

While the world squid catch octupled between 1938 and 1968, the resource potential is still enormous.

Northwest Atlantic Squids

WARREN F. RATHJEN

In 1938 the world catch of squids amounted to about 115 thousand metric tons. Thirty years later (1968) this figure had increased to approximately 900 thousand tons, most of which was harvested by the Japanese and utilized in various oriental and southern European markets. In addition to squids, there are harvested large amounts of other cephalopods. Octopus and cuttlefish are taken for food. If one adds to this estimates of squids and related animals, incredibly large resources are indicated. Indeed, squids are so varied in size, shape, aggregation, and habitats that we are only beginning to comprehend the scope of these unique species. Although there are no really authentic measures of the potential of the world squids, the total is certainly enormous. In the waters near the Americas there are about 80 squid species, of which more than 70 are found adjacent to North America (Lane, 1960).

In a recent (1973) (Voss, Gilbert L. "Cephalopod Resources of the World" FAO Fisheries Circular No. 149) review of world squid and octopus potentials, Voss indicated that the present catch for the Northwest Atlantic (Eastern North America—Mexico) is about 27,000 tons with an estimated potential take of up to 500,000 tons. Most of the present catch consists of two species, the short-finned squid,

Illex illecebrosus, and the long-finned squid, *Loligo pealei*.

SHORT-FINNED SQUID

Canadian and American fishermen have never been aggressive in fishing for squids in the waters of the Northwest Atlantic. In Canada there has been a traditional fishery for the short-finned squid (Figure 1) (*Illex illecebrosus*). This squid has been valued primarily as bait and is caught by "jigging" (Figure 2). Up to the present this fishery has been a "passive" one, that is, fishing is carried on only in coastal Newfoundland waters during the summer period when squids have migrated there. Variations in seawater temperature and other hydrographic conditions appear to control the local (inshore) abundance of squid; con-

Warren Rathjen is on the staff of the Northeast Regional Office, National Marine Fisheries Service, NOAA, 14 Elm Street, Gloucester, MA 01930.

sequently fishing results are dependent on environmental conditions (Mercer, 1970).

The short-finned squid, object of a traditional fishery in waters adjacent to Newfoundland, represents one variety of at least three different species of the same genus present in waters of the Northwest Atlantic (Roper et al., 1969). Mercer (1970) indicates that the annual catch may vary from insignificant amounts up to 11,000 tons during a single season. On the basis of pilot whale catches and their known consumption of this squid species as food, he speculates on the minimum standing crop of the short-finned squid as occasionally exceeding 4-5 times the greatest catch in the existing fishery (put another way, at least 50,000 tons). Soviet fisheries studies conducted aboard the exploratory vessel *Argus* in June 1971 (Noskov and Rikhter, 1971) revealed quantities of this species off southern New England. The above authors stated that there was a "relatively high abundance" of the short-finned squid along the edge and outer portions of the continental shelf from western Nova Scotia to Long Island. Unpublished data resulting from groundfish surveys conducted by the NMFS Northeast Fisheries Center indicate wide distribution of this species over the continental shelf in the fall (Sep-

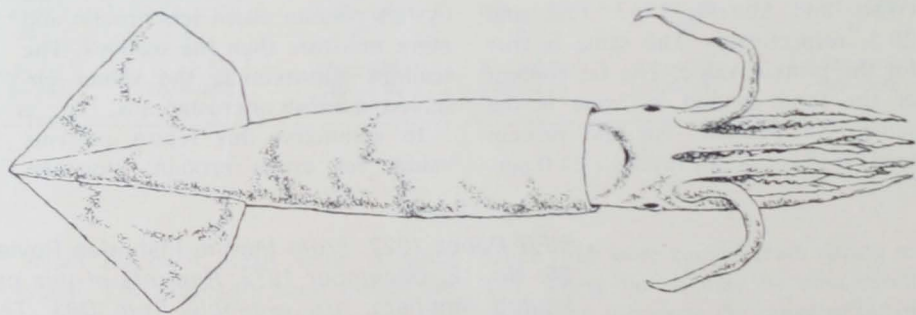


Figure 1.—One of the most common squids known from the continental shelf area in the Northwest Atlantic, the short-finned squid, *Illex illecebrosus*.

