Squid Fishery Resources and Development in the Northwest Atlantic and Gulf of Mexico

WARREN F. RATHJEN
National Marine Fisheries Service
Gloucester, MA 01930

RAYMOND F. HIXON and ROGER T. HANLON
Marine Biomedical Institute
University of Texas Medical Branch
Galveston, TX 77550

RESUMEN

La pesca de los calamares en el Atlantico noroeste ha crecido rapidamente en el decenio pasado y ahora constituye una porción significativa del consumo japonés y europeo. La pesca es por el calamar de aletas cortas *Illex illecebrosus* y el calamar de aletas largas *Loligo pealei.* Una flota internacional domina la pesca afuera de la costa, pero aumentadas cantidades se están recogiendo por los pescadores costeños de los Estados Unidos y Canadá.

No hay ninguna pesca grande en el Golfo de México, pero los datos recientes sobre los recursos indican que cuatro especies tienen un potencial para la pesca: el calamar breve *Loleguncula brevis,* el calamar de flecha *Loligo plei,* el calamar de aletas largas *Loligo pealei,* y el calamar de espalda anarnajada *Ommastrephes pteropus.* Se tratan los métodos de mostrar, los resultados de capturar, y la distribución de las profundidades de estas especies.

Los conocimientos actuales indican que la pesca del Atlantico noroeste se puede extender y que el potencial existe para una pesca en pequeña escala en el Golfo de México. Se dan recomendaciones para direcciones posibles del futuro en las dos areas.

INTRODUCTION

Aggressive international fisheries development combined with a worldwide trend toward control of fishing areas has created an intense interest in developing resources that are not fully harvested. One such major resource group identified for development on a worldwide basis is the cephalopods, which include octopus and squid. Squid is a versatile raw material with relatively large yields compared to fish (ca 80 vs. 50% yield). It is marketed in many forms in Japan where squid represent about 7% of the marine food consumption of 7,500,000 metric tons (mt) per year. In 1976 imports constituted about 14% (70,000 mt) of the total cephalopods consumed (Anon. 1978). European markets led by the Spanish imported over 43,000 mt in 1973 (Morehead and Ellington 1976).

A substantial portion of these imports was derived from the Northwest Atlantic. Development of squid resources here has been intense over the past 10 years and much of the activity has been by Japanese and Spanish fishermen. Lesser but important interest has been generated in Canada and the United States. To date most of the developments have taken place between Newfoundland and Cape Hatteras (U.S.A.). Recently, interest has started to

crystalize in resources south of Cape Hatteras (Whitaker 1978), in the Gulf of Mexico (Rathjen et al. 1977) and the Caribbean Sea.*

FISHERY DEVELOPMENT IN THE NORTHWEST ATLANTIC

In the Northwest Atlantic the utilization of squid has reached record levels as a result of increased fishing over the past decade. The largest portion of the increases is related to activities by international fishing operations, but traditional fisheries in Canada and the United States have also contributed to the harvest. Experimentation with harvesting, handling, processing, and marketing techniques has assisted in accomplishing these gains.

The International Fishery

Directed fishing for squid in the Northwest Atlantic by foreign vessels became significant in 1968-69 when Japan, Spain, and the U.S.S.R. were attracted to the harvest of the longfinned squid *Loligo pealei* in the waters along the edge of the continental shelf off New York. Since 1968 Japan has been the major harvester, in some years sharing top production levels with Spain. Other countries taking significant amounts include Italy, Poland, and the U.S.S.R. Lesser but important amounts have also been harvested by Canada, Bulgaria, Cuba, the Federal Republic of Germany, German Democratic Republic, Romania, and Mexico.

As a result of the Fishery Conservation and Management Act of 1976, the National Marine Fisheries Service has had a unique opportunity to place observers aboard some of these foreign vessels for the purpose of monitoring compliance with U.S. fishery regulations. Observations relative to squid harvesting and handling techniques used by the international fleet have been summarized (Kolator and Long, in press) and some of the highlights are extracted for presentation here.

