INFORMATION REPORTS

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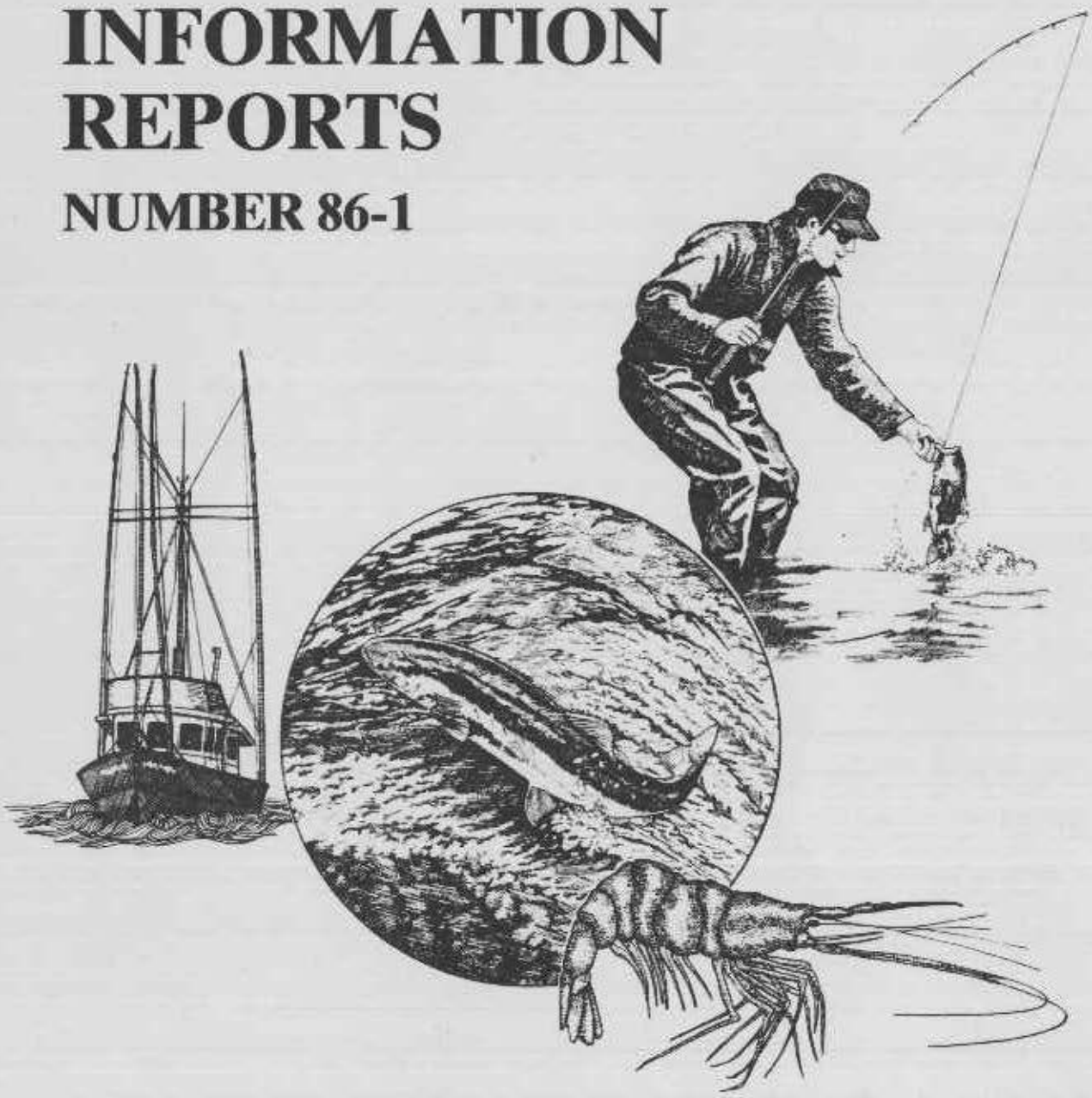

FISH DIVISION

Oregon Department of Fish and Wildlife

Annotated Bibliography of References Pertaining
to the Biology, Fisheries, and Management of
LOLIGO OPALESCENS

Annotated Bibliography of References Pertaining to the Biology, Fisheries, and Management of LOLIGO OPALESCENS

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Marine Region, Newport, Oregon

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Contents

INTRODUCTION

Commercial landings of the market squid (LOLIGO OPALESCENS) have rapidly increased in Oregon since the first substantial landing occurred in 1982. In response to the development of a new fishery, we designed a research project to provide information for use in the management of LOLIGO OPALESCENS. One of our first tasks was to conduct a literature search. This annotated bibliography is the result of our initial efforts to gather the available information to use in our research and management of LOLIGO OPALESCENS off Oregon.

Included in the bibliography are references that pertain specifically to LOLIGO OPALESCENS, and references describing studies of other species that may provide us with insights to the biology and fisheries management of the market squid. A wide variety of subjects are included, such as biology and life history, population assessment, capture gear and techniques, processing and marketing techniques, and descriptions of other squid fisheries.

References were obtained from a variety of sources. The National Marine Fisheries Service and Oregon State University (OSU) provided us with bibliographic listings, we collected citations from Hixon's (1983) excellent summary of the state of knowledge of LOLIGO OPALESCENS, and we obtained reference citations from the many articles contained in Recksiek and Frey's (1978) publication. In all cases we tried to provide annotations that summarized the important points of the article. Many annotations were compiled by utilizing existing abstracts when an existing abstract astutely summarized the article. We used an abstract entirely or further summarized

it when possible, but in most cases we excerpted from the available abstract. When abstracts were poorly worded or missing we wrote a new annotation.

We cataloged the references with the Library of Congress classification system used by the OSU Kerr and Hatfield Marine Science Center libraries. In many cases we cited references for which Library of Congress call letters are not available (NA), usually because the reference was obtained from a source other than the OSU libraries. We created 97 key words which reference over 300 entries. References were entered into an Apple /// microcomputer using an integrated word processor and database program (/// E-Z Pieces). The /// E-Z Pieces program is able to access and sort publications by using key words.

ANNOTATED BIBLIOGRAPHY

1. Akimushkin, I.I. 1965. Cephalopods of the seas of the U.S.S.R. Translated by Israel Program for Scientific Translations, Jerusalem. 223 pp.

Cephalopods of the seas of Russia are described and illustrated. Geographic distribution and economic uses are discussed.
CALL LETTERS: QL430 .2 A55
KEYWORDS: other species; description; distribution

2. Ally, J.R., R.G. Evans, and T.W. Thompson. 1975. The results of an exploratory fishing cruise for LOLIGO OPALESCENS in southern and central California. Moss Landing Marine Laboratories Tech. Pub., 75-2:22 pp.

Objectives of the cruise included: Gather samples of market squid for population, growth, aging, and food chain studies; Locate potential new fishing grounds; and investigate methods for determining spawning intensity. No significant difference was found in mantle lengths of squid taken in Monterey area versus areas south of Point Conception. Squid spawning was observed utilizing an underwater observation chamber aboard the vessel. Mating and feeding behavior were observed in shipboard aquaria. The most abundant co-occurring organism in the trawl catches was SEBASTES species. Trawl gear was relatively unselective with respect to age or sex. The squid jig appears to be selective for adult animals and highly selective for males.
CALL LETTERS: (NA)
KEYWORDS: LO; catch composition; distribution; length; behavior-spawning; diet-artificial; fecundity; sex ratio; acoustics; gear used-video; gear selectivity

3. Ally, J.R.R. and S.A. Keck. 1978. A biochemical-genetic population structure study of market squid, LOLIGO OPALESCENS, along the California coast. Calif. Dept. Fish Game, Fish Bull., 169:113-121.

Using starchgel electrophoretic procedures and mantle muscle tissue, an intensive study of the enzyme phosphoglucomutase (PGM) was conducted to make stock discriminations of market squid. Enzymes were tested for polymorphism, but only PGM was found to be sufficiently polymorphic for the study. Although results suggest possible geographically and temporally structured populations, further study is necessary to substantiate these hypotheses.
CALL LETTERS: SH11 C24
KEYWORDS: LO; electrophoresis; stock delineation

4. Amaral, E.H. and H.A. Carr. 1980. Experimental fishing for squid with lights in Nantucket Sound. Mar. Fish. Rev., 42(7-8):51-56.

Lights were installed forward, midship, and astern approximately 3 m above the water on both sides of the vessel PAYDAY to test their feasibility to attract LOLIGO PEALEI. Incandescent lamps of 750 watt and 1500 watt, 175 watt mercury vapor lights, 300 watt incandescent underwater lights, and a 1000 watt quartz halogen lamp were tested. Squid were not attracted in commercial quantities to the various lights used, nor were they observed to float quietly near the surface. Squid were not as readily attracted to the mercury vapor lights as they were to the incandescent lights when both types were illuminated. Positioning of the lights on the vessel revealed some behavior patterns. Squid could be seen at the periphery of the brightly illuminated area approximately a meter below the surface. When the lights were turned inboard, the squid concentrated closer to the vessel. It is suggested that L. PEALEI are not as phototactic as the other species.
CALL LETTERS: SH11 A14
KEYWORDS: other species; gear development; gear used-lights; behavior

5. Amaratunga, T. 1983. The role of cephalopods in the marine ecosystem. FAO Fish. Tech. Pap., 231:379-415.

Commercially important species of cephalopods constitute a very large biomass. These were represented by highly specialized organisms belonging to the groups NAUTILUS, SEPIA, squid, and octopus; the squid belonging to the families ommastrephids and loliginids were the most important. Most presently important species are found in benthic or pelagic habitats in the neritic province not extending far beyond the continental slope edges. Biology, distribution and feeding habits of major species were reviewed. Predation is principally on the crustacea, while fish predation and cannibalism is of lesser importance. Predation models are presented for important cephalopod groups. Cephalopods are preyed upon by a large number of fish, sea birds, and marine mammals. An efficient energy transfer therefore mainly occurs from detritus feeders, scavengers, and plankton consumers to carnivorous cehpalopod predators. A large biomass of cephalopods in turn are available to the upper most trophic levels. A mathematical interpretation of biological parameters is considered in a biomass-production model, with particular reference to the ommastrephid ILLEX ILLECEBROSUS. Effects of predation on the ecosystem are quantified, and it is demonstrated how food consumption rates are transposed into growth. Growth rates in turn can be transposed into time-segmented changes in biomass.
CALL LETTERS: SH1 F539
KEYWORDS: distribution; diet; predators; growth

6. Amaratunga, T. and R.D. Durward. 1978. Field guide for data collection for the squid ILLEX ILLECEBROSUS. pp. 8.1-8.11. In: Proceedings of the workshop on the squid, ILLEX ILLECEBROSUS, Dalhousie Univ., Halifax, Nova Scotia. May, 1978, and a bibliography on the genus ILLEX. Can. Fish. Mar. Serv. Tech. Rep., No. 833. 311 pp.

A guide for collection of data on I. ILLECEBROSUS from catches on fishing and research vessels. The data collected include morphometric measurements and observations that can be done by individuals with minimal training. The procedures and standards presented in this paper as a guide for the biological sampling of ILLEX involve the collection of data on mantle length, total body weight, sex ratio, maturity stages, and gut fullness. The sustematic collection of data provides a foundation for subsequent research and standardization of information. Illustrations and photographs are given.
CALL LETTERS: SH223 A88
KEYWORDS: other species; sampling methods; length; weight; sex ratio; physiology-gonad maturation; anatomy

7. Amaratunga, T., M. Roberge, and L. Wood. 1978. An outline of the fishery and biology of the short-finned squid ILLEX ILLECEBROSUS in eastern Canada. pp. 2.1-2.17. In: Proceedings of the workshop on the squid, ILLEX ILLECEBROSUS, Dalhousie Univ., Halifax, Nova Scotia, May, 1978, and a bibliography on the genus ILLEX. Can. Fish. Mar. Serv. Tech. Rep., No. 833. 311 pp.

This paper presents an introduction to the fishery and the general biology of ILLEX. Historic trends of both offshore and inshore fisheries are considered and the 1977 fishery in ICNAF subareas 3 and 4 is studied. Biological aspects discussed are derived from data obtained from subarea 4 during the 1977 fishing season.
CALL LETTERS: SH223 A88
KEYWORDS: other species; length; weight; sex ratio; landings; growth; fishery-N. Atlantic

8. Amos, D. 1983. Squid jigging gear and techniques. pp. 37-42. In: Proceedings of the west coast squid symposium. February 1-2, 1983. Newport, Oregon. Oregon State Univ. Sea Grant Marine Advisory Program. 149 pp.

Describes some experiences of experimenting with Japanese jigging gear on the east coast of the US. Ninety percent of squid taken by Japanese is by jigging. Can have up to 30 jigs on one line. Lights should create an angle of shadow about 40 degrees. The whole art of catching squid, whether it be trawl or jig, is first finding the squid.
CALL LETTERS: SH374 .52 U6 W41
KEYWORDS: gear used-jigs, lights

9. Amos, D. 1983. Squid trawling gear and techniques. pp. 28-36. in: Proceedings of the west coast squid symposium. February 1-2, 1983. Newport, Oregon. Oregon State Univ. Sea Grant Marine Advisory Program. 149 pp.

Descriptions of the standard two-panel granton trawl used in northern Europe, German high-rise bottom trawl, French trawl used in Scotland, and three quarter Yankee trawl and high rise-low drag trawl used on the eastern US. Vessel horse power. rigging, depths fished, vessel speeds, and doors are discussed.
CALL LETTERS: SH374 .52 U6 W41
KEYWORDS: gear used-trawl

10. Amos, D. and R. Demello. 1982. Application of multi-frequency echo sounders to squid detection. pp. 45-53. In: Proceedings of the International squid symposium. August 9-12, 1981. Boston, Massachusetts. New England Fisheries Development Foundation, Inc. 390 pp.

For full utilization of acoustic detection instruments, fishermen need to understand what influences the machine display and how to interpret the information being displayed. Vessel speed, pulse length of machine, and density of squid school will influence the display.
CALL LETTERS: QL430 .3 L8 I561
KEYWORDS: acoustics

11. Ampola, V.G. 1980. The quality of squid held in chilled sea water versus conventional shipboard handling. Mar. Fish. Rev., 42(7-8):74-76.

The two objectives of this work were to 1) compare the fresh shelf life of squid (LOLIGO PEALEI) held in chilled sea water (CSW) after being caught versus squid iced down in boxes or iced down in pens aboard ship, and 2) to compare the organoleptic quality of squid frozen at sea immediately after capture against squid held in cold sea water, in boxes, in pens aboard the boat, and then frozen 1 to 2 days after capture. Holding squid in CSW after capture did not appreciably extend its iced shelf life over the two methods but has the advantage of being less labor intensive, and was of much better in appearance at dockside. Squid from CSW had fewer bruises, skin tears, and no crush marks. After 9 months of frozen storage, the squid that were frozen immediately after capture showed much more color than other storage methods. The frozen-at-sea were also firmer and were rigid after thawing. After cooking there were no significant differences between any storage methods.
CALL LETTERS: SH11 A14
KEYWORDS: storage-freezing, iced; processing; quality

12. Anderson, M.E. 1978. Notes on the cephalopods of Monterey Bay, with new records for the area. Veliger, 21(2):255-262.

Reports on the cephalopods collected with closing trawls by Moss Landing Marine Laboratories and Steinhart Aquarium, San Francisco, includes some discussion for seasonal variation, provides information on the vertical distribution of some species that occur in Monterey Bay, and increases the number of species known from this area.
CALL LETTERS: QL1 V4
KEYWORDS: LO; distribution-vertical; seasons; west coast species.

13. Anonymous. 1977. France shows interest in the under-exploited squid. World Fishing, 26(8):33.

The world catch of edible squid could be increased by 400%, to 4 million TPY. As a food source, squid have 70% usable wt, 16-20% protein, a low fat content, and a calorific value of 85 cal/1100 g. It is caught in relatively large quantities by trawl, seine, or line; needs no on-board preparation; and freezes well for long periods without loss of quality. The general term "squid", in this context, SEPIA OFFICINALIS, covers cephalopods such as "cuttlefish" and "calamary" (LOLIGO PEALEI and ILLLEX ILLECEBROSUS). The main center of world squid fishing is the Northwest Pacific, mainly caught by Japan, China, and South Korea. Some 15-20,000 tons are fished off California, where stocks are thought to amount to 600,000 tons. The methods of capture (including trawling, traps or pots, jigging, and seines) are described.
CALL LETTERS: SH1 W63
KEYWORDS: other species; gear used; markets; physiology-nutritional value

14. Antonelis, G. A. Jr. and C. H. Fiscus. 1980. The pinnipeds of the California current. CalCOFI Rep., 21:68-78.

Six species of pinnipeds inhabit the study area of the CalCOFI. The numbers of animals in each population are given; the size, distribution, and seasonal movements are described. The known prey species of the pinnipeds are listed for each species. The otariids, with certain exceptions, consume the same kinds of prey, although in slightly different amounts. In general they feed most commonly on the smaller schooling fishes and squids of the epipelagic zone, and the two sea lion species enter nearshore and estuarine waters to prey on small schooling and anadromous fish. The two phocids, again with certain exceptions, prey on different species.
CALL LETTERS: SH351 S2 C22
KEYWORDS: LO; predators-marine mammals

15. Araya, H. 1975. Distribution and migration of the winter subpopulation of TODARODES PACIFICUS (Streenstrup) in the northern waters of Japan. FAO Fish. Rep. 170, Suppl 1:18-23.

The Japanese common squid, TODARODES PACIFICUS, consists of three subpopulations, breeding in winter, autumn, and summer respectively. Each breeds independently. The winter subpopulation is the most abundant of the three. The matured females spawn in the SW waters of Japan. The larvae move north in the early part of summer. Around October the southward migration starts. During this migration the males begin to mature; females mature slightly later.
CALL LETTERS: SH1 F543
KEYWORDS: other species; distribution; migration

16. Arnold, J.M. 1962. Mating behavior and social structure in LOLIGO PEALII. Biol. Bull., 123(1):53-57.

Observations of LOLIGO PEALII have shown that the egg mass acts as a visual stimulus for sexual behavior. This stimulus is followed by establishment of a social hierarchy and by mate selection by the males. During this time the males exhibit warning displays, sham battles, and mate protection. Normally the females respond passively, but occasionally they take an aggressive role. This mating behavior invariably results in copulation followed by egg laying. A method of visually stimulating laying, and obtaining naturally laid egg masses has thus been revealed.
CALL LETTERS: QH301 B56
KEYWORDS: other species; behavior-spawning

17. Arnold, J.M. 1965. Normal embryonic stages of the squid, LOLIGO PEALII (LeSueur). Biol. Bull., 128(1):24-32.

The normal development of this cephalopod has been divided into 30 stages based on morphological criteria. The first 3 stages include maturation divisions and the 4th stage is first cleavage. At stage 10 the blastoderm is well established. In stage 19 invagination of the mouth and eyes begins. In stage 23 the mantle covers about one-half of the gills. Pigmentation first appears in the eyes and chromatophores during stage 26. Hatching occurs at stage 30. A plot of development age versus chronological age is included as well as one labeled diagram and drawings of each stage.
CALL LETTERS: QH301 B56
KEYWORDS: other species; physiology-embryology

18. Arnold, J.M. and L.D. Williams-Arnold. 1977. Cephalopoda: Decapoda. pp. 243-290. In: Giese, A.C. and J.S. Pearse (ed.). Reproduction of marine invertebrates. Volume IV. Molluscs: gastropods and cephalopods. Academic Press. London. 369 pp.

Comprehensive accounting of the reproductive biology of cephalopods. LOLIGO PEALEI is used as a type species and other cephalopods are compared and contrasted with it. Discussion includes: anatomy; development and structure of reproductive organs; sexual maturation; mating and spawning behavior; comparative features of egg capsules; embryonic development.
CALL LETTERS: QP251 G437
KEYWORDS: behavior-spawning; physiology-gonad maturation; anatomy

19. Arnold, J.M. and R.E. Young. 1974. Ultrastructure of a cephalopod photophore: I. Structure of the photogenic tissue. Biol. Bull., 147(3):407-421.

One type of photophore of the deep sea squid PTERYGIOTEUTHIS MICROLAMPAS was examined by electron microscopy and its fine structure described. The photogenic tissue is composed of 4 cell types each with distinctive morphology which suggests their function. The similarity between photoproductive organelles and photoreceptive organelles is striking.
CALL LETTERS: QH301 B56
KEYWORDS: other species; physiology-photophores

20. Arnold, J.M., R.E. Young, and M.V. King. 1974. Ultrastructure of a cephalopod photophore: II. Iridophores as reflectors and transmitters. Biol. Bull., 147(3):522-534.

The iridophores of 1 type of photophore of the deep sea squid, PTERYGIOTEUTHIS MICROLAMPAS. were examined by electron microscopy and 4 different types were found, 3 of which were previously described. The regular iridophores of the posterior cup appear to be 1/4 wave length reflectors and redirect the light produced by the photogenic tissue outward. The regular iridophores of the anterior cap have a different spacing and platelet thickness so they apparently pass blue light. The irregular iridophores form a cone around the photogenic tissue and probably randomly reflect light back into the photogenic tissue. The iridophores of the lens have many precisely aligned iridosomes with platelet spacing and thickness so that they appear to collimate light passing through them. Three of these types of iridophores apparently reflect, transmit, and collimate the light produced in the photophore to match the background illumination, hence making an efficient countershading mechanism. A 4th type of iridophore, the wide spaced iridophore, is rarely encountered and probably does not have a significant role in light attenuation in the photophore.
CALL LETTERS: QH301 B56
KEYWORDS: other species; physiology-photophores

21. Baker, P.F. 1966. The nerve axon. Scientific American, 214(3):74-82.

The nerve axons from squid are used to study the physiology of the nervous system. The giant axon of squid measures up to a millimeter in diameter where as human nerves are only about a hundredth of a millimeter in diameter. All available evidence suggests that experimental results obtained with squid axons are applicable to all other nerve fibers.
CALL LETTERS: Q1 S33
KEYWORDS: physiology-nerves

22. Baker, P.F. (ed.). 1984. The squid axon. Current topics in membrane and transport, Vol. 22. Academic Press, Inc. 593 pp.

This book contains 19 papers relating to the structure and function of squid axons.
CALL LETTERS: QH601 C78
KEYWORDS: physiology-nerves

23. Balch, N., T. Amaratunga, and R.K. O'Dor (eds.). 1978. Proceedings of the workshop on the squid, ILLEX ILLECEBROSUS, Dalhousie Univ., Halifax, Nova Scotia, May, 1978, and a bibliography on the genus ILLEX. Can. Fish. Mar. Serv. Tech. Rep., No. 833. 311 pp.

A workshop on the short-finned squid ILLEX ILLECEBROSUS to review the current status of research on this species and discuss future requirements. Three major subject areas were considered: (1) I. ILLECEBROSUS fishery: historic and current trends; (2) Distribution and biology of I. ILLECEBROSUS; and (3) Laboratory research with I. ILLECEBROSUS. In each topic area, there were two subject addresses followed by several shorter presentations. The proceedings includes 23 papers, a list of participants, a transcript of a summation session in which research needs were identified, and a bibliography on I. ILLECEBROSUS.
CALL LETTERS: SH223 A88
KEYWORDS: other species; landings; distribution; bibliography; fishery-N. Atlantic; physiology

24. Balch, N., T. Amaratunga, and R.K. O'Dor (eds.). 1978. Bibliography of the genus ILLEX. pp. 27.1-27.19. In Proceedings of the workshop on the squid, ILLEX ILLECEBROSUS, Dalhousie Univ., Halifax, Nova Scotia, May, 1978, and a bibliography on the genus ILLEX. Can. Fish. Mar. Serv. Tech. Rep., NO. 833. 311 pp.

A bibliography on the fisheries and biology of ILLEX, assembled by the organizing committee of the workshop. It is intended to be updated on a continuing basis.
CALL LETTERS: SH223 A88
KEYWORDS: other species; bibliography

25. Ballantyne, J.S., P.W. Hochachka, and T.P. Mommsen. 1981. Studies on the metabolism of the migratory squid, LOLIGO OPALESCENS: Enzymes of tissues and heart mitochondria. Mar. Biol. Lett., 2(2):75-85.

Coupled mitochondria were isolated from LOLIGO systemic hearts and characterized by standard criteria. The mitochondria showed the expected behavior when tested with a variety of inhibitors. It is suggested that squid mitochondria use the malate shuttle rather than the glycerophosphate shuttle to transport electrons between the cytosol and the mitochondrion.
CALL LETTERS: QH91 A1 M34
KEYWORDS: LO; physiology-biochemical analysis, metabolism

26. Bartsch, P. 1916. Pirates of the deep-stories of the squid and octopus. Annual Report of the Smithsonian Institution, 1916:347-375.

An assemblage of myths and legends, intertwined with fact, involving cephalopods--from squids and octopus attacking ships and man, fighting with whales, to squids as the basis for sea-serpent yarns. A summary of paleontology of cephalopods is also presented.
CALL LETTERS: (NA)
KEYWORDS: fossils; legends

27. Bartsch, P. 1935. An invasion of Monterey Bay by squids. The Nautilus, 48(3):107-108.

While anchored in Monterey Bay a vessel was surrounded by a very large school of squid which was so thick that squid blocked the intakes of the ship. The ship was anchored off Monterey in ten fathoms of water and over a sandy bottom. The majority of the squid were between 8 and 15 inches long, and the depth of the school appeared to be about four feet. The squid surrounded the ship in all directions, but concentrated in areas illuminated by lights on the ship.
CALL LETTERS: QL401 N3
KEYWORDS: LO; behavior-schooling

28. Bennett, B.A. 1978. Underwater observations of the squid ILLEX ILLECEBROSUS in the Newfoundland inshore waters. pp. 12.1-12.9. In: Proceedings of the workshop on the squid, ILLEX ILLECEBROSUS, Dalhousie Univ., Halifax, Nova Scotia, May, 1978, and a bibliography on the genus ILLEX. Can. Fish. Mar. Serv. Tech. Rep., NO. 833. 311 pp.

I. ILLECEBROSUS were observed in the field using scuba. Squid responses to jigs are described and compared to the responses to offered food. Consideration is given to some aspects of the predatory and schooling nature of this squid.
CALL LETTERS: SH223 A88
KEYWORDS: other species; behavior-feeding, schooling

29. Ben-Yami, M. 1976. Fishing with light. Fishing News Books, Ltd., Surrey England. 121 pp.

This manual reviews briefly the history and development of fishing with light and the various ways of its application by fishermen of many countries, discusses the characteristics of light in water, its effects on different fish and their subsequent behavior pattern on which fishing with light is based, and then describes in technical detail the most important commercial light fishing techniques of today. List of bibliographic references given at the end of this manual.
CALL LETTERS: SH344 .43 L5 B46
KEYWORDS: gear used-lights; behavior; bibliography

30. Bernard, F.R. 1970. A distributional checklist of the marine molluscs of British Columbia: based on faunistic surveys since 1950. Syesis, 3:75-94.

A checklist of the living marine molluscan fauna of British Columbia is presented, comprising 283 gastropod, 180 bivalve, 29 chiton, 21 cephalopod, and 5 scaphopod species.
CALL LETTERS: QH1 S9
KEYWORDS: LO; west coast species; other species

31. Bernard, F.R. 1980. Preliminary report on the potential commercial squid of British Columbia. Can. Tech. Rept. Fish. Aqu. Sci., 942:1-51.

Four species of British Columbia squid may be of commercial interest. The opal squid (LOLIGO OPALESCENS), the nail squid (ONYCHOTEUTHIS BOREALIJAPONICA), the flying squid (OMMASTREPHES BARTRAMII) and the red squid (BERRYTEUTHIS MAGISTER). Biology, life history and fishery for each species is reviewed. These resources are probably insufficient for a specialized fishery, but may allow diversification of effort. Various fishing methods are discussed. The major external constraints to development of a west coast industry are uncertain markets.
CALL LETTERS: SH223 A88
KEYWORDS: LO; gear used-lights, nets, jigs; acoustics; west coast species; fishery-BC; description; distribution

32. Berry, S.S. 1910. A review of the cephalopods of western North America. Bull. Bur. Fish., 30:267-336.

Review of the classification and description of all species known to occur along the western shores of N. America between Bering Strait and Coronado Island. Drawings and photographs of preserved specimens are included.
CALL LETTERS: SH11 A13
KEYWORDS: LO; west coast species; description

33. Berry, S.S. 1911. Preliminary notices of some new Pacific cephalopods. Proc. U.S. Nat. Mus., 40:589-592.

New descriptions of West American squids and devil fish obtained by U.S. Bureau of Fisheries steamer ALBATROSS. New species include; CIRROTEUTHIS MACROPE, ELEDONELLA HEATHI, POLYPUS CALIFORNICUM, POLYPUS LEIODERMA, ROSSIA PACIFICA, LOLIGO OPALESCENS, GALITEUTHIS PHYLLURA.
CALL LETTERS: Q11 U57
KEYWORDS: LO; description; west coast species

34. Berry, S.S. 1920. Light production in cephalopods. I. An introductory survey. Biol. Bull., 38(3):141-169.

The classification of cephalopods is reviewed. A summary of all cephalopods that have been described as possessing photogenic organs is presented. In the Decapoda order, 32% of the species possess photogenic organs, none in the family Loliginidae. Actual observances of the phenomenon of light production are rare. Known observances are summarized.
CALL LETTERS: QH301 B56 (micro)
KEYWORDS: physiology-photophores

35. Berry, S.S. 1920. Light production in cephalopods. II. Biol. Bull., 38(4):171-195.

Colors produced by photogenic organs in cephalopods range from sky blue, ruby red, white, purplish, cobaltish, to pale green. Photophores are almost always located in specialized tissue in definite regions of the body - most commonly around the eye. They may also be found on the mantle, head, arms, and funnel. The structure and origin of photophores are reviewed.
CALL LETTERS: QH301 B56 (micro)
KEYWORDS: physiology-photophores

36. Blake, D.A. 1982. The successful introduction and promotion of a new product: grande calamari. pp. 287-294. In: Proceedings of the International squid symposium. August 9-12, 1981. Boston, Massachusetts. New England Fisheries Development Foundation, Inc. 390 pp.

Discussion of the development of a U.S. market for the Mexican harvest of DOSIDICUS GIGAS.
CALL LETTERS: QL430 .3 L8 I561
KEYWORDS: west coast species; markets

37. Biott, A.J. 1980. Experimental pair trawling for squid in New England. Mar. Fish. Rev., 42(7-8):57-59.

The use of a bottom pair trawl for catching squid was examined in this study. The object was to determine the commercial feasibility of harvesting winter squid (LOLIGO PEALEI) with the pair trawl. The trawl used was designed by the vessel captains involved in the study. Study results show that further experiments are needed using additional trawl designs and that the influence of speed and other fishing parameters need to be investigated. Mesh size of 5 inches in the wings could be increased and towing speeds of 2.5 knots should be increased to 3.5-4 knots in future trials.
CALL LETTERS: SH11 A14
KEYWORDS: other species; gear development; gear used-trawl.