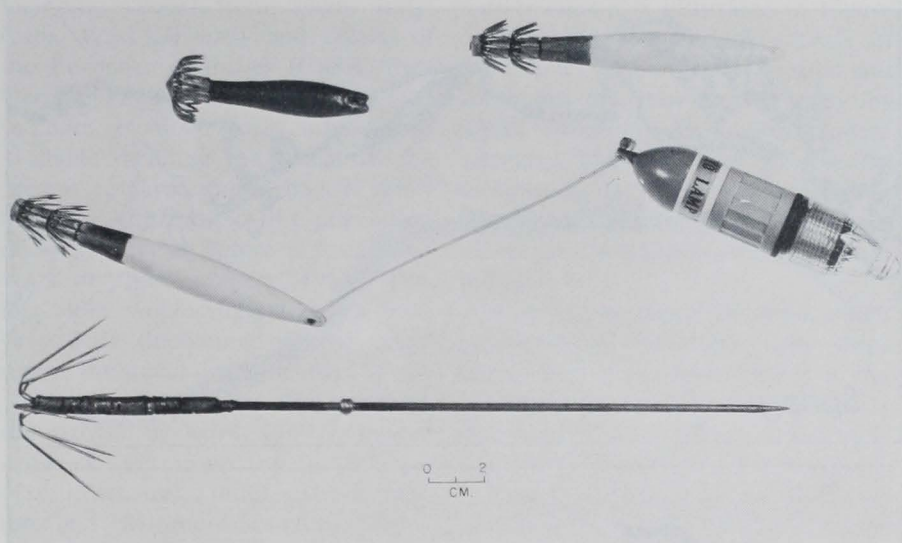


Figure 2.—Typical squid jigs: Newfoundland jig, top left; Japanese jig without light, top right; Japanese jig attached to light, center; mid-Pacific jig, bottom. In use, the jigs are attached to a line which is moved in a manner to simulate prey. After being attracted, the squid are impaled on the barbs.

tember-November) with contrasting restricted distribution along the edge of the shelf (more than 80 m) during the cooler spring (March-May) period. Progressing into more southern areas, south and west of Cape Hatteras, this species appears in deeper waters where it is known as far south as Florida (Roper et al. 1969). In reporting on direct observations of squid from the submersible *Alvin* off Cape Hatteras, Milliman and Manheim (1968) reported on concentrations of squid believed to be short-finned squid at depths of 220-250 m and 490-510 m. Squid were more numerous in the shoaler depth, where it was estimated that there were 500 individuals per 1,000 cubic meters of water. These observations were made in June and water temperatures at the depths where squid were observed ranged from about 5 to 15°C. This range of temperature is in close agreement with optimal temperatures in short-finned squid habitat off Newfoundland of 7-15°C (Squires, 1957). Voss (1971) mentions similar observations made off Miami at greater depths (ca. 650 m) from the *Aluminaut*.

Very little is known concerning the winter distribution of the short-finned squid and there are virtually no details

of its reproductive habits. In a review of the species Nesis (1968) summarizes much of the available information. Interesting biological details provided include growth, which averages an eightfold increase in weight from 50 to 450 grams between May and October and death following spawning at the end of the second year.

All squid are known to be voracious feeders; the short-finned squid well illustrates this point. The young live on a diet which consists predominantly of small crustaceans gradually changing to young fish including cod, haddock, ocean perch, flounders, herring, mackerel and others. In addition to this varied diet the short-finned squid

may also be cannibalistic, feeding on smaller individuals of its own kind (Nesis, 1968).

Squid jigging remains the basic approach to squid harvesting in Canadian-Atlantic waters. Commercial trawling for short-finned squid as the primary species was started experimentally by the Japanese during 1972.¹

LONG-FINNED SQUID

Long-finned squid (*Loligo pealei*) (Figure 3) is known in North America as the bone squid, the common squid, and the winter squid. In southern New England during the summer this squid is often seen near docks at night attracted by lights. Pound net fishing, which was an effective method of harvesting during the late 19th and early 20th centuries, often yielded catches of long-finned squid (True, 1887). Not only pound nets fished on both sides of Cape Cod, but those farther south also often took squid. Pound net operations in waters adjacent to Delaware Bay took squid in significant amounts during the period 1949-1954 (June and Reintjes, 1957).