Foreign vessels in the fishery vary widely. The smallest observed during 1977 was 34-m long with 870 main engine horsepower and a crew of 18, and the largest was 85-m long with a crew of over 90. All vessels utilized high-opening bottom trawl gear as the primary harvest technique. In response to regulations dealing with "by-catch" some fishing is now being conducted with off-the-bottom trawls. In most operations the net configuration is monitored by net recorders that provide the captain with real-time information on height of trawl opening, water temperature, and presence or absence of squid and/or fish concentrations.

Presently the fishery is conducted on a year-round basis along the edge of the continental shelf in the Middle Atlantic area. During 1977 fishing was restricted to depths of 200 m (100 fathoms) or less due to a potential conflict with U.S. based deep-water lobster fisherman.

There are two species of squid taken in the fishery, the most valuable being *Loligo pealei,* known as the "Boston" or longfinned squid. This species is taken in the greatest abundance from October through April. In 1977 average

*Fishery development opportunities in the WCAFC - Western Central Atlantic Fishery Commission — Second Session — Panama City, Panama, 22-26 May 1978.

daily catches during the winter *Loligo* fishery were only 2.3 mt per day, a dramatic reduction from previous years when catches averaged more than twice that rate. This contrasts with the fishery for a second species, the shortfinned squid *Illex illecebrosus* which is taken in greatest abundance during the summer. In 1977, June-July catches averaged 8.2 mt daily and this catch rate apparently increased during 1978. From the insignificant harvest of the early 1970's the fishery has grown to a point where it now represents more than half of the total squid taken in the offshore fishery.

Squid processing onboard the vessels is limited to sorting into size groups, washing, and packing in 10- or 20-kg boxes. The boxes are usually frozen by blast freezers and plate freezers at -30°C or colder and stored at -20°C or colder. Freezing capacities vary from 250-750 mt per vessel.

There are several factors that may influence the future of the international squid fishery off the northeastern United States; these include: (1) limiting the foreign vessels to small geographically defined "windows" that do not take into account natural variations in squid distribution, (2) imposing squid catch restrictions, and (3) limiting the "by-catch" that normally consists of butterfish, silver hake, and other fishes. In 1978, 48,000 mt of both squid species were allocated to the international fishery. At this time it does not appear that these quotas will be reached despite heavy worldwide market demands.

Canadian Fishery

For over a century squid have been fished in Newfoundland's inshore waters. Fluctuations in abundance on the inshore coastal "squid jigging" grounds were discussed by Squires (1957). He concluded that "the appearance of squid every summer and early autumn in large numbers near the coast where they may be jigged is an expected occurrence, and any year of scarcity on the east or south coasts is unusual and difficult to explain." Such a period of scarcity was reported during the early portion of the 1970's but large catches occurred in 1977 and again in 1978 (Myers 1978).

The reappearance of squid in 1977 coincided with increased interest from Japanese buyers and the introduction of semi-automatic squid jigging equipment that had been introduced during the 1960's (Kasahara 1965). In 1977 inshore fishermen (Fig. 1) landed over 25,000 mt of squid that were processed by freezing and/or drying.

The fishery in Newfoundland is conducted from small boats typically 4-to 14-m long and operated by one to four men. Virtually all the catch is taken near the shore in protected waters often in close proximity to the processing facility (Fig. 2). Most of the catch is washed and packed into 10-kg boxes and then frozen for export as food or bait. Some squid is dried for shipment to oriental markets. This practice has been underway for at least 40 years (Ewbank 1937) although recent production levels have been low. Interest in dried squid is being rejuvenated in Newfoundland following demonstrations of automated mantle splitting devices and mechanically controlled drying equipment. The drying of squid introduces a number of advantages: it circumvents the requirement for refrigeration, it creates employment in rural environments, it increases the value of the product, and it falls into a more

Figure 1. Small boat fisherman fishing near Holyrood, Newfoundland. Note the "homemade" jigging equipment fabricated after Japanese operated squid fishing machines.

favorable trade category. It is probable that this practice will be encouraged in the future.

