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1. INTRODUCTION

With the stabilization of world finfish catches in general, and the depletion of a number of fish stocks that used to support industrial-scale fisheries, increasing attention is now being paid, to the so-called unconventional marine resources which include many species of cephalopods. A first general review of the world's cephalopod resources, in particular in regard to their exploitation and future potential, was prepared for FAO by G.L. Voss in 1973. Since the publication of this document, the growing number of cephalopod species entering commercial fisheries as a result of the extenson of fisheries operations to new fishing areas and to deeper waters, calls for a refinement of species identifications and for better compilation of pertinent information by species on distribution, biology and fisheries of these species. Okutani's (1980) well-illustrated book on "Useful and latent cuttlefishes and squids" was of great help to us in our attempt to make the present document as comprehensive as possible.

This catalogue includes: (i)species of cephalopods exploited commercially; (ii) species utilized at the subsistence and artisanal levels, even those which comprise only a minor percentage of the catch; (iii) species considered to have a potential value to fisheries, based on criteria such as edibility, suspected abundance, accessibility, etc. The inclusion of such a wide range of species appears justified in order to give the catalogue the character of a comprehensive inventory of species useful to mankind, regardless of their current commercial status.

The catalogue is based primarily on information available in the literature. Unpublished reports and working documents also have been used as far as possible. This, information was supplemented by field observations made by the authors in several parts of the world. Particularly informative was a two-months FAO/UNDP sponsored field trip of the first two authors through the Indo-West Pacific area which gave us the opportunity to examine fresh material at landing sites, markets and laboratories, as well as to obtain first-hand information about local cephalopod fisheries from regional fisheries workers. Furthermore, valuable information was supplied to us by colleagues knowledgeable about various aspects of cephalopod fisheries.

Sometimes it has proved very difficult to evaluate the reliability of published data. It is quite understandable that field workers far away from good library facilities have difficulties in correctly identifying the species they encounter in the field. Moreover, the discovery of new species, the more correct delimitation of known species, or even the introduction of nomenclatoral changes, may cause confusion and lead to the use of scientific names that are incorrect by modern standards or that apply to more than one species. Although great care was exercised in evaluating the published information used in the catalogue, some misjudgements and incorrect interpretations undoubtedly have occurred. Another difficulty is that in taxonomic literature information on economic importance of species is rather scarce or of a very general nature. Also we may have overlooked important information in relevant fisheries literature that is difficult to locate or available only locally.

Readers who are interested in information related to cephalopods resources and biology beyond the scope of this catalogue are referred some of the more recent sources:

- Expert consultation on fisheries for squid and other cephalopods, held in Japan in September 1975 (FAO, 1976).

- The recent workshop on Biology and Resource Potential of Cephalopods, held in Melbourne, Australia, in April 1981 (Roper, Lu & Hochberg (eds), 1983).

- Accounts on the cephalopod stocks in the eastern central Atlantic (Special Working Group on Cephalopod Stocks in CECAF (FAO/UNDP, 1982) and in the Indo-Pacific (Indo-Pacific Fishery Commission, 1982) and advances in the assessment of world cephalopod resources (Caddy, ed., in press).

Acknowledgements

The authors are pleased to acknowledge the contributions of persons who supplied information or read drafts of this catalogue. Without their good efforts this work would have been a mere skeleton. W. Fischer (FAO, Rome) was the initiator of this project and without his very much appreciated support and encouragement this publication would not have been forthcoming. We thank most kindly G.L. Voss (Rosenstiel School of Marine and Atmospheric Science, University of Miami, Florida), W.F. Rathjen (National Marine Fisheries Service, Gloucester, MA), and T. Okutani (National Science Museum, Tokyo) for their critical review and helpful corrections from sources unavailable to us and from unpublished data.

Early in 1979 the first two authors travelled for FAO to 11 countries in the eastern Indian Ocean and the western central Pacific (FAO Fishing Areas 57 and 71) to gather information for the Cephalopod Identification Sheets for those areas, and we wish to thank most heartily all the FAO and UNDP personnel, as well as the biologists and administrators from laboratories and universities in each country who so generously and willingly provided specimens, data, logistical support, information and hospitality. Their assistance has been a major contribution to this catalogue.

