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

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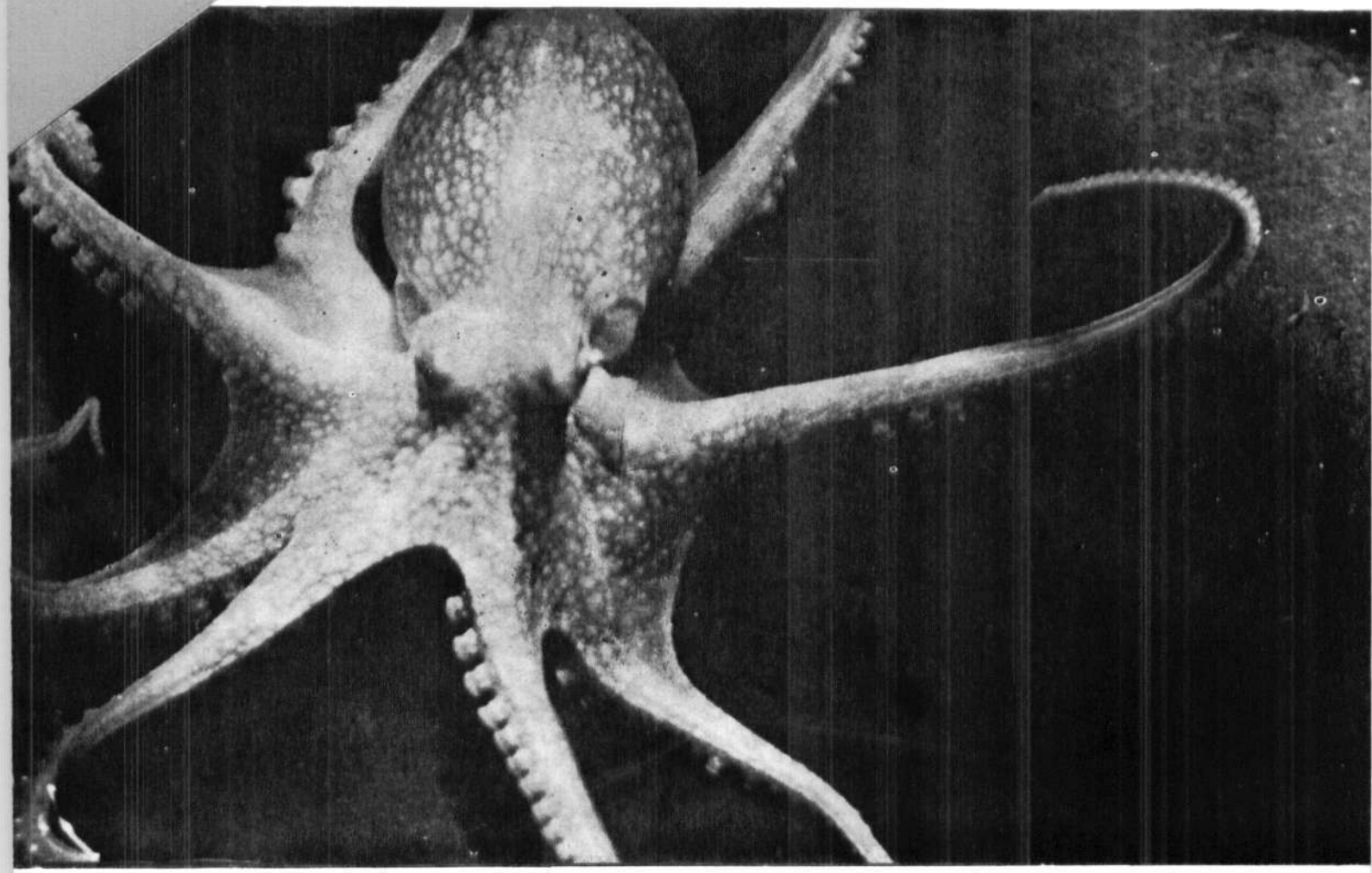

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CEPHALOPOD FISHERIES OF INDIA—AN INTRODUCTION TO THE SUBJECT WITH METHODOLOGIES ADOPTED FOR THIS STUDY

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ABSTRACT

The world production of cephalopods is briefly reviewed with observations on the situation in India. The methodologies adopted for the present studies on the taxonomy, aspects of biology and stock assessment of the resources of squids and cuttlefishes in some of our fishing grounds are outlined. For fully utilizing the resources the need for a close link up of product development and marketing with resource surveys and commercial harvesting is stressed.