In the waters east of the Canadian Maritime Provinces, offshore fishing is being conducted by the international fleet. This fishery is primarily dependent on trawl catches; however, some offshore jigging with light attraction has been employed by Japanese fishermen on an experimental basis (Ichikawa and Sato 1976). The future for increased development appears good but will depend upon improved handling ability ashore and/or the expansion of the squid fishery into offshore waters by Canadian nationals.

The U.S. East Coast Domestic Fishery

Although experimental fishing has been underway for some time (Rathjen et al. 1977), increased catches by the U.S. Atlantic fleet have not been sustained. As a result of increased market demand generated by European and Oriental buyers, value has reached record levels. As in the Canadian fishery the U.S. landings at the present time have been dependent upon the migration of squid to waters within range of the inshore fisherman. The lack of freezing equipment in U.S. vessels and the somewhat questionable economics of experimenting with this equipment have been deterrents in the development of an offshore squid fishery by U.S. fishermen. However, with continuing res-

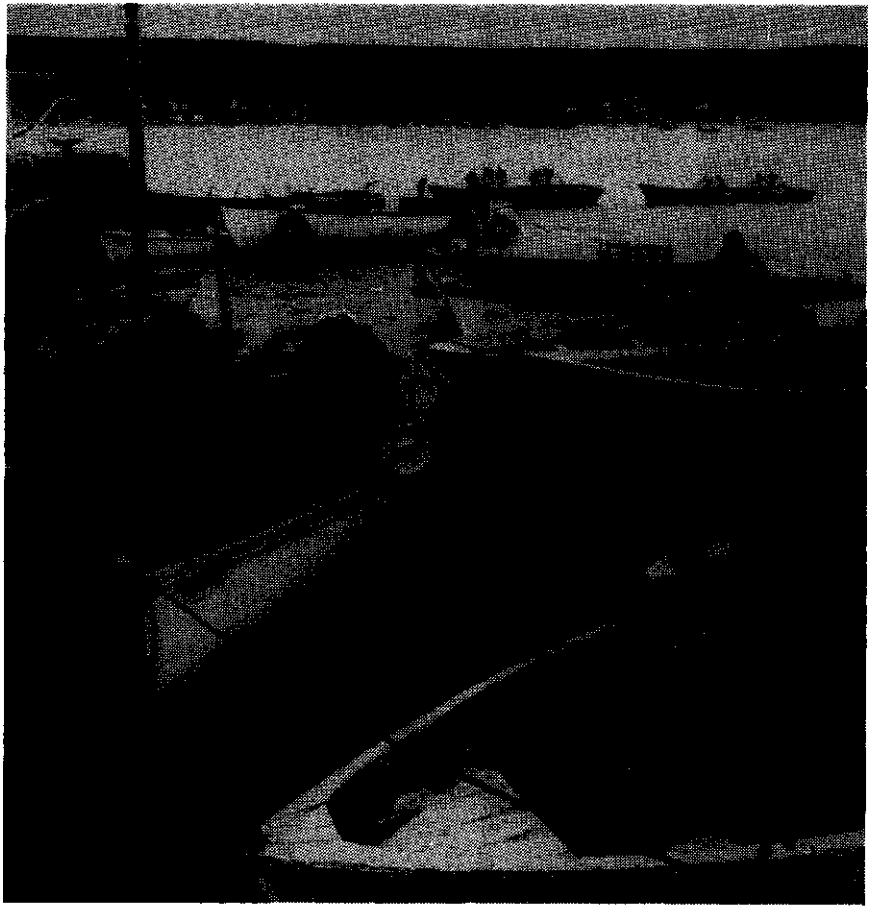

Figure 2. A portion of the local fishing fleet at Holyrood, Newfoundland. Boat on the left is taking out a catch of about 0.5 mt of squid from the morning's fishing. In the distance some vessels are still fishing within sight of the processing plant. The season takes place in summer and autumn.

trictions on traditional species such as haddock, cod, and flounders expected to continue for some years, more interest is being demonstrated in either installing freezing facilities aboard existing vessels or incorporating it into the planning of new vessel construction.