Of course, a compilation of this nature must rely heavily on already published works. We acknowledge with gratitude T. Okutani, G.L. Voss, W. Adam, S.S. Berry, J. Wormuth, R. Toll and F. Palacio whose monographic and revisionary works have been most helpful to us (see bibliography). Most especially we acknowledge here that many illustrations from the works of these (and other) authors have been redrawn for the purposes of this catalogue.

Cephalopod workers especially will appreciate that for many species either no or very poor illustrations exist in the literature. We acknowledge with special thanks Paolo Lastrico and Marylin Schotte for the excellent job they have done in redrawing and greatly enhancing many illustrations from the literature, and Giulia Sciarappa-Demuro for her invaluable collaboration in typing and skillfully page-composing this highly technical and complex document on a word processor. Special thanks are also due to Ingrid Roper for her technical assistance during the final stages of preparing this catalogue for printing.

1.1 Plan of the Catalogue

This catalogue is arranged systematically by higher classification down to family and generic level, then alphabetically by species. Each major group and family is introduced with general descriptive remarks, illustrations of diagnostic features,highlights on the biology, and relevance to fisheries. The information pertaining to each species is arranged by categories as follows: (1) scientific name, (2) synonymy, (3) FAO species names, (4) diagnostic features with illustrations, (5) geographical distribution with map, (6) habitat and biology, (7) size, (8) interest to fisheries, (9) local species names, (10) literature, and (11) remarks.

(1) **Scientific name :** Reference is given to the original description of each species so no confusion will arise as to precise identification.

(2) **Synonymy:** Synonyms and different name combinations are listed (misidentifications and other nomenclatorial problems are discussed under (11) Remarks).

(3) **FAO species names :** English, French and Spanish names for each species, to be used primarily within FAO, were selected on the basis of the following criteria: (i) each name must apply to one species only, in a worldwide context; (ii) the name must conform to FAO spelling nomenclature; (iii) the name should not lead to confusion with major groups other than cephalopods. Wherever possible, the denominations selected were based on vernacular names (or parts of names) already in existence within the areas where the species is fished. FAO species names are, of course, not intended to replace local species names, but they are considered necessary to overcome the considerable confusion caused by the use of a single name for many different species, or severa1 names for the same species.

(4) **Diagnostic features :** Distinctive characters of the species are given as an aid for identification, accompanied by pertinent illustrations. Species identifications should be attempted only after verification of the familv throuah use of the illustrated key to families. However. caution must be exercised in using the specific key characters given here, -and it is strongly suggested that species identifications be verified, whenever possible, through primary literature or by cephalopod experts. Reference to FAO Species Identification Sheets is given wherever relevant.

(5) **Geographical distribution :** The entire known geographic range of the species, including areas of seasonal occurrence, is given in the text and shown on a small map. In cases where only scattered records of occurrence are available, interrogation marks have been used to indicate areas of suspected or unconfirmed distribution.

(6) **Habitat and biology :** The known depth range of the species and information on salinity and temperature of its habitat are given where known. Information on biological aspects, such as migrations, spawning seasons and areas, longevity, food, and predators, also is included.

(7) **Size :** The known mantle length (or total length in some cases) of both males and females is provided where possible. Total length is measured from the posterior tip of the mantle to the anterior tip of the outstretched tentacles (squids and cuttlefishes) or arms (octopuses), but because of the elasticity of tentacles and arms total length is not a very accurate measurement. Mantle length, the standard measure of size in cephalopods, is measured along the dorsal midline from the posterior tip of the mantle ("tail") to the anterior border of the mantle (squids and cuttlefishes) or to the leve1 of the eyes (octopuses) (see Chapter 1.3). Where both total length and mantle length are given, the respective figures do not necessarily pertain to the same specimens but may have been obtained from different sources. The available information on the size attained by some species often is very meagre, so the maximum size cited here may be well below the actual maximum size.

(8) **lnterest to fisheries :** This paragraph gives an account of the areas where the species is fished and of the nature of the fishery; its importance is either qualitatively estimated (minar, moderate, major or potential) or actual figures of annual landings are provided. Data on utilization (fresh, dried, cooked, frozen, canned, etc.) also are given where available. Here, too, the quality and quantity of the available information vary considerably with the species.