A characteristic feature of the biology of the long-finned squid is an annual inshore migration in the spring season (Figure 4). Spawning takes place at this time in waters from the shore to depths of about 90 meters

¹ Anonymous report in *Boston Market News*, 28 August 1972.

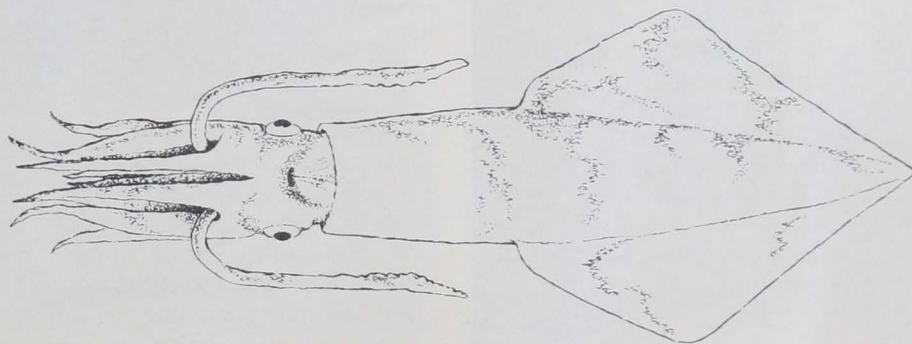


Figure 3.—The long-finned squid, *Loligo pealei*, long considered valuable for scientific study, is now the object of a growing fishery off the east coast of the United States.

Figure 4.—Shaded area represents typical distribution of long-finned squid over continental shelf in the spring (March-May) and fall (September-November). Data have resulted from Northeast Fisheries Center groundfish surveys which do not cover areas of less than 27 meters.

(Verrill, 1882); the young squid remain in coastal waters until fall (mid-November in Martha's Vineyard waters, according to Summers, 1968). Heavy concentrations of long-finned squid aggregate in the vicinity of the outer continental shelf during the cool season (November-March); it is at this time that an international fishing fleet takes quantities of them. Perhaps the heaviest fishing on the squid stock at this season has been prosecuted by the Japanese, who began regular seasonal fishing off the U.S. east coast about 1969. Catches by the large Japanese stern trawlers have averaged 10 or more tons per fishing day. Since 1969, others have entered the fishery

Figure 5.—Examining a catch of the oceanic squid, *Pholidoteuthis adami*, taken by shrimp trawl fished from the *Oregon II* off the coast of Surinam. These specimens were taken from 841 meters.

