

Squid Resources of the Gulf of Mexico and Southeast Atlantic Coasts of the United States

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Abstract

Five species of commercially important squid occur in the southeastern fisheries region of the United States, which includes the northern Gulf of Mexico and the Atlantic coast south of Cape Hatteras. These are *Loligo pealei*, *Doryteuthis plei*, *Lolliguncula brevis*, *Illex illecebrosus* and *I. coindeti*, although the last two species are usually not separated in the reported catches due to difficulty of identification. Although there is considerable overlap in the distributions, the species exhibit somewhat different seasonal patterns of distribution as well as differences in depth and temperature preferences. With the exception of *Lolliguncula brevis* which inhabits the shallow inshore waters, major concentrations appear to be associated with topographic features such as the Charleston Bump, which cause upwellings of nutrient-rich waters, or with the nutrient-laden water around the delta of the Mississippi River. Anecdotal information from surveys and commercial fishermen supports the existence of substantial stocks of squid in the Gulf of Mexico and along the Atlantic coast from southern Florida to Cape Hatteras.

Introduction

Five species of commercially important squid occur in the southeastern fisheries region of the United States: longfin squid (*Loligo pealei*), arrow squid (*Doryteuthis plei*), brief squid (*Lolliguncula brevis*), shortfin squid (*Illex illecebrosus*), and southern shortfin squid (*Illex coindeti*). The sharptail shortfin squid (*Illex oxygonius*) also occurs in the region but is often unrecognized in the catches. Because the characters for separating some of the species are not easily distinguishable, the longfin, arrow and brief squid are often recorded as longfin squid, and the shortfin, southern shortfin and sharptail shortfin squid are seldom distinguished and are listed as shortfin squid. Although misidentification of species is common, it is possible that only the longfin, brief and shortfin squid are taken north of Cape Canaveral, Florida. The situation is more complicated south of Cape Canaveral and in the Gulf of Mexico because all five species occur together along with significant numbers of *I. oxygonius*. In cases where the catches are separated by species, it is found that migrational patterns as well as spawning times and abundances are different among species (Voss, 1973, 1983).

For many years, the shortfin squid has been fished mainly for bait in eastern Canadian waters (Squires, 1957) and both the shortfin and longfin squids have been exploited off the northeastern United States (Voss, 1973). Only in the last 10 years or so has the fishery extended southward from New England waters to the Middle Atlantic region and the catch used for human consumption. Exploratory investigations by distant-water fleets, notably from Japan, Soviet Union

and Spain, have mainly ended at Cape Hatteras, with only a few vessels operating off North and South Carolina and one as far south as northern Florida (Long and Rathjen, 1980; Whitaker, 1980).

In the southeastern region of the United States, the only sources of information on distribution and abundance of squid have been research vessel surveys (Rathjen, 1981), resource studies on groundfish, and records of by-catch from shrimp trawlers (Hixon *et al.*, 1980). Increased interest in the possibility of developing a southern squid fishery has put pressure on various agencies to assess the squid stocks. With recent funding from the Gulf and South Atlantic Fisheries Development Foundation, a program was started to bring together all known records on the presence of commercially important squid along the Gulf of Mexico and Atlantic coasts of the southeastern United States.

Materials and Methods

Squid records were obtained from research and exploratory vessel reports, museum collections, Bureau of Land Management studies, marine laboratories along the Gulf of Mexico and Atlantic coasts of the United States, computer files of the National Marine Fisheries Service (NMFS), by-catches of the shrimp and groundfish fisheries, etc. These records were entered into the computer at the University of Miami, accompanied by data on date and locality of collection, depth of capture, temperature, and available biological information such as size, sex and number of specimens caught. Unfortunately, there were almost no catch-

TABLE 1. Depth and temperature ranges and means (bold type) for squids in the Gulf of Mexico and along the Atlantic coast south of Cape Hatteras.