INTRODUCTION

Three recent publications on cephalopods of the world oceans have helped to focus greater attention on squids, cuttlefishes and octopods, considered in many areas as non-conventional resources. The Report on ' Stock Assessment of Cephalopod Resources Fished by Japan ' (Okutani, 1977) ; ' Advances in Assessment of World Cephalopod Resources ' (Ed. Caddy, 1983a) and ' Cephalopods of the World—An annotated and Illustrated Catalogue of Species of Interest to Fisheries ' (Roper *et al.*, 1984) have in a way updated our knowledge of this lesser exploited resource. Countries such as Japan, Spain, the Republic of Korea, Thailand and the U.S.S.R. have established squid, cuttlefish and octopod fisheries. With the advent of the Law of the Sea and the declaration of the Exclusive Economic Zone (EEZ) by many nations, the cephalopod resource is gaining considerable importance from mere subsistence fisheries to directed fisheries in many developing countries and Island States.

In the oceanic waters cephalopods are second only to Tunas and Billfishes. Voss (1973) estimated the cephalopod potential from the continental shelf and slope as 8 to 12 million tons and opined that in oceanic waters the Oegopsid squids' potential could be 8 to 60 times that of the neritic shelf resources. While these are optimistic figures, we may also take into consideration that large areas of the world oceans have never been sampled for cephalopod resources although indirect information of occurrence and abundance is available from the food of toothed whales or from the occurrence and distribution of larval forms collected during international expeditions. Squids and cuttlefishes are short-lived species and the improved methods of stock assessments that are being evolved should help eventually in giving a more realistic picture of the resource. Today the world production of cephalopods stands around 1.5 million tonnes, and as mentioned earlier, in many countries cephalopods form only subsistence fisheries. In view of the possibilities of export earnings and the development of new markets for cephalopods, in the recent past, a number of countries have started cephalopod fisheries or intend doing so in the immediate future. Cephalopods, particularly cuttlefishes have in many areas in tropical waters formed an important by-catch in the shrimp fisheries. For long these have been discarded and only now efforts are made to use this also for processing and product development.

WORLD CEPHALOPOD PRODUCTION

The annual estimated World production of cephalopods has fluctuated during 1977-'81 between 0.98 (1977) and 1.5 million (1981) tonnes (Year Book of Fishery Statistics, F.A.O., 1983). Of this about three fourths catch has been squids, both from neritic and oceanic waters (0.71 to 1.16 million tonnes). The cuttlefish catch has fluctuated between 0.1 and 0.2 million tonnes

while octopods have ranged between 0.15 and 0.19 million tonnes.

Japan ranks as the leading cephalopod fishing country of the world with an average annual production of 604,734 t during 1977-'81, followed by Spain (111,430 t), Republic of Korea (109,992 t), Thailand (81,115 t) and China (60,025 t). The other countries in the order of production are U.S.S.R., Canada, Italy, Argentina and Philippines. The high production is achieved by Japan not only from her waters but also from distant water fishing operations, using diverse gears such as mechanised jigs with light fishing, drift nets and trolling lines. The Ommastrephid squid *Todarodes pacificus* is the most important species of the catches. Spain is the second largest cephalopod producing country with an annual production ranging between 102,117 to and 130,904 t and Republic of Korea third with yearly production of 69,883 t to 145,265 t. India's average annual production of 12,370 t (C.M.F.R.I., 1982) shows that the country ranks seventeenth in the World in cephalopod production.

World Squid Landings

The annual World squid landings ranged from 845,110 t to 1,169,308 t during 1977-'81 and contributed 73.3% of the total cephalopod landings. In squid production also Japan is the leading country with an average annual production of 526,888 t. China is second with landings of 60,024 and Republic of Korea third with 56,312 t. The other squid producing countries in the order of production are U.S.S.R., Thailand, Canada, Argentina, Spain, Philippines and U.S.A.

World Cuttlefish Landings

The annual World production of cuttlefish ranged between 178,103 t and 208,013 t and contributed an average of 14.1% to the world cephalopod production. The Republic of Korea is the largest producer of cuttlefish in recent years with an average annual landings of 35,508 t during 1977-81. Thailand is next in importance with an average production of 30,121 t and Spain third with 22,425 t. Japan, Vietnam, Italy, PDR Yemen, Malaysia, Morocco and France are the other countries in the order of importance and their production varied between 4,099 t and 21,097 t.