(9) **Local species names:** These are the names used locally for the various species. The present compilation is necessarily incomplete, since only a fraction of the local names used throughout the world is actually published. In many cases, local names were available only for species supporting traditional fisheries. Apart from possible omissions due to limitations of literature available, some of the denominations included may be somewhat artificial (i.e. through transliteration of indigenous words into English). The local species denomination is preceeded by the name of the country concerned (in capital letters) and, where necessary, by geographical specifications (in lower case). Whenever possible, the language of the transcribed vernacular name is added in parenthesis. When more than one name is used within a country, the official name, if available, is underlined.

(10) **Literature :** This includes references to the most important publications relevant to the species, the emphasis being on biology and fisheries. Additional references are included in the bibliography. In the case of a few uncommon species, only systematic papers are available. Of particular importance to the present catalogue were the published works of W. Adam, T. Okutani, and G.L. Voss.

(11) **Remarks :** Important information concerning the species but not fitting in any of the previous categories is given here. For instance, in some cases the scientific name used in the present catalogue, although nomenclaturally correct, is not the best known. Other nomenclatural problems, such as the use of subspecies, are discussed.

1.2 General Remarks on Cephalopods

The group known as cephalopods (class Cephalopoda) consists of bilaterally symmetrical molluscs with a well developed head that contains a circumoral (surrounding the mouth) crown of mobile appendages that bear suckers and/or hooks (except in Nautilus). The mouth has chitinous beak-like jaws and a chitinous tongue-like radula (band of teeth). The shell is variously modified, reduced, or absent and is enveloped by the mantle; an external shell occurs only in the primitive form Nautilus (restricted to Indo-Pacific). Cephalopods are soft-bodied animals with their primary skeletal features a cranium and, in most forms, a mantle/fin support (cuttlebone or gladius). One pair of ctenidia (gills) is present (two pairs in Nautilus only). The central nervous system is highly developed, especially the well-organized eyes. A funnel or siphon (tube) expells water from the mantle (body) cavity providing propulsion and expelling waste products. Coloration is variable depending on group and habitat; most forms have numerous chromatophores (pigment sacs) and iridocytes (shiny, reflective platelets) in the skin, to accommodate rapid changes in colour and colour patterns that are an integral part of their behaviour.

The size of adults ranges from about 2 cm to 20 m in total length; largest specimens may weigh over 1 ton (average size of commercial species is 20 to 30 cm total length and 0.1 to 1 kg). Locomotion is achieved by drawing water into the mantle cavity followed by its jet-like expulsion through the funnel, and also by crawling along the bottom on the arms (mostly octopods, occasionally sepioids). Fins on the mantle provide stability, steering, and secondary locomotion. The sexes are separate; eggs are heavily yolked and development is direct, without metamorphic stages.

Cephalopods first evolved as a separate entity, the Nautiloids, in the Upper Cambrian period, 450 million years ago.Most species of the subclass Nautiloidea became extinct during the Jurassic, between about 180 and 150 million years ago and are largely replaced today by more recent forms, i.e. cuttlefishes, squids, octopuses and vampire squids, all belonging to the subclass Coleoidea.This subclass arose in the late Paleozoic (Upper Devonian to Carboniferous periods, about 400 to 330 million years ago, but most of its forms became extinct by the end of the Mesozoic, about 150 million years ago, and the only members of the subclass existing today are the forms that developed in the Upper Triassic and Lower Jurassic, which are placed in the four surviving orders. An overview of the subclasses, orders and suborders of cephalopods is given in Fig. 1.

The total number of living species of cephalopods is fewer than 1 000 distributed in 43 families. Cephalopods occur in all marine habitats of the world: benthic, cryptic, or burrowing on coral reefs, grass flats, sand, mud and rocks; epibenthic, pelagic and epipelagic in bays, seas, and the open ocean. The range of depths extends from the surface to over 5 000 m. Abundance of cephalopods varies (depending on group, habitat, and season) from isolated territorial individuals (primarily benthic octopods) through small schools with a few dozen individuals to huge schools of neritic and oceanic species with millions of specimens.

