FAO Areas 61 and 21 respectively), while in other geographical areas the percentage of cephalopod catch is very low. In the two aforesaid areas, the bulk of the catch of cephalpods is that of oceanic squids, and the presemption and implication is that in the other geographical areas globally oceanic squids are greatly under exploited. Not only this, Mercer (1974), Fiscus (1982) and others have shown that the locations from where the stomach contents of marine mammals have been examined and found to contain a preponderance of squids are spatially widely separated from the areas of abundance of these squids as evident from fishing operations.

Two important areas where production could be augmented in the littoral and island states of the Indian ocean are :

1. The neritic waters which wholly accounts for the cephalopod production in the Indian Ocean today.
2. The oceanic waters for pelagic squids which has remained untapped, but exploratory surveys in different parts of the Indian ocean have indicated resources of high magnitude.

The same holds good for India as well. First there is an urgent need for developing directed fishery for cephalopods from our continental shelf waters and the most promising method for immediate development seems to be the utilization of some of the mechanised boats of 9 to 13 m for light fishing with lift nets. There is also need for upgrading the traditional gears for specific capture of squids and cuttlefishes as well as use of traps, pots etc. for *Octopus*, the latter especially in the reefs and lagoons. There is also considerable scope for improving the utilization of the presently exploited resources from the continental shelf waters in our multispecies trawl fisheries by better post-harvest handling and product development to create greater internal demand and cater to the export trade. Chikuni (1983) has given the nominal catch of cephalopods by area in 1970 and 1975-1981 (' 000 t) as follows :

Area	1970	1975	1976	1977	1978	1979	1980	1981
Bay of Bengal ..	1	4	3	11	10	12	9	9
Eastern Arabian Sea ..	0	5	6	8	19	15	12	14

Part of this catch is accounted from the shallower neritic waters along the Indian Coast. According to him, the major species of cephalopods in the above two sub-areas are as follows :

Species	*Bay of Bengal*	*Eastern Arabian Sea*
CUTTLE FISH		
Sepia pharaonis	+	++
S. aculeata	+	+
S. recurvirostrata	(+)	(+)
S. latimanus	+	(+)
S. esculenta	(+)	(+)
S. kobiensis	+	+
S. prashadi	(+)	++
Sepiella inermis	+	+
NERITIC SQUID		
Loligo edulis	+	(+)
L. chinensis	++	+
L. singhelensis	+	++
L. duvaucelii	++	++
L. uyii	+	+
Notodarus philippensis	+	+
Sepioteuthis lessoniana	+	++
OCEANIC SQUIDS		
Onchoteuthis banksii	+	+
Symplectoteuthis oualaniensis	+	+
OCTOPUS		
Octopus vulgaris	+	+
O. aegina	+	+
O. macropus	+	+
Cystopus indicus	+	+

+ Present ; ++ Abundant ; (+) Probably present.

In addition to these species listed by Chikuni (1983), many others occur along our coast some of which may eventually turn out to be equally important on the basis of their occurrence and abundance.

Based on Silas *et al* (1982), Chikuni (1983), has given the catch of cephalopod by species groups for the east and west coasts of India as follows :

Species group		1970	1975	1976	1977	1978	1979	1980	1981
A. EAST COAST AND ANDAMAN SEA									
Cuttlefish	..	0	2	1	1	1	1	1	1
Squid	..	0	2	1	1	1	1	1	1
Octopus	..	?	?	?	?	?	?	?	?
Sub total	..	?	4+	2+	2+	2+	2+	2+	2+
B. WEST COAST									
Cuttlefish	..	0	2	3	4	7	6	5	6
Squid	..	0	2	3	4	7	6	5	6
Sub Total	..	?	4+	6+	8+	14+	12+	10+	12+
Total	..	?	8+	8+	10+	16+	14+	12+	14+

+ Given here.

Chikuni has arbitrarly shown the proportion of squid and cuttlefish as 50 : 50, but the cuttlefish catch has always been higher accounting for 60 per cent or more of the total catch from our waters. There has been a stepping up of Cephalopod production since 1981 and the annual landings for India for 1982, 1983 and 1984 are 15,799, 18,355 and 21,079 tons respectively. The average for these three years for the east coast of India is 4351 tons and for the west coast and Lakshadweep Islands 14026 t. These figures also reflect the increase in production after the mid-seventies when an export trade for cephalopods from India to Japan started developing. It needs reiteration that the entire catch comes from the small scale fisheries sector ; the major quantity from the trawl fishery and the rest from hook and line, shore seines, boat seines, gill nets and stake nets. About half the catch is utilized for local consumption. In the Nicobar Island and the Lakshadweep, *Octopus* spp are caught at the subsistence level for use as food and bait.