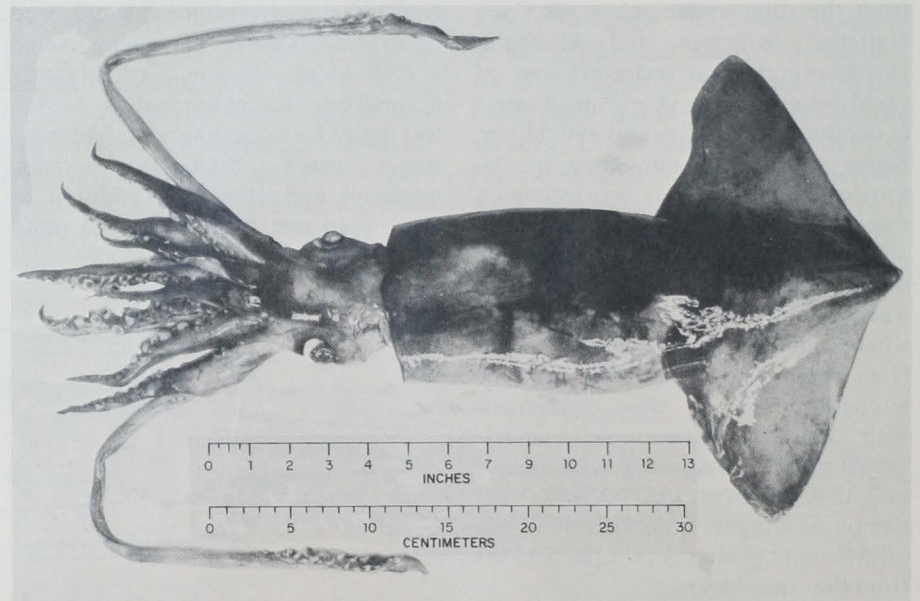
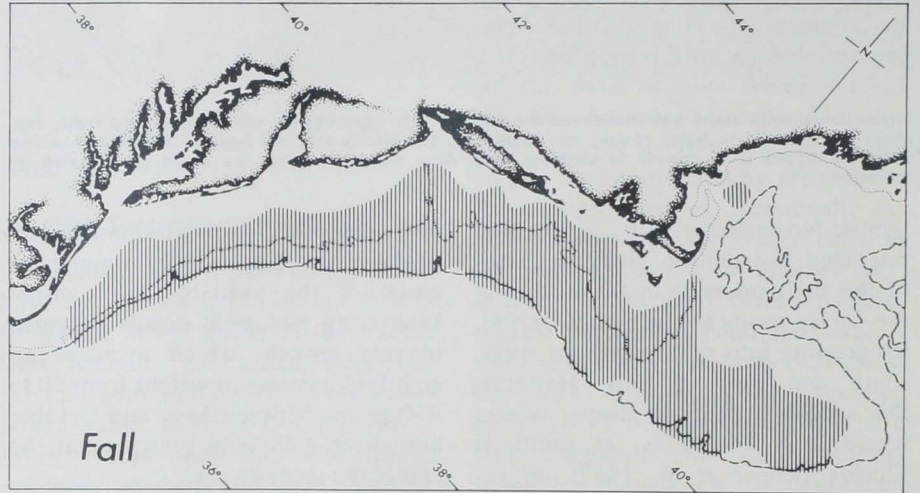
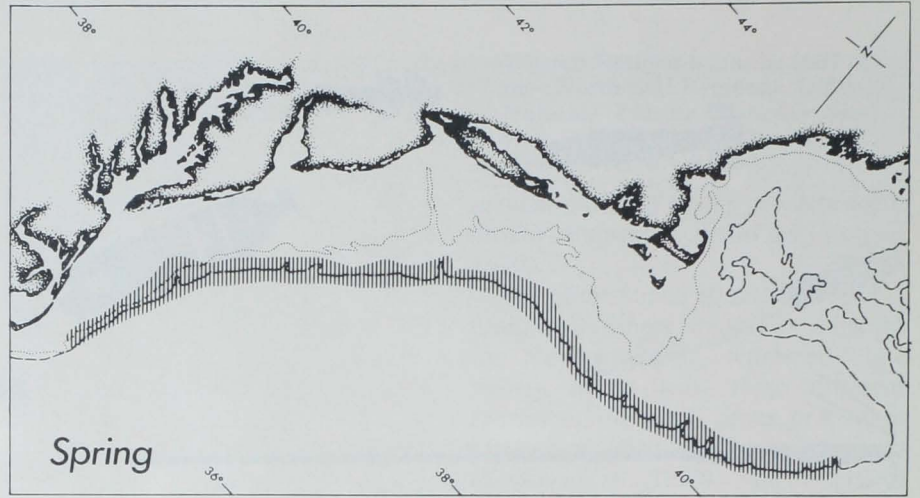


Figure 6.—The orangeback squid, *Ommastrephes pteropus*, broadly distributed over wide areas of the warmer oceanic Atlantic. Clarke (1966) states that "there is no doubt" that this species is present in enormous numbers where they occur. This specimen was from the Caribbean Sea.

including vessels from Spain, Italy, Cuba, West Germany and several of the European countries (USSR, East Germany, Poland and others).²

There is not much information available detailing the extent of the present resource. Squid have a short life span with most of the population of squid expiring before reaching two years of age (Summers, 1968). This fact alone would suggest that a poor year class (incoming broods) could reduce the stocks dramatically.