SQUID FISHERY RESOURCES IN THE WESTERN GULF OF MEXICO[1]

The purpose of this section is to present to the fishing industry some pertinent results of studies currently being conducted on squid in the western Gulf

[1]This section authored by Raymond F. Hixon and Roger T. Hanlon, Marine Biomedical Institute, 200 University Blvd., Galveston, Texas 77550.

of Mexico. Although the primary aim of these investigations is to capture and maintain live squid as research animals, we believe our collecting techniques and observations of these animals are applicable to their possible commercial exploitation. We will describe the available species, their distribution in the western Gulf of Mexico, our capture techniques, and the relation of these factors to existing fisheries.

Species Available for Harvesting

There are four squid species in the western Gulf of Mexico that occur in sufficient number to be considered for fisheries potential. These include one oceanic species, the orange-back squid *Ommastrephes pteropus,* and three shallow water loliginid species: the thumbstall or brief squid, *Lolliguncula brevis,* the longfinned squid, *Loligo pealei,* and the arrow squid, *Loligo plei* (Voss 1960; Rathjen et al. 1977). In fishermen's parlance *Lolliguncula brevis* is referred to as the "white" squid while the other three species are grouped as "red" squid. Figure 3 shows the relative size and proportions of the adults of each species. Descriptions and keys useful for separating these animals have been presented by Voss (1971) and Voss, Opresko, and Thomas (1973). There has been some confusion in distinguishing the two species of *Loligo* especially in areas where they occur together. This has been largely resolved by Cohen (1976), but the characters separating them are usually difficult to determine at sea.

Sampling Gear and Methods

Because the available literature and fisheries statistics on squid in the Gulf of Mexico are sparse, we instituted a sampling program near Galveston,

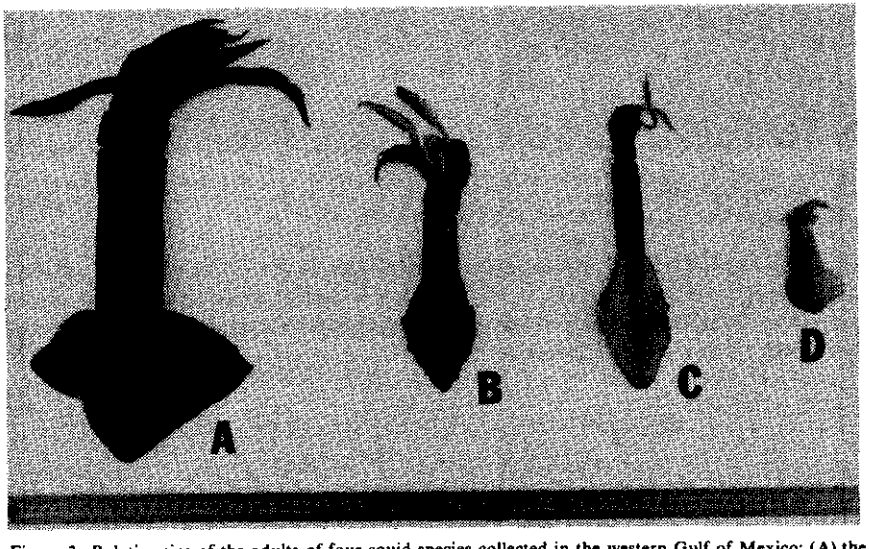

Figure 3. Relative size of the adults of four squid species collected in the western Gulf of Mexico: (A) the oceanic orange-back squid *Ommastrephes pteropus,* (B) the longfinned squid *Loligo pealei,* (C) the arrow squid *Loligo plei,* and (D) the thumbstall or brief squid *Lolliguncula brevis.*

Texas, to determine the depth distribution of each species and to test different types of fishing gear. We also participated in six exploratory oceanographic cruises in the western Gulf of Mexico and we obtained additional samples from the Bureau of Land Management (BLM) survey of the Texas continental shelf. All of these investigations have relied primarily on two capture strategies: the use of otter trawls during the day (BLM samples have both day and night trawls), and at night the use of squid jigs and dip nets under night lights. Our standard bottom sampling gear is a modified semi-balloon otter trawl with a 30-ft (10 m) footrope, 1.5-in (38 mm) nylon netting and 0.5-in (12 mm) mesh cod-end liner to retain small specimens. We also used standard commercial 10-ft (3 m) shrimp try nets and 41-ft (13 m) otter trawls. Ship speed was near 2 knots during each haul and bottom time was 15 or 30 minutes.