38. Bodholt, H. 1977. Variance error in echo integrator output. Rapp. P.-v. Reun. Cons. Int. Explor. Mer. 170:196-204.

The variance error involved in the abundance estimate from a hydroacoustic system comprising an echo-sounder with a 20 log r TVG and an echo intregrator is investigated. The model used on the analysis is a random distribution of fish in a horizontal layer. A mathematical expression for the variance error is derived, and the contributions from the three variance sources, random phases, Poisson distribution of the number of fish in the sampling volume, and variation in target strength, are discussed. The variance error increases when the number of fish in the insonified volume decreases, and it increases with the pulse length. Having regard to the variance error, one should therefore use short pulse and a wide beam and avoid being in close range to the layer. A typical example, with integration over one nautical mile, is analyzed.
CALL LETTERS: GC1 I66
KEYWORDS: acoustics

39. Borderias, J.A. 1982. Technology of squid in Spain. pp. 167-172. In: Proceedings of the International squid symposium. August 9-12, 1981. Boston, Massachusetts. New England Fisheries Development Foundation, Inc. 390 pp.

Discussion about squid as food, processing and handling, and different methods of squid consumption in Spain.
CALL LETTERS: QL430 .3 L8 I561
KEYWORDS: landings; fishery-Spain; processing; quality

40. Boycott, B.B. 1953. The chromatophore system of cephalopods. Proc. of Linnean Soc. London, 164:235-240.

This project compared the neurophil of the posterior chromatophore lobe of OCTOPUS VULGARIS, SEPIA OFFICINALIS, LOLIGO VULGARIS, and ARGONAUTA ARGO. The chromatophore systems of OCTOPUS and SEPIA are organised in such a way as to produce a wide variety of complicated color patterns, while that of LOLIGO and ARGONAUTA can produce only limited and simple changes in the chromatophores.
CALL LETTERS: (NA)
KEYWORDS: other species; physiology-chromatophore

41. Brown, D.E. and R.P. Singh. 1981. A machine to eviscerate and skin squid. Trans. Amer. Soc. Agri. Eng., 24(1):259-264.

Design features of a new squid eviscerating and skinning machine are presented. Physical properties of the squid were used in design of an orienting and feeding device. Parts of squid anatomy help in alignment before separating the tentacles from the body. The conical body is automically conveyed to and lodged on an evisceration/skinning peg. Fan-shaped water spray is used to remove the skin and eviscerate. The output from the machine is a clean white mantle ready for further processing. Performance trials of a pilot-scale unit and scale-up design aspects indicate that the system is feasible for a large-scale processing operation.
CALL LETTERS: S671 A52
KEYWORDS: processing-automated, skinning

42. Brown, D.E., R.P. Singh, and R.J. Coffelt. 1981. A system to singulate and align squid for packaging and processing. Mar. Fish. Rev., 43(6):21-26.

To reduce packaging time of whole California market squid, LOLIGO OPALESCENS, and facilitate automatic feeding of a newly developed squid cleaning machine, a system to align and singulate squid has been developed. Squid are circulated in a holding tank by water jets which also singulate and direct the squid through ducts to an alignment slide. The squid slide down the alignment ramp and are oriented mantle first. As the squid slides down the ramp, the tentacles drag, causing the body to rotate clockwise or counterclockwise and orient itself. Data are presented relating system performance to processing rates for the squid cleaning machine and the packing industry.
CALL LETTERS: SH11 A14
KEYWORDS: LO; processing-automated

43. Brzeski, M.M. 1982. Approach to the problems of squid utilization for the new food products in Poland. pp. 173-181. In: Proceedings of the International squid symposium. August 9-12, 1981. Boston, Massachusetts. New England Fisheries Development Foundation, Inc. 390 pp.

Poland does not traditionally eat squid as in the other northern European countries. Generally, there is a wide spread prejudice because of its appearance. In order to be utilized in the Polish market, squid food products should be in a form which does not produce disadvantageous associations with squid such as appearance, taste, texture, flavor, and its name. Manual processing should be replaced by mechanical processing.
CALL LETTERS: QL430 .3 L8 I561
KEYWORDS: markets; processing-automated

44. Bullock, T.H. 1948. Properties of a single synapse in the stellate ganglion of squid. Jour. Neurophysiol., 11(4):343-364.

In a preparation of the isolated stellate ganglion with pre- and postganglionic nerves it is possible to record impulses from the giant pre- and postfibers and from the synapse between them in such a way that a single junction is active.
CALL LETTERS: (NA)
KEYWORDS: physiology-nerves

45. Bullock, T.H. 1965. Mollusca: Cephalopoda. Chapter 25. pp. 1433-1515. In: Bullock, T.H. and G.A. Horridge. Structure and function in the nervous systems of invertebrates. Vol. II. W.H. Freeman and Co., San Francisco. 1719 pp.

Cephalopods have a very highly developed nervous system. A varied repertoire of behavior, recognition of complex objects, rapid muscle, color, and luminescent responses, and rapid learning are characteristic. Discussion includes: Anatomy and structure of central and peripheral nervous system; receptors; physiology of nervous control of muscles; and function of the brain.
CALL LETTERS: QL925 B8
KEYWORDS: physiology-nerves

46. Burczynski, J. 1979. Introduction to the use of sonar systems for estimating fish biomass. FAO Fish. Tech. Pap., No. 191. 89 pp.

This paper provides an introduction to certain aspects of acoustic surveys of fish stocks, namely the general structure and functioning of sonar systems, and how echoes returned by fish are processed to measure fish abundance. It aims to convey an understanding of the basic principles and problems involved rather than detailed guidance on how to adjust and operate acoustic systems.
CALL LETTERS: SH1 F539
KEYWORDS: acoustics

47. Burukovsky, R.N. 1978. An approach to the construction of sexual maturity scales of ovaries in squids. Malacological Rev., 11:133.

The gonad development in squid, in contrast to fishes and shrimps, is characterized by constant asynchronism. Due to this, one can find in gonads of pre-spawning individuals oocytes at all phases of pre- and vitellogenesis. Such type of development aims at a gradual extension of maturation of eggs and spawning. However, most, and very possibly all, squids are characterized by a simultaneous laying of the whole mass of eggs. So the contradiction arises between the aim of gonad development and the character of spawning. The contradiction is removed by the formation of voluminous oviducts. During the maturation process, the eggs migrate to the oviducts and are preserved there until spawning. A scheme for sexual maturity scales is presented.
CALL LETTERS: QL401 M177
KEYWORDS: other species; physiology-gonad maturation

48. Caddy, J.F. 1983. The cephalopods: factors relevant to their population dynamics and to the assessment and management of stocks. FAO Fish. Tech. Pap., 231:416-452.

Following a brief review of the cephalopods and their global resource potential, those aspects which are essential to an understanding of their role in the ecosystem, and to the modelling of their population dynamics, and design of research and monitoring systems are briefly reviewed. The methodologies appropriate to assessment of these generally short-lived migratory organisms are looked at and their implications for fisheries management are discussed.
CALL LETTERS: SH1 F539
KEYWORDS: abundance; growth; diet; migration; stock assessment; regulations; mortality; modelling

49. Cahill, P. and W.E. Mansfield. 1984. Squid nets of the mid-Atlantic. Marine Resource Advisory. Virginia Sea Grant Marine Advisory Service, No. 27. 16 pp.

Illustrates squid nets commonly used along the mid-Atlantic coast. High Rise nets are replacing those like the origional "Yankee 36 trawl" or its modified version, the URI 41. Net diagrams, dimensions, descriptions, and operating techniques are given for Cape May 64-inch, Roger Harris 16-inch, Cash corner 8-inch, and Cash corner 16-inch High Rise nets and Irish wing trawl.
CALL LETTERS: (NA)
KEYWORDS: gear used-trawl

50. Calliet, G.M., K.A. Karpov, and D.A. Ambrose. 1979. Pelagic assemblages as determined from purse seine and large midwater trawl catches in Monterey Bay and their affinities with the market squid, LOLIGO OPALESCENS. CalCOFI Rep., 20:21-30.

The catches of large midwater trawls and commercial anchovy purse-seine hauls were analyzed for recurrent assemblages of pelagic organisms in Monterey Bay. Samples were taken in the upper 50 fathoms using large (30-and 50-foot-mouth) midwater trawls. Species composition data were obtained from California Department of Fish and Game records and the CalCOFI data report series for 1968-74. In 1975 and 1976, commercial anchovy hauls were subsampled. Due to the differences in sampling methods, data for individual taxa are presented only as presence or absence, relative abundance, and frequency of occurrence. Ranks of relative abundance for the dominant taxa are presented for both methods. In addition, catches were subjected to recurrent group analysis, and both methods showed similar assemblages despite the obvious differences in purpose of sampling and the type of gear employed. Catches taken over deeper water (more than 35 fathoms, or 64 m) were compared with those from shallower water, and the differences are discussed. In general, catches were dominated by LOLIGO OPALESCENS and ENGRAULIS MORDAX.
CALL LETTERS: SH351 S2 C22
KEYWORDS: LO; catch composition; abundance; stock assessment

51. Calliet, G.M. and D.L. Vaughan. 1983. A review of the methods and problems of quantitative assessment of LOLIGO OPALESCENS. Biol. Ocean., 2(2-3-4):379-400.

An examination of the knowledge about sampling LOLIGO OPALESCENS populations leads to two general conclusions regarding the assessment of their abundance. First, it is suggested that studies concentrate on spawning ground organisms, since they aggregate during spawning, are commercially fished at this time, and their numbers can be assessed using a combination of data from market catch, adult and egg case

densities, acoustic sensing, and perhaps larval densities. Second, it is suggested that large-scale acoustic surveys coupled with large midwater trawling activities be used to qualitatively assess adult organisms off the spawning grounds.
CALL LETTERS: QH91 A1
KEYWORDS: LO; stock assessment; acoustics

52. Chikuni, S. 1983. Cephalopod resources in the Indo-Pacific region. FAO Fish. Tech. Pap., 231:264-305.

The information and the data available are still very poor and fragmentary in the region. The current commercial fishing has generally been small in comparison to the supposedly large potential yields. In many countries the bulk of the catch of neritic cephalopods is taken by the larger trawlers. The potential yield of the neritic cephalopods has been roughly estimated to be about 1.1-1.4 million tons from the entire region compared with the current catch of about 0.3 million tons. Problems involved in the future development of the cephalopod fishery are discussed. Recommendations on the studies required in the immediate future have also been made. Information collected so far does not appear to be sufficient to assess the stocks for the immediate commencement of commercial fishing on them. Further surveys and studies on both biology and environment are required.
CALL LETTERS: SH1 F539
KEYWORDS: fishery-Indo-Pacific; landings; distribution; other species; length; gear used

53. Christofferson, J.P., A. Foss, W.E. Lambert, and B. Welge. 1978. An electrophoretic study of select proteins from the market squid, LOLIGO OPALESCENS Berry. Calif. Dept. Fish Game, Fish Bull., 169:123-133.

Select proteins from blood, eye tissue, digestive gland, mantle, and tentacular muscle of LOLIGO OPALESCENS were separated by electrophoresis to determine if more than one stock exists in the population in California waters. Analysis of the esterase results suggests there may be some population changes but overall it is not possible to conclude that there are or are not subpopulations of L. OPALESCENS along the California coast.
CALL LETTERS: SH11 C24
KEYWORDS: LO; electrophoresis; stock delineation

54. Chun, C. 1975. The Cephalopoda. Part I: Oegopsida. Part II: Myopsida, Octopoda. Text and atlas. Translated by Israel Program for Scientific Translations, Jerusalem. 436 pp.

Species of Decapoda Oegopsida are described and illustrated. Comparative external and internal organization is discussed.
CALL LETTERS: QL430 .2 C4
KEYWORDS: other species; description; anatomy

55. Cincotta, D.E. 1982. The visual system of the squid, LOLIGO OPALESCENS: Functional implications of membrane structures. Ph.D. thesis, Univ. of California, Berkeley. 201 pp.

The retinas of freshly-killed squid were examined by thin-section and freeze-fracture electron microscopy. Three membrane systems appeared to have membrane proteins arranged in an ordered lattice.
CALL LETTERS: (NA)
KEYWORDS: LO; physiology-vision

56. Clark, F.N. and J.B. Phillips. 1936. Commerical use of the jumbo squid, DOSIDICUS GIGAS. Calif. Fish Game, 22:143-144.

Catches of the jumbo squid (DOSIDICUS GIGAS) in commercial fisheries of 1934-36 are described; size caught, areas, seasonal variations, and gears used are discussed.
CALL LETTERS: SH11 C22
KEYWORDS: west coast species; gear used; description; length; fishery-Monterey Bay, S. California

57. Clarke, M.R. 1962. The identification of cephalopod "beaks" and the relationship between beak size and total body weight. Bull. Brit. Mus. (Nat. Hist.) Zool., 8(10):421-480.

Cephalopod beaks are described and precise terms defined which are applicable to both upper and lower beaks. Changes in the relative dimensions and the darkening of beaks during growth have been described in a wide range of cephalopod families. Beak shape changes with increase in beak size and the dimensions bear a simple allometric relationship to one another. These relationships are different in the different families and were calculated by using the formula $\log y = m \log x + \log c$. The standard deviations of points from these "average" regressions was also found. The variation of beak form has been studied and stable criteria have been found which may be used to identify beaks to family. Features have been found which can be used to distinguish between some species within the same family. A key for the preliminary grouping of beaks into families has been constructed. The relationship between beak size and the total body weight has been found for all the families studied. Limitations in the use of beak size to estimate total weight are discussed.
CALL LETTERS: QL1 B75
KEYWORDS: LO; other species; beaks; weight

58. Clarke, M.R. 1966. A review of the systematics and ecology of oceanic squids. Adv. Mar. Biol., 4:91-300.

Accounting of the superfamily Oegopsida and the Sepioidea oceanic species SPIRULA SPIRULA. Information obtained from an extensive search of the literature includes: distribution; larvae; growth; maturity; mating; eggs and egg laying; food; predators; and economic uses.
CALL LETTERS: QH91 A3
KEYWORDS: other species; distribution; larvae; growth; behavior-spawning, feeding; diet; predators; sex ratio

59. Clarke, M.R. 1977. Beaks, nets and numbers. Symp. Zool. Soc. Lond., 38:89-126.

Comparisons are made between collections of cephalopod beaks obtained from the stomachs of a variety of predators, including sperm whales, porpoises, seals, sharks, tuna, and birds, and collections of cephalopods obtained with several kinds of nets. Comparisons are made between the family composition of various samples from different regions, and the coverage is often sufficient to distinguish between regional effects and differences due to type of sampler. In the North Atlantic, nets with small mouths, nets with large mouths, and sperm whales all take different proportions of different families of cephalopods. The relative numerical importance of families and the relationship, by weight in the diet of the sperm whale in different regions is assessed. A rough estimate of the total weight of cephalopods eaten by sperm whales each year is over 110 million tons, but is likely to have been twice as much in the years before 1946. The possible significance of the increase in the number of species caught by opening-closing nets between 60 and 11 degrees N in the N Atlantic is discussed.
CALL LETTERS: QL1 Z712
KEYWORDS: beaks; predators

60. Clarke, M.R. and J.E. Fitch. 1979. Statoliths of cenozoic teuthoid cephalopods from North America. Palaeontology, 22(2):479-511.

Statoliths of fossil teutholds are described in detail for the first time. The evolution of LOLIGO and the ecology of the species are discussed.
CALL LETTERS: QE701 P45
KEYWORDS: LO; fossils

61. Classic, R.F. 1929. Monterey squid fishery. Calif. Fish Game, 15(4):317-320.

Description of commercial squid fishing in Monterey Bay for 1926-1928. Summary of landings, prices, seasons, gear used, markets, descriptions of drying techniques.
CALL LETTERS: SH11 C22
KEYWORDS: fishery-Monterey Bay; landings; seasons; processing-dried; gear used; markets; LO

62. Classic, R.F. 1949. Squid. pp. 172-175. In: The commerical fish catch of California for the year 1947. Calif. Div. Fish Game, Fish Bull., 74:1-267.

Review of commerical landings of LOLIGO OPALESCENS in California. Although a few squid are caught throughout the year, a large percentage of the landings are made from April to July. A brief history of the processing techniques and values of freezing, drying, and canning is discussed. Most of the drying of squid was discontinued after 1932 because of unstable markets and increased competition. The canning of squid has been minor except between 1943-47. Fishermen use three types of round haul nets in catching squid: lampara, purse seine, and half-ring nets.
CALL LETTERS: SH11 C24
KEYWORDS: LO; landings; processing-freezing, canning, dried; markets; gear used

63. Cohen, G. 1982. Squid handling and processing in southern Europe. pp. 183-186. In: Proceedings of the International squid symposium. August 9-12, 1981. Boston, Massachusetts. New England Fisheries Development Foundation, Inc. 390 pp.

Squid tubes are the key products for several dishes and markets in southern Europe. Instructions for their preparation are given. Whole squid are washed, the wings removed, skinned, washed in a citric acid bath, and glazed with ice.
CALL LETTERS: QL430 .3 L8 I561
KEYWORDS: processing

64. Collins, J.W. 1892. Report on the fisheries of the Pacific coast of the United States. pp. 3-269. In: U.S. Commission of the fish and fisheries. Part XVI. Report of the Commissioner for 1888. 269 pp.

Review of fisheries and fishing industry between southern California and northwest Washington in 1888 with mention of Alaskan fisheries perspective. Economic output of industry is summarized. Landings, fishing grounds, fishing and processing methods are discussed.
CALL LETTERS: SH11 A4
KEYWORDS: fishery- Pacific NW, Monterey Bay, S. California; gear used; processing; landings

65. Court, W.G. 1980. Japan's squid fishing industry. Mar. Fish. Rev., 42(7-8):1-9.

A review of the Japanese squid fishing industry from approximately 1960-1980. Domestic landings have been decreasing since record high in 1968 of >770,000 tons with the characteristics of the fishery changing markedly since then. Depletion of TODARODES PACIFICUS is widely attributed to over fishing. Imports were banned until 1970 because Japan's fishery satisfied domestic demand. Landings began to decline after 1968. Catches by Japanese boats in overseas waters have increased. The percentage of squid landed by jigging is declining. Other fishing methods include drift gill nets, set nets, and bottom trawls. Percent of larger boats in fleet has been increasing. The focus of the fishery has shifted from coastal to offshore waters. Fishery was unregulated until 1969 because the resource was abundant, but with declining CPUE, competition among large numbers of boats became a problem. Boats over 5 tons are regulated, seasons and area closures were established. Demand for squid by consumers has increased, new products and markets have been developed. About 40% of landings are marketed fresh or frozen and 50% processed into dried and flavored forms.
CALL LETTERS: SH11 A14
KEYWORDS: other species; landings; gear used; markets; processing; fishery-Japan; seasons; regulations

66. Court, W. 1982. Japan's squid market. pp. 295-316. In: Proceedings of the International squid symposium. August 9-12, 1981. Boston, Massachusetts. New England Fisheries Development Foundation, Inc. 390 pp.

Describes Japan's squid markets, and considers prospects for and approaches to marketing squid in Japan. Discussion includes supply and demand, distribution channels, products and prices, exporting squid to Japan, and Japan's drift gill net fishery for OMMASTREPHES BARTRAMII.
CALL LETTERS: QL430 .3 L8 I561
KEYWORDS: fishery-Japan; markets; processing-products

67. Craig, R.E. (ed.). 1984. Fisheries acoustics. A symposium held in Bergen, 21-24 June 1982. Rapp. P.-v. Reun. Cons. Int. Explor. Mer. Vol. 184. 154 pp.

Topics covered at this international symposium included calibration of acoustic equipment, survey design, and target strength measurements.
CALL LETTERS: GC1 I66
KEYWORDS: acoustics

68. Crossman, R. 1982. State of the art in handling, processing and new product development in New Zealand. pp. 187-195. In: Proceedings of the International squid symposium. August 9-12, 1981. Boston, Massachusetts. New England Fisheries Development Foundation, Inc. 390 pp.

Discussion of the process of and problems associated with developing, from scratch, a strong economically viable squid industry.
CALL LETTERS: QL430 .3 L8 I561
KEYWORDS: processing; markets

69. Dailey, M.D. 1969. A survey of helminth parasites in the squid, LOLIGO OPALESCENS; smelt, OSMERUS MORDAX; jack mackerel, TRACHURUS SYMMETRICUS; and Pacific mackerel. SCOMBER JAPONICUS. Calif. Fish and Game, 55(3):221-226.

Specimens of squid, smelt, jack mackerel, and Pacific mackerel were examined for larval and adult helminth parasites. Infection rates were 8.0%, 76.9%, 84.0% and 92.0% in the smelt, squid, Pacific mackerel and Jack mackerel respectively. Parasites recovered represented classes Cestoda, Trematoda, and Nematoda, and phylum Acanthocephala.
CALL LETTERS: SH11 C22
KEYWORDS: LO; parasites

70. Dewees, C.M. and R.J. Price. 1982. Overview of the squid fishery on the Pacific coast of the United States. pp. 197-221. In: Proceedings of the International squid symposium. August 9-12, 1981. Boston, Massachusetts. New England Fisheries Development Foundation, Inc. 390 pp.

Provides a general overview of the Pacific coast squid fishery for the market squid (LOLIGO OPALESCENS). The biology of the market squid, history of the fishery, fishing gear and methods, processing methods, marketing and product development, and future outlook are described.
CALL LETTERS: QL430 .3 L8 I561
KEYWORDS: LO; landings; gear used; processing-products; markets;

71. Durward, R.D., T. Amaratunga, and R.K. O'Dor. 1978. Maturation index and fecundity for the female squid ILLEX ILLECEBROSUS. pp. 24.1-24.10. In: Proceedings of the workshop on the squid, ILLEX ILLECEBROSUS, Dalhousie Univ., Halifax, Nova Scotia, May, 1978, and a bibliography on the genus ILLEX. Can. Fish. Mar. Serv. Tech. Rep., No. 833. 311 pp.

Data obtained from squid maintained in captivity and from the wild population are used to examine the maturation process in the females. Fecundity was determined from egg counts of females maintained in captivity. For females of average weight of 443 $\pm$ 13 g, average fecundity was calculated to be 400,000 $\pm$ 40,000.
CALL LETTERS: SH223 A88
KEYWORDS: other species; physiology-gonad maturation; fecundity

72. Ehrenberg, J.E. and D.W. Lytle. 1977. Some signal processing techniques for reducing the variance in acoustic stock abundance estimates. Rapp. P.-v. Reun. Cons. Int. Explor. Mer, 170:205-213.

In this paper, the various sources of error are discussed. A theoretical model for acoustic assessment systems is presented and error expressions for counting and integrating systems are given. A lower bound on the mean squared error of abundance estimates shows that intregators are optimum processors in high densities and that counters are optimum in low densities. An adaptive prosessor that satisfies the lower bound on the mean squared error of the estimate is described.
CALL LETTERS: GC1 I66
KEYWORDS: acoustics

73. Ehrhardt, N.M., et al. 1983. On the fishery and biology of a giant squid DOSIDICUS GIGAS in the Gulf of California. Mexico. FAO Fish. Tech. Pap., 231:306-340.

The population of giant squid in the Gulf of California is clearly a single stock with multiple cohorts. These migrate separately on occasions but are contemporaneous: their recruitment to the major fishing grounds occurs around May each year. From May to September the stock presents the highest densities and thus an optimum situation for the fishery. The cohorts grow at different rates depending on their birth date, and probably their natural mortality rates are equally different even though it has been impossible to measure this parameter separately for each cohort as yet. Stock assessment analyses indicate that after explosive fishery development, the stock is approaching the Maximum Sustainable Yield (MSY). Management schemes are difficult to define unless the fishery is regulated in terms of the less productive cohorts, and since D. GIGAS is a fast growing and fast dying species, it is essential to obtain better knowledge of its reproduction potential before advice in terms of fishing levels can be given.
CALL LETTERS: SH1 F539
KEYWORDS: west coast species; growth; distribution; abundance; migration; landings; gear used-jigs; modelling; stock assessment

74. Engel, H.H. 1975. Commercial trawling gear used for squid fishing in the north Atlantic (Japanese gear excluded). FAO Fish. Rept. 170, Suppl. 1:133-141.

Trawl gear used by squid vessels from countries other than Japan is discussed. For several types of trawls, net diagrams, dimensions, catches, towing speeds and other information is detailed. Italian and French trawlers are using French high opening bottom trawls, Canadians are using Engel high opening bottom trawls, Americans are using the standard 41 A Yankee trawl, and Germans are using pelagic Engel nets, Engel high opening bottom trawls, and Mewes bottom trawls.
CALL LETTERS: SH1 F543
KEYWORDS: gear used-trawl

75. Ennis, G.P. 1978. A Review of the fishery for squid and the general biological characteristics of the species, ILLEX ILLECEBROSUS, in the Newfoundland area. pp. 5.1-5.8. In: Proceedings of the workshop on the squid, ILLEX ILLECEBROSUS, Dalhousie Univ., Halifax, Nova Scotia, May, 1978, and a bibliography on the genus ILLEX. Can. Fish. Mar. Serv. Tech. Rep., No. 833. 311 pp.

The purpose of this brief review is to summarize the salient features of the Newfoundland squid fishery and the general biological characteristics of the species during its seasonal occurrence in the Newfoundland area.
CALL LETTERS: SH223 A88
KEYWORDS: other species; landings; length; sex ratio; weight; fishery-N. Atlantic

76. Ennis, G.P. and P.W. Collins. 1979. Food and feeding of the short-finned squid, ILLEX ILLECEBROSUS., during its seasonal occurrence in the Newfoundland area. Sel. Pap. ICNAF, 5:25-29.

The high percentage of empty stomachs generally found in squid caught in the Newfoundland area is inconsistent with the observation that their occurrence in this area is primarily the result of a feeding migration and with the fact that they grow rapidly while in the area. Samples collected from offshore areas in May and June have a higher incidence of crustacean remains than fish remains in the stomachs. Feeding conditions appear to improve somewhat when squid first migrate inshore and their diet changes to mainly capelin (MALLOTUS VILLOSUS). However, the incidence of fish remains in the stomachs decline from August to November and the incidence of squid remains (cannibalism) increases, indicating a deterioration in feeding conditions over this period. Squid collection from the offshore area in November-December have a higher incidence of crustacean remains than fish remains in their stomachs, and both the incidence of cannibalism and the

percentage of empty stomachs is much lower than for the inshore samples collected during approximately the same period, indicating that feeding conditions improve considerably as squid move offshore in the autumn.
CALL LETTERS: SH1 I674
KEYWORDS: other species; diet

77. Evans, R.G. 1976. Aspects of the population biology of the California market squid (LOLIGO OPALESCENS, Berry). M.A. Thesis, California State University, Hayward. 88 pp.

Two spawning populations of LOLIGO OPALESCENS were detected from morphometric analyses of sub-samples collected from Monterey and Southern California commercial squid catches during 1974. Using polymodal size frequency analyses, a life span of one to one-and-a-half years was predicted with a corresponding growth rate of 17 mm per month for the first six months, and a decreasing growth rate thereafter. Sexual dimorphism was demonstrated, as were weight losses attributed to spawning. Samples revealed an imbalanced sex ratio with male squid predominating. The squid demonstrated one major spawning period per month centered around the new moon.
CALL LETTERS: (NA)
KEYWORDS: LO; stock delineation; growth; sex ratio; behavior-spawning

78. Fields, W.G. 1950. A preliminary report on the fishery and on the biology of the squid, LOLIGO OPALESCENS. Calif. Fish Game, 36(4):366-377.

History of squid fishing in Monterey Bay is given, and the annual catch from 1916 to 1948 is shown. Length (mantle length) frequencies are shown. The average male is about 10 mm longer than the average female. Four times as many small male as small female animals occur. Selection for small animals shows that males may become mature when as small as 72 mm, or may remain immature until longer than 110 mm; comparable sizes for females are 81 mm and 120 mm. Weight-length curves are shown. In larger animals the weights of males exceed those of females of comparable length.
CALL LETTERS: SH11 C22
KEYWORDS: LO; landings; length; weight; fishery-Monterey Bay; gear used

79. Fields, W.G. 1963. The structure, development, food relations, reproduction and life history of the squid, LOLIGO OPALESCENS Berry. Masters thesis, Dept. Biology, Stanford University. 60 pp.

The description of LOLIGO OPALESCENS is ammended. The oceanographic seasons affect the life of the squid at Monterey, California. The fishery is centered at Monterey, where lampara nets are used. Feeding behavior of the squid is described. While eating

one crustacean, L. OPALESCENS continues capturing others with its tentacles. Studies of stomach contents show that crustacea, fish and polychaete worms are commonly eaten, with the proportion of crustacean meals decreasing and fish meals increasing in larger animals. Reproductive systems, spermatophores, gametes and the processes of mating and spawning are described and illustrated. L. OPALESCENS spawns in winter in the southern portions of its range and in late summer in the northern portion. Some spawning may occur in every month of the year. Gross embryology is described and illustrated. The incubation period is 3 to 4 weeks at 16 degrees C. Sex ratio is 1:1. Two distinct populations enter the spawning grounds during the year. One is dominant from January to June, the other from July to December. Almost all females spawn at the age of 3 years; this is the modal age for spawning males. All squid die after one season of spawning.
CALL LETTERS: (NA)
KEYWORDS: LO; description; diet; behavior-feeding; sex ratio; age; length; physiology-embryology

80. Fields, W.G. 1965. The structure, development, food relations, reproduction, and life history of the squid LOLIGO OPALESCENS Berry. Calif. Fish Game, Fish Bull., 131:1-108.

The description of L. OPALESCENS (Berry, 1912) is ammended to note that arms of the male are approximately 50% longer than those of the female, and is supplemented by description of the colors of the living animal. The oceanographic seasons affecting the life of the squid at Monterey, California, include a period of upwelling from Mar.-Aug., an oceanic period during Sep. and Oct. when offshore water approaches the coast, and a Davidson Current period from Nov. to Feb. when an inshore current flows northward along the coast. Feeding behavior of the squid is described. While eating one crustacean (e.g. SPIRONTOCARIS sp.) L. OPALESCENS continues capturing others with its tentacles, building up a reserve of active prey within the loosely-held cone of arms. No evidence of the use of cephalotoxin was seen. Studies of squid stomach contents show that crustacea, fish and polychaete worms are commonly eaten, with the proportion of crustacean meals decreasing and fish meals increasing in larger animals. Squid larger than 120 mm dorsal mantle length exhibit some cannibalism, but squid remains were not seen in stomachs of animals smaller than this. Plerocercoid stages of tapeworms are occasionally found in the gut. Reproductive systems, spermatophores, gametes and the processes of mating and spawning are described and illustrated. Two distinct populations entered the spawning grounds during the year. One was dominant from Jan.-Jun., the other from Jul.-Dec. Each population was associated with different oceanographic conditions at Monterey; the Nov. spawning group apparently migrated from south of Point Conception with the Davidson Current. Males may be mature at 72 mm or remain immature to 130 mm; comparable sizes for females are 81 mm and 140 mm, respectively. Almost all females spawn at the age of 3-yrs; this is the modal age for spawning males, but a few older and many younger individuals greatly extend the size range of males in spawning schools. All die after one

season of spawning. A severe reduction in average size of the spring spawning stock occurred in 1947-1952 and persisted through 1961; sizes in 1962 were equal to or larger than those of 1948.
CALL LETTERS: SH11 C24
KEYWORDS: LO; description; behavior-spawning, feeding; age; distribution; habitat; gear used; landings; markets; seasons; length; weight; growth; diet; fecundity

81. Filatova, Z.A. (ed.). 1974. Multidisciplinary investigations of the continental slope in the Gulf of Alaska area. Can. Trans. Fish. Aquat. Sci., No. 3204. 494 pp.