World Octopod Landings

The world annual production of octopods during the period 1977-'81 varied from 151,790 t to 190,419 t and accounted for 12.6% of the total cephalopod production. Spain is the largest octopus fishing country with an average annual production of 57,885 t followed by Japan (56,749 t). The Republic of Korea ranks third but its production is much lower, being 18,333 t. Italy, Morocco, Thailand, Mexico, Portugal, U.S.S.R and Tunisia are the other important octopus fishing countries and their annual production varied between 3,416 t (Italy) and 11,535 t (Tunisia).

India's Contribution

Cephalopods are fished from the seas around India from very early times and constitute one of the important exploited marine fishery resources of our country at present. The cephalopod landings of India were low, less than 1,400 t until 1972 and have been gradually increasing only from 1973 onwards with the commencement of export of frozen cephalopod products to several countries—a transition from a discard to a quality resource. The production rose steeply from 3,677 t in 1974 to 21,079 t in 1984 with slight fluctuations during 1979-'82. The bulk of the production includes cuttlefishes which account for about 60% and the rest consists of squids and negligible quantities of octopods.

Valuable contributions have been made on the systematics and identity of cephalopods of the Indian region by Goodrich (1896), Massy (1916), Adam (1939b) and Adam and Rees (1966) who have described a number of species of squids, cuttlefishes and octopods. Hornell (1917, 1951) has given an account of the fishing gear and fishery for cephalopods in Madras Presidency. In recent decades the biology and fishery of cephalopods have attracted the attention of some workers in India. Rao (1954) has investigated the morphology, biology and fishery of the Myopsid squid *Sepioteuthis arctipinnis* (= *S. lessoniana*) of the southeast coast of India. Alagarswami (1967) has described the eggs and early developmental stages of *S. arctipinnis*. Silas (1968) has given an exhaustive account of the cephalopod species distributed in the Indian Ocean and the occurrence and abundance of planktonic developmental stages as well as adults collected from the continental shelf waters along the southwest coast of India and the Lakshadweep Sea together with a bibliography of the literature on the subject. Sarvesan (1969b) has given an account of parental care and hatching in *Octopus dollfusi*. Oommen (1971, 1975, 1976, 1977a, b) has carried out studies on the identity and biology of some cephalopods of Cochin area.

Publications such as 'The Cephalopods of the Philippine Island' by Voss (1963), 'A review of systematics and ecology of oceanic squids' by Clarke (1966),

'Cephalopods of Hong Kong' by Voss and Williamson (1971), 'Biology of Cephalopods' by Nixon and Messenger (1977) and 'Octopus' by M. J. Wells (1978) need special mention. Some interesting papers have also been published in the Proceedings of the Symposium on Mollusca conducted by the Marine Biological Association of India at Cochin in 1968.

The report of Filippova (1968) on the distribution of cephalopods in the Indian Ocean ; the report of the Fishery Agency of Japan (1976, 1977) on the capture of squids in jigs and hand-lines in the Northern Arabian Sea ; the squid jigging feasibility study conducted by the Japan Marine Fisheries Research Centre (1979, 1980) in southwestern Pacific Ocean off the east coast of Tasmania, Bass Strait and the waters off the west coast of Tasmania, the book 'Fisheries of Japan, Squid and Cuttlefish' by Yoshikawa (1978) on the cephalopod resources, gear and utilization in Japan, the reports of erstwhile Exploratory Fisheries Project (1979a, b, c, 1982) about the results of fishing programmes ; and the series of papers of Court (1980) and others in *Mar. Fish. Rev.*, 42 on fisheries, processing and utilization of squids in various countries are of great interest in programmes of investigation and exploitation of cephalopod resources in the Indian Ocean.

In February, 1976 India declared an Exclusive Economic Zone extending our jurisdiction up to two hundred nautical miles from the coastline and efforts are necessary to explore and exploit the resources in the vast areas open for fishing. Recognizing the importance of cephalopods as a potential fishery resource which is now not properly exploited, at the Central Marine Fisheries Research Institute I had initiated a major research project on the spatial distribution, fisheries and biological aspects of potentially important species in different areas along the east and west coasts of India. In the present work, our knowledge of the identity, distribution, existing fisheries, results of the exploratory fishing programmes and biological aspects of cephalopods of India are presented comprehensively. It is hoped that this publication will generate greater interest in the systematics, abundance and exploitation of cephalopods in the seas around India and will lead to intensive studies and proper exploitation of the resources.

Plan of Work and Methodologies adopted

In this work the pertinent literature on cephalopods and cephalopod resources of the Indian region have been briefly dealt with in the Chapter on the Resume of work.