Soviet research on this species, summarized by Vovk, 1969, indicated dense concentrations (up to 200 tons of squid per square mile) near Wilmington and Baltimore canyons. These observations were made for the period February through April. It was stated that during this period catches by a BMRT-type vessel (ca. 2,000 hp) could be expected to reach 10 to 12.5 tons daily. These rates are similar to those experienced by comparably sized Japanese vessels.

Based on bottom trawl survey data generated from the research cruises of *Albatross IV* of the Northeast Fisheries Center, Edwards (1968) estimated the standing crop of long-finned squid between Nova Scotia and Cape Hatteras to be about 318 thousand tons. Japanese Fisheries Reports have indicated winter-season (December-February) catches of up to 15,000 tons by about a dozen vessels.

OTHER SPECIES

In addition to the squid species discussed above there are a number of other squid varieties distributed along the continental shelf area of the western Atlantic. These include the "arrow squid," *Loligo plei*; the "brief squid," *Lolliguncula brevis*; and others.

Off the continental shelf and approaching the ocean depths somewhat more exotic and lesser known species are recorded. One of these (as yet without a common name), *Pholido-*

teuthis adami, is illustrated in Figure 5. Voss (1956) mentions schools of this species in the Gulf of Mexico and speculates that they may be prey for sperm whales which occur there regularly. This squid was described as recently as in 1956, but is possibly present in much greater numbers than the sparse information available would indicate.

A second moderate size squid, which is commonly observed near ships laying to over oceanic depths, is the "orangeback squid" *Ommastrephes pteropus* (Figure 6). Voss, 1971, indicates that the supply is probably great.

It would be inappropriate to engage in a general discussion of Northwest Atlantic squids without mention of the "giant squid" *Architeuthis* sp. (Figure 7). In a recent (1966) account Clarke summarizes some of the widely varying material recorded for giant squid over the past century. The following facts are extracted from his report.

1. Size—occasionally reaches 60 feet in total length.
2. Species—about 20 species accounts in the literature.
3. Probable habitat—200-400 meters or deeper.
4. Weight—possibly over one ton (1,000 kg).

One reason we know so little of the giant squid results from our inability to capture them easily. Practically all, if not all, records are the result of wounded or otherwise incapacitated squid drifting ashore or being found on the surface by a vessel.

This brief discussion offers only a smattering of what is known; much more is unknown regarding squid biology, distribution, and abundance. Reviews of the oceanic squids provided by Clarke (1963, 1966) indicate our knowledge of these animals is extremely fragmentary due to sampling problems. Some of the information on oceanic squid distribution has become available by examining stomach contents of large pelagic fish (i.e., tunas) and various mammals such as porpoises and whales.

HARVESTING

Fishing Gear and Technology

Japanese fishermen are by far the most proficient harvesters of squid. Of the total domestic Japanese landings of squid, one species stands out as the most important: the common squid of Japan, *Todarodes pacificus*. This species has accounted for annual catches of over 600,000 tons (1952) and typically represents 85 to 90 percent of all the squid and octopus taken by Japanese fishermen who in turn can be expected to take more than half of the world catch. In some years 90 percent of the catch of Japanese common squid is taken by "squid angling." The squid are attracted to the catching vessel at night by lamps. The squid are then caught on jigs fished either by individual fishermen (up to 35) or by automatic "squid jiggers." In addition to this technique a substantial part of the catch (up to 10 percent) is sometimes taken by various set nets. Other types of gear are insignificant (Anon., 1958).

In the Northwest Atlantic, as in Japan, jigging is the most important fishing method in Newfoundland waters when fishing for the related species (*Illex*). In a discussion of the adaptation of mechanical Japanese jigging equipment to the Newfoundland fishery, Quigley (1964) cites one instance when a vessel with automatic "jiggers" took about two tons during one hour of fishing on the same grounds in which a vessel fishing with traditional hand-operated jigs took only 15 percent of that amount.

The Japanese fishery off the east coast of the United States, now in its fifth year, uses large trawl nets. Vessels (1,500-1,900 gross tons) with up to 2,700 hp fish trawl nets and average about one ton of squid (*Loligo*) for each of 10 trawl tows taken during a 24-hour period. Catches tend to be heavier during daylight hours than at night,³ reflecting the habits of the squid.

² Various NMFS sources, primarily Market News and International Activities Staff reports.