This collection contains the results of investigations in the Gulf of Alaska and the Aleutian abyssal trench. Quantitative data were obtained on the vertical and horizonal distribution of life along the slope of the bathyal zone and on biological zonation. There are also articles on hydrology, hydrochemistry and microbiology in the region investigated.
CALL LETTERS: SH223 A9 (micro)
KEYWORDS: other species; distribution-vertical

82. Fiscus, C.H. 1982. Predation by marine mammals on squids of the eastern North Pacific Ocean and the Bering Sea. Mar. Fish. Rev., 44(2):1-10.

This paper is an attempt to consolidate and make available information from several sources on the relationship between squids and their major marine mammal predators. Over the continental shelf, fishes comprise most of the diet of marine mammals, but along the continental slope fish and squids are equally important prey. In oceanic waters squids are usually the most important prey. The frequency of occurrence of squids in the stomach contents of marine mammals was used to assess whether a species was sufficiently abundant in some parts of the North Pacific Ocean and Bering Sea to support commercial fisheries.
CALL LETTERS: SH11 A14
KEYWORDS: LO; predators-marine mammals; abundance

83. Fiscus, C.H. 1984. Catalogue of cephalopods at the National Marine Mammal Laboratory. NOAA Tech. Memo., NMFS F/NWC-65. 120 pp.

The cephalopod collection at the National Marine Mammal Laboratory is used primarily as an aid to the identification of cephalopod remains found in the stomachs, scats, and spewings of marine mammals. As such, those parts of cephalopods which persist after the soft parts are gone are prominent in the collection (i.e., beaks, gladii, and statoliths).
CALL LETTERS: SH11 A5414
KEYWORDS: LO; west coast species; predators-marine mammals; beaks

84. Flanagan, P. 1983. Squid handling and processing in California. pp. 97-112. In: Proceedings of the west coast squid symposium. February 1-2, 1983. Newport, Oregon. Oregon State Univ. Sea Grant Marine Advisory Program. 149 pp.

Discussion of the squid processing procedures used by the General Fish Co., California. Production is maintained at a low level in order to keep quality high. Squid is frozen as quickly as possible to keep bacteria count low. Carton design and preservation procedures are very important. Hydraulic conveyer belt system is much more effective then mechanical system. Consumer education is of critical importance in marketing of squid.
CALL LETTERS: SH374 .52 U6 W41
KEYWORDS: processing; markets

85. Flores, E.E.C. 1972. Handline fishing for squid in the Japan Sea. FAO Fish. Circ., 142:1-6.

Discusses the development of the handline (jigging) fishing gear and its operation. Originally the squid handline was a simple pole, line, and jig. The multiple handline was developed to improve catching efficiency. A series of jigs, a revolving drum, and automation were later developed.
CALL LETTERS: SH1 F537
KEYWORDS: gear used-jigs

86. Flores, E.E.C. 1982. Light attraction techniques in squid fishing. pp. 55-68. In: Proceedings of the international squid symposium. August 9-12, 1981. Boston, Massachusetts. New England Fisheries Development Foundation, Inc. 390 pp.

There is a trend of replacing incandescent lamps with halogen lamps. Preference to a given type of light by one species may be different for another species. The type of fishing gear and behavior of squid can affect the desired lighting arrangement. The effective light intensity is about 2-3 KW per meter of the vessel length. Reaction of squid to colored light may be to brightness rather than color.
CALL LETTERS: QL430 .3 L8 I561
KEYWORDS: gear used-lights; behavior-schooling

87. Frey, H.W. 1971. California's living marine resources and their utilization. Calif. Dept. of Fish and Game, Sacramento. 148 pp.

This report is intended to be a comprehensive master inventory and preliminary master plan for utilization of all ocean fish resources from existing scientific information which includes the biology, history, statistics, and economics of the fisheries. Squid portion summaries the history of the fishery, status of biological knowledge, and status of population.
CALL LETTERS: QH95 .3 F7
KEYWORDS: LO; landings; processing; gear used

88. Fry, D.H. Jr. 1931. The ring net, half ring net, or purse lampara in the fisheries of California. Calif. Bur. Mar. Fish Bull., 27:1-67.

Gives a detailed account of ring nets as they were first being used in California. Gives account of the history, structure and types of boats used in the California fisheries. Operation and comparison with purse seine and lampara is discussed.
CALL LETTERS: SH11 C24
KEYWORDS: gear used-ring net, purse seine, lampara

89. Giese, A.C. 1969. A new approach to the biochemical composition of the mollusc body. Oceanogr. Mar. Biol. Ann. Rev., 7:175-229.

In the cephalopod portion, the body components (by % weight) of LOLIGO OPALESCENS is described. Data for males and females are separate because of the greater relative bulk of reproductive organs in the females. Muscular mass dominates the body, with the reproductive organs being the next most important component. Water levels in LOLIGO are highest in the mantle, gills, brain, and eyes. Ash levels of LOLIGO are relatively low, the highest being in the testis. Protein is the major organic constituent. Lipid levels are relative high, carbohydrates and glycogen levels are relatively low. Changes are seen comparing gravid and spent squid. In spent squid protein level decreases and lipid level increases. Total body mass of tissue decreases by as much as 50% in females and 30% in males.
CALL LETTERS: QC1 O375
KEYWORDS: LO; lengths; physiology-nutritional analysis

90. Gilpin-Brown, J.B. 1977. The squid and its giant nerve fibre. Symp. Zool. Soc. Lond., 38:233-241.

An explanation of the importance of the squid's giant nerve fibre to the squid, and to man. This report is a transcript of the commentary of a 16 mm film of the same title which was made for the Symposium. It gives a brief account of Professor J.Z. Young's investigations of the giant nerve fibres of squid in the 1930s and describes some of the techniques that other scientists have developed for subsequent studies of nerve fibres.
CALL LETTERS: QL1 Z712
KEYWORDS: physiology-nerves

91. Gosline, J.M., J.D. Steeves, A.D. Harman, and M.E. Demont. 1983. Patterns of circular and radial mantle muscle activity in respiration and jetting of the squid LOLIGO OPALESCENS. J. Exp. Biol., 104:97-110.

The authors were able to distinguish the pattern of radial muscle activity from circular muscle activity, and in so doing were able to determine the functional role of these muscle groups in motor behaviors. Three distinguishable phases of activity appear during escape jets: (I), hyper-inflation brought about by the contraction of the radial muscles; (II), the jet powered by the contraction of circular muscles; and (III), refilling powered largely by the elastic recoil of the mantle wall. Two distinctly different patterns of muscular activity were seen in respiratory movements. One pattern (pattern I) is powered by the radial muscles alone, while the other (pattern II) is powered by the circular muscles alone.
CALL LETTERS: QH501 J6
KEYWORDS: LO; physiology-biochemical analyis; behavior-swimming

92. Grieb, T.M. and R.D. Beeman. 1978. A study of spermatogenesis in the spawning population of the squid. LOLIGO OPALESCENS. Calif. Dept. Fish Game, Fish Bull., 169:11-21.

Describes the maturation process in a spawning population and provides information concerning spermatogenesis at the election microscopic level in the market squid. Data indicate that males spawn only once and die soon afterward and that there is no possibility that some males mature precociously, survive the initial spawn, and spawn again the following spawning period or year.
CALL LETTERS: SH11 C24
KEYWORDS: LO; physiology-gonad maturation;

93. Griswold, C.A. and Jerome Prezioso. 1981. IN SITU observations on reproductive behavior of the long-finned squid, LOLIGO PEALEI. U.S. NMFS Fish. Bull., 78(4):945-947.

The authors observed a large squid egg mass in 6 m of water attached to one side of a small boulder. The surrounding area was a sandy/mud bottom. Squid moved toward the egg mass in a semicircle about 2.5-3.0 m from the mass approximately 1 m off the bottom. The squid were in well-defined pairs with the smaller females parallel to and on the left of each male. They did not observe color changes during the observation period. All of the animals appeared to be in good condition. One pair of squid at a time approached the egg mass with their arms held forward and tentacles extended. The female and male intertwined arms as they extended them into the egg mass. They surmised that the female was depositing an egg capsule and that the male was exhibiting parental care or "grooming" behavior. Each pair stayed 2-4 seconds then moved backward into the same position it had previously occupied in the semicircle. At that time another pair moved forward. There did not appear to be any order in which pairs approached the egg mass; however, no more than one pair approached at any given time. The same pair approached more than once. Their observations of L. PEALEI indicate a social structure which is well defined and different from that described for other species.
CALL LETTERS: SH11 A13
KEYWORDS: other species; behavior-spawning

94. Gutworth, M.S., B.L. Tinker, and R.J. Leason. 1982. Textural evaluation of squid (ILLEX ILLECEBROSUS) as affected by cook time: sensory and instrumental analysis. pp. 223-233. In: Proceedings of the International squid symposium. August 9-12, 1981. Boston, Massachusetts. New England Fisheries Development Foundation, Inc. 390 pp.

Study determined how the texture of I. ILLECEBROSUS changes as a function of cook time. Results show that the method of cooking squid has a marked effect on the texture of the flesh. The sensory results support the theory that squid should be cooked either very quickly for 2-3 minutes or simmered for periods greater than 16 minutes for optimum textural properties.
CALL LETTERS: QL430 .3 L8 I561
KEYWORDS: physiology-biochemical analysis

95. Haard, N.F. 1982. Utilization of squid in Canada. pp. 235-243. In: Proceedings of the International squid symposium. August 9-12, 1981. Boston, Massachusetts. New England Fisheries Development Foundation, Inc. 390 pp.

ILLEX ILLECEBROSUS is harvested off the coasts of Nova Scotia and Newfoundland. It is primarily sold to foreign markets, although some is used domestically as bait. Frozen squid has been exported since 1950 and recently sales have increased. Production and export of dried squid has increased in recent years.
CALL LETTERS: QL430 .3 L8 I561
KEYWORDS: processing-dried, freezing; markets; fishery-N. Atlantic

96. Hamabe, M., T. Kawakami, Y. Watabe, T. Okutani. and K. Ikeda. 1975. Review of cephalopod resources and their exploitation by Japan. FAO Fish. Rept. 170, Suppl 1:1-3.

The species of world cephalopods presently exploited are mostly large-sized cuttlefish and squids in the families SEPIIDAE, LOLIGINIDAE, and OMMASTREPHIDAE and a few octopods. The common Japanese squid, TODARODES PACIFICUS, yields the largest catch, chiefly by jigging, of 300 - 700,000 tons annualy. It is estimated that a yield of 500,000 tons a year could be obtained from each species of ommastrephids through modern fishing practices. A brief summary of ecology, biology, and fishery of some species is given.
CALL LETTERS: SH1 F543
KEYWORDS: other species; landings; gear used; migration

97. Hamuro, C. 1975. Concept and design of the 99 GT squid jigging vessel. FAO Fish. Rept. 170, Suppl 1:103-106.

The 99 GT squid jigging vessel was developed to decrease the labor necessary in the fishery. Automated jigging machines, with the possibility of remote control, are used and squid are moved on conveyer belts. The new vessel requires less than half the number of crew as the traditional vessels. General layout and specifications of the vessel are given.
CALL LETTERS: SH1 I543
KEYWORDS: gear used-vessel; gear development

98. Hanlon, R.T. and R.F. Hixon. 1983. Laboratory maintenance and culture of octopuses and loliginid squid. pp. 44-61. In: Berg, C. J. Jr (ed.). Culture of Marine Invertebrates: selected readings. Hutchinson Ross Publishing Co. Stroudsberg, Penn. 386 pp.

Cephalopods are used by the scientific community as research models in a wide variety of applications. Developments over the past 15 years in aquarium design and the successful maintenance and rearing of a few cephalopod species indicate that future potential is high for

mariculture of selected cephalopod species. In rearing experiments, the best results have been achieved with littoral cephalopods, especially bottom dwellers. Less success has occurred with pelagic species. Bibliography of closed seawater system rearing or maintenance of cephalopods is given. Rearing methodology for OCTOPUS JOUBINI and loliginid squids is outlined. Major problems in culturing LOLIGO from eggs to adult are associated with providing the right size and type of food at the right time.
CALL LETTERS: QL362 .8 C84
KEYWORDS: LO; other species; artifical rearing; diet-artificial

99. Hanlon, R.T., R.F. Hixon, and W.H. Hulet. 1978. Laboratory maintenance of wild-caught loliginid squids. pp. 20.1-20.13. In: Proceedings of the workshop on the squid, ILLEX ILLECEBROSUS. Dalhousie Univ., Halifax, Nova Scotia, May, 1978, and a bibliography on the genus ILLEX. Fish. Mar. Serv. Tech. Rep., No. 833. 311 pp.

Adult (wild-caught) loliginid squid were kept in onshore closed-system seawater tanks for several weeks, and in isolated experiments individual squids remained healthy for as long as four months. It should be pointed out that success in keeping large squids in onshore aquaria was directly related to capturing undamaged animals. Prevention of skin abrasion during capture, transport aboard ship, and transfer to the laboratory is mandatory for long-term survival.
CALL LETTERS: SH223 A88
KEYWORDS: other species; artifical rearing; growth; diet-artifical

100. Hanlon, R.T., R.F. Hixon, and W.H. Hulet. 1983. Survival, growth, and behavior of the loliginid squids LOLIGO PLEI, LOLIGO PEALEI, and LOLLIGUNCULA BREVIS (Mollusca: Cephalopoda) in closed sea water systems. Biol. Bull., 165:637-685.

Squids were captured by night lighting, trawling, or seining in the northern Gulf of Mexico for laboratory maintenance. Two types of recirculating sea water systems were designed and evaluated: a 2 m circular tank and a 10 m long raceway. Mean laboratory survival was: LOLIGO PLEI to (12 to 252 mm mantle length, ML) 11 days, maximum 84 days; LOLIGO PEALEI (109 to 285 mm ML) 28 days, maximum 71 days; LOLLIGUNCULA BREVIS (27 to 99 mm ML) 19 days, maximum 125 days. Smaller squids showed significantly poorer survival than larger ones. All squids fed well on a variety of live estuarine fishes and shrimps. Growth rates depended upon stage of maturity. The highest rates were LOLIGO PLEI 59 mm/month (23.8 g/mo), LOLIGO PEALEI 77 mm/mo (67.3 g/mo), and LOLLIGUNCULA BREVIS 31 mm/mo (17.2 g/mo). Key factors for laboratory survival were (1) prevention of skin damage, (2) tank systems with sufficiently large horizontal dimensions, (3) high quality

water, (4) ample food supply, (5) no crowding, (6) maintaining squids of similar size to reduce aggression and cannibalism, and (7) segregating sexes to reduce aggression associated with courtship, mating, and egg laying.
CALL LETTERS: QH301 B56
KEYWORDS: other species; artifical rearing; growth; length; diet-artifical

101. Hanlon, R.T., R.F. Hixon, W.H. Hulet, and W.T. Yang. 1979. Rearing experiments on the California market squid LOLIGO OPALESCENS Berry, 1911. Veliger, 21(4):428-431.

Attempts were made in the laboratory to rear squid hatchlings from eggs. Hatchlings were reared up to 79 days at 16 degrees C. Live copepods were the primary diet. Initial high mortality was partially due to the inability of the squid hatchlings to catch copepods: Successful hatchlings learned to attack the copepods from behind to avoid their antennae. Fin abrasion was the principal cause of mortality. Growth rates were highly variable, ranging from 1.1-5.6 mm mantle length per month; maximal mantle length attained was 17.3 mm. LOLIGO may be reared to adults in laboratory aquaria.
CALL LETTERS: QL1 V4
KEYWORDS: LO; artifical rearing; growth; diet-artifical;

102. Hardwick, J.E. and J.D. Spratt. 1979. Indices of the availability of market squid, LOLIGO OPALESCENS, to the Monterey Bay fishery. CalCOFI Rep., 20:35-39.

The availability of market squid to the Monterey lampara fleet has fluctuated grossly in the past two decades, causing considerable economic hardship in recent years. The poor availability of squid at Monterey during 1952, 1958, 1960-61, 1966, 1970, and 1973 and 1975 was the primary reason for poor catches those years. Catches were also low in 1950, 1953, and 1962, but this was apparently due to lack of demand. High fourth-quarter sea levels and a strong Davidson Current appear to be one set of factors often associated with poor availability of squid to the Monterey fishery the following summer.
CALL LETTERS: SH351 S2 C22
KEYWORDS: LO; fishery-Monterey Bay; landings; markets; abundance

103. Hartzell, D. 1983. Automation in the squid processing industry. pp. 113-121. In: Proceedings of the west coast squid symposium. February 1-2, 1983. Newport, Oregon. Oregon State Univ. Sea Grant Marine Advisory Program. 149 pp.

This article provides a description of the operation of an automatic squid cleaning machine developed by the Squid Machine Corp., Santa Cruz, CA.
CALL LETTERS: SH374 .52 U6 W41
KEYWORDS: processing-automated

104. Hedgepeth, J.B. 1983. Annotated references to techniques capable of assessing the roles of cephalopods in the eastern tropical Pacific Ocean, with emphasis on pelagic squids. NOAA Tech. Memo. NMFS, No. 39. 74 pp.

This annotated bibliography presents a list of publications relevant to pelagic cephalopod assessment, especially the assessment of epipelagic squids, in the eastern tropical Pacific Ocean (ETP). Two criteria were used for selection of articles. Articles concerning cephalopods were of primary interest, articles have been selected from worldwide sources. The second criterion was presentation of assessment techniques applicable to ETP cephalopods. Selection was not confined to methods which have been used solely within the ETP. A summary of the article and a list of key words for each reference was compiled. A wide variety of subjects were considered to be relevant to the topic of assessment. Some pertinent subjects were capture gear and techniques, stock differentiation, trophic dynamics, identification of species, population modelling, growth and reproduction, distribution, and other censusing methods. The references were entered into a microcomputer disk storage. There are about 500 keywords which reference approximately 200 entries.
CALL LETTERS: SH11 A5415
KEYWORDS: other species; bibliography; stock assessment

105. Herring, P.J. 1977. Luminescence in cephalopods and fish. Symp. zool. Soc. Lond., 38:127-159.

Bioluminescence in cephalopods is probably restricted to the Teuthoidea, the Sepioidea and Vampyromorpha. The majority of the genera within these orders are known to include luminous species. Luminiscence may be produced either by intrinsic chemical systems or by symbiotic luminous bacteria in special organs. Light organs are found in a variety of anatomical positions and range from simple patches of photogenic tissue to highly elaborate organs with many accessory optical structures. The organization and disposition of cephalopod light organs is described and compared with that of the light organs of fishes. Though there are many similarities between the two groups there are also significant differences, particularly in the reflector systems. The chemistry of cephalopod luminescence, though poorly

known, appears to be closely allied to that of many other marine organisms, and, with a few possible exceptions, luminescence is under nervous control. Light organs of different structural types within a single species may operate either independently or in concert. Possible functions considered include ventral camouflage, distraction, disruptive illumination and communication.
CALL LETTERS: QL1 Z712
KEYWORDS: LO; other species; physiology-photophores

106. Hirtle, R.W.M. 1978. Observations on feeding and grooming behaviours of captive squid, ILLEX ILLECEBROSUS (Lesueur, 1821). pp. 13.1-13.5. in: Proceedings of the workshop on the squid, ILLEX ILLECEBROSUS, Dalhousie Univ., Halifax, Nova Scotia, May, 1978, and a bibliography on the genus ILLEX. Can. Fish. Mar. Serv. Tech. Rep., No. 833. 311 pp.

This paper describes feeding and other behaviors observed in the squid ILLEX ILLECEBROSUS. I. ILLECEBROSUS employs speed, color change, and tentacular manipulation of free-swimming prey to effect capture.
CALL LETTERS: SH223 A88
KEYWORDS: other species; behavior-feeding, grooming; diet-artifical

107. Hixon, R.F. 1980. Potential commercial squid resources of the Gulf of Mexico -- an updated review. pp. 54-73. in: Flandorfer, M. and L. Skupien (eds.). Proceedings of a workshop for potential fisheries resources of the northern Gulf of Mexico. Louisiana State Univ. Sea Grant Program.

Six species of squid that occur in the Gulf of Mexico have been suggested to have commercial potential. The description, distribution, size, life history, migrations, and existing fishery is reviewed for each species. At the present time squids contribute only a small fraction of the total landings from the northern Gulf of Mexico. The size of possible stocks of each species are unknown at the present time. Recommendations for development and expansion of the Gulf squid fishery are given.
CALL LETTERS: (NA)
KEYWORDS: other species; description; distribution; migration; length; gear used

108. Hixon, R.F. 1983. LOLIGO OPALESCENS. Chapter 17. pp. 95-114. In: Boyle, P.R. (ed.). Cephalopod life cycles. Volume I. Species accounts. Academic Press, London. 475 pp.

Comprehensive account of cephalopod biology and description of life history by species. Chapter on LOLIGO OPALESCENS includes discussion on egg and juvenile stages, growth, maturation, reproduction, mortality, and ecology.
CALL LETTERS: QL430 .2 C461
KEYWORDS: LO; distribution; growth; behavior-spawning; physiology-gonad maturation; predators; diet; abundance

109. Hixon, R.F., R.T. Hanlon, S.M. Gillespie, and W.L. Griffin. 1980. Squid fishery in Texas: biological, economic, and market considerations. Mar. Fish. Rev., 42(7-8):44-50.

Presently no major squid fishery exists in the Gulf of Mexico. The constraints that hinder the development of the fishery were examined, using Texas as a model. Several biological, economic, and marketing problems were identified that indicate a squid fishery is not viable in Texas at this time, although future potential for one exists. Reliable biological estimates of population size must first be made. Fishing methods conducive to capturing the fast-moving schooling squid must be employed for optimal catches. Increased demand needs to be established so fishermen and processors will be able to receive higher prices. In the domestic market obstacles exist in terms of product name, texture, and marketable forms.
CALL LETTERS: SH11 A14
KEYWORDS: other species; landings; gear used; markets; values; fishery-SE US; distribution

110. Hixon, R.F., R.T. Hanlon, and W.H. Hulet. 1981. Growth and maximal size of the long-finned squid LOLIGO PEALEI in the northwestern Gulf of Mexico. J. Shellfish Research, 1(2):181-185.

Growth of LOLIGO PEALEI in the northwestern Gulf of Mexico is estimated using length-frequency analyses of seasonal samples obtained via trawling and jigging or dipnetting of specimens attracted to lights at night. Maximal size and age are estimated. Growth of males of L. PEALEI ranged from 6.5 to 24.5 mm per month, while female growth ranged from 8.6 to 14.2 mm per month. Maximal sizes (mantle length) of males and females were 285 mm and 207 mm, respectively, suggesting a somewhat shorter life span than the 14 to 24 months found in more temperate-water populations.
CALL LETTERS: SH370 A1 J61
KEYWORDS: other species; growth; length; age

111. Hixon, R.F., M.J. Solis Ramirez, and M. Villoch. 1980. Aspects of morphometrics and reproduction of the squid OMMASTREPHES PTEROPUS, Steenstrup 1885 in the western Gulf of Mexico. Bull. Amer. Malaco. Union, Inc., 1980:54-60.

Orange-back squids were obtained during nine seasonal cruises. Squids were attracted with night lights and captured with dip nets, hand-held squid jigs or automatic squid jig machines. OMMASTREPHES PTEROPUS was observed and collected in all seasons, with the largest catches recorded in June. Largest catches occurred during the new moon. Females were significantly larger than males, (a mean of 21.6 cm mantle length vs a mean of 15.4 cm mantle length) but females were significantly outnumbered by males in the catch, (36.1 percent vs 63.9 percent). Sexually mature males and females were collected in winter, spring and summer, spawning therefore may take place year-round in the Gulf of Mexico. Two mature females contained approximately 52,600 and 186,500 mature ova when captured. The gut contents (1) showed that crustaceans, fishes and squids were preyed upon, and (2) suggested that food habits change with increasing size of squid.
CALL LETTERS: (NA)
KEYWORDS: other species; gear used-lights, jigs, nets; length; sex ratio; fecundity; diet

112. Hobson, E.S. 1965. Spawning in the Pacific coast squid LOLIGO OPALESCENS. Underwater Naturalist, 3:20-21.

L. OPALESCENS spawns at various times of the year in California costal waters over sandy bottom at a depth of approximately 30 feet. The male uses his left ventral arm to transfer spermatophores from his siphon to the mantle cavity of the female. Following copulation, the female deposits her eggs on sandy bottom. The eggs are encased in elongated gelatinous capsules. They are usally deposited about the periphery of egg masses previously deposited by other squids. Upon completing the reproductive activity, both male and female squids die.
CALL LETTERS: (NA)
KEYWORDS: LO; behavior-spawning

113. Hochberg. F.G. Jr. and W.G. Fields. 1980. Cephalopoda: The squids and octopuses. Chapter 17. pp. 429-444. In: Morris, R.H., D.P. Abbott, and E.C. Haderlie. Intertidal Invertebrates of California. Stanford Univ. Press, Stanford. 690 pp.

Description, habitat, distribution, illustrations, photographs, and natural history notes of cephalopods found in California waters.
CALL LETTERS: QL1376 .1 C3 16
KEYWORDS: description; length; habitat; diet; behavior; LO; west coast species

114. Hulet, W.H., M.R. Villoch, R.F. Hixon, and R.T. Hanlon. 1979. Fin damage in captured and reared squids. Lab. Anim. Sci., 29(4):528-533.

Fin damage was a major factor in the mortality of wild-caught squids kept in the laboratory. Infection of abraded fins by opportunistic bacterial pathogens impaired swimming and led to death. Serious skin abrasions were especially common in trawl-caught squids. Dipnets and jigs inflicted minimal trauma and were preferred for squid capture. Fin damage also occurred during transporation and during maintenance of squids in onshore tanks. A successful aquarium system with recycled sea water was used for squid maintenance. Hatchling, juvenile and adult loliginid squids remained healthy in closed-system aquaria for periods ranging from 1 to 16 weeks.
CALL LETTERS: (NA)
KEYWORDS: physiology-biochemical analysis; gear used; artifical rearing

115. Hurley, A.C. 1976. Feeding behavior, food consumption, growth, and respiration of squid LOLIGO OPALESCENS raised in the laboratory. U.S. NMFS Fish. Bull., 74:176-182.

The squid L. OPALESCENS was raised in the laboratory to a maximum age of 100 days on a diet of ARTEMIA nauplii and adults. Newly hatched squid (2.7 mm mantle length) readily attacked ARTEMIA nauplii (length 0.7 mm), ARTEMIA adults (length 5 mm), copepods (length 1 mm), and larval fish (length 4 mm). Feeding rates varied between 35-80% of squid body w/day. Growth rate was highly variable in different individuals, ranging from 0.5 to approximately 4.5 mm mantle length/mo. Respiration rates were obtained at 15 degrees C for squid of 3 different ages and at 10 degrees, 15 degrees and 20 degrees C for 1 day old squid.
CALL LETTERS: SH11 A13
KEYWORDS: LO; artifical rearing, growth; diet-artifical; length; physiology-respiration

116. Hurley, A.C. 1977. Mating behaviour of the squid LOLIGO OPALESCENS. Mar. Behav. Physiol., 4:195-203.

In the laboratory the squid L. OPALESCENS exhibits dominance behavior during spawning. A single dominant male keeps other male squid from coming near the egg mass he is guarding. Females are allowed to approach the egg mass. The dominant squid uses postural and color displays directed toward challenging males. Similar dominance behavior and displays have not been observed in natural spawns in the ocean.
CALL LETTERS: QL121 M4
KEYWORDS: LO; behavior-spawning

117. Hurley, A.C. 1978. School structure of the squid LOLIGO OPALESCENS. U.S. NMFS Fish. Bull., 76(2):433-442.

The squid L. OPALESCENS forms schools which are similar in many respects to those of obligate schooling fishes. These schools are marked by parallel orientation of individuals and strong cohesiveness. Laboratory experiments indicate that the main sensory modality regulating schooling is vision. Squid on opposite sides of a clear rigid Plexiglas barrier readily schooled. The structure of schools of 6 squid depended on size of individuals and was modified by environmental disturbance. Parallel orientation was weaker in schools of smaller squid (about 7 cm dorsal mantle length) than it was in larger ones (about 12 cm). In the field, L. OPALESCENS schools are composed of uniformly-sized individuals. Laboratory experiments designed to determine whether this was due to actual size selection were inconclusive, but they did suggest mechanisms which might be important in determining squid position in the school.
CALL LETTERS: SH11 A13
KEYWORDS: LO; behavior-schooling; vision

118. Hurley, G.V. 1980. Recent developments in the squid, ILLEX ILLECEBROSUS, fishery of Newfoundland, Canada. Mar. Fish. Rev., 42(7-8):15-22.

Developments in the squid fishery in Newfoundland over the past few years have included noteworthy changes in the management, harvesting, processing, and marketing of squid. The implications of international involvement in the squid fishery and Canada's increased offshore fisheries jurisdiction are discussed. General biology and distribution around Newfoundland are reviewed. Occassionally, mass strandings have occurred on Newfoundland beaches possibly caused by entrapment in unfavorable environmental conditions. By late in the fall, females have grown to a larger size than males. It has been suggested that wind direction and water turbidity may have been an important factor in influencing inshore catch rates. There were higher catch rates when wind caused higher water turbidity.
CALL LETTERS: SH11 A14
KEYWORDS: fishery-N. Atlantic; markets; processing; gear used; other species; landings

119. Hurley, G.V. and R.K. Mohn. 1978. Considerations on the management of the international squid (ILLEX) fishery in ICNAF subarea 4. pp. 7.1-7.14. In: Proceedings of the workshop on the squid, ILLEX ILLECEBROSUS, Dalhousie Univ., Halifax, Nova Scotia, May, 1978, and a bibliography on the genus ILLEX. Can. Fish. Mar. Serv. Tech. Rep., No. 833. 311 pp.