Because certain species of squid can be attracted to lights at night, this technique is employed in squid fisheries throughout the world. The market squid *Loligo opalescens* supports a substantial fishery in southern California that uses incandescent night lights to draw large schools of squid to the vicinity of the boat, where they are harvested with a power assisted brail or submersible fish pump (Kato and Hardwick 1976). The Japanese use electric lamps to attract shallow water loliginid squid as well as the oceanic ommastrephid squid *Todarodes pacificus* which constitutes up to 50% of the Japanese squid landings (Okutani 1977). For our samples we usually positioned our lights (incandescent bulbs, mercury-vapor lamps, and quartz-iodide lamps) over the stern or side railing of the ship and used either dip nets or squid jigs to collect specimens.

Squid jigging is one of the most productive and widely used methods for the commercial exploitation of squid (Voss 1973). Jigs are lures armed with one or two circlets of sharp barbless hooks (Fig. 4). They are fished by hand, fishing pole, and by handcranked or automatic machines that can accommodate a large number of jigs attached in series. Most of the Japanese catch of the squid *Todarodes pacificus* is taken with jigs. In our work we fished several types of Japanese squid jigs at night, either with poles or with a handcranked squid jig machine.

Capture Results and Discussion

We pooled our data from the exploratory cruises and plotted the squid catch by species and capture method (Fig. 5). Most of our sampling effort was over the continental shelf; the only samples taken in depths exceeding 500 m came from night light stations. The total catch consisted of 4270 squid, of which 57% were *Loligo pealei,* 34% *Loligo plei,* 8% *Lolliguncula brevis* and 1% *Ommastrephes pteropus.* These numbers do not represent the actual or true percentage of these species; they reflect a bias based on our sampling locations. Figure 5 shows that all four species occur throughout the sampled area. The three loliginid species occupy the continental shelf (usually less than 200 m deep) while *Ommastrephes pteropus* is restricted to the deeper area beyond the shelf.