The four groups of cephalopods, squids, cuttlefishes, octopuses, and chambered nautiluses are easily distinguished by external characteristics. The squids have an elongate, torpedo-like body with posterolateral fins, and 8 circumoral arms, not connected at bases with a web, with 2 (occasionally more) rows of stalked suckers bearing chitinous rings (and/or hooks) running the entire length, plus 2 longer tentacles with an organized cluster (tentacular club) of 2 or more rows of suckers (and/or hooks) at the distal end. The cuttlefishes have broad sac-like bodies with lateral fins that either are narrow and extend the length of the mantle (Sepiidae) or are short, round and flap-like (Sepiolidae): in either case the posterior lobes of the fins are free (subterminal) and separated by the posterior end of the mantle; 10 circumoral appendages, the longest (4th) pair (= tentacles) retractile into pockets at the ventrolateral sides of head; the 8 remaining arms frequently with 4 rows of stalked suckers with chitinous rings, never hooks (otherwise 2 rows); eyes covered with a transparent membrane and eyelids present; shell thick, chalky, calcareous (cuttlebone of Sepia) or thin, chitinous (Sepiolidae). The octopuses have a short, sac-like body either with no lateral fins or with separate paddle-like fins in some deep-sea forms, and 8 circumoral arms only (no tentacles) with bases connected by a membraneous web and unstalked suckers, without chitinous rings, along the length of the arms. The chambered nautiluses are characterized by an external,