A yield per recruit model for the ILLEX fishery in ICNAF subarea 4 was developed based on catch statistics from the 1977 international fishery. An optimal fishing rate for 1978 was derived using this model.
CALL LETTERS: SH223 A88
KEYWORDS: other species; modelling; growth; mortality

120. Hurley, G.V. and D.E. Waldron. 1978. 1977 population estimates for squid (ILLEX ILLECEBROSUS) in ICNAF subarea 4 from the international fishery in 1977. pp. 6.1-6.10. In: Proceedings of the workshop on the squid, ILLEX ILLECEBROSUS, Dalhousie Univ., Halifax, Nova Scotia, May, 1978, and a bibliography on the genus ILLEX. Can. Fish. Mar. Serv. Tech. Rep., No. 833. 311 pp.

This paper is a summary of the population estimates of squid in ICNAF subarea 4 using models which have been tried in other areas. Where thought advisable, the models were modified to suit specified situations. The models reviewed are areal expansion, DeLury method, and cohort analysis.
CALL LETTERS: SH223 A88
KEYWORDS: other species; modelling

121. Iverson, L.K. and L. Pinkas. 1971. A pictorial guide to beaks of certain eastern Pacific cephalopods. Calif. Dept. Fish Game, Fish Bull., 152:83-105.

Drawings of beaks collected from 20 species of eastern North Pacific squid were made for use in the identification of stomach contents of marine predators. Beaks were used because they can be seen with the unaided eye, resist digestion, and are frequently the sole item in an otherwise empty stomach.
CALL LETTERS: SH11 C24
KEYWORDS: LO; beaks; west coast species

122. Jarman, N.E. 1982. Development of a world resource (squid): The New Zealand experience. pp. 7-19. in: Proceedings of the international squid symposium. August 9-12, 1981. Boston, Massachusetts. New England Fisheries Development Foundation, Inc. 390 pp.

New Zealand possesses an underutilized squid resource which, until recently, has only benefited foreign fishermen, mainly Japanese jigging boats. Other fisheries during the same seasons and markets dampen further development of the squid fishery.
CALL LETTERS: QL430 .3 L8 I561
KEYWORDS: fishery-Australia; markets; gear used

123. Jefferts, K. 1983. Squid distribution, biology, and life history. pp. 3-10. in: Proceedings of the west coast squid symposium. February 1-2, 1983. Newport, Oregon. Oregon State Univ. Sea Grant Marine Advisory Program. 149 pp.

LOLIGO OPALESCENS is endemic to the California current system and British Columbia. It moves inshore to spawn in waters of 5-40 m on sand or mud bottom. Spawning animals show sexual dimorphism. Adults die after spawning. Few things eat egg capsules. Squid are sexually mature at about 100 mm. They do most feeding during day time.
CALL LETTERS: SH374 .52 U6 W41
KEYWORDS: LO; description; habitat; behavior-spawning, feeding; predators; diet

124. Jefferts, K. 1983. Zoogeography and systematics of cephalopods of the northeastern Pacific Ocean. Ph.D. Thesis, Oregon State University, Corvallis. 291 pp.

Collections of cephalopods from the northeastern Pacific were examined in order to elucidate zoogeographic patterns for the region. Sixty-four species were identified, including two new species of GONATUS. Ten pelagic distributional types are defined for cephalopods in this area. The relative abundance of cephalopods in the major water mass types is considered, using diversity and evenness statistics. Possible mechanisms for population maintenance are discussed, and consideration is given to speciation processes relative to the observed distributions.
CALL LETTERS: (NA)
KEYWORDS: west coast species; description; abundance; distribution

125. Jefferts, K., J. Burczynski, and W.G. Pearcy. 1984. Acoustical assessment of squid (LOLIGO OPALESCENS) off the central Oregon coast. College of Oceanography, Oregon State University, Corvallis, OR and BioSonics, Inc, Seattle, WA. unpublished manuscript. 28 pp.

This survey demonstrated that the 120 kHz acoustic system consisting of a dual-beam echo sounder and an echo integrator can provide useful information on target strength, distribution, and abundance of L. OPALESCENS. Prior to this study, no IN SITU measurements of the target strength of squid had been reported. The average target strength of squid measured while the vessel was drifting was -58.6 dB and while the vessel was cruising was -58.7 dB. The target strength value for an individual squid was much lower than for a fish of similar size due to the lack of a gas-filled swim bladder in the squid. Characteristics of squid schools such as abundance, size, and depth distribution were discussed.
CALL LETTERS: (NA)
KEYWORDS: LO; acoustics; behavior-schooling

126. Juanico, M. 1980. Developments in South American squid fisheries. Mar. Fish. Rev., 42(7-8):10-14.

At the present, squid are not a significant component of the South American fisheries. There are no resource evaluations or well based estimates of squids near the continent, and only some indirect and isolated data are available. Fish products in general have never been a very big part of the diet of the people in South America. Therefore, most of the catches are exported. Landings, distribution, gear used and markets are discussed.
CALL LETTERS: SH11 A14
KEYWORDS: west coast species; other species; landings; gear used; processing; markets; fishery-S. America; distribution

127. Juanico, M. 1982. Squid spatial patterns in a two species mixed fishery off southern Brazil. pp. 69-79. in: Proceedings of the International squid symposium. August 9-12, 1981. Boston, Massachusetts. New England Fisheries Development Foundation, Inc. 390 pp.

Catches of two very similar LOLIGINID species (L. BRAZILIENSIS and L. PLEII) from trawl hauls off southern Brazil were analyzed. Both species were caught together in most of the hauls with catches, batches of one species were always caught with only few specimens of the other.
CALL LETTERS: QL430 .3 L8 I561
KEYWORDS: other species; distribution; catch composition

128. Juanico, M. 1982. South American squid fisheries: Some new aspects. pp. 245-264. In: Proceedings of the international squid symposium. August 9-12, 1981. Boston, Massachusetts. New England Fisheries Development Foundation, Inc. 390 pp.

The Argentinian - Uruguaian fisheries on ILLEX ARGENTINUS are analyzed. Distribution and biomass, structure and evolution of the industry, squid handling and processing, and marketing are discussed.
CALL LETTERS: QL430 .3 L8 I561
KEYWORDS: fishery-S. America; landings; markets; processing; distribution; abundance; other species

129. Juanico, M. 1983. Squid maturity scales for population analysis. FAO Fish. Tech. Pap., 231:341-378.

This paper is an exhaustive review of the present stage of our knowledge of squid maturity scales, oriented to serve as a guide for population analysis. Twenty-three tables present the different male and female scales now in use and their equivalences. The review also includes a glossary, and describes aspects of the anatomy of the reproductive system, gametogenesis, gonadal development, maturation process, mating, fertilization, spawning and life cycles. Subjects on which there is inadequate information, discussion points and practical problems are pointed out.
CALL LETTERS: SH1 F539
KEYWORDS: physiology-gonad maturation; anatomy

130. Kajimura, H., C.H. Fiscus, and R. Stroud. 1980. Food of the Pacific white-sided dolphin, LAGENORHYNCHUS OBLIQUIDENS, Dall's propoise, PHOCOENOIDES DALLI, and northern fur seal, CALLORHINUS URSINUS, off California and Washington with appendices on size and food of Dall's propoise from Alaskan waters. NOAA Tech. Memor., NMFS F/NWC-2:1-30.

The Pacific white-sided dolphin and the Dall's porpoise feed primarily on small schooling fishes and cephalopods. They, like the northern fur seal, are opportunistic feeders, preying on available species, including some that are commercially important such as salmon, anchovy, jack mackerel, and the squid, LOLIGO OPALESCENS. Stomach content analysis indicates that most feeding is done at night or in the morning. Northern fur seals tend to congregate in areas of abundant food supply and usually feed at night. Food species consumed by the seal vary by area, but the important food in the diet of this mammal in a given area generally does not change. The animals collected on the continental shelf appear to feed on fishes, whereas those taken beyond the shelf feed primarily on squids.
CALL LETTERS: SH11 A5414
KEYWORDS: LO; west coast species; predators-marine mammals

131. Karpov, K.A. and G.M. Cailliet. 1978. Feeding dynamics of LOLIGO OPALESCENS. Calif. Dept. Fish Game, Fish Bull., 169:45-65.

Prey were identified from samples of LOLIGO OPALESCENS taken from a variety of sources in Monterey Bay and its surrounding areas. In general, squid fed mostly on crustacea (mostly euphausiids and copepods) and to a lesser degree on fish, cephalopods, gastropods, and polychaetes. Comparison of prey from large versus small squid revealed few major differences. Some fragments of L. OPALESCENS were found and were most often identifiable as tentacle tips. Comparison of prey by depth revealed major differences. Squid taken near the surface fed less on euphausiids (still predominate) and more on fish, cephalopods, mysids, and megalops larvae. On the spawning grounds a different composition of crustaceans were found with megalops larvae replacing euphausiids. Little difference was found between males and females on spawning grounds. Squid feeding was found to be most pronounced during daylight hours and least during night hours. Squid also fed less on cloud covered days.
CALL LETTERS: SH11 C24
KEYWORDS: LO; diet; behavior-feeding

132. Karpov, K.A. and G.M. Cailliet. 1979. Prey composition of the market squid, LOLIGO OPALESCENS Berry, in relation to depth and location of capture, size of squid, and sex of spawning squid. CalCOFI Rep., 20:51-57.

Squid feeding was investigated for Monterey Bay and adjacent areas. Squid were found to feed mostly on crustacea and to a much lesser degree on fish, cephalopods, gastropods, and polychaetes. Animals from deeper offshore waters fed more on euphausiids and copepods. Inshore, off the spawning ground, euphausiid feeding still dominated, although to a lesser degree. Mysids, megalops larvae, cephalopods, and fish were more important in these waters. On the spawning ground, feeding habits changed a great deal. Here crustacean feeding still dominated, although euphausiids were lacking from the diet. Demersal feeding became most important. Little difference in prey composition was found between sexes on the spawning grounds. A comparison of large and small squid from non-spawning ground areas revealed little difference in prey composition.
CALL LETTERS: SH351 S2 C22
KEYWORDS: LO; diet; behavior-feeding

133. Kasahara, S. 1978. Descriptions of offshore squid angling in the Sea of Japan, with special reference to the distribution of common squid (TODARODES PACIFICUS Steenstrup): and on the techniques for forecasting fishing conditions. Bull. Jap. Sea. Reg. Fish. Res. Lab., No. 29:179-199.

Since 1967, when fishing activities became regular, the number of vessels and the catch have been increasing two-fold each year. In recent years, around three thousand vessels were engaged in this fishery and the catch amounted to two hundred thousand tons. At the first stage of development, fishing grounds for squid were limited mainly to the middle part of the Japan Sea. As the fishery developed, the fishing grounds extended every year, chasing seasonal distribution and migration of the squid all over the Japan Sea until 1971, when no more unexploited fishing grounds for this fishery remained. These common squid caught in offshore areas consist mainly of fall-born squid. There is no indication which positively shows aggravation of reproduction caused by fishing. However, undue competition caused by the concentration of fishing vessels, decline of inshore catch caused by the interception of offshore fishing, and leveling-off the total annual catch are remarkable features in this fishery in recent years. Since this fishery has already passed the stage of development, the most important object is to use the stock rationally and efficiently, and to put this fishery under steady conditions. The history and present situation of the offshore squid fishery, seasonal distribution, migration, fishing ground formation of the fall-born squid stock (which is the main fishing stock), and the fishery forecasting activities are introduced. Forecasting consists mainly of experimental fishing and oceanographic surveys twice a year.
CALL LETTERS: SH301 N52
KEYWORDS: fishery-Japan; distribution; migration; fishing areas; stock assessment

134. Kasahara, S. and T. Nasumi. 1975. Present state and future aspects of the fishery for the common squid TODARODES PACIFICUS (Streenstrup) in the Sea of Japan. FAO Fish. Rept. 170, Suppl. 1:30-46.

History of offshore fishing is summarized. Although there is no clear indication of overfishing yet, both vessel competition and the decline of inshore catches have led to a leveling off of the total annual catch. Distribution, migration, fishing grounds and season of the autumn subpopulation are reviewed. It is apparent that both distribution and migration are related to patterns of oceanographical conditions. Fishery forecasts are made from data collected by research vessels twice a year.
CALL LETTERS: SH1 F543
KEYWORDS: other species; landings; distribution; temperature; stock assessment

135. Kasahara, S., T. Nazumi, T. Shimizu, and M. Hamabe. 1978. Contributions of biological information useful for development of inshore squid fishery in the Japan Sea. Part 2. A note on reproduction and distribution of BERRYTEUTHIS MAGISTER assumed from biological observations on trawl catches in the waters around the Oki Islands Japan Sea. Bull. Jap. Sea Reg. Fish Res. Lab., 29:159-178.

Biological observations and measurements were made on 219 specimens of BERRYTEUTHIS MAGISTER (Berry) trawled from the fishing area in the western part of the Japan Sea. Sketches were taken on external and internal morphology. Judging from development of gonads, the specimens under study were assumed to be in propagative phase. Females predominated in all three catches. Among 208 females, some specimens carried fully mature ova measuring 1.5-2.0 mm in diameter. Among 11 males, 10 carried pale purplish spermatophores in a fully matured condition in their penis. No female had any trace of copulation or implanted spermbulbs in any part of the body. In many other cephalopod species present, spermbulbs remained attached to some parts of the female's body. It was considered that some opaque materials (other than parasites) in the mantle cavity might be spermbulbs implanted in the mantle wall, although they had never been confirmed at the preliminary investigations. No hectocotylization was observed in any male. B. MAGISTER (Berry) is one of the dominant animals among bathyal fauna in the Japan Sea. Results on observations on trawl catches revealed that the potentiality of this species as exploitable stock is high and it is very promising if processing techniques for this particular squid will be improved.
CALL LETTERS: SH301 N52
KEYWORDS: other species; physiology-gonad maturation; length

136. Kashiwada, J. and C.W. Recksiek. 1978. Possible morphological indicators of population structure in the market squid, LOLIGO OPALESCENS. Calif. Dept. Fish Game, Fish Bull., 169:99-111.

Investigates sources of morphological variation in LOLIGO OPALESCENS collected between Puget Sound and Baja California to determine whether there are geographic subpopulations and if so, which of the features could be distinguished in the field. Criteria for judging sexual maturity was established. Sexual dimorphism was found in length of arms of mature squid. Arms of males were longer than females. Little sexual dimorphism could be found in immature squid. Effects of spawning created differences between mature and immature animals. Mantle thickness and width became reduced in spent squid. The pattern of geographical variation in morphology is unclear. The measurments of tentacle sucker width suggests there may be three groups: Baja California, northern and central California, and Puget Sound.
CALL LETTERS: SH11 C24
KEYWORDS: LO; length; stock delineation; physiology-gonad maturation

137. Kashiwada, J., C.W. Recksiek, and K. Karpov. 1979. Beaks of the market squid, LOLIGO OPALESCENS, as tools for predator studies. CalCOFI Rep., 20:65-69.

This report investigated the relationship between body size and various beak dimensions to develop a technique for estimating body sizes by measurements of beaks of LOLIGO OPALESCENS taken from predator stomachs. Also investigated whether beak morphology could be used to detect the presence of subpopulations of L. OPALESCENS. The lower crest length and upper hood length dimensions were the most useful for estimation of the size of squid but these measurements involve structures which are fragile and easily damaged. The lower hood length and upper rostral width dimensions were found to be the most durable and therefore more valuable as tools for stomach analysis. Little evidence was found for variation in beak morphology with geographic location.
CALL LETTERS: SH351 S2 C22
KEYWORDS: LO; length; beaks; stock delineation

138. Kato, S. 1983. An overview of California squid fisheries and the California light fishery. pp. 23-27. In: Proceedings of the west coast squid symposium. February 1-2, 1983. Newport, Oregon. Oregon State Univ. Sea Grant Marine Advisory Program. 149 pp.

The fisheries of Monterey Bay and southern California are compared as to history, fishing methods, seasons, and price. Operation of a hydraulic squid pump is described.
CALL LETTERS: SH374 .52 U6 W41
KEYWORDS: LO; fishery-Monterey Bay, S. California; gear used; seasons; markets

139. Kato, S. and J.E. Hardwick. 1975. The California squid fishery. FAO Fish. Rept. 170, Suppl. 1:107-127.

Numerous species of squid are found in the California current system, but only the common market squid, LOLIGO OPALESCENS, is the object of a fishery. Market squid congregate in vast numbers in shallow water to spawn. It is not known whether or not all squid die after a single spawning season. Recent evidence suggests a longevity of about one to one and a half years. Sex ratio is essentially 1:1. Differential feeding patterns are found between spawning and nonspawning schools. Studies suggest the existance of more than one population of squid. In the southern California fishery, a power-assisted brail is the principal fishing gear. Some purse seines are used and a hydraulic centrifugal pump has been developed with some interest. All methods use lights to attratact squid to the boats. In the Monterey Bay fishery, lampara nets are used. Purse seines and lights are banned by law. Both fisheries use bioluminescence,

predators, and depth sounders to locate squid. A comparison of fishing methods is discussed. The annual catch off California could be increased; the chief constraint to growth of the fishery is market demand.
CALL LETTERS: SH1 F543
KEYWORDS: LO; growth; distribution; sex ratio; stock delineation; gear used

140. Kawaguchi, T. and T. Nazumi. 1972. Echo-traces of squid, OMMASTREPHES SLOANI PACIFICUS, in the central waters of Japan Sea. FAO Fish. Circ., 142:15-25.

The squids could be recorded through the day whether the boat was running or stationary. During the day time, squid were recorded as clumps or comet-shaped traces, but at night, they were very small, scattered dots 30-100 m deep. While the boat was fishing, squid traces were found in 0-60 m depth around the traces of fishing gear, and dense concentrations were recorded as patches. The optimum sounder characteristics were 75-200 kHz, narrow beams, and minimum pulse length.
CALL LETTERS: SH1 I537
KEYWORDS: acoustics

141. Kawahara, S. 1978. A brief description of the Japanese squid, TODARODES PACIFICUS Steenstrup. pp. 16.1-16.9. In: Proceedings of the workshop on the squid, ILLEX ILLECEBROSUS, Dalhousie Univ., Halifax, Nova Scotia, May, 1978, and a bibliography on the genus ILLEX. Can. Fish. Mar. Serv. Tech. Rep., No. 833. 311 pp.

This paper provides a brief description and the bibliography of Japanese squid, TODARODES PACIFICUS, allied to ILLEX, for a help to the future study of I. ILLECEBROSUS. Migratory patterns were estimated mainly by tagging experiments.
CALL LETTERS: SH223 A88
KEYWORDS: other species; distribution; migration; growth; behavior-spawning; tagging

142. Kimura, D.K. and N.A. Lemberg. 1981. Variability of line intercept density estimates (a simulation study of the variance of hydroacoustic biomass estimates). Can. J. Fish. Aquat. Sci. 38:1141-1152.

"Line intercept densities" are defined as estimates of mean density arrived at by sampling density along randomly selected transects. By simulating schools as circles the variance component due to schooling was calculated by numerical integration. Results indicate that the component of variability due to schooling is large; that it can be effectively reduced by increasing sampling density. Stratified methods of sampling were uniformly more efficient than random parallel sampling. Zig-zag sampling was more efficient than stratified parallel sampling at low sampling intensities.
CALL LETTERS: SH223 A52
KEYWORDS: acoustics

143. Klett, K. 1982. Jumbo squid fishery in the Gulf of California, Mexico. pp. 81-100. In: Proceedings of the International squid symposium. August 9-12, 1981. Boston, Massachusetts. New England Fisheries Development Foundation, Inc. 390 pp.

General distribution, migration patterns and relative abundance of DOSIDICUS GIGAS have been studied, showing particular seasonal changes throughout the area. Exploitation means are still primitive, but fishing vessels from other federal states are being attracted. Further development of the fishery is limited because of the lack of freezing and storage facilities, proper technology, and unstable local and international markets.
CALL LETTERS: QL430 .3 L8 I561
KEYWORDS: west coast species; distribution; migration; abundance; markets; gear used; fishery-Mexico

144. Klos, A. 1983. Squid handling and processing for export markets. pp. 87-96. In: Proceedings of the west coast squid symposium. February 1-2, 1983. Newport, Oregon. Oregon State Univ. Sea Grant Marine Advisory Program. 149 pp.

Discussion of east coast US squid processing techniques for foreign markets. One of the main factors which allows one to sell at a profit is product quality, which means proper handling. Problems with quality of squid can occur by using too much ice in storage, and trucking too much too far. Trap caught squid packed in barrels with sea water and ice are excellent products.
CALL LETTERS: SH374 .52 U6 W41
KEYWORDS: markets; processing; quality

145. Kluchnik, T.S. 1978. List of species and the distribution of oceanic squid larvae in the eastern Atlantic. Malacological Review, 11:132.

From samples collected by the expedition, larvae were found which belonged to 23 species of squids. The character of the quantitative distribution of the squid larvae depends on the peculiarities of the circulation of the water mass in the area investigated. Their greatest accumulations are confined to the regions of intensive upwelling. Relatively constant abiotic conditions stipulate year-round spawning. For some species, larvae of which were most abundant in the samples, the borders of the reproductive part of the area can be established. Almost all larvae found belonged to oceanic squids. In general, squids inhabit the upper 100 m layer of water.
CALL LETTERS: QL401 M177
KEYWORDS: other species; larvae; distribution

146. Knipe, J.H. and R.D. Beeman. 1978. Histological observations on oogenesis in LOLIGO OPALESCENS. Calif. Dept. Fish Game, Fish Bull., 169:23-33.

Provided oogenesis information at the election microscopic level in the market squid. No evidence could be found which would indicate the squid would spawn more than once.
CALL LETTERS: SH11 C24
KEYWORDS: LO; physiology-gonad maturation;

147. Koyama, T. 1975. Japanese trawling gear for octopus and squid. FAO Fish. Rept. 170, Suppl. 1:128-132.

So far, Japanese trawlers fish for octopus off west Africa and for squid in the northwest Atlantic. The Japanese prefer the six panel trawl nets which are considered to have better performance and prevent the catch from being damaged. The disadvantage of the six panel net is its complicated design requiring more skill and time for construction and repair. The trawl boards are of the common type used in Japanese bottom trawling. Diagrams of net designs and dimensions are illustrated.
CALL LETTERS: SH1 F543
KEYWORDS: gear used-trawl

148. Kristensen, T.K. 1980. Periodical growth rings in cephalopod statoliths. Dana, 1:39-51.

In this paper a direct age determination method for squid is introduced. Periodical growth rings in statoliths of the squid GONATUS FABRICII (Lichtenstein) are described. By comparison with the previously determined growth rate of juvenile specimens and a biomodal monthly size distribution, growth rings, called first-order bands, are for the first time shown to be daily whereas bands of second, and third

order are fortnightly and monthly, respectively. The relationship between the pen length and both statolith length and the number of growth rings are shown. Presence of organic material in statoliths and its significance for bandings are demonstrated. Periodical growth rings are also shown in statoliths of ROSSIA GLAUCOPIS (Loven) and ALLOTEUTHIS SUBULATA (Lamarck).
CALL LETTERS: SH75 D3
KEYWORDS: other species; age; growth; length

149. Kubodera, T. and K. Jefferts. 1984. Distribution and abundance of the early life stages of squid, primarily gonatidae (Cephalopoda, Oegopsida), in the northern North Pacific. Part 1. Bull. Natn. Sci. Mus., Tokyo, Ser. A, 10(3):93-106.

Cephalopods collected with micronekton nets in the Subarctic North Pacific are shown to be primarily young stages of the family Gonatidae. Regional and seasonal changes of abundance of cephalopods in the northern North Pacific are discussed. A pattern of low winter abundance with a rapid early summer increase and gradual autumn decrease is evident. Distribution patterns of species in the family gonatidae show good correlation with large scale oceanographic features. Species of the family gonatidae are classified into four groups according to the geographical pattern of relative abundance of the early life stages. One group shows high abundance in neritic waters, another in offshore waters, a third is intermediate, and larvae of the fourth group were rarely or never caught. The geographical area and timing of spawning or hatching are estimated for most gonatid species. A growth curve is derived for young individuals of GONATUS MADOKAI in the Sea of Okhotsk.
CALL LETTERS: (NA)
KEYWORDS: other species; distribution; abundance; seasons; growth

150. Kubodera, T. and K. Jefferts. 1984. Distribution and abundance of the early life stages of squid, primarily gonatidae (Cephalopoda, Oegopsida), in the northern North Pacific. Part 2. Bull. Natn. Sci. Mus., Tokyo, Ser. A, 10(4):165-193.

Continuation of results and discussion of part 1.
CALL LETTERS: (NA)
KEYWORDS: other species; distribution; abundance; seasons; growth

151. Kubodera, T., W.G. Pearcy, K. Murakami, T. Kobayashi, J. Nakata, and S. Mishima. 1983. Distribution and abundance of squids caught in surface gillnets in the subarctic Pacific, 1977-1981. Mem. Fac. Fish., Hokkaido Univ., 30(1/2):1-49.

This paper analyzes tha 1977-1981 surface gillnet catches of squids from both the eastern and western Subarctic Pacific. We compare data with previous information for this region and attempt to describe

the zoogeography and abundance of epipelagic squids from the entire Pacific. Topics discussed include species composition, fluctuations in the catch over time, distribution and abundance, relationship between vertical distribution of temperature and salinity and abundance of squid, and size and maturity.
CALL LETTERS: (NA)
KEYWORDS: other species; abundance; distribution-vertical; temperature; salinity; gear used-gill net

152. Laevastu. T. and C. Fiscus. 1978. Review of cephalopod resources in the eastern North Pacific. NW Alaska Fish. Cntr., Proc. Rept. 15 pp.

Cephalopods used by man are reviewed with brief notes on their ecology. Cephalopods are a delicacy in south European countries and Japan. They are high in protein and low in fat. Most of the world wide catch is by Japan and Mediterranean countries. Octopuses are caught mainly with trawls and pots, cuttlefishes with trawls and set nets, squid with seines, trawls, and jigs. Squid as a food source for fish and mammals and the diet of squid themselves are discussed. Recommendations are given for future cephalopod resource assessment and research.
CALL LETTERS: SH11 A5 N61
KEY WORDS: LO; other species; markets; gear used; predators; diet

153. Lange, A.M.T. 1978. Historical trends and current status of the squid fisheries off the northeastern United States. pp. 3.1-3.10. In: Proceedings of the workshop on the squid, ILLEX ILLECEBROSUS, Dalhousie Univ., Halifax, Nova Scotia, May, 1978, and a bibliography on the genus ILLEX. Can. Fish. Mar. Serv. Tech. Rep., No. 833. 311 pp.

The squid stocks off the NE US have supported a small coastal fishery since the late 1800's, primarily for bait. Arrival of distant-water fleets which fished offshore changed the picture of the squid fishery in the 1960's. Seasonal distributions of squid are presented. Management of the squid stocks in this area were initiated in 1974.
CALL LETTERS: SH223 A88
KEYWORDS: other species; distribution; regulations; migration

154. Lange, A.M.T. and K.L. Johnson. 1981. Dorsal mantle length-total weight relationships of squids LOLIGO PEALEI and ILLEX ILLECEBROSUS from the Atlantic coast of the United States. NOAA Tech. Rpt. NMFS SSRF, No. 745. 17 pp.

Length-weight data were collected from the NW Atlantic, for two commercially important species of squid, LOLIGO PEALEI and ILLEX ILLECEBROSUS. These data, in total and by year, sex, season, and area of capture, were fit to length-weight relationships of the form $W=aL^b$. Analysis of covariance indicate that for each species, differences

exist between relationships determined for each area. For L. PEALEI, differences also exist between sex and among years and seasons. However, comparisons of sums of total observed weight versus sums of total weight, predicted by equations obtained for all data within a given set, indicate that the net results of using a single equation for each species is about as precise as using separate equations for each sex, area, season, and year. These equations are: W=0.25662L^2.15182 for L. PEALEI and W=0.04810L^1.71990 for I. ILLECEBROSUS.
CALL LETTERS: SH11 A542
KEYWORDS: other species; length; weight

155. Lange, A.M.T. and M.P. Sissenwine. 1980. Biological considerations relevant to the management of squid (LOLIGO PEALEI and ILLEX ILLECEBROSUS) of the Northwest Atlantic. Mar. Fish. Rev., 42(7-8):23-38.

The general biology and distribution of squid in the northwest Atlantic are reviewed (life span estimated at 14-24 months, maximum of 36 months; some survive two spawning seasons). Commercial catch and effort data from the Middle Atlantic area to Gulf of Maine inshore and offshore squid fisheries are presented. Research vessel catch per tow data provide indices for abundance, prerecruit indices, and stock size and biomass estimates. A dynamic pool model designed to simulate the effect of fishing on squid is presented. The instantaneous growth, fishing, and natural mortality rates were varied on a monthly basis, and spawning was simulated over an extened period. Recruitment was described by the Beverton and Holt stock-recruitment function. Based on these models, the exploitation rates that will result in maximum sustainable yield are 0.40 and 0.37 for L. PEALEI and I. ILLECEBROSUS, respectively, assuming moderate dependence of recruitment on spawning stock size.
CALL LETTERS: SH11 A14
KEYWORDS: other species; landings; distribution; length; stock assessment; modelling; age

156. Lange, A.M.T. and M.P. Sissenwine. 1983. Squid resources of the Northwest Atlantic. FAO Fish. Tech. Pap., 231:21-54.

LOLIGO PEALEI and ILLEX ILLECEBROSUS are commercially important species of the Northwest Atlantic. Small coastal fisheries expanded during the late sixties and seventies. Total yield increased from a few thousand tons to over 150,000 t. Catch quotas were established in 1974. LOLIGO PEALEI migrate to shallow waters to spawn during spring and return off-shore to overwinter at the edge of the continental shelf. They are abundant from Cape Hatteras to Georges Bank. ILLEX ILLECEBROSUS are commercially abundant from New Jersey to Newfoundland. They migrate onto the continental shelf during the warmer months and migrate to deep water off the edge of the continental shelf before winter, presumably to spawn. The spawning season of both species is protracted. Modal analysis of length frequencies indicates multiple

cohorts each year. For L. PEALEI, peak spawning occurs inshore during spring, with a secondary peak during late summer and autumn. During most years, peak spawning of I. ILLECEBROSUS is during winter. Spawning also occurs during summer. During some years, cohorts spawned during summer dominate the fishery off the northeast USA. Research surveys indicate that the abundance of both species increased significantly during the seventies. I. ILLECEBROSUS abundance peaked later than L. PEALEI adundance. Models indicate that the yield per recruit could be increased by an increase in mesh size and by altering the seasonal distribution of fishing effort.
CALL LETTERS: SH1 F539
KEYWORDS: other species; distribution; abundance; modelling; landings; regulations; length; growth; stock assessment

157. LaRoe, E.T. 1971. The culture and maintenance of the loliginid squids SEPIOTEUTHIS SEPIOIDEA and DORYTEUTHIS PLEI. Marine Biology, 9(1):9-25.