All orange-back squid *(Ommastrephes pteropus)* were collected at night by

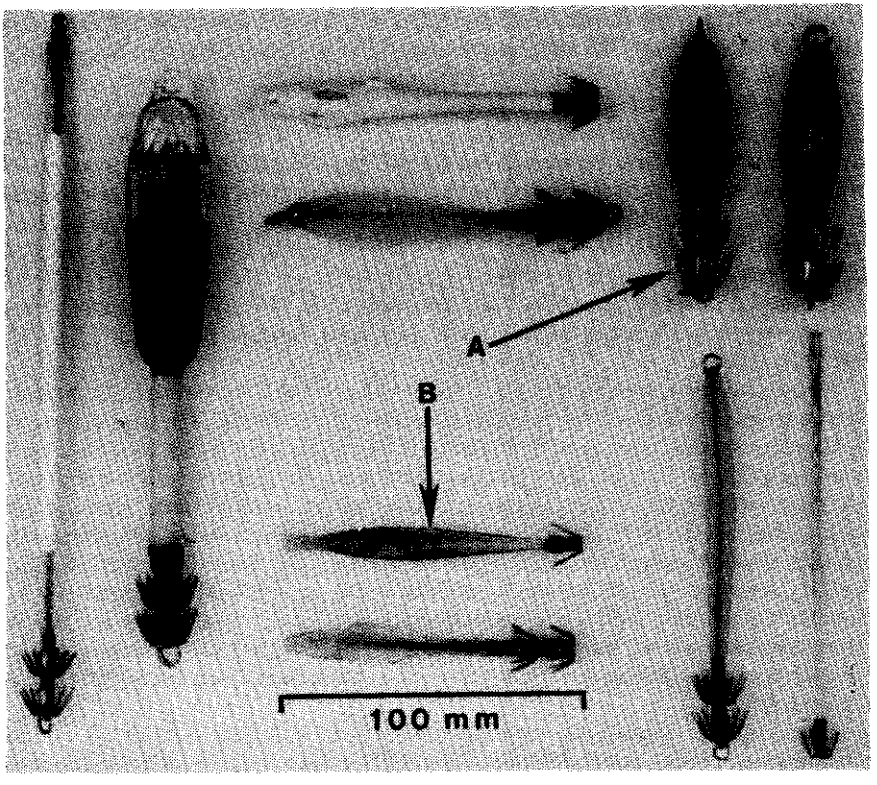

Figure 4. Assorted plastic and metal squid jigs that we have tested for capturing squid. The oceanic squid *Ommastrephes pteropus* was usually collected with brightly colored, solid plastic jigs (A). The loliginid species *Loligo pealei* and *Loligo plei* preferred transparent or lightly colored hollow plastic jigs. (B).

squid jigs or dip nets. Our best catches were made in the Gulf of Campeche, especially near the western edge of Campeche Bank. Although few orangeback squid were actually collected, they represented only a small percentage of the animals observed under the lights.

The distributional pattern of the shelf species is complex. To show this relationship we combined the exploratory cruise data with the results of our sampling program near Galveston, which better represents shallow depths (Fig. 6). The species are generally distributed by depth in three overlapping bands.

Although each species occupies a primary depth range there are considerable areas of overlap. *Lolliguncula brevis* is associated with brackish or low salinity conditions and is found primarily in bays and nearshore to a depth of 20 m. *Loligo plei* occupies a mid-shelf range, generally from 20-75 m, while *Loligo pealei* prefers deeper water, from 50-200 m. Figure 6 depicts their general depth distribution, but this varies in different areas, seasons, or from year to year. For example, all three species are occasionally caught in the same

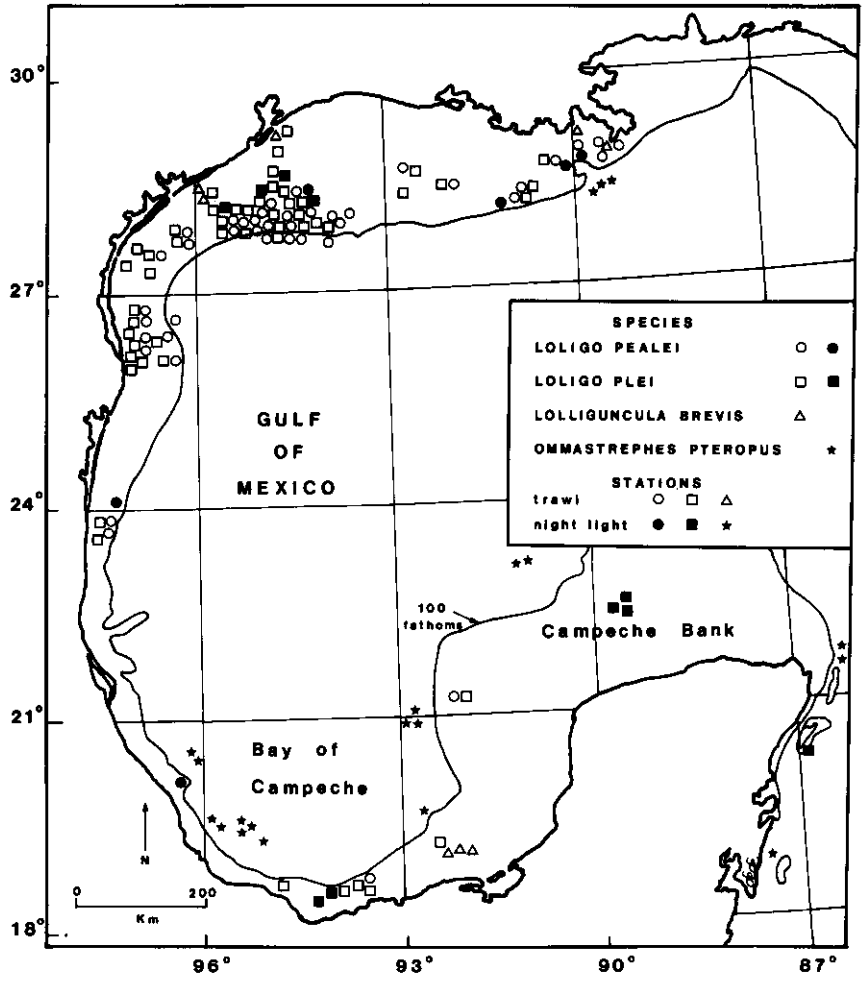

Figure 5. Location of successful trawl and night light stations conducted during six exploratory cruises in the western Gulf of Mexico.