³ Personal communication by NMFS personnel with Japanese fishermen.



Figure 7.—Giant squid about 47 feet in overall length taken by the vessel *Silver Bay* off the coast of Florida. This specimen was later deposited in the collection of the University of Miami. Only rarely are such specimens obtained.

Most fishing is done near the edge of the continental shelf in the general vicinity of the Hudson Canyon, during winter months of December through March.

In addition to Japanese vessels,

others from Spain, Italy, West Germany, USSR and other countries are sometimes represented in this fishery. United States fishermen fishing the same areas have traditionally taken some squid while trawling along the outer continental shelf during the winter season. Most of the U.S. domestic catch has been incidental to trawling for other species. This catch has been consistently under 2,000 tons a year.

Almost one hundred years ago in pound net (trap) fishing along the mid-Atlantic states from Virginia to Massachusetts quantities of long-finned squid were taken during their inshore migration. One reference to the large numbers sometimes taken was provided by True (1887) in which he cites an occasion when pound nets installed along the Long Island shore averaged 15 tons of long-finned squid daily for



a period of six weeks during the latter part of May through June 1887. Discussions with various individuals on Cape Cod have indicated that good catches of squid are still accounted for occasionally in the now dwindling number of pound nets fished there. Due to lessened availability of fish, pound net gear is rapidly disappearing from the mid-Atlantic states.

Small amounts of squid are some-

times taken by midwater trawls but records of significant landings using this fishing gear are not available. It is possible to speculate that the technology of midwater trawling may be upgraded to the point where it is effective on certain species of squid.

Locating Squids

A number of possibilities exist for measuring the abundance and distribution of squids which, due to their elusive habits, are only poorly sampled by trawl nets.

Japanese research has demonstrated the potential of detecting squids with echo sounding equipment (Anon., 1972). When this method is refined, it may be used for effectively locating and estimating stocks of squids and other pelagic species.

Photographic techniques have been employed by British researchers Baker (1957) and Clarke (1966). This method is particularly attractive for high seas studies and involves the use of undersea cameras with bait. Direct observation from a submersible vehicle has been described by Milliman and Manheim for the waters adjacent to Cape Hatteras, N.C.

Squire (1972 and personal communication) has indicated that schools of squids are sometimes detectable at night from aircraft over California waters. This opens the possibility for the eventual employment of low-light sensing as described by Roithmayr (1970). Ultimately remote sensing via satellite may be a potential tool in measuring squid and other resources.

Technological Advances

One of the more interesting developments in fishing technology was recently reported by Kato (1970). West coast squid (*Loligo opalescens*), close relatives to our east coast long-finned

squid, were attracted to a fishing vessel with lights and pumped aboard the vessel. The system has harvested as much as 10 tons of squid during 15 minutes (Figure 8). On occasions up to 50 tons of squid have been harvested in this manner in a single night, though traditionally these west coast squid have been harvested primarily by small seines and lift nets. This experience suggests that some species of squid may be rational targets for large automated fishing platforms (Figure 9) such as that suggested by Klima and Roe (1970). In addition to behavioral response to light, certain squid species tend to aggregate in particular thermal conditions. This characteristic might become apparent in the future when seabased power generating operations come into being.

A scientist working at the University of Miami recently demonstrated the ability to raise a tropical Loliginid squid from egg to maturity in only five months (Anon., 1970). This interesting accomplishment opens for speculation the potential of aquaculture methods in raising squid.

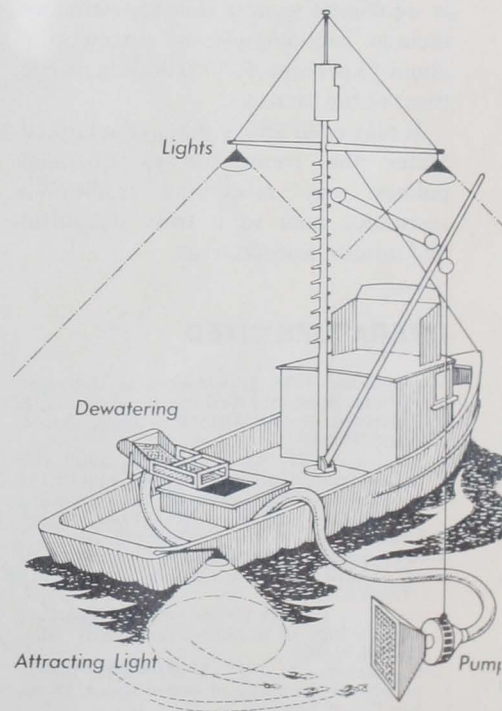


Figure 8.—Schematic view of squid harvesting system utilizing light attraction and mechanical pumping. This technique has been used effectively off California.