A technique for rearing the loliginid squids SEPIOTEUTHIS SEPIOIDEA and DORYTEUTHIS PLEI is reported. Specimens of the former were reared from eggs to sexually mature adults, and maintained for a maximum of 146 days; adult D. PLEI were maintained for 38 days. Choice and quantity of food was most important for the survival of all sized, particularly young squid. Newly hatched specimens thrived on MYSIDIUM COLUMBIAE. Both species fed at a rate of 30 to 60% of their body weight daily; starvation occurred when intake fell below 10 to 15%. Food conversion efficiency averaged between 10 to 20 %. Growth was rapid and steady. S. SEPIOIDEA grew to a maximum of 105 mm and 77 g in less than 5 months; D. PLEI grew an estimated 20 mm/month. Experimental data indicate a lethal minimum salinity for both species at about 27 ppt. Lethal minimum and maximum temperatures for young S. SEPIOIDEA are 17.5 degrees to 18.0 degrees C, and 32.5 to 33 degrees C, respectively. Opaque tanks, with a seminatural bottom substrate and special ultra-violet (UV) illumination, are advantageous for rearing and maintenance.
CALL LETTERS: QH91 A1 M3
KEYWORDS: other species; artifical rearing; diet-artificial; growth; length

158. Learson, R.J. and V.G. Ampola. 1977. Care and maintenance of squid quality. Mar. Fish. Rev., 39(7):15-16.

Some general recommendations are made for the maintenance of squid quality at sea and through the processing and distribution stages. The catch should be iced immediately after capture and squid-to-ice ratios should not exceed 3:1. A 2:1 ratio is recommended with the squid and ice well intermixed. Squid should be shelved or boxed to reduce physical damage. All sorting and processing should be carried out rapidly taking care to maintain as low a temperature as possible. Only good-quality squid should be frozen and the containers and cartons

should be relatively thin to promote rapid freezing. Plate freezing or blast freezing is recommended with adequate spacing to promote efficient heat removal. Storage temperatures of 0 degrees F (-18 degrees C) or below are necessary. All thawing, processing, and refreezing operations should be carried out as rapidly as possible to prevent quality loss.
CALL LETTERS: SH11 A14
KEYWORDS: processing-freezing; storage-iced; quality

159. Learson, R.J. and V.G. Ampola. 1982. The status of squid processing and preservation technology in the northeastern United States. pp. 265-274. In: Proceedings of the international squid symposium. August 9-12, 1981. Boston, Massachusetts. New England Fisheries Development Foundation, Inc. 390 pp.

This paper describes the state of the art and research carried out on the preservation and processing of squid. Includes preservation of quality; freezing; grading; evisceration; skinning; enzyme, caustic and acid solutions; mechanical skinning and slicing; and product development.
CALL LETTERS: QL430 .3 L8 I561
KEYWORDS: processing-skinning, automated, products; storage; quality

160. Learson, R., R. Crossman, and N. Haard. 1982. Overview of developments in squid processing - panel discussion. pp. 31-41. In: Proceedings of the international squid symposium. August 9-12, 1981. Boston, Massachusetts. New England Fisheries Development Foundation, Inc. 390 pp.

Discussion on areas of squid processing that needs further development. Topics include: technology data concerning quality differences between species and different processing techniques; developing machines for automatic grading, evisceration, and skinning; utilizing the entire squid - the pen for its chitin, the beak as an aphrodisiac, and the roe.
CALL LETTERS: QL430 .3 L8 I561
KEYWORDS: processing

161. LeBrasseur, R.J. 1966. Stomach contents of salmon and steelhead trout in the northeastern Pacific Ocean. J. Fish. Res. Bd. Can., 23(1):85-100.

Stomachs of pink, chum, sockeye, and coho salmon and steelhead trout caught in gill nets fished overnight in the northeastern Pacific Ocean contained mainly zooplankton, squid, and fish. Except for sockeye, there were no differences in contents related to fish size or state of maturity. Differences were found between species in the kinds of stomach contents present. The predominant organisms were amphipods and fish in pink salmon, crustaceans in immature sockeye, euphausiids and squid in maturing sockeye, euphausiids, fish, and squid in coho and

fish and squid in steelhead stomachs. Comparison with the findings of workers in the northwestern Pacific showed no significant differences in the kinds of stomach contents, however, a greater amount of material was present in the stomachs they examined. Greater differences were noted in the stomach contents of fish from different domains than from different species. It is suggested that feeding is associated more with availability rather than with preferences for specific organisms.
CALL LETTERS: SH223 A5
KEYWORDS: predators-salmon

162. Lemon, D. and J. Rycroft. 1982. Canadian harvesting experience. pp. 101-121. in: Proceedings of the international squid symposium. August 9-12, 1981. Boston, Massachusetts. New England Fisheries Development Foundation, Inc. 390 pp.

Describes the Canadian (Newfoundland and Nova Scotia) squid fishery: Biology of ILLEX ILLECEBRSUS; inshore fishery; offshore fishery. Projects by the Dept. of Fisheries and Oceans, initiated to aid in the development of the squid industry. Projects included: developmental charters to introduce the technology of onboard handling and freezing; development of onshore processing technology; evaluation of automated squid jigging in the offshore fishery; conversion of a longliner to a squid jigger.
CALL LETTERS: QL430 .3 L8 I561
KEYWORDS: other species; landings; gear used-jigs; gear development

163. Leta, H. 1982. Harvesting of squid in Uruguay. pp. 123-136. in: Proceedings of the international squid symposium. August 9-12, 1981. Boston, Massachusetts. New England Fisheries Development Foundation, Inc. 390 pp.

Results of research regarding multiple aspects of squid harvesting under both trawling and jigging. Aspects studied included: environmental characteristics of harvest area; types of vessels involved; harvesting gear including trawling and jigging; seasons, seasonal abundance, and migration of ILLEX ARGENTINUS; CPUE and landings.
CALL LETTERS: QL430 .3 L8 I561
KEYWORDS: other species; gear used-trawl, jigs; seasons; migration; landings; fishery-S. America

164. Leta, H.R. 1982. Outlook to the actual situation of squid processing and marketing in Uruguay. pp. 275-284. In: Proceedings of the International squid symposium. August 9-12, 1981. Boston, Massachusetts. New England Fisheries Development Foundation, Inc. 390 pp.

Summarizes information available on handling practices, processing and marketing of squid in Uruguay. Includes handling at sea and on shore, manual and mechanical processing, and marketing.
CALL LETTERS: QL430 .3 L8 I561
KEYWORDS: processing-automated; markets

165. Lipinski, M. and O. Wrzesinksi. 1982. Some observations on the behavior of squid (Cephalopoda: Ommastrephidae) during jigging operations. pp. 137-144. In: Proceedings of the International squid symposium. August 9-12, 1981. Boston, Massachusetts. New England Fisheries Development Foundation, Inc. 390 pp.

The behavior of two species of squid living near the bottom (ILLEX ARGENTINUS and MARTIALIA HYADESI) and two typical oceanic species (OMMASTREPHES BARTRAMII and O. PTEROPUS) were studied. Differences between both groups are discussed, referring to the schooling patterns influenced by artificial light, the build-up process of a squid concentration, the reaction to artificial bait (jigs), color of the attracting light, natural light, and appearance of marine mammals and euphausids are discussed.
CALL LETTERS: QL430 .3 L8 I561
KEYWORDS: other species, behavior-schooling; gear used-lights

166. Long, D. and W.F. Rathjen. 1980. Experimental jigging for squid off the northeastern United States. Mar. Fish. Rev., 42(7-8):60-66.

Established commercial vessels from Japan and Poland conducted exploratory squid jigging for ILLEX ARGENTINUS and ILLEX ILLECEBROSUS. Each vessel used automated jigging machines, jigs with a variety of sizes, shapes, luminescent, nonluminescent, and incandescent lamps for attracting the squid. Lamps were turned on between 1900 and 1930 hours and jiggers started between 1930 and 2030 hours and run continuously throughout the night. Depth of jigs is adjusted to the location of the squid. Catches were usually low and sporatic until midnight at which time they would increase and peak between 0400 and 0515 hours. Catches were poor during the full moon unless there was a heavy cloud cover. Catches were larger in areas where surface water was 18.4-26.0 degrees C. Females consistantly showed a higher mean length and weight than males. Most females were immature while most males were mature or maturing. Catches were increased by creating a wider shade zone along

the side of the vessel when lamps were moved farther inboard. Squid were frozen onboard. Squid jigging is a relatively simple fishing technique, few people are needed for operation, and cost are relatively low making it a favorable technique for commercial fishing.
CALL LETTERS: SH11 A14
KEYWORDS: other species; gear development; gear used-jigs, lights; fishery-N. Atlantic; length; weight; behavior

167. Longhurst, A.R. 1969. Pelagic invertebrate resources of the California Current. CalCOFI Rept., 13:60-62.

Survey of literature summarizing world trade in cephalopods and major squid resources. Concluded that resources of the California Current, including LOLIGO OPALESCENS, could be harvested at a much higher level of yield.
CALL LETTERS: SH351 S2 C22
KEYWORDS: LO; west coast species; landings

168. Loukashkin, A.S. 1976. On biology of the market squid, LOLIGO OPALESCENS, a contribution toward the knowledge of its food habits and feeding behavior. CalCOFI Rept., 18:109-111.

Out of 1,000 stomachs of the market squid, LOLIGO OPALESCENS, from the waters of southern and central California collected in different months and different years, only 33.1% contained food in various quantities, while 66.9% were empty. The amount of food in the stomachs varied from full stomach capacity to less than 1/8 capacity. Dominating food items were found to be crustaceans (42.0%), indeterminate fleshy material and fluid matter (24.8%), fish (19.6%) and polychaete worms and miscellaneous material (13.6%).
CALL LETTERS: SH351 S2 C22
KEYWORDS: LO; diet

169. Lozow, J.B. 1977. The role of confidence intervals in the application of hydroacoustic techniques for biomass estimates. Rapp. P.-v. Reun. Cons. int. Explor. Mer, 170:214-218.

If a hydroacoustic system is employed to estimate population density, uncertainty due to randomness of the environment and uncertainty due to ignorance of the true state of the system parameters must be contended with. An estimate of population density is not meaningful without a measure of confidence in that estimate. The theory of calculation of confidence intervals for acoustic estimates of biomass is explored and a working method developed. Practical examples of the method are given.
CALL LETTERS: GC1 I66
KEYWORDS: acoustics

170. Lu, C.C. 1978. Characteristics and distribution of ILLEX ILLECEBROSUS. pp. 9.1-9.2. In: Proceedings of the workshop on the squid, ILLEX ILLECEBROSUS, Dalhousie Univ., Halifax, Nova Scotia, May, 1978, and a bibliography on the genus ILLEX. Can. Fish. Mar. Serv. Tech. Rep., No. 833. 311 pp.

The morophological characteristics which distinguish I. ILLECEBROSUS from the other species in the genus were described and the geographical ranges of the species reviewed. These geographic ranges were discussed in relation to the distribution of recently identified rhynchoteuthion larvae. There was also a summary of the physical conditions in which adult I. ILLECEBROSUS are found in various parts of their range and of their seasonal distribution.
CALL LETTERS: SH223 A88
KEYWORDS: other species; description; distribution; migration

171. Lu, C.C. and M.R. Clarke. 1975. Vertical distribution of cephalopods at 40° N, 53° N, and 60° N at 20° W in the north Atlantic. J. Mar. Biol. Ass. U.K., 55:143-163.

Cephalopods comprising 18 identified species and 42 young unidentified larvae were collected with opening-closing RMT combination nets. Discrete horizons were fished between the surface and 2000 m. The number of species caught roughly doubles for each 10 degrees of latitude from 60 degrees N to 30 degrees N while the number of specimens remains much the same except at 40 degrees N where there were less than one-fifth of the number found at the other three positions. This probably reflects a seasonal difference since 40 degrees N was sampled in the autumn while the other three stations were sampled in the spring. The three commonest species, BRACHIOTEUTHIS RIISEI, GONATUS FABRICII, and TAONIUS MEGALOPS, ascend from deep water in the early larval stage, they then grow further in the upper 200 m. At this later stage G. FABRICII and T. MEGALOPS seem to undergo reverse diel migrations, i.e. they are deeper during the night than in the day. At a still later stage of growth G. FABRICII and T. MEGALOPS spread down in the water column.
CALL LETTERS: (NA)
KEYWORDS: other species; distribution-vertical

172. Lu, C.C., and C.F.E. Roper. 1979. Cephalopods from the deepwater dumpsite 106 (western Atlantic): Vertical distribution and seasonal abundance. Smithsonian Contributions to Zoology, No. 288. 36 pp.

The vertical distribution, seasonal occurrence, relative abundance, spawning cycles, growth trends, and relationship to water types of 36 species of oceanic cephalopods are delineated. The most commonly captured species were PTERYGIOTEUTHIS GEMMATA, ABRALIOPSIS PFEFFERI, ILLEX ILLECEBROSUS, HISTIOTEUTHIS REVERSA, and MASTIGOTEUTHIS MAGNA. Information on probable spawning seasons was gained for the first time for I. ILLECEBROSUS, A. PFEFFERI, P. GEMMATA, H. REVERSA,

MEGALOCRANCHIA MEGALOPS, and ALLOPOSUS MOLLIS. Closing-net captures provided data on several species for which vertical distributions formerly were unknown. Several species occurred primarily in a particular water type. Tests of co-occurrence of species between water types and cruises indicated that the species compositions were largely dissimilar. Only five species occurred on all four cruises while five additional species occurred on any three of the four cruises.
CALL LETTERS: QL1 S5
KEYWORDS: other species; distribution-vertical; abundance; seasons; habitat

173. Macfarlane, S.A. and M. Yamamoto. 1974. The squid of British Columbia as a potential fishery resource - a preliminary report. Can. Fish. Mar. Serv. Tech. Rept., 447:1-36.

Summarizes information gathered through a survey of existing literature and published reports. Summary of biology - with emphasis on LOLIGO OPALESCENS, fishing methods, international fisheries, status in British Columbia, and processing techniques. Also discussion of nutritional aspects of squid meat. If a strong market develops for B.C. squid as food, the squid represents a valuable, renewable resource.
CALL LETTERS: SH223 A88
KEYWORDS: LO; fishery-BC; gear used; landings; processing; physiology-nutritional value

174. MacGinitie, G.E. and N. MacGinitie. 1968. Natural history of marine animals. Second edition. McGraw-Hill New York. 523 pp.

General text book type description of life history of marine animals. Section on cephalopods gives descriptions of the class and general life history of LOLIGO OPALESCENS.
CALL LETTERS: QL121 M3
KEYWORDS: LO; description; behavior-spawning

175. MacLennan, D.N. and S.T. Forbes. 1984. Fisheries acoustics: a review of general principles. Rapp. P.-v. Reun. Cons. int. Explor. Mer, 184:7-18.

The physical principles of echo sounding are discussed with particular reference to system design and the accuracy of the echo-integration method of biomass estimation. The velocity, absorption, and scattering of underwater sound are reviewed, especially the scattering properties of multiple targets. Many types of sonar have been applied in fisheries investigations. The various techniques are described and the factors which limit performance are critically examined.
CALL LETTERS: GC1 I66
KEYWORDS: acoustics

176. Macy, W.K. III. 1982. Feeding patterns of the long-finned squid, LOLIGO PEALEI, in New England waters. Biol. Bull., 162:28-38.

Gut content analyses have shown that the diet of the long-finned squid, L. PEALEI, differs between inshore spawning and nursery grounds and offshore winter grounds. Crustaceans were more frequently consumed than either fish or squid, but fish were eaten by a wider size range of squid and more frequently inshore. Prey-type selection based on size was common in both samples, but it is unlikely that the species composition is the same in both areas sampled. These data suggest that L. PEALEI is a highly opportunistic predator, whose diet primarily reflects the local abundance of potential prey species. Such felxible feeding strategy could account for the large spatial and temporal variations which have been reported in the diet of this squid from various offshore areas.
CALL LETTERS: QH301 B56
KEYWORDS: other species; diet; behavior-feeding

177. Mais, K.F. 1974. Squid. pp. 69-70. In: Pelagic fish surveys in the California current. Calif. Dept. Fish Game, Fish Bull., 162:1-79.

Sea surveys strongly indicated squids are the largest latent fishery resource in California waters and may be on par with northern anchovies in terms of total biomass. The resource is comprised chiefly of LOLIGO OPALESCENS which comprised nearly 90% of all sea survey catches. The total squid population must be at least 1 million tons and probably much larger. Squid abundance increased northward reaching a maximum in central or northern California. Catches were very widespread with respect to locality. No particular habitat or areas excelled in squid catches. Squid have a low vulnerability to midwater trawl gear. Frequency of trawl catches were high but the amounts caught were quite low. Nonspawning squid attracted to the light were very active and easily frightened away. Spawning squid attracted to the night-light concentrated in a very dense layer near the surface where they remained docile and relatively inactive. Spawning concentrations are the source of nearly all commercial catches. The few known localities where spawning concentrations occur and the invulnerability of nonspawning squid to present fishing methods may restrict harvest to only a very small portion of the total resource.
CALL LETTERS: SH11 C24
KEYWORDS: LO; distribution; abundance; behavior-schooling

178. Mangold, K. and D. Froesch. 1977. A reconsideration of factors associated with sexual maturation. Symp. Zool. Soc. Lond., No. 38:541-555.

Until now, it has not been possible to describe unequivocally any external factor that would induce sexual maturation in cephalopods in general. The present investigation is based on (a) a gonad weight/body weight analysis of OCTOPUS VULGARIS and (b) a gonad weight/body weight

analysis and an ultrastructural study of optic glands of different octopods kept under various experimental conditions in the laboratory. Our data from Mediterranean octopods suggest that the gonads develop relatively independently of external factors. At the ultrastructural level we have found no evidence for hormone synthesis and release in the optic gland at any moment in the life of an octopus. The abundance of lipofuscin and the presence of haemocyanin in the cells of the optic gland suggest that it may also be involved in other functions than the control of sexual maturation.
CALL LETTERS: QL1 Z712
KEYWORDS: other species; physiology-gonad maturation

179. Manzer, J.I. 1968. Food of Pacific salmon and steelhead trout in the Northeast Pacific Ocean. J. Fish. Res. Bd. Can., 25(5):1085-1089.

Reports on observations on the food of salmonids, mainly sockeye (ONCORHYNCHUS NERKA) and pinks (O. GORBUSCHA) caught during the winter. Sockeye fed predominately on fish of the family Myctophidae (71% by volume) and squid (27% by volume). Pink salmon feed almost exclusively on amphipods (97% by volume). Sockeye and pinks seem to feed most actively in the early mornings, and more intensively in early summer than in winter.
CALL LETTERS: SH223 A52
KEYWORDS: predators-salmon

180. Margetts, A.R. (ed.). 1977. Hydro-acoustics in fisheries research. A symposium held in Bergen 19-22 June 1973. Rapp. P.-v. Reun. Cons. Int. Explor. Mer, Vol. 170. 327 pp.

This symposium on acoustic methods in fisheries research was to provide a forum for the exchange of new research results, experience and ideas in this field between scientists from all parts of the world; specifically it did not include consideration either of the use and application of acoustic intruments in commercial fishing or of bioacoustics. Session topics included studies of fishing gear, topography, fish behavior and migration, abundance estimation, and target strength measurement and sizing.
CALL LETTERS: GC1 I66
KEYWORDS: acoustics

181. Mather, J.A. and R.K. O'Dor. 1984. Spatial organization of schools of the squid ILLEX ILLECEBROSUS. Mar. Behav. Physiol., 10(4):259-271.

ILLEX ILLECEBROSUS squid appear to have a species-typical and internally organized spatial arrangement of their groups. Squid maintained an average angle of 25 degrees with respect to their nearest neighbor, and mostly had angular deviations between 5 degrees and 20 degrees. They maintained distances to nearest, second and third neighbors in a ratio of 1:1.5:2. The distances were strongly affected

by group size, with larger groups maintaining closer distances. Interindividual distances were not affected by two variables, day-night and presence of a current in the large pool in which they were kept. The similarity of this organization to that of fish is discussed.
CALL LETTERS: QL121 M4
KEYWORDS: other species; behavior-schooling

182. Matsui. T., Y. Teramoto, and Y. Kaneko. 1972. Target strength of squid. FAO Fish. Circ., 142:27-29.

The maximum echo from a squid was obtained in the dorso-ventral direction of the roll plane. The maximum target strength of a squid 12 cm mantle length was about -45 dB at 50 kHz and -42 dB at 200 kHz.
CALL LETTERS: SH1 F537
KEYWORDS: acoustics

183. McConathy, D.A., R.T. Hanlon, and R.F. Hixon. 1980. Chromatophore arrangements of hatchling loliginid squids (Cephalopoda, Myopsida). Malacologia, 19(2):279-288.

The color, location and number of chromatophores were studied as a basis for identifying hatchlings of 3 western Atlantic loliginid squids (LOLIGO PLEI, L. PEALEI and LOLLIGUNCULA BREVIS) and 1 eastern Pacific species (LOLIGO OPALESCENS). Counts of chromatophores were made on the head and mantle of the squid hatchling, and the mean number and frequency distribution were calculated to establish a standard number of chromatophores for each area. Lines drawn to connect specific groups of chromatophores formed rows and shapes that were used to describe a specific arrangement for each species. Comparisons among the species indicate that all 4 are distinguishable by their characteristic chromatophore arrangements at hatching. L. OPALESCENS and L. BREVIS are the most easily identifiable species, while L. PLEI and L. PEALEI are more difficult to distinguish.
CALL LETTERS: (NA)
KEYWORDS: LO; other species; physiology-chromatophore

184. McConnaughey, B.H. 1959. DICYEMENNEA NOUVELI, a new mesozoan from central California. J. Parasitol., 45:533-537.

New description of a mesozan parasite found on two octopuses and on one squid, LOLIGO OPALESCENS. Suggested the octopus is the normal host for this species, while the infection in the squid is accidental.
CALL LETTERS: QL750 J65
KEYWORDS: LO; parasites

185. McGowan, J.A. 1954. Observations on the sexual behaviour and spawning of the squid, LOLIGO OPALESCENS, at La Jolla, California. Calif. Fish Game, 40(1):47-54.

Sequence of events in spawning of L. OPALESCENS seems to be as follows: (1) a population moves from offshore into a shallow area near shore. It seems probable that at this time males transfer sperm to buccal seminal receptacles of females. (2) Squid tend to congregate near sandy bottoms of semiprotected bays. (3) A few minutes before females lay eggs males transfer a second group of spermatophores. (4) Females attach egg capsules either to sandy bottom or to base of some previously laid egg capsule. This results in large masses of egg capsules, which may be as much as forty feet in diameter (5) Both males and females die after spawning. (6) Eggs require from 30 to 35 days to hatch at a temp. of 13.6 degrees C.
CALL LETTERS: SH11 C22
KEYWORDS: LO; behavior-spawning

186. McGowan, J.A. 1967. Distributional atlas of pelagic molluscs in the California Current region. CalCOFI Atlas, 6:1-218.

It is the purpose of this atlas to record the distribution and estimates of abundance of the Thecosomata (Opisthobranchia), Heteropoda (Prosobranchia) and larval Cephalopoda. Data came from zooplankton tows on six cruises made within the California Current. In addition to the charts of monthly distribution and abundance, the total areal range of all positive collection records are shown.
CALL LETTERS: GC1 C17
KEYWORDS: LO; west coast species; larvae; distribution; abundance

187. McInnis, R.R. and W.W. Broenkow. 1978. Correlations between squid catches and oceanographic conditions in Monterey Bay, California. Calif. Dept. Fish Game, Fish Bull., 169:161-170.

The purpose of this study was to examine statistically the relation between squid landings in Monterey Bay and available environmental data to better understand fishery variations. The presence of squid in great numbers on the spawning grounds seems to be tied to the warming which follows cessation of upwelling. Spawning may be triggered by this warming trend. Year-to-year variations in the water temperature of the bay correlated with the squid catch-per-delivery day at a lag of 18 months. Periods of higher temperatures preceded good squid landings by 18 months and conversely, poor squid catch followed periods of low temperatures. The lag time of 18 months between temperature and squid catch is consistent with the age estimates for market squid. Since squid die after sqawning, this suggests that the mechanism which links temperature to stock abundance acts upon juvenile squid.
CALL LETTERS: SH11 C24
KEYWORDS: LO; landings; abundance; temperature; upwelling

188. Mercer, M.C. 1970. A synopsis of the recent cephalopoda of Canada. Fish. Res. Bd. Can. Studies, 1327:55-66.

Records of cephalopods taken in the zone extending from the coasts of Canada to the 1000 fm contour and also including the West Greenland-Baffin Bay area, are discussed. The Artic cephalopod fauna is composed of North Atlantic post-glacial immigrants, comprises 21 teuthoids, 4 sepioids, and 6 octopods. The Pacific fauna comprises 14 teuthoids, 1 sepioid, and 5 octopods. Provides a species list and discusses briefly the composition and relationships of the fauna.
CALL LETTERS: SH223 C23
KEYWORDS: LO; west coast species; other species; distribution

189. Mercer, R.W. (ed.). 1981. Proceedings of the squid workshop. NW Alaska Fish. Cntr., Proc. Rept., No. 81-11. 34 pp.

The workshop focused on current knowledge of the distribution, seasonal abundance, commercial utilization, and ecosystem role of squids in the NE Pacific Ocean.
CALL LETTERS SH11 A5 N61
KEYWORDS: distribution; abundance; gear used; predators-marine mammals, birds, fishes; growth

190. Mercer, R.W. and M. Bucy. 1983. Experimental squid jigging off the Washington coast. Mar. Fish. Rev., 45(7-8-9):56-62.

Squid jigging machines were used for experimental squid fishing off the Washington coast. This experimental fishing was prompted by reports of possible commercial quantities of nail squid, ONYCHOTEUTHIS BOREALIJAPONICUS, and flying squid, OMMASTREPHES BARTRAMII. Fishing locations were selected based on northern fur seal stomach content data which indicated either or both species of squid might be found over depths greater than 200 m at the head of submarine canyons. Nocturnal squid jigging operations were conducted as an adjunct to daylight jigging for black rockfish or trolling for albacore. A total of 1,261 squids were caught during 21 nights of jigging from 10 May to 14 September 1981. Two of the squid caught were flying squid and the rest were nail squid. About half of the squid caught were measured and examined for gender and sexual maturity. Squid were not captured in commercial quantities during these experiments, but it is felt that commercial quantities of nail squids might be available off the Washington coast during periods when coastal upwelling occurs.
CALL LETTERS: SH11 A14
KEYWORDS: west coast species; gear used-jigs; fishery-Pacific NW; gonad maturation

191. Merdsoy, B. 1978. IN SITU observations of squid. pp. 11.1-11.2. In: Proceedings of the workshop on the squid, ILLEX ILLECEBROSUS, Dalhousie Univ., Halifax, Nova Scotia, May, 1978, and a bibliography on the genus ILLEX. Can. Fish. Mar. Serv. Tech. Rep., No. 833. 311 pp.

Observations of squid by a diver reveal hitherto unrecorded behaviors which are of importance in the understanding of this organism. The observations made throughout the water column over a 15 m depth include: behavior towards diver; behavior towards jig; intraspecific and prey-predator behavior.
CALL LETTERS: SH223 A88
KEYWORDS: other species; behavior-feeding

192. Merkel, T.J. 1957. Food habits of the king salmon, ONCORHYNCHUS TSHAWYTSCHA (Walbaum) in the vicinity of San Francisco, California. Calif. Fish Game, 43(4):249-270.

The stomach contents of troll-caught king salmon were analyzed and it was found that fishes, crustaceans, cephalopods, and polychaete worms comprised their diet. 6 items constituted 92.5% of total food consumption: northern anchovy, 29.1%; rockfishes, 22.5%; euphausiids, 14.9%; Pacific herring, 12.7%; squid, 9.3%; crab megalops, 4.0%. Seasonal changes in feeding habits were noted. Food habits of different sizes of king salmon were found generally similar. Most of these squid were between 3.0 and 6.0 inches in body length. Only one species, LOLIGO OPALESCENS, was identified. Squid was observed in all of the monthly samples, although it was never of primary importance. The majority had been eaten by salmon taken beyond the 20-fathom curve.
CALL LETTERS: SH11 C22
KEYWORDS: LO; predators-salmon

193. Mikulich, L.V. and L.P. Kozak. 1971. Experimental rearing of Pacific Ocean squid under artificial conditions. Soviet Jour. Ecol., 2(3):266-268.

Experiments were made on rearing young specimens of the Pacific Ocean squid TODARODES PACIFICUS (Steenstrup) under artifical conditions. The squid were more active by night than during the day. When put into tanks, the squid began to feed even during the first 24 hours. Instances of cannibalism were observed. The amount of food consumed by the squid was assessed. The average daily ration for an individual squid weighing 35 g was found to be 8.3 g. Larger squid (60 to 63 g) ate up to 15 to 20 g of fish daily. Squid cannot survive a shortage of oxygen. In high water temperature (25.0 to 27.5 degrees C) they survived perfectly well and fed normally. Given regular change of water, squid fed successfully and lived 23 to 35 days.
CALL LETTERS: QH540 S5
KEYWORDS: other species; behavior-feeding; diet-artificial; artifical rearing

194. Milnes, J. 1982. Perspective on the Spanish squid market. pp. 21-30. In: Proceedings of the International squid symposium. August 9-12, 1981. Boston, Massachusetts. New England Fisheries Development Foundation, Inc. 390 pp.

Review of the principal types of LOLIGO and ILLEX squids which are being supplied to and consumed in varying levels and degrees of preference on the Spanish and other southern European markets. There is little demand for LOLIGO OPALESCENS because its characteristics do not meet the end-use requirements of the Spanish market.
CALL LETTERS: QL430 .3 L8 I561
KEYWORDS: fishery-Spain; markets; LO; landings; processing-products

195. Milnes, J. 1982. Marketing squid in southern Europe. pp. 317-321. In: Proceedings of the International squid symposium. August 9-12, 1981. Boston, Massachusetts. New England Fisheries Development Foundation, Inc. 390 pp.

In Spain, during the last three years, the supply and demand for squid has been constantly changing and unpredictable. Major factors for this situation include health of markets, parity of U.S. dollar, current stock situation, performance of principal supply areas, and present and anticipated governmental policies.
CALL LETTERS: QL430 .3 L8 I561
KEYWORDS: fishery-Spain; markets

196. Mishima, S. 1951. Detection of squid school by the fish-detector (recording echo sounder by super sonic). Bull. of the Faculty of Fish., Univ. Hokkaido, 1(2):97-101.

The detection of squid schools by the "fish-detector" (recording echo sounder) was attempted. It is possible to detect a squid school using the fish-detector from a fishing boat while drifing after sunset. The record of the shade on the graph indicates the squid schools are near the surface. The shading on the graphs are proved to be caused by the squid schools by actual fishing of squids. If they are deeper than 50 meters, it is impossible to detect the squid schools using the fish detector. It is also difficult to detect them between the surface and a depth of 8 meters.
CALL LETTERS: (NA)
KEYWORDS: acoustics

197. Miwa, K., et al. 1975. Preservation on board. FAO Fish. Rept. 170, Suppl. 1:148-150.

The prerequisite for fresh consumption or processing of cephalopods is adequate quality when landed. The freshness is organoleptically judged by the change of hemochromatic cells in the skin, the breaking of viscera and the odor from the mucus on the skin.