trawl. We have also observed a general inshore movement of squid in the spring and a migration offshore in fall and winter. In addition, at least one species, *Loligo plei*, is subject to wide fluctuations in abundance from year to year.

At present, most squid landings in the northwestern Gulf consist of incidental catches of "white" squid *(Lolliguncula brevis)* in the bay and nearshore trawl fishery for white shrimp. In contrast, few "red" squid *(Loligo plei* and *Loligo pealei)* are caught by the offshore brown shrimp fishery, which operates primarily at night. The low catch of offshore squid by nighttime trawling

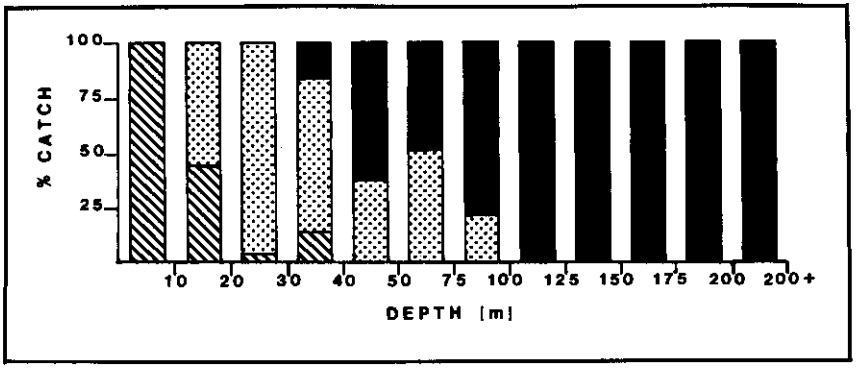

Figure 6. The percent catch of *Lolliguncula brevis* (diagonal stripes), *Loligo plei* (dots) and *Loligo pealei* (all dark) in 10-m depth increments from 0-200 m, showing the depth distribution of each species. The data were compiled from trawl and night light stations taken in all months of the year in the western Gulf of Mexico.

is mostly due to their nocturnal feeding habits high in the water column (Fig.7). Another factor is that our best catches of the two *Loligo* species are over rough bottom or near submerged obstructions where shrimp trawling is hazardous.

An examination of long-standing squid fisheries indicates that some are dependent on very localized feeding congregations *(Illex illecebrosus* in Newfoundland) or spawning concentrations *(Loligo opalescens* in California). The fishing grounds may be limited to only several hundred square meters. We have not yet found any such intensive squid concentrations in the western Gulf of Mexico. However, because they are so localized, similar spawning or feeding grounds may occur in the western Gulf of Mexico, but more exploratory work is needed to locate them.

The economical exploitation of Gulf squid will also depend on a more efficient means of harvest, using innovative means such as midwater trawls or squid jigs and lampara nets with night lights. We have found that squid jigs selectively attract different size animals and species. As with other fishing lures, fishing success varies considerably depending on the size, color, materials, and construction of the jig. With *Ommastrephes pteropus,* heavy pink or red plastic jigs work best (Fig. 4-A). For *Loligo,* we caught most specimens with transparent, fish-shaped plastic jigs fished just below the surface (Fig.4-B).