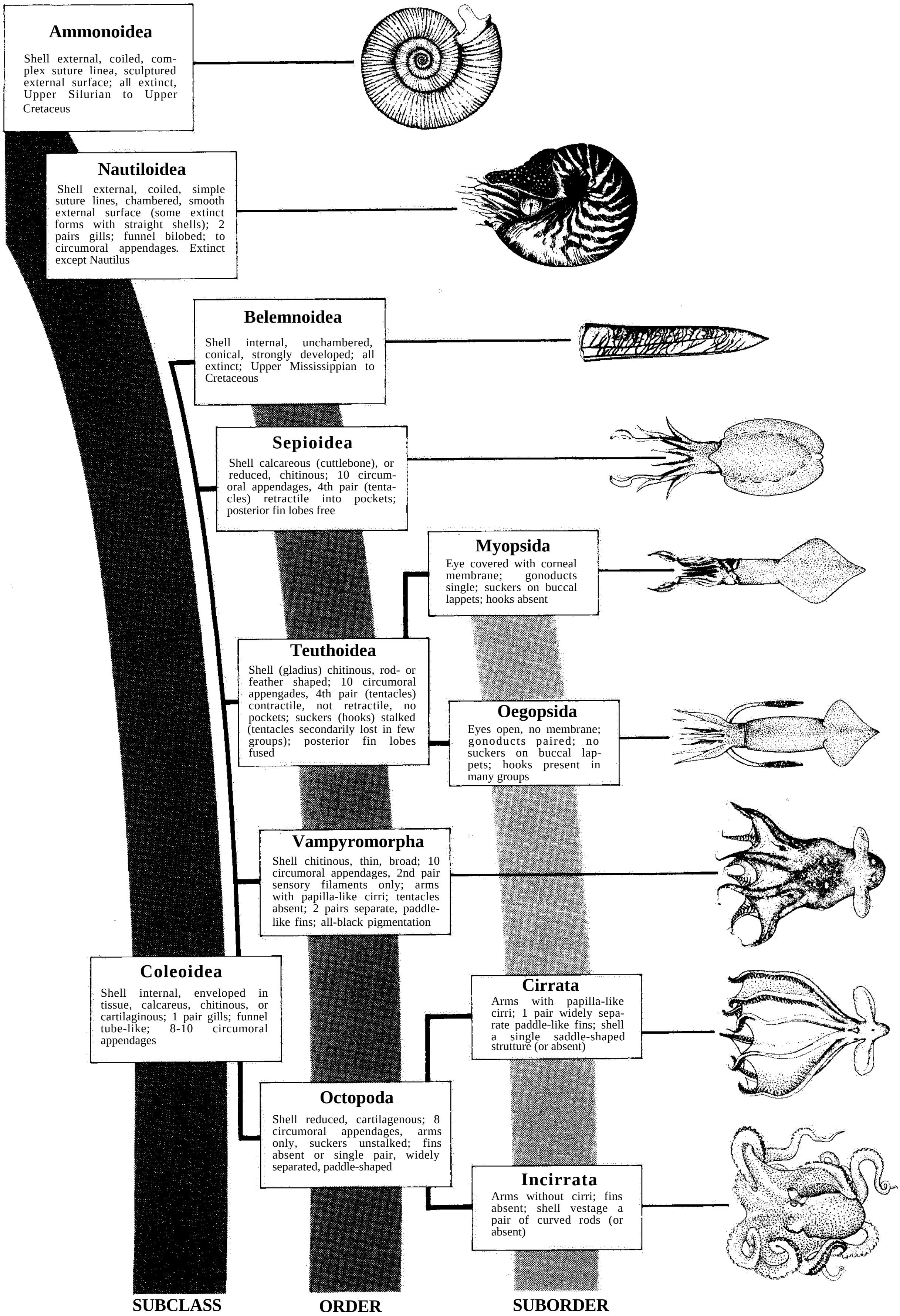

Fig. 1 Classification of cephalopods

smooth, coiled, chambered shell, 63 (males) to 94 (females) circumoral appendages without suckers, a "funnel" consisting of two flaps or lobes simple eyes without lenses, and the absence of an ink sac. More detailed descriptions of these four groups are presented in the systematic section.

All cephalopods are dioecious (separate sexes) and manythough not all, 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 (hectocotylus) for mating. The hectocotylus may consist of modified suckers, papillae, membranes, ridges and grooves, flaps, etc., but in any case it functions to transfer the spermatophores (sperm packets) from the male's mantle cavity to a locus of implantation on the female, which may occur inside the mantle cavity, around the mantle opening on the neck, in a pocket under the eye, around the mouth, etc. Fertilization takes place in the female as the eggs are laid. Eggs of squids generally are encased in a gelatinous matrix secreted by the nidamental glands and are laid as multi-finger-like masses (sometimes called "sea mops") attached to rocks, shells or other hard substrate on the bottom in shallow waters (inshore squids), or they are extruded as large, singular, sausage-shaped masses that drift in the open sea (oceanic squids). The fingers each may contain from a few to several hundred eggs, while the sausages contain tens or even hundreds of thousands of eggs. The mode of reproduction and egg-laying is unknown for many forms,especially oceanic and deep-sea species. Cuttlefishes lay relatively few, large grape-like eggs that are attached to hard substrates and are usually coloured black by a covering of ink deposited by the, female at egg-laying. Benthic octopuses lay their eggs in great, grape-like clusters and strands in lair sunder rocks and in abandoned mollusc shells, where they brood them until they hatch. The eggs are attached to each other,but they are not encased in a gelatinous matrix. The female of the pelagic octopus Argonauta constructs a thin, shell-like egg case in which she resides and lays festoons of eggs, fertilization having taken place from sperm contained in the highly modified hectocotylus that was autotomized (detached) from the male and deposited in the egg case. The life expectancy of cephalopods is about one to two years in most forms, but larger species of squids and octopus, for example, the giant squid (Architeuthis spp.) and the giant octopus (O. dofleini), must live for several years. Many species die after spawning, but this phenomenon apparently is not universal.

Cephalopod eggs are very yolky and hence cleavage is incomplete so that typical molluscan spiral cleavage is absent. Development is direct and the young hatch as miniatures of the adult (to a greater or lesser extent depending on the species). Thus, no discrete larval stages or metamorphoses occur. Cephalopod eggs may vary in size from about 1.7 cm long in some demersal Octopus species to 0.8 mm long in the pelagic Argonauta, both octopods. Eggs of Sepia can attain 9 or 10 mm in diameter. Time of embryonic development also varies widely, from a few weeks to several months, depending on the species and temperature conditions. Hatching may occur rapidly from a single clutch or be extended over a period of 2 or 3 weeks. At hatching, young animals often inhabit different habitats than the adults. For example, the young of some species of benthic octopuses spend periods of time as planktonic organisms before settling to their bottom habitat, and the "larvae" of many deep-sea forms occur in the upper 100 m of the open ocean then exhibit an ontogenetic descent, gradually occurring at deeper depths with increasing size.