The preservation on board is through cooling or freezing. Cooling with ice should preferably be preceded by cooling in chilled water. In the Japanese fishery the weight relation of cephalopods to ice without pre-chilling should be about 1:3 in summer, 1:2 in spring and autumn and 1:0.3 in winter. For fishing operations lasting longer than 3 days from first catch to landing, cephalopods must be frozen to about -25 to -35 degrees C, the blocks of ice glazed and stored at -20 to -25 degrees C.
CALL LETTERS: SH1 F543
KEYWORDS: storage; quality

198. Mommsen, T.P., J. Ballantyne, D. MacDonald, J. Gosline, and P.W. Hochachka. 1981. Analogs of red and white muscle in squid mantle. Proc. Natl. Acad. Sci., 78(5):3274-3278.

In 5 species of squid (LOLIGO OPALESCENS, ILLEX ILLECEBROSUS, OMMASTREPHES sp., BERRYTEUTHIS MAGISTER and SYMPLECTOTEUTHIS OUALANIENSIS), varying in life-style from fast-swimming pelagic predators to sluggish benthic forms, the circular muscle of the mantle was metabolically and structurally differentiated into inner, middle and outer zones. In the middle zone, mitochondrial abundance and the ratios of oxidative to glycolytic enzyme activities were low. This zone was sandwiched between thinner bands of muscle, lining the inner and outer edges of the mantle. In these bands, mitochondrial abundance and the ratios of oxidative to glycolytic enzyme activities were high. This metabolic differentiation is analogous to the development of red and white muscles in vertebrates, and it serves a similar function, white muscle mainly supporting burst-type swimming and red muscle sustaining steady-state oxidative work.
CALL LETTERS: (NA)
KEYWORDS: LO; west coast species; physiology-biochemical analysis

199. Morejohn, G.V., J.T. Harvey, and L.T. Krasnow. 1978. The importance of LOLIGO OPALESCENS in the food web of marine vertebrates in Monterey Bay, California. Calif. Dept. Fish Game, Fish Bull., 169:67-97.

Provides information on the extent of predation on and relative importance of LOLIGO OPALESCENS in life cycles of marine fishes, seabirds, and marine mammals of Monterey Bay. Nineteen species of fish (including salmon) and several avian species were found to feed on Loligo. The market squid, anchovy and rockfish are important prey items for most marine mammals as well. Food webs were developed illustrating the relation of squid to their predators.
CALL LETTERS: SH11 C24
KEYWORDS: LO; predators-marine mammals, salmon, birds

200. Muntz, W.R.A. 1977. Pupillary response of cephalopods. Symp. Zool. Soc. Lond., 38:277-285.

The cephalopod pupil may have many shapes. In OCTOPUS VULGARIS, for example, it contracts to an elongated slit, and in SEPIA OFFICINALIS, it has the form of an elongated letter W, with a horizontal middle section and vertical segments at each end.
CALL LETTERS: QL1 Z712
KEYWORDS: other species; physiology-vision

201. Murakami, K. 1975. Distribution in relation to environment of squid in the northwest Pacific and the Okhotsk sea. FAO Fish. Rept. 170, Suppl. 1:9-17.

Distribution of larvae and spawning grounds of four species relative to temperature and time of year is illustrated.
CALL LETTERS: SH1 F543
KEYWORDS: distribution; temperature; seasons

202. Murata, M. 1978. The relation between mantle length and body weight of the squid, TODARODES PACIFICUS Steenstrup. Bull. Hokkaido Reg. Fish. Res. Lab., 43:33-51.

The allometry formulas showing the relative growth between mantle length (L) and body weight (W) of the squid, TODARODES PACIFICUS Steenstrup were estimated by year and by month in the different waters around Hokkaido. The value b of relative growth coefficient, estimated by year from samples of male and female squid together, varies irregularly in the range of 3.06 to 3.46 during the years of 1951-1975. Also, the degree of fatness by year of the squid was inferred on the basis of the body weight calculated from the allometry change, namely, increasing from June to September, and decreasing from October to December. The value b of the male squid tends to be a little longer than that of the female, though the difference is very small. The value b and calculated body weight varied between areas. The value of b seems to be a little more than 3.0 in the range of 17 to 22 cm, almost equal to, or a little less than 3.0 in the range of 12 to 17 cm and over 23 cm, and less than 3.0 in the range of 2 to 12 cm in mantle length. Study of the developmental stages of the squid in samples taken is necessary when examining relations between populations of squid in different waters based on the relative growth coefficient (b), or coefficients of fatness (F=W/L.SUP-3).
CALL LETTERS: (NA)
KEYWORDS: other species; length; weight; stock delineation; growth; modelling

203. Murata, M. 1983. Quantitative assessment of oceanic squid by means of jigging surveys. Biol. Ocean., 2 (2-3-4):433-456.

Few attempts have been made to quantitatively assess standing stocks of squid and cuttlefish. Jigging surveys have been conducted since 1971. Their purpose has been to assess the abundance of oceanic squid. The stock size index (N) and the density index (F) for TODARODES PACIFICUS, OMMASTREPHES BARTRAMII, and ONYCHOTEUTHIS BOREALIJAPONICA were calculated. N and F correspond reasonably well to periodic changes in the annual yield (Y) of T. PACIFICUS. Since Y is presumed to correspond well to abundance, the results of these surveys give rough estimates of T. PACIFICUS abundance. Changes in N and F for O. BARTRAMII and O. BOREALIJAPONICA do not show good correspondence with Y, probably because the study area covers only a part of the range of the the two species. The equation relating F and Y for T. PACIFICUS AND O. BARTAMI combined is Y (tons) = 10,500F + 16,300 (r = 0.972). This relationship might be used as a first approximation for expected yield, but to make a precise assessment of the abundance of these oceanic squids it will be necessary to accumulate more biological data on their distribution and migration and to adjust the grid surveys accordingly.
CALL LETTERS: QH91 A1
KEYWORDS: other species; abundance; modelling; stock assessment

204. Murata, M. 1983. On the distribution and the behavior under fishing lamps of young Japanese common squid, TODARODES PACIFICUS Steenstrup, in the offshore waters of northern Japan during spring and early summer. Bull. Hokkaido Reg. Fish. Res. Lab., 48:37-52.

The distribution of young squid in coastal and offshore waters was investigated. The results give details of the living environment, behavior under fishing lamps, and a classification of the developmental stage. There were two or three groups in the young squid which had different ranges of mantle length. Their distribution is uneven and shows a concentration in and around the polar front areas and in coastal regions. The smallest size squid appeared on the water surface under fishing lamps and stayed for some minutes and disappeared suddenly. The larger squid rarely came to the surface. When they did, it was only for a few seconds.
CALL LETTERS: (NA)
KEYWORDS: other species; distribution; length; behavior-schooling, feeding; temperature

205. Murata, M. and M. Ishii. 1977. Some information on the ecology of the oceanic squid, OMMASTREPHES BARTRAMI (Lesueur) and ONYCHOTEUTHIS BOREALIJAPONICUS Okada, in the Pacific Ocean off northeastern Japan. Bull. Hokkaido Reg. Fish. Res. Lab., 42:1-23.

The authors carried out jigging experiments with research vessels, biometical research, etc., in the Pacific. In this paper, they considered some biological aspects such as growth, maturity, sex ratio and structure of the population of O. BARTRAMI and O. BOREALIJAPONICUS. The major results obtained for O. BARTRAMI are as follows: (1) As a whole, the average mantle length of the squid became gradually larger from June to February of the succeeding year; (2) it is thought that males mature prior to females; (3) it is supposed that the population appearing in the Pacific off North Japan contains two groups, which are different in growth. The large sized group tends to be distributed more northerly than the small sized group in summer. The growth patterns of both groups are sigmoid in type; (4) it is inferred that both groups are the same year class born in different seasons, and that the main spawning season of both groups is January to May. The life span of this species is supposed to be normally about 1 yr. The results for O. BOREALIJAPONICUS are as follows: (1) the squid often had a remarkably wide range in the mantle length compositions; (2) it seems that males mature prior to females; (3) the ratio of males in the samples decreased from June to October, probably because the period from Aug to Oct may be the copulating season, after which the males leave the schools; (4) the population consists of several groups differing in size. It is supposed that they are the same year class born in different seasons; (5) it is presumed that the main spawning season is from late autumn to winter, and that the life span of this species is normally about 1 yr.
CALL LETTERS: (NA)
KEYWORDS: other species; length; growth; sex ratio; behavior-spawning; stock delineation

206. Murata, M., M. Ishii, and C. Shingu. 1983. Seasonal changes in location and water temperature of the fishing grounds by jigging fishery for flying squid, OMMASTREPHES BARTRAMI (Lesueur), with some considerations on migration and occurence of the fishing ground. Bull. Hokkaido Reg. Fish. Lab., 48:53-77.

The relationship between the fishing grounds of O. BARTRAMI and seasonal changes in water temperature were investigated. The range of the major fishing grounds and the location of good fishing grounds differ from year to year. The water temperature of the region which is commonly fished is 11-21 degrees C at the surface and further offshore the grounds tend to be in the regions with lower water temperatures. Shortly before the fishing season O. BARTRAMI is mainly distributed in the offshore warm water with surface temperatures of 16-21 degrees C, surface salinity of 33.7-34.8%, and water temperatures above above 10 degrees C at 100 m in depth. Major fishing grounds from July to

September are regions with water temperatures of 5-10 degrees C at 100 m in depth and in and around the region where isotherms of 5 degrees C concentrate. The location of fishing grounds and the catch volume is considered to be closely related to the boundary between warm water masses and cold water.
CALL LETTERS: (NA)
KEYWORDS: other species; distribution; temperature; fishery-Japan; migration

207. Murata, M. and Y. Shimazu. 1982. On some population parameters of frying squid, OMMASTREPHES BARTRAMI (LeSueur) in the northwest Pacific. Bull. Hokkaido Reg. Fish. Res. Lab., 47:1-10.

Catch and effort statistics for jigging boat fishery in 1979 were compiled by ten day basis. Some linear regression methods of De Lury type estimator and a nonlinear regression method were applied to the data. Total mortality coefficient during two months was estimated to be 0.14-0.15 per decade. Although a value of 0.1495/decade was estimated as natural mortality coefficient by nonlinear regression method, it was considered too high. Judging from other biological information and some previous estimates for similar species, natural mortality coefficient of this species seemed to be less than 0.07/decade and thus rate of exploitation during two months exceeds 30 percent.
CALL LETTERS: (NA)
KEYWORDS: other species; mortality; modelling

208. Nagao, K. and T. Kimura. 1951. Bacteriological studies of Shiokara or "Soused Squid." 2. The studies on the chemical changes in the ripening process. Bull. Faculty Fish., Univ. Hokkaido, 1(2):81-86.

In this report, the change of the chemical components during ripening of Shiokara was observed.
CALL LETTERS: (NA)
KEYWORDS: other species; physiology-biochemical analysis

209. Nagao, K., T. Kimura, and A. Seino. 1951. Studies on enzymes of bacteria. 1. On the catalase of bacteria which were isolated from Shikokara or "Soused Squid". Bull. Faculity Fish., Hokkaido, 1(2):86-89.

In this report, the authors first used bacteria which were isolated form the Shiokara or "Soused Squid" and made Exoenzyme and Endoenzyme-solution of catalase by using the technique for destroying the cell wall of the bacteria by grinding with quartz sand.
CALL LETTERS: (NA)
KEYWORDS: other species; physiology-biochemical analysis

210. Nash, D.M., C.A. Eaton, and N.F. Crewe. 1978. Lipid classes and fatty acid composition of squid (ILLEX ILLECEBROSUS). pp. 22.1-22.8. In: Proceedings of the workshop on the squid, ILLEX ILLECEBROSUS, Dalhousie Univ., Halifax, Nova Scotia, May, 1978, and a bibliography on the genus ILLEX. Can. Fish. Mar. Serv. Tech. Rep., No. 833. 311 pp.

We have analyzed the lipid composition of squid and squid meal. Squid mantle lipids are similar to other marine species such as cod. Detailed fatty acid analyses were performed to identify any components which might be considered nutritionally undesirable.
CALL LETTERS: SH223 A88
KEYWORDS: other species; physiology-nutritional value

211. Nazumi, T., S. Kasahara, and M. Hamabe. 1979. Contribution of biological information useful for development of inshore squid fishery in the Japan Sea. III. Supplements and amendments to a previous paper on reproduction and distribution of BERRYTEUTHIS MAGISTER (Berry). Bull. Jap. Sea Reg. Fish. Res. Lab., 30:1-14.

In order to obtain supplementary information on biology of BERRYTEUTHIS MAGISTER (Berry), 171 specimens extracted from bottom trawl samples were investigated. The fishing grounds for them were at a depth of 320 meters in the western part of the Japan Sea. The samples were collected during March to November, but the majority of them were in May. Therefore, the ecological information obtained from the present material is concerned with that for the late spring to early summer. Various morphometrical measurements that were taken and some illustrations of important reproductive organs including "sperm rope" (or sperm mass) implanted on the female are given. The "sperm ropes" are implanted in a bundle of a dozen or more around the base of the gills. Measurements were also taken on eggs within the ovary and oviduct in which ovoidal or spherical eggs are linked with a filament. The sizes of the eggs were underestimated in the previous report but were proved to be 4-5 mm in diameter. The observed fecundity was about 5,000 eggs per female. This survey concluded that B. MAGISTER in the western sector of the Japan Sea may copulate during fall to winter seasons and spawn during spring to summer in the stratum close to the ocean floor.
CALL LETTERS: SH301 N52
KEYWORDS: other species; fecundity; behavior-spawning

212. Nicol, S., and R.K. O'Dor. 1985. Predatory behaviour of squid (ILLEX ILLECEBROSUS) feeding on surface swarms of euphausiids. Can. J. Zool., 63:15-17.

Squid (I. ILLECEBROSUS) were observed and filmed feeding on daytime surface swarms of euphausiids in the Bay of Fundy. The squid captured euphausiids by tentacular attack, a predatory behavior described previously for this and other species of squid feeding on mobile prey. This method of predation is quite different from the only other documented account of squid on euphausiid surface swarms.
CALL LETTERS: QL1 C23
KEYWORDS: other species; behavior-feeding; diet; gear used-video

213. Nixon, M. and J.B. Messenger (eds.). 1977. The biology of cephalopods. Symp. Zool. Soc. Lond., No. 38. 615 pp.

Proceedings of a symposium held at the Zoological Society of London, 1975, which reflects current research into different aspects of the life of cephalopods. Includes presentations on; evolution of cephalopods; gear techniques; bioluminescence; neurobiology; behavior; and others.
CALL LETTERS: QL1 Z712
KEYWORDS: other species; physiology-nerves, photophores, vision; gear used-trawl

214. O'Dor, R.K. 1978. Laboratory experiments with ILLEX ILLECEBROSUS. pp. 18.1-18.10. In: Proceedings of the workshop on the squid, ILLEX ILLECEBROSUS, Dalhousie Univ., Halifax, Nova Scotia, May, 1978, and a bibliography on the genus ILLEX. Can. Fish. Mar. Serv. Tech. Rep., NO. 833. 311 pp.

This report outlines the major problems of keeping squid in captivity and the ways of avoiding these problems. The critical factors defining good condition (in order of importance) are 1) skin condition, 2) feeding and 3) infection. Tattooing has been the most effective and least damaging method of marking squid.
CALL LETTERS: SH223 A88
KEYWORDS: other species; artifical rearing; tagging

215. O'Dor, R.K. 1982. Respiratory metabolism and swimming performance of the squid, LOLIGO OPALESCENS. Can. J. Fish. Aquat. Sci., 39(4):580-587.

Maximum sustainable and burst speed, standard and active metabolic rates, and metabolic scope at temperatures from 7.5 to 17.5 degrees C were determined for the squid, LOLIGO OPALESCENS, with a Brett tunnel respirometer. A comparison with sockeye salmon of similar size at 15 degrees C indicates that squid have higher standard and active rates but have sustainable speeds half those of salmon. This confirms the

low efficiency of jet-propelled swimming, and the resultant high cost of transport raises interesting questions about how and why squid make large-scale vertical and horizontal migrations and the tactics they use to compete with fish that are both their predators and prey. Burst speeds after several maximal jets do not appear to be significantly greater than the peak speed after a single jet suggesting squid must depend primarily on maneuverability and high acceleration rather than high speed. A low capacity for accumulating an oxygen debt confirms predictions based on biochemical evidence. This debt is approximately equal to the energy needed to rephosphorylate muscle phosphagens.
CALL LETTERS: SH223 A52
KEYWORDS: LO; physiology-metabolism; behavior-swimming

216. Ogura, M. 1975. Fishing tackle and fishing efficiency in squid jigging. FAO Fish. Rept. 170, Suppl. 1:99-102.

Color and material of jigs, size of jig stems, and diameter of fishing line are major factors to consider in fishing tackle. Red and orange colored stems proved to be the best with green and fluorescent the poorest. The most efficient material for jigs was red and orange stems with inserted pieces of shell, while white bakelite and silvery metal were poorest. Jigs with long stems and three rows of long hooks proved to be the best in bringing squid in. The thinnest possible monofilament line should be used. Automatic jigging machines were superior on dense schools and schools near the surface, but hand operated machines were better able to adjust to fishing conditions and could apply more complex jigging patterns.
CALL LETTERS: SH1 F543
KEYWORDS: gear used-jigs; gear development

217. Ogura, M. and T. Nasumi. 1975. Fishing lamps and light attraction for squid jigging. FAO Fish. Rept. 170. Suppl. 1:93-98.

The common squid (TODARODES PACIFICUS) does not concentrate at bright light, but preferably in the boundry between light and shade. Jigging machines are positioned so that lines pass through the boundary zone of light and shade of the vessel. To develop an efficient light attraction system, the physical factors of light distribution in water and reaction pattern of squid have to be taken into account. The area of illumination from lights has the shape of butterfly wings. Comparison trials indicate mercury vapor lamps are more efficient in attracting squid and are less power consumptive than incandescent lamps.
CALL LETTERS: SH1 F543
KEYWORDS: gear used-lights, jigs; behavior-schooling; gear development

218. Okutani, K. and N. Morikawa. 1978. Purification and characterization of the polysaccharide obtained from squid internal shell. Bull. Jap. Soc. Sci. Fish., 44(7):749-753.

Polysaccharides A and B were isolated in pure form from the squid internal shell. The purification of the polysaccharide was carried out by using DEAE-cellulose colume chromatography. These purified products were homogeneous when examined by gel-filtrations and ultracentrifugations. Both polysaccharides were composed of glucose as the sole constituent monosaccharide.
CALL LETTERS: SH1 J2
KEYWORDS: physiology-biochemical analysis

219. Okutani, T. 1977. Stock assessment of cephalopod resources fished by Japan. FAO Fish. Tech. Pap., 173:1-62.

The distribution and abundance of the resource of cephalopods fished by Japan are reviewed. Japanese fishermen take over half the world catch of these species. The main Japanese fisheries are around the coast of Japan, but significant catches are taken in several other areas. By far the most important species (rather more than half the total) is TODARODES PACIFICUS, caught by jigging. The rest of the Japanese catch consists of other squids (15-20 percent), octopods (10-15 percent) and cuttlefish (around 5 percent). Most of the stocks around Japan are fully exploited, and the important winter stock of T. PACIFICUS appears to have been depleted by heavy fishing. Fisheries to the northeast of Japan on oceanic squids seem to be affecting only the fringe of very substantial stocks.
CALL LETTERS: SH1 F539
KEYWORDS: other species; landings; distribution; fishery-Japan

220. Okutani, T. and H. Hatanaka. 1975. Distribution of ommastrephid and large-sized loliginid squid. FAO Fish. Rept. 170, Suppl. 1:4-8.

Physical and ecological similarities and differences between ommastrephids and large-sized loliginids as a group are summarized. The distributions for most species are given by geographical region.
CALL LETTERS: SH1 F543
KEYWORDS: LO; other species; distribution

221. Okutani, T. and J.A. McGowan. 1969. Systematics, distribution, and abundance of the epiplanktonic squid (Cephalopoda, Decapoda) larvae of the California Current, April 1954 - March 1957. Bull. Scripps Inst. Oceanogr., 14:1-90.

Fourteen species of cephalopod larvae from 4 years of zooplankton collections made in the California Current were described and illustrated. Distributions and relative seasonal abundance were summarized for each species.
CALL LETTERS: QH91 C22
KEYWORDS: LO; other species; larvae; description; distribution; abundance

222. Okutani, T. and T. Watanabe. 1983. Stock assessment by larval surveys of the winter population of TODARODES PACIFICUS Steenstrup (CEPHALOPODA: OMMASTREPHIDAE), with a review of early works. Biol. Ocean., 2 (2-3-4):401-431.

This is a study of larval abundance and distribution pattern of the winter population of the Japanese common squid, TODARODES PACIFICUS Steenstrup, based on plankton net collections. The larval abundance index (LI) was compared with CPUE (catch per boat day), an index of recruitment of adult stock size. Mortality seems to be highest for stages up to several millimeters DML than for later stages. Because of the short life-span (one year) of this squid, abrupt decreases of larval abudance and/or recruitment have a serious effect on stock size. The future recovery of the stock will depend on biotic and physical conditions that are favorable for the survival of early stages. A significant positive correlation between catch per effort of adults and the abudance of larvae (LI) in the following year indicates that larval abundance can be used to assess the size of the spawning stock of the winter population of T. PACIFICUS.
CALL LETTERS; QH91 A1
KEYWORDS: other species; larvae; stock assessment; distribution

223. Osako, M. and M. Murata. 1983. Stock assessment of cephalopod resources in the northwestern Pacific. FAO Fish. Tech. Pap., 231:55-144.

This report outlines the status of major Japanese fisheries for "Surume Ika" (TODARODES PACIFICUS) and "Aka Ika" (OMMASTREPHES BARTRAMII) and reviews the methods of recruitment forecast and stock assessment used for these two squid. In the "Surume Ika" fishery the greater part of catch is taken by jigging boats and from 5 to 500 GRT. Annual catch of "Surume Ika" was between 50,000 t and 200,000 t up until 1945 and sharply increased from 1945 through 1955. Since 1970 however, the catch has decreased to around 200,000 t. It now seems that all "Surume Ika" fishing grounds around Japan have been completely exploited since 1971. In 1974 the "Aka Ika" fishery began in response to poor success of the "Suruma Ika" fishery. This fishery now takes

nearly the same catch as in the present "Suruma Ika" fishery. Since 1978 a drift-gill net fishery for squid has been introduced. Forecast and estimation of squid recruitment are made and announced officially twice a year in a cooperative meeting of national and prefectural institutes. Data on size composition, larva, water temperature, catch statistics, CPUE, etc. are used for forecasting. No overall management of the Japanese squid fishery has been established to present however. Recently population dynamics has become a main theme of study on squid. Some preliminary work suggests that there is a relation between recruitment and fishing effort for "Surume Ika" and "Aka Ika" stocks around Japan.
CALL LETTERS: SH1 F539
KEYWORDS: fishery-Japan; other species; landings; gear used; abundance; stock assessment

224. Otwell, S. and G.G. Giddings. 1980. Scanning electron microscopy of squid, LOLIGO PEALEI: raw, cooked, and frozen mantle. Mar. Fish. Rev., 42(7-8):67-73.

Scanning electron microscopy (SEM) was used to investigate the tissue structure in raw, frozen, and cooked mantles from squid, LOLIGO PEALEI. The mantle consists of five distinct layers of tissue. Each layer in the raw state is described. The freeze fracture techniques used to prepare samples for SEM viewing revealed tissue structural alterations caused by freezing the mantle to -29 degrees C. The same technique was used to observe thermal alterations caused by cooking the mantle to 100 degrees C. Loss of structural differentiation in the muscle fibers was the only discernible alteration caused by freezing, but cooking caused gross distortions in all mantle tissues.
CALL LETTERS: SH11 A14
KEYWORDS: other species; physiology-biochemical analysis

225. Pacific Fishery Management Council. 1978. Draft. Squid management plan. Portland, OR. 160 pp.

This draft presents scientific and socio-economic information pertinent to the choice of management options for the squid fisheries. The first section of the plan addresses the management of the fishery for LOLIGO OPALESCENS. The second section is directed towards the fishery for DOSIDICUS GIGAS, which occurs sporadically off the coast of southern California. The third section addresses all other species of squid. There is no directed fishing on these other species and there is limited knowledge about the life histories, abundance, behavior, ecology, and distribution. The present state of knowledge, variabilities in population sizes, age structures, and the possibility of local over harvesting, dictates lower optimum yield than existing population estimates might suggest.
CALL LETTERS: SH328 P345
KEYWORDS: LO; west coast species; distribution; age; sex ratio; abundance; habitat; regulations; gear used; markets

226. Palmer, B.W. and R.K. O'Dor. 1978. Changes in vertical migration patterns of captive ILLEX ILLECEBROSUS in varying light regimes and salinity gradients. pp. 23.1-23.12. In: Proceedings of the workshop on the squid, ILLEX ILLECEBROSUS, Dalhousie Univ., Halifax, Nova Scotia, May, 1978, and a bibliography on the genus ILLEX. Can. Fish. Mar. Serv. Tech. Rep., NO. 833. 311 pp.

Results showed that there was a distinct diurnal vertical migration pattern exhibited by I. ILLECEBROSUS - nearer the surface at night than in the day. Experiments suggest that salinities between 27-30 o/oo were prefered and salinities below 26 o/oo were avoided. It is possible that temperature also influenced the selection of gradient layers.
CALL LETTERS: SH223 A88
KEYWORDS: other species; salinity; temperature; behavior-photoperiod

227. Pavlychev, V.P. and G.A. Shevtsov. 1977. Effect of hydrological conditions on the fishery of squid, TODARODES PACIFICUS Steenstrup in the Northwest Pacific. Izv. TINRO. v.101.

The long-term dynamics of the Japanese squid fishery are considered in relation to water temperature. Increases of squid catches in the Sea of Japan are associated with increases of water temperature in the Tsushima Current region. It is shown with reference to long-term fluctuations in the Kuroshio regime that another increase in the squid abundance may be expected in late 1970s or early 1980s.
CALL LETTERS: (NA)
KEYWORDS: other species; temperature

228. Pearcy, W.G. 1965. Species composition and distribution of pelagic cephalopods from the Pacific Ocean off Oregon. PACIFIC SCI., 19(2):261-266.

Midwater trawl collections provided data on vertical, geographic, and seasonal distribution of small oceanic cephalopods. A total of 17 different species, including 6 new distributional records, is reported. GONATUS FABRICII, GONATUS spp., and ABRALIOPSIS sp. dominated the 0-200 m. midwater trawl catches at nearly all stations regardless of latitude or season of the year. Differences in the catchs of GONATUS and ABRALIOPSIS made during day and night at different depths indicated that these squid migrate vertically. The total number of cephalopods per tow during the summer was about an order of magnitude greater than during the other seasons. Analysis of size-frequency distributions for these periods showed that small ABRALIOPSIS dominated summer collections, suggesting seasonality of breeding, whereas the shape of the size-frequency histograms for GONATUS were similar for both summer and non-summer seasons.
CALL LETTERS: Q1 P2
KEYWORDS: LO; west coast species; distribution-vertical; seasons

229. Pearcy, W.G. and G.L. Voss. 1963. A new species of gonatid squid from the northeastern Pacific. Proc. Biol. Soc. Wash., 76:105-112.

This paper describes a new species of squid, GONATUS ANONYCHUS, which was collected in oceanic waters of the northeastern Pacific Ocean off the Oregon coast during 1960-62.
CALL LETTERS: QH1 B6
KEYWORDS: west coast species; description

230. Phillips, J.B. 1941. Squid canning at Monterey, California. Calif. Fish Game, 27(4):269-271.

History of early squid fisheries and processing techniques. During early part of fishery most squid were dried. The next phase in processing was freezing. In the late thirties, the canning process was developed. The canning procedure for squid is reviewed. Most squid are still exported to foreign markets.
CALL LETTERS: SH11 C22
KEYWORDS: LO; processing-dried, canning

231. Phillips, J.B. 1960. Squid. pp. 20-21. In California ocean fisheries resources to the year 1960. California Dept. of Fish and Game. 79 pp.

A report of California ocean fisheries resources to the year 1960 presented to the Governor and Legislature. Section on squid reviews biology of LOLIGO OPALESCENS. Squid congregate to spawn in the spring in semi-protected bays with sandy bottoms. Fishery is conducted in only a small segment of the range of this species. The resource is underharvested. Lampara nets are the primary gear used in Monterery Bay. In southern California, "scoop boats" are used.
CALL LETTERS: SH11 C225
KEYWORDS: LO: fishery-Monterey Bay, S. California; landings; gear used

232. Quigley, J.J. 1964. Mechanized squid jigger. Can. Dept. Fish. Trade News, 17(5):3-5.

A technician from a Japanese trawler demonstrated the use of a mechanized squid jigger for the Newfoundland Dept. of Fisheries. Initial experimental operation produced results that were most encouraging. Vessels using the mechanized jigger were catching nearly 4,000 lbs of squid while another vessel using traditional jigs and traps was taking about 600 lbs. The light attraction system used consisted of three 100 watt ordinary light bulbs. The jigs on the mechanized units had two sets of pins, compared with only one on the more traditional gear.
CALL LETTERS: SH223 A28
KEYWORDS: gear used-jigs, lights

233. Rathjen, W.F. 1973. Northwest Atlantic squids. Mar. Fish. Rev., 35(12):20-26.

Discussion on distribution, abundance, harvest methods, and life histories of short-finned, long-finned squid and several other Atlantic species. Brief discussion on harvest methods-most done by Japanese fleet trawling near the edge of the continental shelf during the winter months. Heavier catches are made during daylight hours. Jigging is also an important fishing method. Review of methods for measuring abundance and distribution included using echosounding equipment, underwater cameras, and aerial surveying. Recent technical advances reviewed included pumping method of harvesting, and rearing squid from eggs to maturity in five months.
CALL LETTERS: SH11 A14
KEYWORDS: other species; gear development; distribution; abundance; sampling methods

234. Rathjen, W. 1983. East coast squid fisheries. pp. 11-21. in: Proceedings of the west coast squid symposium. February 1-2, 1983. Newport, Oregon. Oregon State Univ. Sea Grant Marine Advisory Program. 149 pp.

Description of fisheries of the western North Atlantic from Newfoundland to NE US. Description of vessels, gear used, and markets.
CALL LETTERS: SH374 .52 U6 W41
KEYWORDS: other species; gear used; markets; fishery-N. Atlantic

235. Rathjen, W.F. 1984. Squid fishing techniques. Gulf and South Atlantic Fisheries Development Foundation, Inc. 15 pp.

Provides a general discussion of the primary methods used in squid harvesting around the world at this time. Included are discussions, illustrations, and distribution of use maps for jig, trawl, lift nets, seines, traps, and gill nets.
CALL LETTERS: (NA)
KEYWORDS: gear used-jigs, trawl, lights, nets, purse seine, lampara, traps, gill net

236. Rathjen, W.F. and D.W. Stanley. 1982. A harvesting and handling demonstration, Cape Ann, Massachusetts. pp. 145-152. In: Proceedings of the international squid symposium. August 9-12, 1981. Boston, Massachusetts. New England Fisheries Development Foundation, Inc. 390 pp.