Our experience with night lighting has shown that several physical and environmental factors affect the attraction of squid. Incandescent and quartz-iodide lamps generally attract more squid than mercury-vapor lights. Bright illumination can attract squid to a general area but it is sometimes useful to then lower the light intensity with a rheostat to draw them closer to the boat. Rough sea conditions, a bright moon or the intrusion of large predators such as mackerel, sharks, or jack usually cause the squid to move deeper and away from the lights. Dark moonless or overcast nights are sometimes more pro-

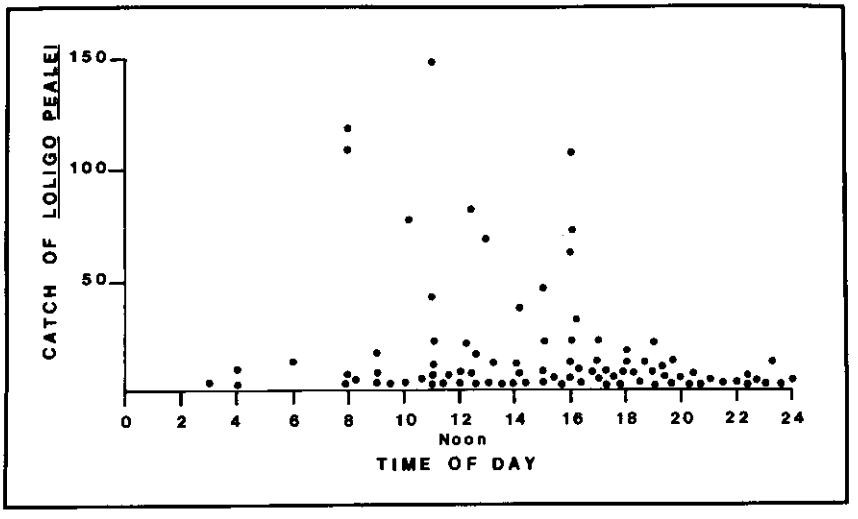

Figure 7. The trawl catch of the longfinned squid *Loligo pealei* in relation to time of day. Each dot represents one trawl station. *Loligo pealei* is demersal during the day and rises into the water column to feed at night. The data were assembled from samples taken by the Bureau of Land Management survey of the Texas outer continental shelf. Replicate day and night trawls were made in this survey.

ductive, especially if small bait fish and crustaceans congregate under the lights.

Large encirclement nets such as a lampara net or purse seine could be an efficient capture technique for Gulf squid. Lampara nets are used successfully in the California fishery for the market squid *Loligo opalescens* located in Monterey Bay. Another promising alternative is the midwater trawl. The introduction of midwater trawling techniques has substantially increased the squid catch in the Mediterranean Sea near Sète, France (J. Worms, pers. comm. 1976), and recently some substantial catches of California market squid using midwater trawls have been reported (Vaughn and Recksiek 1976; Caillet and Karpov 1976).

POSSIBLE FUTURE DIRECTIONS

In the Northwest Atlantic the major constraint on the fishery is the unpredictable, seasonal nature of squid migrations to inshore grounds where they are primarily captured by jigs or trawls. There may be a potential to expand the present level of catches by applying techniques known to be successful in other countries. This may be expedited by the placement of foreign technicians, who are skilled in methods of the fishery, aboard U.S. vessels. Promising developments using depth recorders of varying frequencies to locate squid and discriminate them from other marine animals would be a positive step toward accelerating their exploitation. In the short term, Canadian and United States fishermen can improve their ability to participate in the fishery by

installing freezing or other preservation systems aboard suitable vessels or considering this accommodation.

The situation in the Gulf of Mexico is different. There is no large fishery presently operating and the resources are only recently being evaluated. At this time relatively little is known about squid populations on the vast continental shelf areas throughout the Gulf, although our recent research indicates that there are sufficient quantities to justify continued investigation of their exploitation. The major emphasis should be in refining capture techniques and locating areas of squid concentrations. The refinement of light attraction and subsequent capture techniques (i.e. squid jigging and lampara nets) must be accomplished before any large scale harvesting of squid at night can take place. A systematic investigation of the outer continental shelf utilizing these and other capture techniques may pinpoint squid concentrations and also provide important information on migrations and habitat preference.

In summary, squid fishery resources and development in the western Atlantic have only recently been actively investigated but increased interest in hem may lead to the greater exploitation of this underutilized resource.

Acknowledgements

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