An important development during the first half of the eighties was fishing under charter agreement involving a large number of Taiwanese vessels used for Bull trawling especially along the north west coast of India (Gujarat, Maharashtra). This has confirmed the existence of excellent squid and cuttlefish grounds in the area, but precise estimates of catch are not available and is not reflected in the catch from India. When the charter agreement was in full operation in 1983-84, my estimate was an annual take of about 15,000 t of cuttlefishes (@ 70%) and squids (@ 30%) besides quality fin fish from the area. These operations have been phased out.

On available information for the sub-area Bay of Bengal and Eastern Arabian Sea, Chikuni (1984) estimated the potential harvest of cuttlefish and squids to be 10-fold over the present catch. His estimates of potential yield of neritic cephalopod ('000 t) is as follows :

Sub Area	*Average catch 1979-81*	*Estimated potential*	*Catch/ Potential*
Bay of Bengal ..	10	50-100	0.20-0.10
Eastern Arabian Sea	14	100-150	0-14-0.09

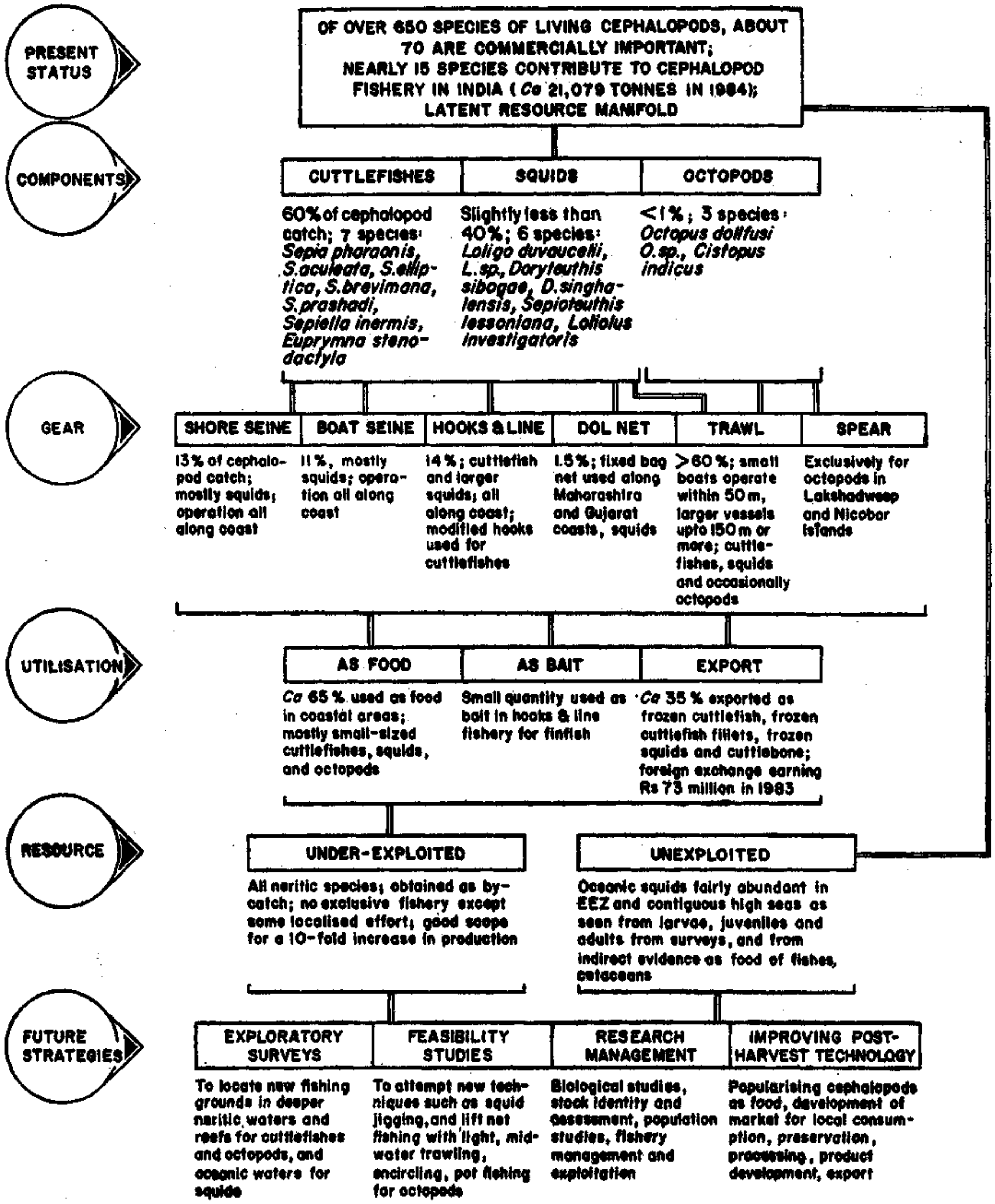
That the values of catch/potential are too low from these two areas will be quite evident when these figures are compared with those for two sub areas where high exploitation of cephalopods takes place. *viz.*, The Yellow Sea—East China Sea and the South China Sea as estimated by Chikuni (1983).