Experimental demonstration fishing for ILLEX ILLECEBROSUS used light attraction and jigging equipment. Evaluation of the maintenance of squid quality was examined by using an assay that measured protein deterioration.
CALL LETTERS: QL430 .3 L8 I561
KEYWORDS: other species; gear used-jigs, lights; quality

237. Raynes, G.W. 1982. The Canadian experience in marketing squid. pp. 323-328 in: Proceedings of the international squid symposium. August 9-12. 1981. Boston, Massachusetts. New England Fisheries Development Foundation, Inc. 390 pp.

Until recently the demand for Canadian Atlantic squid, ILLEX ILLECEBROSUS, was insignificant in the context of the world market. In 1976 a new market began to emerge, brought about in large measure by the declining trend in the Japanese catches of common squid.
CALL LETTERS: QL430 .3 L8 I561
KEYWORDS: markets; fishery-N. Atlantic

238. Recksiek, C.W. 1978. California's market squid. Pacific Discovery, 31(6):19-27.

This article is a summary of research by the author and other investigators on LOLIGO OPALESCENS. Echosounders are being used for detection and biomass estimation of squid. Spawning grounds are often located near submarine escarpments or canyons. Possibly squid prey species, such as euphausiids, are concentrated in these areas. Most spawning takes place during spring months but is also known to occur throughout the year. Spawning behavior is described. Most L. OPALESCENS spawn and die when 14-20 lunar months old. Larvae hatch in 3-4 weeks depending on water temperature. It has been suggested that larval squid can maintain their position in the water and they may orient to the sea floor to the extent that their dispersion by the currents is controlled. The beaks of L. OPALESCENS are arranged opposite that of birds: the lower jaw closes over the upper one. Squid digestive rates exceed those in fishes by 5-10 times. It has been estimated that L. OPALESCENS consume about 14% of their weight in food daily. A correlation between the commercial catch at Monterey Bay and water temperature 18 months earlier has been demonstrated.
CALL LETTERS: Q1 P17
KEYWORDS: LO; acoustics; habitat; diet; behavior-spawning, feeding; age; predators; larvae; beaks;

239. Recksiek, C.W. and H.W. Frey (eds.). 1978. Biological, oceanographic, and acoustic aspects of the market squid, LOLIGO OPALESCENS Berry. Calif. Dept. Fish Game, Fish Bull., Vol. 169. 185 pp.

This report describes the results of three years of research on the market squid. Areas of study included spermatogenesis and oogenesis; age and growth; feeding dynamics and prey of market squid; marine fish, birds, and mammal predators of this species in Monterey Bay; assessment of total population size and structure (number of stocks), and possible morphological indicators of stocks; the properties of market squid with respect to acoustic identification and quantification; and the relationship of the availability of this species to the commercial fishery in relation to the physical oceanographic conditions in Monterey Bay.
CALL LETTERS: SH11 C24
KEYWORDS: LO; physiology-gonad maturation; age; growth; diet; predators; abundance; stock assessment; stock delineation; acoustics; temperature; upwelling.

240. Recksiek, C.W. and J. Kashiwada. 1979. Distribution of larval squid, LOLIGO OPALESCENS, in various nearshore locations. CalCOFI Rep., 20:31-34.

Three distinct sampling efforts employing different plankton-collecting gears aimed at collecting California market squid, LOLIGO OPALESCENS, in nearshore waters from San Diego to Monterey Bay are described. Larval L. OPALESCENS occurrence in the hauls was low and patchy, corroborating the experience of past workers. Over the Monterey spawning grounds, the use of a specially designed bottom-fishing plankton net was found to be more generally effective than the other gears.
CALL LETTERS: SH351 S2 C22
KEYWORDS: LO; distribution; larvae; gear used; sampling methods

241. Robinson, S.M.C. and G.S. Jamieson. 1984. Report on a Canadian commercial fishery for flying squid using drifting gillnets off the coast of British Columbia. Can. Ind. Rep. Fish. Aquat. Sci., No. 150. 25 pp.

During July and August 1983 a Canadian commercial fishing vessel used monofilament drifting gill nets to catch flying squid (OMMASTREPHES BARTRAMII), fishing approximately 322 km offshore with a mean net length per set of 3.89 km. The total catch of O. BARTRAMII was 33.0 t which was 56.8% of the entire catch from 25 sets. Salmonids and tuna represented 0.24 and 0.82% respectively, pomfret (BRAMA JAPONICA) 24%, sharks 17.7% and other miscellaneous catch 0.44%. Squid weight was fairly consistent with a mean weight of 2.33 kg, and average

CPUE was 339.2 kg squid/km net. An automatic, electric squid jigging machine was tested but the catch was low partly because the weight of the squid caused the animal to tear off the hook. Mean catch was 0.6 squid/hour.
CALL LETTERS: SH223 C148
KEYWORDS: west coast species; gear used-gill net, jigs; catch composition; weight

242. Roper, C.F.E. 1966. A study of the genus ENOPLOTEUTHIS (Cephalopoda: Oegopsida) in the Atlantic Ocean with a redescription of the type species, E. LEPTURA (Leach, 1817). Dana - Report, 13(66). 46 pp.

Specimens from the cephalopod genus of ENOPLOTEUTHIS are described and illustrated. Internal and external anatomy, bathymetric and geographic distribution are discussed.
CALL LETTERS: Q115 C27
KEYWORDS: other species; description; length; distribution-vertical; anatomy

243. Roper, C.F.E. 1977. Comparative captures of pelagic cephalopods by midwater trawls. Symp. Zool. Soc. Lond., 38:61-87.

The captures of pelagic cephalopods by the 3 m Isaacs-Kidd midwater trawl (IKMT), the 8 m^2 rectangular midwater trawl (RMT8), and the small Engel trawl (EMT) are compared. The comparisons were made on net captures taken at 13 standardized depth increments from the surface to 1250 m for both day and night-time. Comparisons were developed for catch rate, species composition, size distribution, and co-occurrence of species. The comparison of IKMT and the RMT8 nets with nearly equivalent mouth openings, indicates that the IKMT catches slightly larger specimens of the same species than the RMT8. The RMT8, however, catches more specimens per hour of a given species than the IKMT, and it tends to catch a greater diversity of species. The Engel trawl, a net with a much larger area of mouth opening, catches a significantly greater number of species, more specimens of each species, and very much larger specimens then either the IKMT or the RMT8.
CALL LETTERS: QL1 Z712
KEYWORDS: gear used-trawl; gear selectivity

244. Roper, C.F.E. and C.C. Lu. 1978. Rhynchoteuthion larvae of ommastrephid squids of the western North Atlantic, with the first description of larvae and juveniles of ILLEX ILLECEBROSUS. pp.14.1-14.26. In: Proceedings of the workshop on the squid, ILLEX ILLECEBROSUS, Dalhousie Univ., Halifax, Nova Scotia, May, 1978, and a bibliography on the genus ILLEX. Can. Fish. Mar. Serv. Tech. Rep., No. 833. 311 pp.

Rhynchoteuthion larvae of three species of ommastrephid squids from the western north Atlantic are described and illustrated. Larvae and juveniles of ILLEX ILLECEBROSUS are characterized for the first time.
CALL LETTERS: SH223 A88
KEYWORDS: other species; description; larvae

245. Roper, C.F.E., M.J. Sweeney and C.E. Nauen. 1984. FAO species catalogue. Vol. 3. Cephalopods of the world. FAO Fish. Synop., 125(3). 277 pp.

This is the third in the FAO series of worldwide annotated and illustrated catalogues of major groups of organisms that enter marine fisheries. The present volume includes 173 cephalopod species of actual or potential fishery interest, belonging to the nautiluses, cuttlefishes, squids, and octopuses. It provides a comprehensive and illustrated key to all the 43 cephalopod families, with a glossary of technical terms and measurements. Within each family are given individual accounts of species, which include drawings, scientific and vernacular names, information on habitat, biology and fisheries, and a distribution map; for most families there is also a key to genera.
CALL LETTERS: (NA)
KEYWORDS: LO; west coast species; other species; description; distribution

246. Roper, C.F.E. and G.L. Voss. 1983. Guidelines for taxonomic descriptions of cephalopod species. Memoirs of the National Museum Victoria, 44:49-63.

This paper presents a format of guidelines considered necessary for the description (or redescription) of species of cephalopods. These guidelines or standards include specific requirements for descriptive characters of species within the Orders Sepioidea, Teutholdea and Octopoda as well as general information, e.g., synonymy, locality, etc. Standards are given for descriptions, counts of measurements, and illustrations. Appendices list definitions of counts, measurements, and indices; diagramatically illustrate standard measurements; and give examples from the literature of descriptions that approach these standards.
CALL LETTERS: (NA)
KEYWORDS: description

247. Roper, C.F.E., R.E. Young, and G.L. Voss. 1969. An illustrated key to the families of the order Teutholdea (Cephalopoda). Smithsonian Institution Press, Washington, D.C., 32 pp.

A dichotomous key to the twenty-five families of cephalopods of the order Teutholdea is presented. A supplementary chart of basic, external teuthold characters is included. Representatives of each family are illustrated. The current state of systematics within each family is briefly discussed.
CALL LETTERS: QL1 S5
KEYWORDS: description; anatomy

248. Roper, C.F.E. and R.E. Young. 1975. Vertical distribution of pelagic cephalopods. Smithsonian Contributions to Zoology, No. 209. 51 pp.

The vertical distributions of pelagic cephalopods are analyzed, based primarily on studies undertaken in the waters off California, Bermuda, and Hawaii. Much of the information is derived from midwater trawl nets equipped with closing apparatus. The study revealed that several basic types of vertical distributional patterns occur: near-surface dwellers, first order diel vertical migrators, second order diel vertical migrators, diel vertical shifters, diel vertical spreaders, non-migrators, vertical wanderers, species associated with the ocean bottom, species exhibiting ontogenetic descent.
CALL LETTERS: QL1 S5
KEYWORDS: LO; west coast species; other species; distribution-vertical

249. Rosenberg, A.A., K.F. Wiborg, and I.M. Bech. 1980. Growth of TODARODES SAGITTATUS (Lamarck) (Cephalopoda, Ommastrephidae) from the northest Atlantic, based on counts of statolith growth rings. Sarsia, 66:53-57.

Growth is described from size-at-age data. Size-at-age was determined from counts of daily growth rings on the statoliths of 65 individuals. A mean growth rate of 2 mm/day was calculated for a dorsal mantle length range of 15-52 cm. The month in which each individual hatched was back-calculated from the age data. A histogram of the frequency of hatching through the year is presented and shows peaks in May and October.
CALL LETTERS: QH301 S3
KEYWORDS: other species; growth; length; age

250. Rowe, L. 1978. Research on ILLEX ILLECEBROSUS at the MSRL, Logy Bay, Newfoundland. pp. 17.1-17.3. In: Proceedings of the workshop on the squid, ILLEX ILLECEBROSUS, Dalhousie Univ., Halifax, Nova Scotia, May, 1978, and a bibliography on the genus ILLEX. Can. Fish. Mar. Serv. Tech. Rep., No. 833. 311 pp.

Summary of graduate research projects carried out at the Marine Sciences Research Lab. Includes: blood properties; morphology and taxonomy; growth; physiology; histology; parasites; and behavior.
CALL LETTERS: SH223 A88
KEYWORDS: other species; parasites; growth; behavior

251. Saito, R. 1975. The Japanese fishery (jigging) for NOTOTODARUS SLOANI SLOANI in New Zealand waters. FAO Fish. Rept. 170, Suppl. 1:53-60.

Long-liners and pelagic trawlers indicated the existance of and suggested a wide spread distribution for the squid NOTOTODARSUS SLOANI SLOANI. Exploratory fishing cruises were carried out in preparation for developing a commercial jigging fishery. Fishing grounds that have developed are summarized as to location, oceanographic conditions, squid catches. Jigging around New Zealand has been concentrated over the insular shelf. Unless the fishery expands further off shore, this fishery will hardly prosper.
CALL LETTERS: SH1 F543
KEYWORDS: other species; fishery-Australia

252. Sasaki, M. 1929. A monograph of the dibranchiate cephalopods of the Japanese and adjacent waters. J. Faculty Agriculture, Hokkaido, 20(Suppl.). 357 pp.

Descriptions and illustrations of 125 species of dibranchiate cephalopods occurring in the Japanese and adjacent waters.
CALL LETTERS: QL430 .2 S3
KEYWORDS: other species; description

253. Sato, M., M. Stevens, and W. Lund. 1982. Discussion on joint venture operations. pp. 153-163. In Proceedings of the International squid symposium. August 9-12, 1981. Boston, Massachusetts. New England Fisheries Development Foundation, Inc. 390 pp.

Panel discussion on joint venture problems in squid jigging off New Zealand and Australia. Pacific whiting fishery in the Pacific NW, and Japanese trawl fishery off the east coast of the US.
CALL LETTERS: QL430 .3 L8 I561
KEYWORDS: joint venture

254. Sato, T. 1975. Results of exploratory fishing for DOSIDICUS GIGAS (D'Orbigny) off California and Mexico. FAO Fish. Rept. 170, Suppl. 1:61-67.

Population density of D. GIGAS in the Gulf of California was low, most of the catch taken in the eastern part of the Gulf. In the area around Manzanillo, Mexico, fishing grounds were scattered and population densities were low. The relationships between water temperature and catch rate are shown. The majority and larger squid were found in waters of 24-28 degrees C suggesting a close relation between temperature and growth. More females than males were found possibly because males die after mating. Comparisons of mantle length versus reproductive stages suggest the existence of four subpopulations. Forage of D. GIGAS is rich with red crab as a dominant component; and shark and marine mammals are the major predators.
CALL LETTERS: SH1 F543
KEYWORDS: west coast species; abundance, distribution; stock delineation; length; temperature; sex ratio; diet; predators

255. Sato, T. and H. Hatanaka. 1983. A review of assessment of Japanese distant-water fisheries for cephalopods. FAO Fish. Tech. Pap., 231:145-180.

This historical progress of Japanese distant-water fisheries for cephalopods and the state of some important cephalopod stocks fished by Japan is reviewed. The total Japanese annual catch of cephalopods has been maintained at about 110,000 t in recent years, which includes 14 commercially important species of squid, cuttlefish and octopus from seven FAO fishing areas. Preliminary stock studies have been made on seven species from six areas, and the current status of five species, namely LOLIGO, NOTOTODARUS and ILLEX squid in South African, New Zealand and Argentine waters, respectively. octopus off northwestern Africa, and cuttlefishes off the P.D.R. of Yemen are reviewed in this paper. As for most cephalopods fished by Japan, however, the lack of knowledge on the stock-recruitment relationship and the wide-ranging year-to-year fluctuations of catchable populations have made it difficult to apply analytical models to the stock assessment. Stock studies on those stocks have therefore laid stress on biomass estimation by means of the areal expansion method as the best way available for the time being of estimating population size, and potential yield results obtained suggest that fisheries for the three species of squid have not yet been fully exploited, although wide variation in annual recruitment made it difficult to specify one fixed level of sustainable yield for these short-lived species.
CALL LETTERS: SH1 F539
KEYWORDS: other species; abundance; stock assessment

256. Schoene, R. 1977. The biology, distribution and importance of some economically important squid (Cephalopoda) of the North Atlantic. Mitt. Inst. Seefisch. Bundesforschungsanst. Fisch. Hamb., 21:1-48.

The author reports on the present status of cephalopod fishery. Data on the biology, distribution and commerically useful species are also presented. One section is devoted to the fishing and location methods of cephalopod fishery.
CALL LETTERS: (NA)
KEYWORDS: other species; distribution; abundance; gear used

257. Scofield, W.L. 1924. Squid at Monterey. Calif. Fish Game, 10(4):176-182.

History of squid fishing in Monterey Bay up to mid 1920's. Discussion of history of gears used, fishing methods, and drying process.
CALL LETTERS: SH11 C22
KEYWORDS: LO; fishery-Monterey Bay; gear used; processing-dried

258. Scofield, W.L. 1951. Purse seines and other roundhaul nets in California. Calif. Fish Game, Fish Bull., 81:6-83.

Describes the history and development of purse seines, ringnets, and lamparas used in various California fisheries. Construction methods such as mesh sizes, bag and wing shapes, webbing, knots, and floats are described and illustrated. Fishing techniques and net operation are also discussed.
CALL LETTERS: SH11 C24
KEYWORDS: gear development; gear used-purse seine, ring net, lampara

259. Sheehy, D.J. and S.F. Vik. 1980. 'Saki-ika': dried squid processing equipment and markets. Mar. Fish. Rev., 42(7-8):85-92.

Dried and seasoned squid products, in a wide variety of forms, are very popular in Japan. Over 400,000 t of raw squid are processed into these products annually. Traditionally processed by hand and sun-dried, most of the processing and drying can now be accomplished with automated equipment. The manufacturing of "daruma" and "saki-ika" two forms of seasoned, dried squid which are not subject to Japanese import quotas, is described. The potential use of this technology for processing American squid for the large Japanese market is discussed.
CALL LETTERS: SH11 A14
KEYWORDS: processing-dried, seasoning, skinning, automated, products

260. Shibata, K. and E.E.C. Flores. 1972. Echo-traces typical of squids in waters surrounding Japan. FAO Fish. Circ., 142:7-13.

This paper deals with the typical echo-traces of squid appearing on sonar and on a vertical echo-sounder. Means of verifying that the traces are of squid are examined. Behavior of squid in the fishery is studied by echo-sounder and by underwater television.
CALL LETTERS: SH1 F537
KEYWORDS: acoustics; gear used-video

261. Shibata, K. and P. Masthawee. 1980. Experimental echo survey for squid fishing around the Phuket waters. Southeast Asian Fisheries Development Center, Current Technical Paper, No. 9. 30 pp.

An experimental echo survey in regard to squid handline fishing was carried out. The aim of this survey was to detect fish and squid schools in the Phuket waters and to measure the target strengths of various fish and squids by means of a 50 kHz echosounder. The present report deals with the method and various aspects of use of the 50 kHz echosounder. The authors have also attempted to evaluate the results obtained by its use, particulary its effectiveness in detection of fish schools. After calibration of the 50 kHz sounder used in this survey, and the target strength measurements, it was demonstrated that the sounder can detect an individual squid at maximum depth of 20 to 30 m, when the sensitive gain control is set at magnitude -3. It was very difficult to identify echoes from fish swimming in layers below 30 m and in the surface layer of less than 10 m. Detection in depths over 30 m is restricted by the signal/noise ratio, particularly in the night-time. The high noise level of the shallow layer may have been caused by the depth of the transducer.
CALL LETTERS: (NA)
KEYWORDS: other species; acoustics

262. Shingu, C., M. Murata and M. Ishii. 1983. Changes in catch of common squid, TODARODES PACIFICUS Steenstrup, in the Pacific Coast of Japan. Bull. Hokkaido Reg. Fish. Res. Lab., 48:21-36.

The jigging fishery for common squid (TODARODES PACIFICUS Steenstrup) extends over nearly all the coasts of Japan. Virtually all of the commercial catch is made by jig fishing. The total catch in Japan began to increase around 1954 and remained at high levels, between 300 and 600 thousands tons, for the 1950-1970 period. After 1970 the catch sharply decreased. Up to early 1960's, the catch in the Pacific fishing grounds, made from the coasts of northern Japan during June through December, showed that there was a considerable geographical decline in the relative density along Japanese coasts. In recent years after 1972, however, such a trend in catch and relative density disappeared from the Pacific coasts. Fishing effort for the squid jigging fishery, in terms of fishing days, increased twofold or more, from 1953 to 1979, in the Pacific coasts, suggesting an opposite

correlation between catch and effort. Total mortality estimated from the cummulative catch curves also showed the increasing trend from 0.3 to 0.6 during that period (natural mortality estimated to be about 0.246). From the view points of efficient capturing as well as conservation of the adult population, it seems to be desirable to start to fish in August or September for the squid population entering into the northern fishing grounds of the Pacific.
CALL LETTERS: (NA)
KEYWORDS: other species; fishery-Japan; gear used-jigs; landings; mortality; stock assessment

263. Shotton, R. and G.P. Bazigos. 1984. Techniques and considerations on the design of acoustic surveys. Rapp. P.-v. Reun. Cons. Int. Explor. Mer, 184:34-57.

The objectives of acoustic surveys and the application of sampling theory, especially probability sampling, to survey design are discussed. The concepts of bias and its sources are described. Some methods of calculating the precision of sample results are noted. Robust methods are reviewed as potential techniques to be used in the analysis of acoustic surveys results. The information about the nature of the distribution of fish schools necessary to answer questions such as how much sampling effort should be used, or what separation transets should have, generally does not exist. Such information is necessary for selecting a design which will give greatest precision of the sample estimates.
CALL LETTERS: GC1 I66
KEYWORDS: acoustics

264. Singh, R.P. and D.E. Brown. 1980. Development of a squid-skinning and eviscerating system. Mar. Fish. Res., 42(7-8):77-84.

A squid skinning and eviscerating machine was designed for California market squid, LOLIGO OPALESCENS. Various operations such as orientation, cutting, skinning, and evisceration were completely automated. Solenoid valves were used to operate the various components for the cleaning operations. The output from the machine was a cleaned white mantle in tubular shape and tenacles. The machine operates with a low consumption of water. The pilot-scale machine cleaned squid at a rate of four squid per minute. Industrial scale-up for processing 10 tons of squid per 8-hour shift is explored in the paper.
CALL LETTERS: SH11 A14
KEYWORDS: LO; processing-skinning, automated

265. Sloan, N.A. 1984. Canadian-Japanese experimental fishery for oceanic squid off British Columbia, summer 1983. Can. Ind. Rep. Fish. Aquat. Sci., No. 152. 42 pp.

A joint Canadian-Japanese test fishery for oceanic squid occurred in summer, 1983 mostly within 200 nautical miles off the British Columbia coast. In forty drift gill net sets (averaging 34.4 km in length) 329.5 tonnes of the flying squid, OMMASTREPHES BARTRAMII, were caught. Major by-catch species were the pomfret, BRAMA JAPONICA, (188.8 tonnes), salmon shark, LAMNA DITROPIS. (32.8 tonnes) and blue shark, PRIONACE GLAUCA, (29.1 tonnes). Fishing stations were mainly determined by sea surface temperature between 14.0 degrees to 16.0 degrees C. On 42 nights jigging with automatic jigging machines under strong lighting yielded poor catches. A Canadian drift gill net fishery for oceanic squid is considered possible although with smaller vessels and less crew than Japanese deep-sea vessels.
CALL LETTERS: SH223 C148
KEYWORDS: west coast species; gear used-gill net, jigs; catch composition; length

266. Spratt, J.D. 1978. Age and growth of the market squid, LOLIGO OPALESCENS Berry, in Monterey Bay from statoliths. Calif. Dept. Fish Game, Fish Bull., 169:35-44.

Statoliths were used to age market squid and length frequency data were used for verification. Two patterns in growth rings were found. Rings in young animals were interpreted as daily growth and larger rings in older animals were interpreted as lunar monthly growth. Maximum age encountered was 25 lunar months or almost 2 years. During spawning season, most squid showed ages of 14-22 lunar months. Some large squid (>200 mm) may have lived through two summers before spawning.
CALL LETTERS: SH11 C24
KEYWORDS: LO; age; growth; length

267. Spratt, J.D. 1979. Age and growth of the market squid, LOLIGO OPALESCENS Berry, from statoliths. CalCOFI Rep., 20:58-64.

Growth increments have been found in statoliths. Growth increments correlate best with daily growth in juveniles and monthly growth in animals over six months of age. Monthly length at age reveals that market squid spawn at 1 to 2 years of age and most spawn when 14 to 22 lunar months of age at about 100-145 mm dorsal mantle length.
CALL LETTERS: SH351 S2 C22
KEYWORDS: LO; age; growth; length

268. Squire, J.L. Jr. 1972. Apparent abundance of some pelagic marine fishes off the southern and central California coast as surveyed by an airborne monitoring program. Fish. Bull., 70(3):1005-1019.

From 1962 through 1969, commercial aerial fish spotter pilots estimated tonnage of species observed during flights off the southern and central California coast. Observations of fish and the aircraft's flight route were recorded on special charts and analyzed using 10-minute by 10-minute "block areas." Data from each block area were used to compute diurnal and nocturnal variation in apparent abundance and an annual index of apparent abundance. From observations of the catch trends in the bonito fishery, the index appears to be little affected by changes in economic demand. Its trend in apparent abundance are evident before they are reflected in catches and are useful in the evaluation of catch variations in underutilized resources. Squid were also observed but data were not summarized.
CALL LETTERS: SH11 A13
KEYWORDS: LO; stock assessment; aerial observations

269. Starr, R.M. 1985. Hydroacoustic estimates of squid (LOLIGO OPALESCENS) abundance off Oregon in 1985. Oregon Dept. Fish and Wildlife. Informational Report, No. 85-9. 41 pp.

Quantitative acoustic surveys off the central Oregon coast produced estimates of squid distribution and abundance from a 10 km^2 area. Squid resided in the middle of the water column early in the study and in the upper one-third later. The center of spawning activity moved southward and shoreward with time. Maximum volumetric densities of squid in any 200 m segment of transect ranged from 2.1 to 83.9 squid/m^3. Maximum areal densities in any file ranged from 8.8 to 178.9 squid/m^2 of surface area. Analysis of weight to length ratios of squid commercially harvested in the study area indicated that two different groups of squid entered the study area over the five week study period. The largest school observed covered a surface area of 2.1 km^2 and contained an estimated 31.4 million squid. Biomass of the largest school was estimated to be 1714 mt. Including commercial harvest, the lower and upper biomass estimates were 2108 and 3735 mt, respectively.
CALL LETTERS: SH222 07 075
KEYWORDS: LO; acoustics; abundance; distribution-vertical

270. Starr, R.M. and J.E. McCrae. 1984. Squid resource assessment. Annual report. Project No. 1-174R Segment 1. Oregon Dept. Fish and Wildlife, Newport, OR. 39 pp.

Commercial landings of the market squid (LOLIGO OPALESCENS) increased from 113,000 lb in 1982 to almost one million lb in 1984. A research project was established to provide information to manage the new fishery. Observers were placed on fishing vessels to identify problems associated with incidental catch of the gear, gear impacts on

squid egg capsules, and gear conflicts. Observers saw few problems associated with the level of harvest and activity in 1984. Samples of squid were collected to obtain estimates of the biological characteristics of spawning squid in Oregon. The average dorsal mantle length of squid collected was 110.8 mm. Females were significantly larger than males. The average mantle length of samples declined throughout the season. Average sample weights declined then increased in the second area of harvest, suggesting that new groups of squid moved into the area to spawn.
CALL LETTERS: SH222 07 075
KEYWORDS: LO; landings; length; weight; behavior-schooling

271. Starr, R.M. and J.E. McCrae. 1985. Market squid (LOLIGO OPALESCENS) investigations in Oregon, 1983-1985. Oregon Dept. Fish and Wildlife, Informational Report, No. 85-10. 41 pp.

The Oregon fishery for LOLIGO OPALESCENS is expanding at a rapid rate. Fishing effort and efficiency are increasing; purse seines are used most frequently to catch squid. In 1985, catch per trip averaged 20.3 thousand lb. Six vessels accounted for 77% of the 1.75 million lb landed. Ex-vessel price averaged $350 per ton. L. OPALESCENS caught off Oregon apparently have different biological characteristics than squid caught in California. Females held in an aquarium laid an average of 23 egg capsules per animal. A total of 700 egg capsules collected in the field yielded an average of 98 eggs per capsule. The mean dorsal mantle length of squid sampled diminished with time. Females had longer mantle lengths than males. The sex ratio of all samples collected is weighted toward males. Storage tests revealed that squid whole weights declined with time when frozen. Length to weight ratios of spawning female squid indicated that three different groups of squid entered the harvest area to spawn.
CALL LETTERS: SH222 07 075
KEYWORDS: LO; behavior-spawning; fishery-Pacific NW; gear used-purse seine; landings; length; weight; regulations; sex ratio; storage; fecundity

272. Street, D. 1982. Squid fishery development for southeast Alaska. Report prepared for the Alaska Fisheries Development Foundation. Marine Advisory Program, University of Alaska Sea Grant, Petersburg. 62 pp.

The objectives of the squid fishery development project were to identify and locate spawning concentrations of squid, collect biological information, attempt a preliminary estimate of resource abundance and determine a potential for a commercial squid fishery. This was the first documentation of the existance of LOLIGO OPALESCENS north of Vancouver Island, B.C.. Large fishable concentrations of

squid were found but the project was unsuccessful in catching more than samples. One problem encountered was a lack of darkness during that particular time of year causing the attracting lights to be less effective.
CALL LETTERS: (NA)
KEYWORDS: LO; stock assessment; distribution; gear used; fishery-Pacific NW

273. Stroud, R.K., C.H. Fiscus, and H. Kajimura. 1981. Food of the Pacific white-sided dolphin, LAGENORHYNCHUS OBLIQUIDENS, Dall's porpoise, PHOCOENOIDES DALLI, and northern fur seal, CALLORHINUS URSINUS, off California and Washington. U.S. NMFS Fish. Bull., 78(4):951-959.

The Pacific white-sided dolphin and the Dall's porpoise feed primarily on small schooling fishes and cephalopods. They, like the northern fur seal, are opportunistic feeders, preying on available species, including some that are commercially important such as salmon, anchovy, jack mackerel, and LOLIGO OPALESCENS. Too few stomachs have been examined to make any estimate of the percentage of commercially important fishes included in the diet. Based on stomach content volume and time of collection, large stomach volumes were most often observed in animals collected before 1000 h in the morning, indicating that most feeding is done at night or in the morning. Northern fur seals tend to congregate in areas of abundant food supply and usually feed at night, probably because most prey species rise toward the surface after dark and are more readily available. Food species consumed by the seal vary by area, but the important food in the diet of this mammal in a given area, based on percentage of stomach content volume, generally does not change-only ranking by volume changes. The animals collected on the continental shelf appear to feed on fishes, whereas those taken beyond the shelf feed primarily on squids.
CALL LETTERS: SH11 A13
KEYWORDS: predators-marine mammals

274. Summers, W.C. 1968. The growth and size distribution of current year class LOLIGO PEALEI squid cephalopod. Bio. Bull., 135(2):366-377.