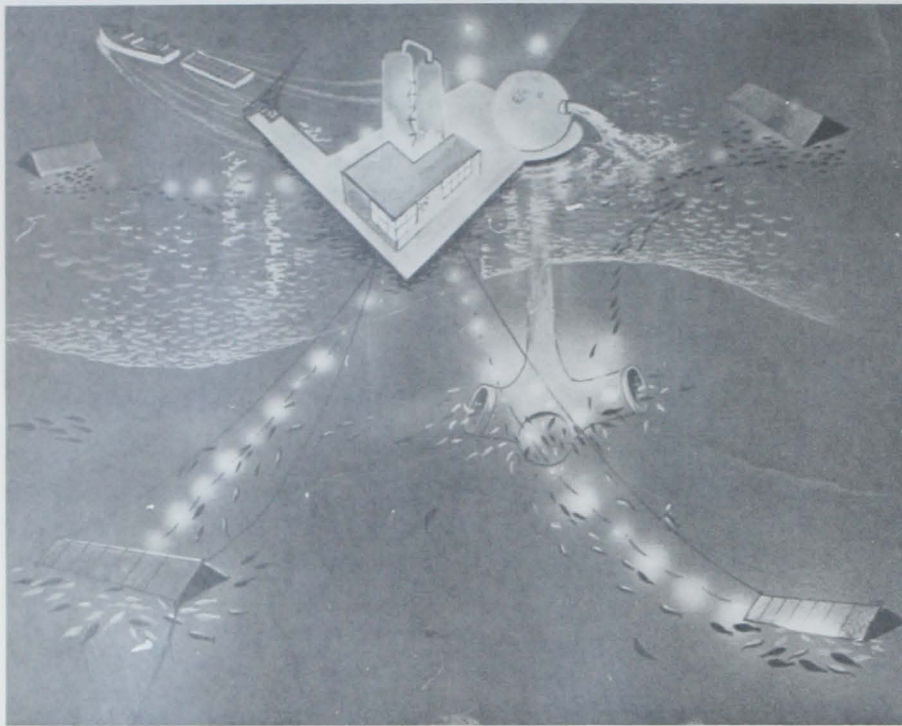


Figure 9.—Conceptual view of proposed automated fishing platform. This scheme might be adaptable to harvesting some species of squid which are attracted to light and are responsive to certain temperature conditions. (From Klima and Roe, 1972.)

In a recent review of world fisheries potentials, Suda (1972) suggested a possible range for potential increase in the world catch of 43.1-55.3 million metric tons over the present catch. It is significant to note that his estimates include cephalopods as representing about 13 percent (5.7-7.0 million metric tons) of the increase.

It may even follow that in the United States the trend toward liberated palates may relax the traditional resistance here to a truly delightful and unique seafood treat.

LITERATURE CITED

- Anonymous. 1958. Illustration of Japanese Fishing Boat and Fishing Gear — 1958. Published by Nurinicyokai (Jap. Assoc. Agric. For.).
- _____. 1970. Squid raised to adult size in laboratory. *Commer. Fish. Rev.* 32(10):13.
- _____. 1972. Japanese echo-sounding research on squid. FAO (Food Agric. Organ., U.N.) Fish. Circ. No. 142, 29 p.
- Clarke, M.R. 1963. Economic importance of North Atlantic squids. *New Sci.* 17:568-570.
- _____. 1966. A review of the systematics and ecology of oceanic squids. *Adv. Mar. Biol.* 4:91-300.
- deC. Baker, A. 1957. Underwater photographs in the study of ocean squid. *Deep-Sea Res.* 4:126-129.