Many species of oceanic cephalopods undergo diel vertical migrations, wherein they occur at depths of about 400 to 800 m during the day, then ascend into the uppermost 200 m or so during the night. 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 (light-producing organs) which eliminates their silhouettes against the downwelling light in the dimly-lit mid-depths.

Cephalopods are active predators that prey upon shrimps, crabs, fishes, other cephalopods, and, in the case of octopuses, on bivalved molluscs. In turn, cephalopods are major food items in the diets of toothed whales, seals, pelagic birds (penguins, petrels albatrosses, etc.), and both benthic and pelagic fishes (e-g., sea basses, lancetfishes, tunas, billfishes, sharks and rays).

The role of cephalopods in the ecosystem seems to be that of subdominant predators which tend to increase in biomass when other species (particularly their predators and competitors for food) become depleted as a result of heavy fishing. This has been observed, for example, in the sparid fishery off Sahara, the gadoid fishery in the northwest Atlantic and the trawl fishery in the Gulf of Thailand.

Catches of cephalopods have been steadily increasing in most parts of the world until 1982. In fact, world catches of squids and cuttlefishes increased by 57% and 84%, respectively, in the period from 1970 to 1980, compared to only 8% increase in total catches from the sea. The more traditional octopus fisheries, however, showed only a 2% increase for the same period, with a peak in 1974. Table 1 gives figures for the world catch of cephalopods for the period between 1975 and 1981 (FAO, 1983).

Cephalopod fisheries are unevenly distributed in the world's oceans. 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. The reported catch of cephalopods totalled 1 304 000 metric tons in 1981, of which 71.8% was accounted for by neritic and oceanic squids (i.e., Todarodes, Loligo, Illex, etc.), 13.6% by cuttlefish (Sepia, Sepiella and allied genera) and about 14.6% by octopuses (mainly, Octopus and Eledone). Most of this catch (around 700 000 metric tons) was taken by Japanese vessels throughout the world.

TABLE 1

World catch (in metric tons) of cephalopods by statistical categories for the period between 1975 and 1981

(Source: FAO, 1983)

	1975	1976	1977	1978	1979	1980	1981
Sepia officinalis	12 253	11 140	10 886	8 595	9 350	14 028	12 855
Other Sepioidea	137 633F	163 506F	185 083F	192 547F	198 663 F	174 729F	165 248F
Sepioidea	(12.7%) 149 886	(14.4%) 174 646	(15.9%) 195 969	(15.1%) 201 142	(13.7%) 208 013	(12.3%) 188 757	(13.6%) 178 103
Loligo pealei	24 621	21 311	16 470	10 725	17 401	23 612	10 602
Loligo spp.	113 171	92 859	105 379	119 217	106 149	104 375F	108 457F
Illex illecebrosus	34 223	68 321	104 215	88 236	179 361	88 660	39 076F
Illex argentinus	4 620	8 266	2 348	61 847	92 252	9 827	13 723
Dosidicus gigas	365	897	658	2 709	11 144	19 069	9 695
Todarodes sagittatus	4 399	4 683	4 307	3 474	5 270	5 864	12 971
Todarodes pacificus	398 660	325 740	225 932	234 344	238 978	378 954	228 355
Nototodarus sloani	18 786	19 692	27 149	27 480	28 301	62 983	30 970
Unidentified Loliginidae and Ommastrephidae	204 052F	284 688F	358 652F	391 582F	482 974F	475 964F	482 073F
Loliginidae, Ommastrephidae	(67.9%) 802 897	(68.3%) 826 457	(68.6%) 845 110	(70.6%) 939 614	(76.3%) 1 161 830	(76.4%) 1 169 308	(71.8%) 935 922
Octopus vulgaris	38 977	40 014	42 772	32 659	25 612	17 113	24 361
Eledone spp.	2 612	2 497	2 369	3 134	2 375	2 070	2 299
Other Octopodidae	188 144F	166 888F	145 278F	153 757F	123 803F	153 181F	163 469F
Octopodidae	(19.4%) 229 733	(17.3%) 209 399	(15.5%) 190 419	(14.3%) 189 550	(10.0%) 151 790	(11.3%) 172 364	(14.6%) 190 129
Total Cephalopoda	1 182 516	1 210 502	1 231 498	1 330 306	1 521 633	1 530 429	1 304 154

F = FAO estimate

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