The author reports estimates of the growth rate and size distribution of current year class LOLIGO PEALEI based upon the population statistics of daytime, otter trawl collections. The selectivity of a #35 otter trawl with a 1.25-inch mesh stretched measure cod end liner was estimated by a 50% retention of L. PEALEI with a dorsal mantle length of approximately 3.7 cm. The current year class, summed older year classes and individual older year classes of L. PEALEI were found to have lognormal size-frequency distributions. The current year class could readily be separated from the older year classes by the use of Cassie's method of lognormal probability paper. The growth rate of a median individual in the current year class of 1967 was found to be 1.8 cm. dorsal mantle length per month for the

first four months past hatching. Approximately one half of the one-year-old L. PEALEI did not mature sexually before the second fall migration. None of the current year class L. PEALEI matured before the first fall migration. The results indicate that L. PEALEI egg deposition was isolated in time and location, and repeated throughout the Vineyard Sound area from at least June through September.
CALL LETTERS: QH301 B56
KEYWORDS: other species; growth; length

275. Summers, W.C. and J.J. McMahon. 1970. Survival of unfed squid LOLIGO PEALEI in an aquarium. Biol. Bull., 138(3):389-396.

This paper reports the survival rate of unfed squid, LOLIGO PEALEI, in a 600 liter aquarium with running sea water and constant illumination. Squid captured by a floating fishtrap and by otter trawl nets survived at the average rate of approximately 71% per day over a period of one week apparently independent of time in the tank, method of capture, water temperature, size or sex. Initial numbers of squid between four and forty did not greatly alter the relative results. The early results, in conjunction with the survival rate given above and the initial number of squid, were useful in empirically evaluating the probable course of an experimental run. It is possible that observed mortalities resulted from crowding and mechanical confinement. Other anticipated causes of mortality, (i.e., capture trauma and starvation) were not obvious in our results.
CALL LETTERS: QH301 B56
KEYWORDS: other species; mortality; artifical rearing

276. Summers, W.C. and J.J. McMahon. 1974. Studies on the maintenance of adult squid (LOLIGO PEALEI): I. Factorial survey. Biol. Bull., 146(2):279-290.

Conditions affecting the survival of adult squid were studied in laboratory aquaria. Squid (468) were used in 16 experiments run between May and November, 1970. Feeding, crowding, water temperature and aquarium shape were examined as were normally varying factors. Mean and maximum survival times were 87 and 666 h, respectively. Analyses of variance demonstrated that rectangular shapes promoted longer survival than square ones. Survivorship is reported by age group, breeding condition and season. Behavioral observations are used to discuss potential mortalities resulting from collisions with the aquarium walls.
CALL LETTERS: QH301 B56
KEYWORDS: LO; artifical rearing; diet-artificial; behavior; temperature

277. Summers, W.C., J.J. McMahon, and G.N.P.A. Ruppert. 1974. Studies on the maintenance of adult squid (LOLIGO PEALEI): II. Empirical extensions. Biol. Bull., 146(2):291-301.

Survival of adult squid was studied in laboratory aquaria. Squid (246) were used in 3 experiments run between May and December, 1971. Various aquarium configurations were studied in conjunction with evaluation of a tank wall bumper system, water temperature and normally varying conditions. Mean and maximum survival were 177 and 1400 h, respectively. In one design, 120 squid had mean survivorships of 248 hr and mortalities closely following a log-normal distribution. The bumper system produced a statistically significant survival advantage over bare aquaria. The procedure is discussed with suggestions for prolonged maintenance.
CALL LETTERS: QH301 B56
KEYWORDS: LO; artifical rearing; behavior; temperature

278. Suzuki, H. and M. Hamabe. 1978. Ecological studies on common squid, TODARODES PACIFICUS Steenstrup, in the offshore area in the Sea of Japan. Part 1. The condition of the squid shoals moving across the Tsushima warm current front viewed from distribution and structure of the north-going shoals. Bull. Tokai Reg. Fish. Res. Lab., 86:71-80.

This report deals with the distribution, oceanography and structure of shoals (schools) of young and immature squids that acquired abilities of swimming and selection of favorite environment. The results obtained are summarized as follows: (1) the squid schools in May are concentrated in a limited area. (2) area distribution of squid schools in June-July is different each year. Such a contrast in choice of environment may show that the squid in this season does not stay only in warm water but moves to expand its habitat into the cold water domain. This is the most imporant and critical period of the life history of this squid species. (3) one of the characteristics in distribution patterns of the north-going squid schools may be patchy schooling. Every school may have a different structure of size-maturity relationship. (4) the squids found in May in the offshore waters mostly belong to the "autumn population". However, judging from occurrences of young specimens smaller than 15 cm in mantle length, a small fraction of "winter population" may also be mingled with them. (5) the squids found in June-July in the offshore waters belong mostly to the "autumn population", too. However, occurrence of some squids in an advanced stage of maturity mostly along the Honshu coast suggests that a small portion of them may belong to the "summer population".
CALL LETTERS: (NA)
KEYWORDS: other species; distribution; temperature; behavior-schooling; stock delineation

279. Suzuki, T. 1975. Echosounding for squid TODARODES PACIFICUS (Streenstrup) in the offshore waters of the Sea of Japan and estimation of its abundance. FAO Fish. Rept. 170. Suppl. 1:89-92.

The type of echo traces from fish schools depends on the sound frequency, beam angle, and speed of recording paper and ship. For common squid, 200 kHz is more effective than lower frequencies. A formula by de Lury for estimating the decreasing rate of the resource is given. Small schools consist of about 100 individuals and large ones up to 2000, with most consisting of 400-500 individuals.
CALL LETTERS: SH1 F543
KEYWORDS: other species; acoustics; stock assessment

280. Taber, R.E. 1977. Some recent examples of fishing gear technology development or transfer in New England. Mar. Fish. Rev., 39(2):24-25.

Some gear developments for the New England squid and herring fisheries are described. Purse seining squid which had been attracted by lights proved potentially effective. Squid could be concentrated in approximately a 200 foot diameter area around a vessel to a depth of 5 fathoms. However, the squid did not come to the surface where they could be brailed or pumped. The use of a two-bridle bleaksprutte trawl for the herring fishery is also discussed.
CALL LETTERS: SH11 A14
KEYWORDS: gear development; gear used-purse seine, lights

281. Talmadge, R.R. 1967. Notes on cephalopods from northern California. Veliger, 10(2):200-202.

Brief notes describing distribution, some physical characteristics and basic ecology of 10 cephalopod species found on the extreme northern coast of California. Specimens obtained by commercial dragboat fleet from Humboldt Bay.
CALL LETTERS: QL1 V4
KEYWORDS: LO; west coast species; description; distribution

282. Thrower, S.J. 1978. Catching and handling squid. Methods used by Japanese vessel during trial off Tasmania. Austral. Fish., 37:20-25.

Survey conducted by Japanese research vessel for six months on squid fishing in south eastern Australian waters, 1977-78. Fishing operations using jigging machine and lights are described. Handling and onboard storage and processing for Japanese markets also discussed.
CALL LETTERS: SH131 A3
KEYWORDS: other species; gear used-jigs, lights; processing-freezing; fishery-Australia

283. Tricas, T.C. 1979. Relationships of the blue shark, PRIONACE GLAUCA, and its prey species near Santa Catalina Island, California. U.S. NMFS Fish Bull., 77(1):175-182.

Small fishes and cephalopods associated with both pelagic and inshore habitats composed the major prey for the blue shark, PRIONACE GLAUCA, near Santa Catalina Island, Calif. The northern anchovy was the predominant prey for sharks in the immediate study area while at least 13 species of pelagic cephalopods constituted major prey for sharks in more distant oceanic waters. Inshore species taken by sharks include pipefish, jack mackerel, and blacksmith. In addition, sharks moved inshore to feed on winter spawning schools of market squid, LOLIGO OPALESCENS. Digestive rate studies and telemetric monitoring of activity patterns indicate that sharks forage in waters near the surface from around midnight through dawn. Diel activities of prey species were examined and show that most prey dispersed in the upper water column at night and refuged during the day either by schooling (anchovies and jack mackerel) or by retreating to deeper waters (pelagic cephalopods). Field observations of shark feeding behavior indicate that predatory modes vary in response to prey behavior.
CALL LETTERS: SH11 A13
KEYWORDS: LO; predators-fishes

284. Van Hyning, J.M. and A.R. Magill. 1964. Occurrence of the Giant Squid (MOROTEUTHIS ROBUSTA) off Oregon. Research Briefs, Fish Commission of Oregon, 10(1):67-68.

A summary of reported observations of M. ROBUSTA off the Oregon coast. Size and weight of specimens, depth and location of capture are given when available.
CALL LETTERS: SH11 05
KEYWORDS: west coast species;

285. Vaughan, D.L. 1978. An acoustic investigation of market squid, LOLIGO OPALESCENS. MS thesis, California State Univ., Hayward. 100 pp.

The objectives of this study were (1) to describe the echogram traces that vertical echo sounders make when insonifying market squid; (2) to interpret behavior and dispersion patterns based on echogram analysis; (3) to investigate the feasibility of estimating squid abundance and biomass using echo sounders; and (4) to determine the acoustic properties of individual market squid. Schools of market squid produced four types of traces on echograms depending on the location of the squid in the water column. Various behavior and dispersion patterns for market squid could be interpreted through analysis of echograms. Densities of IN SITU spawning schools of squid

were determined. Mean densities ranged from 1.6 to 106.7 squid/m^3. In the dorsal aspect, the target strength measurements of market squid varied from a low of -49.3 to a high of -38.8 dB 1 m^2. No relationship between size and target strength was apparent.
CALL LETTERS: (NA)
KEYWORDS: LO; acoustics; abundance; distribution-vertical; behavior-schooling

286. Vaughan, D.L. 1978. The target strength of individual market squid, LOLIGO OPALESCENS. Calif. Dept. Fish Game, Fish Bull., 169:149-159.

The target strengths of 11 squid were measured in the dorsal aspect with a 200 kHz echo sounder Their dorsal mantle lengths ranged from 45 to 160 mm. The target strength measurements of L. OPALESCENS varied from a low of -49.3 dB to a high of -38.8 dB. Target strengths varied with the size of squid but no particular relationship became apparent. In order to process acoustic signals electronically from a densely packed school of squid, an echo integrator, as opposed to an echo counter, must be used. An echo integrator can sum up overlapping echoes and determine density for marine organisms in numbers or biomass.
CALL LETTERS: SH11 C24
KEYWORDS: LO; acoustics

287. Vaughan, D.L. and C.W. Recksiek. 1978. An acoustic investigation of market squid, LOLIGO OPALESCENS. Calif. Dept. Fish Game, Fish Bull., 169:135-147.

This study had three objectives: 1) to describe the echogram traces that vertical sounding echo sounders produce when insonifying market squid; 2) to interpret behavior and dispersion patterns of market squid; 3) to determine market squid school formations most conducive to acoustic market squid abundance and biomass estimations. Schools of market squid were shown to produce four types of traces on echograms; a feather plume-like trace when the squid are pelagic, a more or less continuous trace when the schools were on or near the bottom, "splotches" scattered throughout the water column, and blackening of the entire water column when squid were in thick concentration through out the water column. It is speculated that the higher frequency machines can better detect small pelagic schools of squid. Density estimates of 7.3 squid/m^3 without lights on and 99.6/m^3 with lights on were obtained using and underwater camera with acoustic gear.
CALL LETTERS: SH11, C24
KEYWORDS: LO; behavior-schooling; acoustics

288. Vaughan, D.L. and C.W. Recksiek. 1979. Detection of market squid, LOLIGO OPALESCENS, with echo sounders. CalCOFI Rep., 20:40-50.

Schools of the squid, LOLIGO OPALESCENS, were located with low (38-kHz) to high (200-kHz) frequency echo sounders in nearshore waters of the Southern California Bight and Monterey Bay. Verification of squid traces on echograms was accomplished by midwater trawling, jig fishing under lights, and visual observation. Two radically different behavior patterns are represented by the echograms: 1) continuous bottom-associated traces which can be resolved over a substantial frequency range (38-200 kHz); and 2) midwater plume-like traces which may be more effectively resolved at higher frequencies.
CALL LETTERS: SH351 S2 C22
KEYWORDS: LO; acoustics; behavior-schooling

289. Veasy, E.B. and M.O. Blaxall. 1983. Export opportunities for United States producers of squid. West Coast Fisheries Development Foundation, Portland, OR. 88 pp.

This report describes the consumption levels, sources of supply, product forms, packaging standards, tariff and non-tariff barriers and recent price trends for squid in Japan, Greece. Spain, Italy, France, Portugal and West Germany. It also describes current squid production activities in the US, analysis of US landings, and US export markets.
CALL LETTERS: HD9469 S71 V41
KEYWORDS: LO; other species; fishery-Monterey Bay, S. California, N. Atlantic; landings; markets; processing-products; quality

290. Vecchione, M. 1978. Larval ILLEX (Cephalopoda, Oegopsida) from the middle Atlantic bight. pp. 15.1-15.16. In: Proceedings of the workshop on the squid, ILLEX ILLECEBROSUS, Dalhousie Univ., Halifax, Nova Scotia, May, 1978, and a bibliography on the genus ILLEX. Can. Fish. Mar. Serv. Tech. Rep., No. 833. 311 pp.

The larval development of ILLEX is described and figured for the first time, with particular attention to development of the tentacles and the fourth pair of arms. Growth of the tentacles appears to occur at the base as well as the distal tip.
CALL LETTERS: SH223 A88
KEYWORDS: other species; larvae; anatomy; distribution; growth

291. Vesper, K.H. 1977. A scheme for expansion of the U.S. west coast squid industry. Univ. Wash. Seattle. 74 pp.

A student report of the Ocean Engineering course in Ocean Systems Design. This report is a scheme for expanding the U.S. West Coast squid industry. The most important facet of the scheme allowing a viable industry expansion is an eneregtic and innovative marketing effort. Selling would be directed initially at the established export trade and later moving into domestic markets for clam-substitute products.
CALL LETTERS: (NA)
KEYWORDS: markets

292. Voss, G.L. 1967. The biology and bathymetric distribution of deep-sea cephalopods. Stud. Trop. Oceanogr. Inst. Mar. Sci., Univ. Miami, 5:511-535.

The decapod cehpalopods are clearly divisible into three oceanic groups; epipelagic, mesopelagic, and bathypelagic. Similarly, the octopods may be divided into three oceanic groups; epipelagic, bathypelagic, and abyssoepibenthic. There are characteristic families and subfamilies of decapods and octopods for each depth zones. The squid of the upper layer are strong active swimmers with well muscled mantles. The octopods are similary well muscled. With increasing depth, the mantles of all groups become increasingly modified by the decrease in musculature and the appearance of a gelatinous material which forms the bulk of the mantle. Variation and changes with depth of pigmentation, light organs, feeding, and reproduction are described. The probable functions of light organs are discussed.
CALL LETTERS: (NA)
KEYWORDS: distribution-vertical; behavior-feeding; physiology-photophores, biochemical analysis

293. Voss, G.L. 1973. Cephalopod resources of the world. FAO Fish. Circ., No. 149. 75 pp.

The present study is an attempt to present the world fisheries on a global basis with information on catch and landings, the species of economic importance, a brief account of their biology where known, the various methods employed in their capture, and an attempt to estimate the potential cephalopod resources of the world ocean.
CALL LETTERS: SH1 F537
KEYWORDS: distribution; gear used; landings; markets

294. Voss, G., L. Opresko, and R. Thomas. 1973. Sea Grant field guide series #2. The potentially commercial species of octopus and squid of Florida, the Gulf of Mexico and the Caribbean Sea. University of Miami. 33 pp.

Guide offers identification means and fishing information on 12 species of squid and octopus, from the coasts of Florida, Gulf of Mexico, and the Caribbean Sea, that are now being fished commercially or have the potential for successful mariculture. A summary of the fisheries and fishing gears used in the region is given.
CALL LETTERS: GC4 MIAU A14
KEYWORDS: other species; description; gear used; landings; fishery-SE US; bibliography

295. Vovk, A.N. 1978. Peculiarities of the seasonal distribution of the North American squid LOLIGO PEALEI (Lesueur 1821). Malacological Review, 11:130.

The formation of concentrations of the North American squid depends to a great extent on the peculiarities of the hydrological regime in the area. The densest concentrations of squids are connected with frontal zones with strong temperature gradients. Such concentrations near the junction sites of different water masses are located mostly along the warm water. The North American squid lives at depths from 2 to 450 m, mostly from 30 to 250 m. In connection with the seasonal bathic migrations, the optimal depths for squid change in different months. The bathymetric distribution of different age groups of squid differs: the young usually keep nearer to the coasts, so the average size of the squid caught increases with increasing depths. An analysis of the seasonal distribution of the age groups makes it possible to present the pattern of their seasonal migrations. In hydrologically warm years, the spring migration of squid to the shelf and to the north begins sooner than in cold years.
CALL LETTERS: (NA)
KEYWORDS: other species; distribution-vertical; migration; temperature; seasons;

296. Vovk, A.N. 1978. Peculiarities of the seasonal distribution of the North American squid LOLIGO PEALEI (Lesueur 1821). Presented at: 5. Meeting on the Investigation of Molluscs Leningrad (USSR) 11 Feb. 1975. Atlantic Res. Inst. Fish and Oceanogr., 11(1-2):130.

In the waters of the western Atlantic, the North American squid L. PEALEI is distributed from the peninsula of Nova Scotia in the north to Venezuela in the south. L. PEALEI is not evenly distributed. In the south it is less numerous than on the American shelf to the north of Florida. The formation of concentrations of squids depends to a great extent on the peculiarities of the hydrological regime in the area. The densest concentrations of squids are connected with frontal zones with strong temperature gradients. Such concentrations near the

junction sites of different water masses are located mostly along the warm water. The North American squid lives at depths from 2 to 450 m, mostly from 30 to 250 m. In connection with the seasonal bathic migrations, the optimal depths for squid change in different months: December to April - 100-250 m; July to August - up to 75 m; September to November and in May - 50-100 m. The bathymetric distribution of different age groups of squid differs: the young usually keep nearer to the coasts, so the average size of the squid caught increases with increasing depths. An analysis of the seasonal distribution of the age groups of squid makes it possible to present the pattern of their seasonal migrations in the following way. In April-May, the squid migrate from the open shelf into the coastal waters at depths of 20-50 m with temperatures of 7-9 degrees C. From June to September (at temperatures of 10-18 degrees C.) The reproductive part of the squid's range coincides with the feeding part of the range. In September and until the beginning of November, a displacement of the young squid and maturing ones to the waters close to the slope (50-100 m depth, temperature of 9-14 degrees C) takes place, and active feeding continues. The autumn migration takes place usually in the feeding part of the squid's range. During migration to March, further growth and maturation of gonads take place.
CALL LETTERS: SH351 .S8 092
KEYWORDS: other species; distribution-vertical; temperature; seasons

297. Waldron, D. 1978. Distribution of ILLEX ILLECEBROSUS during the 1977 international fishery on the Scotian Shelf. pp. 4.1-4.26. In: Proceedings of the workshop on the squid, ILLEX ILLECEBROSUS, Dalhousie Univ., Halifax, Nova Scotia, May, 1978, and a bibliography on the genus ILLEX. Can. Fish. Mar. Serv. Tech. Rep., No. 833. 311 pp.

An international observer program was initiated on the Scotian Shelf as a means of evaluating the by-catch which occurred during the international fishery. The highest by-catch occurred in the silver hake bottom trawl fishery while the by-catch was much lower in the squid midwater trawl fishery. The fishery producing the lowest degree of by-catch was the Japanese off-bottom chain trawls.
CALL LETTERS: SH223 A88
KEYWORDS: other species; distribution; catch composition; gear used

298. Whitaker, J.D. 1980. Squid catches resulting from trawl surveys off the southeastern United States. Mar. Fish. Rev., 42(7-8):39-43.

General distribution of squid species of south eastern United States are reviewed. Samples collected during 1973-77 during all seasons using a 3/4 scale version for Yankee No. 36 trawl for .5 hour tows. Distribution in relation to depth, season and temperature were discussed. Temperature appeared to have some affect on distribution - squid moved to deeper waters when water temperature on shelf exceeded 20 degrees C, greatest catch per effort was observed during summer and fall with temperature of 10-14 degrees C. No sexually mature animals were collected. Squid were counted, weighed, and mantle length measured.
CALL LETTERS: SH11 A14
KEYWORDS: other species; fishery-SE US; length; distribution; abundance; temperature; seasons; gear used-trawl

299. Wickham, D.A. 1971. Harvesting coastal pelagic fishes with artificial light and purse seine. Comm. Fish. Rev., 33(1):30-38.

Experimental night-light purse seining revealed that fish could be attracted throughout the night, but moon phase appears to affect size of aggregations-average catches were larger during the new moon. Nightly total catches of Spanish sardine, Atlantic thread herring, and scaled sardine averaged 2,500 lbs. Fish density affects the pattern of fish aggregation. Lights in high density areas need to be set on more frequently during the night because the formation of large fish concentrations early in the evening would block light and reduce its continued efficiency.
CALL LETTERS: SH11 A14
KEYWORDS: gear used-lights, purse seine; gear development

300. Williamson, N.J. 1982. Cluster sampling estimation of the variance of abundance estimates derived from quantitative echo sounder surveys. Can. J. Fish. Aquat. Sci., 39:229-231.

Serial correlation in data collected from fisheries acoustic surveys may have an effect on the precision and accuracy of fish abundance estimates. A simple random sample approach to the data analysis yields unreliable confidence intervals for mean population density when the degree of serial correlation in the data is high. The results of a simulation analysis indicate that more reliable confidence intervals can be obtained using cluster sampling estimation techniques.
CALL LETTERS: SH223 A52
KEYWORDS: acoustics

301. Wilson, J.R. and A.H. Gorham. 1982. Alaska underutilized species. Vol I: Squid. Alaska Sea Grant Rept., No. 82-1. 77 pp.

Discussion of squid species found in the northern North Pacific includes distribution, general biology, harvesting techniques and development of fisheries, processing techniques, economic feasibility analysis, and world trade of squid including dealers addresses, packaging and shipping techniques.
CALL LETTERS: GC4 AKU A2
KEYWORDS: gear used-jigs, trawl; processing; distribution; markets; west coast species

302. Wolff, G.A. 1982. A beak key for eight eastern tropical Pacific cephalopod species with relationships between their beak dimensions and size. U.S. NMFS Fish Bull., 80(2):357-370.

A method of identifying the beaks and estimating body weight and mantle of eight common species of eastern tropical Pacific cephalopods is presented. Twenty specimens were selected from each of the following species: SYMPLECTOTEUTHIS OUALANIENSIS, DOSIDICUS GIGAS, OMMASTREPHES BARTRAMII, ONYCHOTEUTHIS BANKSII, ABRALIOPSIS AFFINIS, PTERYGIOTEUTHIS GIARDI, LIOCRANCHIA REINHARDTI, AND LOLIGO OPALESCENS. Seven dimensions measured on the upper beak and five dimensions measured on the lower beak are converted to ratios and compared individually among the species using an analysis of variance procedure and Tukey's w. Significant differences ($P<0.05$) observed among the species' beak ratios means, in addition to structural characteristics, are used to construct artificial keys for the upper and lower beaks of the eight species. Upper and lower beak dimensions are used as independent variables in a linear regression model with mantle length and body weight (log transformed). Two equations are given for estimating the length and weight for each species from the upper and lower beak. One uses the rostral length dimension because of its durability and the second uses a dimension derived from a stepwise regression procedure.
CALL LETTERS: SH11 A13
KEYWORDS: LO; west coast species; beaks; length; weight

303. Worms, J. 1983. World fisheries for cephalopods: a synoptic overview. FAO Fish. Tech. Pap., 231:1-20.

In this paper the author reviews world cephalopod fisheries as a whole against total world landings of marine products by FAO statistical areas. Where possible, landings are given separately by group of species. A more detailed account is given of the Japanese domestic and long range fisheries. The analysis of landings by species group makes clear that a shift of fishing activities is occurring from heavily exploited species (e.g., OCTOPUS VULGARIS. TODARODES PACIFICUS) to new lightly exploited species (essentially oceanic squids) whose potential proves to be important.
CALL LETTERS: SH1 F539
KEYWORDS: landings

304. Wormuth, J.H. 1976. The biogeography and numerical taxonomy of the oegopsid squid family Ommastrephidae in the Pacific Ocean. Bull. Scripps Instit. Oceanogr., Vol. 23. 90 pp.

This paper deals with the squid family Ommastrephidae of which some species are presently being exploited for food and other species represent potential food sources. It examines the taxonomic relationships of many species of the family and summarizes the distributional information from the literature.
CALL LETTERS: QH91 C22
KEYWORDS: other species; description; distribution-vertical; length

305. Wormuth, J.H. and C.F.E. Roper. 1983. Quantitative sampling of oceanic cephalopods by nets: problems and recommendations. Biol. Ocean., 2(2-3-4):357-377.

Three large data sets on cephalopods are critically examined with respect to several sources of error: day-night avoidance, net size, mode of fishing, and patchiness. Catches are low and variable and results only suggest problems with present sampling techniques. Specific field sampling is suggested to quantify several of these sources of error. Volume filtered and time fished are compared as measures of "effort". Variability of volume filtered and net speed within a single tow are examined.
CALL LETTERS: QH91 A1
KEYWORDS: gear used; sampling methods

306. Yajima, S. and S. Mitsugi. 1975. Japanese squid jigging gear. FAO Fish. Rept. 170, Suppl. 1:85-88.

Approximately 95% of the catch of Japanese common squid (TODARODES PACIFICUS) is caught by jigging and the rest by setnets and trawls. Unlike the other gears which are used in other fisheries, jigging was specifically developed for squid fishing. Rapid development of jigging is partly due to: 1) moderate capital requirements. 2) simple operation - no training. 3) gear is simple - no specific vessel requirements.
CALL LETTERS: SH1 F543
KEYWORDS: gear used-jigs

307. Yang, W.T., R.T. Hanlon, M.E. Krejci, R.F. Hixon, and W.H. Hulet. 1980. Culture of California market squid from hatching - first rearing of LOLIGO to sub-adult stage. Aquabiology, 2(6):412-418.

LOLIGO OPALESCENS was reared from eggs to near sexual maturity in eight months in artifical seawater. Hatchlings were initially reared in a closed seawater system consisting of two 1500-liter capacity circular tanks, and they were later transferred to a 10,000-liter capacity closed system raceway. Squids were fed a diet of live copepods, other crustaceans and fishes. Mortality was highest during the first 20 days and between days 45 and 70. Starvation and fin damage were the principal causes of mortality. Two squids survived for 233 days, and one attained a dorsal mantle length of 77 mm. Mantle length increased exponentially at a rate of 1.69 % per day. Schooling was first observed when squids attained a mantle length of approximatley 15 mm.
CALL LETTERS: (NA)
KEYWORDS: LO; diet-artificial; growth; length; artifical rearing; behavior-schooling

308. Yang, W.T., R.T. Hanlon, M.E. Krejci, R.F. Hixon, and W.H. Hulet. 1983. Laboratory rearing of LOLIGO OPALESCENS, the market squid of California. Aquaculture, 31(1):77-88.

The squid LOLIGO OPALESCENS (Cephalopoda, Mollusca) was reared in artifical sea water in a closed system consisting of two 1300 liter circular tanks. When the squids reached mantle lengths of 20 to 30 mm, they were transferred to a 10.000 liter closed system raceway. From hatching, mantle length increased exponentially at a mean rate of 1.69% per day throughout the experiment. The largest and longest-lived squid attained a maximal size of 77 mm mantle length in 8 months. Only live food organisms, which consisted of copepods, other crustaceans and fishes, were accepted by the squids. Mortality, attributed to starvation and fin damage, was greatest during the first 20 days and again between days 45 and 70.
CALL LETTERS: SH1 A65
KEYWORDS: LO; artifical rearing; growth; length; diet-artificial

309. Yang, W.T., R.G. Hixon, P.E. Turk, M.E. Krejci, R.T. Hanlon, and W.H. Hulet. 1983. Culture of the California market squid from hatching - completion of the rearing cycle to second generation hatchlings. Aquabiology, 5(5):328-339.

A partial, interpretive translation by K. Bettinger and T.E. Bettinger. For the first time the life cycle of a small-egged teuthoid squid (LOLIGO OPALESCENS) has been closed in laboratory culture. Hatchling squids were reared in 1,300 liter and 10,000 liter closed-system tanks, and they grew to sexually mature adults. They successfully mated, and between 196 and 238 days of age they laid viable eggs. Maximum life span was 243 days and maximum size was a dorsal mantle length of 155 mm. Squids ate live zooplankton (mainly copepods), mysid, brine and palaemonid shrimps, and several species of fishes. Daily group feeding rate of subadults and adults averaged 14.9 percent wet body weight per day. The instantaneous growth rate in length averaged 1.75 percent per day. Early high mortality was probably due to inability to capture food (starvation); later mortality was caused by fin or skin damaged and by spawning activities.
CALL LETTERS: (NA)
KEYWORDS: LO; artificial rearing; diet-artificial; length; growth

310. Yasui, T. 1975. Fluctuations in abundance of the winter subpopulation of TODARODES PACIFICUS. FAO Fish. Rept. 170, Suppl. 1:24-29.

Even allowing for the increased fishing effort, there is a periodicity in northern areas of nine (8-10) years in abundance of stocks so regular that there has been only one exception in 70 years. Good years corresponded to gradual declining periods of yearly mean water temperature, while bad years corresponded to highest or lowest temperature or rapidly ascending periods. In southern areas any periodicity is probably camouflaged by shifting of main fishing grounds. Schools occupying different fishing grounds may be separate subpopulations. A correlation has been found between the index of the larval abundance and catch. Another view suggests a correlation of catch to the southward or northward shift in the distributional range of squid.
CALL LETTERS: SH1 F543
KEYWORDS: other species; abundance; temperature; larvae

311. Young, R.E. 1972. The systematics and areal distribution of pelagic cephalopods for the seas off southern California. Smithsonian Contributions to Zoology, No. 97. 159 pp.

The mid-water cephalopods from off the coast of southern California and adjacent areas are described and their areal distribution is discussed. Forty-two species of pelagic cephalopods are now known from this area including ten new species. Off southern California the fauna is part of the transitional and subartic fauna to the north, while primarily tropical species are found off northern Baja California.
CALL LETTERS: QL1 S5
KEYWORDS: LO; west coast species; distribution; description

312. Young, R.E. 1977. Ventral bioluminescent countershading in midwater cephalopods. Symp. Zool. Soc. Lond., 38:161-190.

The requirements for effective bioluminescent countershading are examined in six species of midwater cephalopods. Bioluminescent countershading may occur in species that occupy depths where light levels are compatible with countershading during the day, night, or twilight. These species all seem to possess most of the basic mechanisms necessary for ventral countershading. They apparently have means of shielding opaque structures with bioluminescence, of producing blue, highly directional light, of detecting downwelling light and their own bioluminescent light, and of regulating the intensity of their bioluminescence. However, one species examined probably does not countershade. A comparison of presumed countershading and noncountershading photophores in these species reveals only a single distinctive structural difference: countershading photophores possess "skylight" filters.
CALL LETTERS: QL1 Z712
KEYWORDS: physiology-photophores

KEYWORD INDEX

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