Yellow Sea and East China Sea	119	200-250	0.60-0.48
South China Sea	96	200-250	0.47-0.38

While these figures indicate the possibilities of the greater scope for the expansion of the neritic and oceanic fishery for cephalopods from the Bay of Bengal (East Coast of India and Andaman Sea) and the Eastern Arabian Sea (West Coast of India and the Lakshadweep Sea), I feel that Chikuni's estimates are rather conservative. Assuming that the market constraints within the country and the export trade will improve, I would give the projection for 2000 A.D. for our Cephalopod Fisheries Development as follows :

Sectors	Present Production (AV. for 1982-1984) A. West Coast & Lakshadweep	Present Production (AV. for 1982-1984) B. East Coast & Andaman Sea	Potential Harvest (1990) (A & B Combined (t)	Potential Harvest (2000 A.D.) (A & B Combined) (t)
1. Small Scale Fisheries (Neritic)	14026	4351	25000	50000
2. Oceanic Squids	Nil	Nil	2500	25,000-50,000
Total			27,500	75,000-100,000

CEPHALOPODS: RESOURCES AND UTILISATION



A positive and dynamic approach is necessary for achieving any success. Our ambivalence in the development of tuna fisheries has already left us high and dry and let it not be repeated in our development programme of the cephalopod fisheries. We may consider the following :

1. Systematically carry out exploratory surveys for squids from the deeper neritic and oceanic waters.

2. Streamline the data acquisition system for species-wise information on catch as well as on the discards.

3. Develop improved post harvest handling, storage and transportation.

4. Priority to be given for product development of items for the internal market and to cater to the export trade.

5. Improved techniques and gears for capture of cephalopods from the neritic waters. Special attention may be paid for developing light fishing with lift nets using some of the existing mechanised boats with required modifications. This will call for also short term foreign expertise and training.

6. Tap the resources of oceanic squids based on Resource Surveys, demonstration fishing and training and encouraging joint venture programmes. Foreign expertise will be needed especially in the areas of resource surveys and training for operatives.

7. Cephalopods are non-conventional resources for us but so was prawns in the early fifties. A major extension programme at government level at utilization of this high protein low fat marine product should be generated to get results. At the National level, the Fisheries Division of the Department of Agriculture and the Department of Agricultural Research and Education(ICAR) of the Ministry of Agriculture and Rural Development ; the Marine Products Export Development Authority of the Ministry of Commerce ; the Department of Ocean Development ; and the Fisheries Departments of the maritime states and Union Territories all have an important role to play in planning and executing extension programmes for developing cephalopod fisheries as a major fisheries for India.

Conservation and Management

Conservation of the cephalopod resources is not an immediate priority concern. However as it is known that heavy fishing pressure could completely deplete the resources, the short life-span of species posing a serious problem, recovery may take considerable time. Immediate concern should be on the following :

1. Whether squid and cuttlefish spawning grounds are being indiscreminately disturbed or destroyed by trawling and other man-made activities. Heavy sedimentation of the bottom in inshore areas due to man-made causes such as dumping of sludge affecting benthic conditions could have an adverse effect on recruitment. As a case study the Vizakapatnam coast where one of the largest steel producing complex is being set up may be considered, as enormous quantities of sludge is going to be let into the inshore waters. There is a reasonably good cephalopod fishery (cuttlefish) is this area.

2. Coral reefs are fragile ecosystems and excessive fishing for *Octopus* from such places are bound to adversely affect this resource and also create imbalances in the reef ecosystem.

3. Squids particularly are migratory in habit and any fishery for these would need close monitoring. Our system of data acquisition at the national level should be strengthened and streamlined for information on species-wise resources as well.

4. The exploitation of oceanic squids will also involve monitoring of the catch, unit stock identification and regional cooperations. I propose that an International Data Centre for Cephalopods for the Indian Ocean Area be developed at the Central Marine Fisheries Research Institute which will have the facility of rapid processing and discimination of the data as well. It may be examined how best the system of Data acquisition for such a Centre could be developed. We are at an advantage since major fishing efforts are yet to be expended in the Indian Ocean Region for caphalopods.

In conclusion, I am optimistic that Cephalopd Fisheries has an important future second only to the tunas and related fisheries from our exclusive economic zone and contiguous high seas. The efforts which have gone into this publication should point to the future possibilities and aid as a sound base for the future development of cephalopod fisheries Research and Development in our country.

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