In the Chapter on the identity of the common species of cephalopods, identification keys are provided for the field identification of the various potentially important species, with brief descriptions based on a study of the material and relevant literature.

For biological studies of squids and cuttlefishes, random samples were collected at selected centres twice a week for study on aspects such as sex ratio, maturity, spawning, age and growth, length-weight relationship, food and distribution. For studying the maturity and spawning of the squids and cuttlefishes, four stages of maturity—immature, maturing, mature and spawning/spent were recognized based on the appearance of the reproductive organs. In immature male squids the testis is elongate and thin and in immature male cuttlefishes it is small and triangular ; the spermatophoric sac and penis are small and spermatophores absent. The ovary of females in stage I is small with small immature ova ; the nidamental glands appear as small patch-like structures and the accessory nidamental glands are not discernible. In stage II the maturing stage, the testis is larger and thicker than in the I stage and developing spermatophores are present in the spermatophoric sac ; hectocotylization is apparent. In stage II females the ovary is larger and occupies about one fourth of the mantle cavity and ova with reticulate pattern clearly seen ; the nidamental glands are larger and lobe-like in squids and pear-shaped in cuttlefishes ; accessory nidamental glands are small and not coloured.

In stage III males the testis is mature, fully developed, prominent and spermatophoric sac packed with fully developed spermatophores ; the hectocotylus is well developed. In stage III females, the ovary is mature and prominent filling the posterior mantle cavity ; the ova are ellipsoidal or ovoid in shape with reticulate surface ; the nidamental glands are fully developed, conspicuous, creamy white in colour and with distinct anterior pore ; the accessory nidamental glands are orange in colour.

In stage IV males the testis is either thick or thin and the spermatophoric sac is either partly or almost empty ; in females the ovary contains loosely disposed ova ; ripe ova could be seen in the oviduct. The nidamental glands are creamy white and robust before spawning and flabby in the spent condition. The accessory nidamental glands are of light orange red colour. The size at which 50% of the species matured was considered as the size at first maturity.

Age and growth of different species were determined by studying the modal progression of dorsal mantle length. Using dorsal mantle length frequency data as basic input and assuming the growth of the species

following von Bertalanfy's growth formula, growth parameter $L\infty$ and K were estimated by the straight line method suggested by Alagaraja (1984). Stock estimates were made by length cohort analysis of Jones (1981).

Data on the estimated cephalopod production and total marine fish production in various zones of maritime states of India have been obtained from the records of the Fishery Resources Assessment Division of the Central Marine Fisheries Research Institute. The Institute collects data on marine fish landings by a multistage stratified random sample survey design which is a time-space stratified system, and areawise and gearwise production is estimated. For the period 1968-'72, as information on gearwise effort was not always available, the monthly and seasonal variations in the cephalopod landings in various areas and their percentage in total marine fish production alone have been studied. For the period 1973-'77, data on gearwise effort and cephalopod and all fish production in the different areas were available and from these the seasonal, annual and gearwise production in different areas, CPUE and percentage of cephalopods in total marine fish production have been determined.

The cephalopod fishery has been studied in greater detail during 1976-'80 at eleven important centres in the country *viz.*, Waltair (Visakhapatnam), Kakinada, Madras, Portonovo, Mandapam, Rameswaram and Keelakarai on the east coast of India and at Vizhinjam (Trivandrum), Cochin, Mangalore and Bombay on the west coast where biological studies were also made. At these centres the species composition and CPUE have been investigated.

The catch data of the trawlers of the erstwhile Exploratory Fisheries Project (now Fishery Survey of India) based at Bombay and Visakhapatnam have been analysed and the monthwise, annual, areawise and depthwise cephalopod catches, catch rates and percentage in total trawl catches have been studied.

Data on the magnitude and value of cephalopod products exported from India have been taken from the published reports of the Marine Products Export Development Authority, Cochin (MPEDA, 1985) and the annual trends analysed.

The ensuing chapters could form baseline studies of cephalopods of the Indian seas. The effort should be considered as an initiation to a much more enhanced National programme to be closely linked with both the artisanal and commercial fisheries sectors. It is our view that immense potential exists in this sector for the development of major fisheries for squids and cuttlefishes. The projects taken up at the Central Marine Fisheries Research Institute with proper infrastructure facilities in manpower and vessel facilities should help in improved data acquisition, stock assessment of important species and rapid dissemination of results. An active cooperative programme on product development and marketing of cephalopod products both internally and exports should closely be linked with resource surveys and harvesting if we are to take full advantage of our cephalopod resources.

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