- Edwards, R.L. 1968. Fishery resources of the North Atlantic area. In D.W. Gilbert (editor), *The future of the fishing industry of the United States*, p. 52-60. Univ. Wash. Publ. Fish., New Ser., Vol. 4.
- June, F. C., and J. W. Reintjes. 1957. Survey of the ocean fisheries off Delaware Bay. U.S. Fish Wildl. Serv., Spec. Sci. Rep. Fish. 222, 55 p.
- Kato, S. 1970. Catching squid by the ton—with pumps. *Natl. Fisherman* 51:14-B, 19-B.
- Klima, E. F., and R. B. Roe. 1972. Report of the National Marine Fisheries Service Southeast Fisheries Center, Pascagoula Laboratory, Fiscal Years 1970 and 1971. U.S. Dep. Commer. NOAA Tech. Memo. NMFS SEFC-2, 21 p.
- Lane, F. W. 1960. Kingdom of the octopus. *The life history of the Cephalopoda*. Sheridan House, N.Y., 300 p.
- Mercer, M.C. 1970. Cephalopod resources and fisheries in the Northwest Atlantic. *Annu. Rep. 1970 Malacol. Union*, p. 30-33.
- Milliman, J. D., and F. T. Manheim. 1968. Observations in deep-scattering layers off

- Cape Hatteras, U.S.A. *Deep-Sea Res.* 15:505-507.
- Nesis, K. N. 1968. Source of raw material the biology and fishery of the Atlantic squid (*Illex illecebrosus*). (Translated from Russ.) *Fish. Res. Board Can. Transl. Ser.* 1114.
- Noskov, A. S., and V. A. Rikhter. 1971. Results of a trawl survey carried out on-board R/V *Argus* in June 1971. *Ann. Meet. Int. Comm. Northw. Atlant. Fish., Res. Doc. 72/29, Ser. No. 2720* (mimeo).
- Quigley, J. J. 1964. Mechanized squid jigger. *Trade News* 17(5):3-5.
- Roithmayr, C. M. 1970. Airborne low-light sensor detects luminescing fish schools at night. *Commer. Fish. Rev.* 32(12):42-51.
- Roper, C. F. E., C. C. Lu, and K. Mangold. 1969. A new species of *Illex* from the Western Atlantic and distributional aspects of other *Illex* species (Cephalopoda: Oegopsida). *Proc. Biol. Soc. Wash.* 82:295-322.
- 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., U.S.* 70:1005-1019.
- Squires, H. J. 1957. Squid, *Illex illecebrosus* (LeSueur), in the Newfoundland fishing area. *J. Fish. Res. Board Can.* 14:693-728.
- Suda, A. 1972. Development of fisheries for non-conventional species. *Tech. Conf. Fish. Manage. Dev., Proc.*, p. 1-55.
- Summers, W. C. 1968. The growth and size distribution of current year class *Loligo pealei*. *Biol. Bull. (Woods Hole)* 135:366-377.
- True, F. A. 1887. The Pound Net Fisheries of the Atlantic States. In *Fishing Industries of the United States, Sec. V.*, Vol. 1, p. 597-607. U.S. Fish Commission.
- Verrill, A. E. 1882. Report on the Cephalopods of the northeastern coast of America. *Rep. U.S. Comm. Fish., Part 7 for 1879*, p. 211-450.
- Voss, G. L. 1956. A review of the cephalopods of the Gulf of Mexico. *Bull. Mar. Sci. Gulf Caribb.* 6:85-178.
- _____. 1971. The Cephalopod resources of the Caribbean Sea and adjacent regions. In *Symposium on Investigation and Resources of the Caribbean Sea and Adjacent Regions*, p. 307-323. Food and Agriculture Organization of the United Nations, Rome.
- Vovk, A. N. 1969. Prospects for a squid (*Loligo pealei*) fishery. *Rybn. Khoz.* 10:7-9.

MFR Paper 1023. From *Marine Fisheries Review*, Vol. 35, No. 12, December, 1973. Copies of this paper, in limited numbers, are available from D83, Technical Information Division, Environmental Science Information Center, NOAA, Washington, DC 20235.