Species	Depth (m)		Temperature (°C)	
	G. Mexico	Atlantic	G. Mexico	Atlantic
Brief squid (<i>L. brevis</i>)	1- 26 -325	5- 76 -278	12- 22 -29	14- 19 -26
Arrow squid (<i>D. plei</i>)	11- 43 -136	...	17- 23 -28	
Longfin squid (<i>L. pealei</i>)	9- 56 -298	23- 105 -274	10- 20 -26	8- 10 -13
Shortfin squids (<i>Illex</i> sp.)	281- 318 -517	171- 367 -597	10- 11 -13	7- 10 -14

per-unit-effort data. Most of the data were collected within the past 5 years, but some earlier records are included.

With more than 13,000 catch records in the data bank, monthly records of each species were printed on charts covering the Gulf of Mexico and Atlantic coasts, giving a total of 96 distribution charts, from which 12 were selected for this paper. The available data on temperature and depth of capture were summarized to provide minimum, maximum and mean values for each species in each of the two geographic regions (Table 1).

A major danger in interpretation of the data is that they represent catches which may not be indicative of the numbers of squid present but could represent the fishing effort in an area. However, it was interesting to note, for instance, that there were few to no records of longfin squid on the Texas coast during the winter months, when fishing was usually at a high level, except in January when this species was reported throughout the Gulf. Similarly, concentrations of recorded catches around the Mississippi River delta might be related to groundfish bottom-trawl surveys by the NMFS at Pascagoula, Mississippi, but there were also a high number of catch records in months when groundfish surveys were not carried out. It is also noteworthy that there was a distinct lack of catch records for most species during December. This is probably an artifact of stormy weather and the holiday season.

Gulf of Mexico

Longfin squid (*Loligo pealei*)

This northern species occurs along the Atlantic coast from southern Canadian waters to the Gulf of Mexico and Cuba (Voss, 1973). In winter, longfin squid appear to be rather evenly distributed throughout the northern Gulf from Corpus Christi, Texas, to Dry Tortugas off southern Florida (Fig. 1A). They live on the shelf and are seldom found beyond the 200-m isobath, but they do not enter estuaries or tolerate brackish water. They are more widespread throughout the Gulf in most months of the year than any of the other species. In summer and autumn, particularly November

(Fig. 1B), they concentrate immediately to the east and west of the Mississippi River delta, with spotted occurrence off Texas and on the Western Florida shelf. On the average, they were caught in shallower, warmer water than those along the Atlantic coast (Table 1).

Arrow squid (*Doryteuthis plei*)

This tropical species occurs from the southern United States southward to southern Brazil (Voss, 1973). In winter, arrow squid are found mainly off southwestern Florida (Fig. 2A) and are virtually absent elsewhere in the northern Gulf. As the offshore waters become warmer in April, they move westward in the northern Gulf (Fig. 2B) but do not occur in abundance. In November and December, they move southward along the Mexican coast and support a small fishery in the Gulf of Campeche (C. M. Solis, National Institute of Fisheries, Merida, Mexico, pers. comm.).

Brief squid (*Lolliguncula brevis*)

This species has the widest distribution of all of the commercial species, extending from Maryland to southern Brazil, and is always associated with estuaries, coastal lagoons and inshore shelf areas (Voss, 1973). Brief squid can tolerate lower salinity than any other known cephalopod, living in water with salinity as low as 17.0. In the northern Gulf, they are found from the Rio Grande to the Dry Tortugas (Fig. 3), but the largest concentrations seem to be in the waters of high productivity around the Mississippi River delta. Although marine resource surveys (Hourglass Program) were conducted off southwestern Florida at quarterly intervals over a 2-year period by the Florida Department of Natural Resources, it is interesting that the monthly maps do not reflect the survey pattern except in September.

Shortfin squid (*Illex illecebrosus* and *I. coindetii*)

Because these species were not recognized and thus not reported separately in the catch records, they are considered together in this analysis, although evidence is accumulating that only *I. coindetii* may occur in the Gulf of Mexico. The dearth of records for shortfin

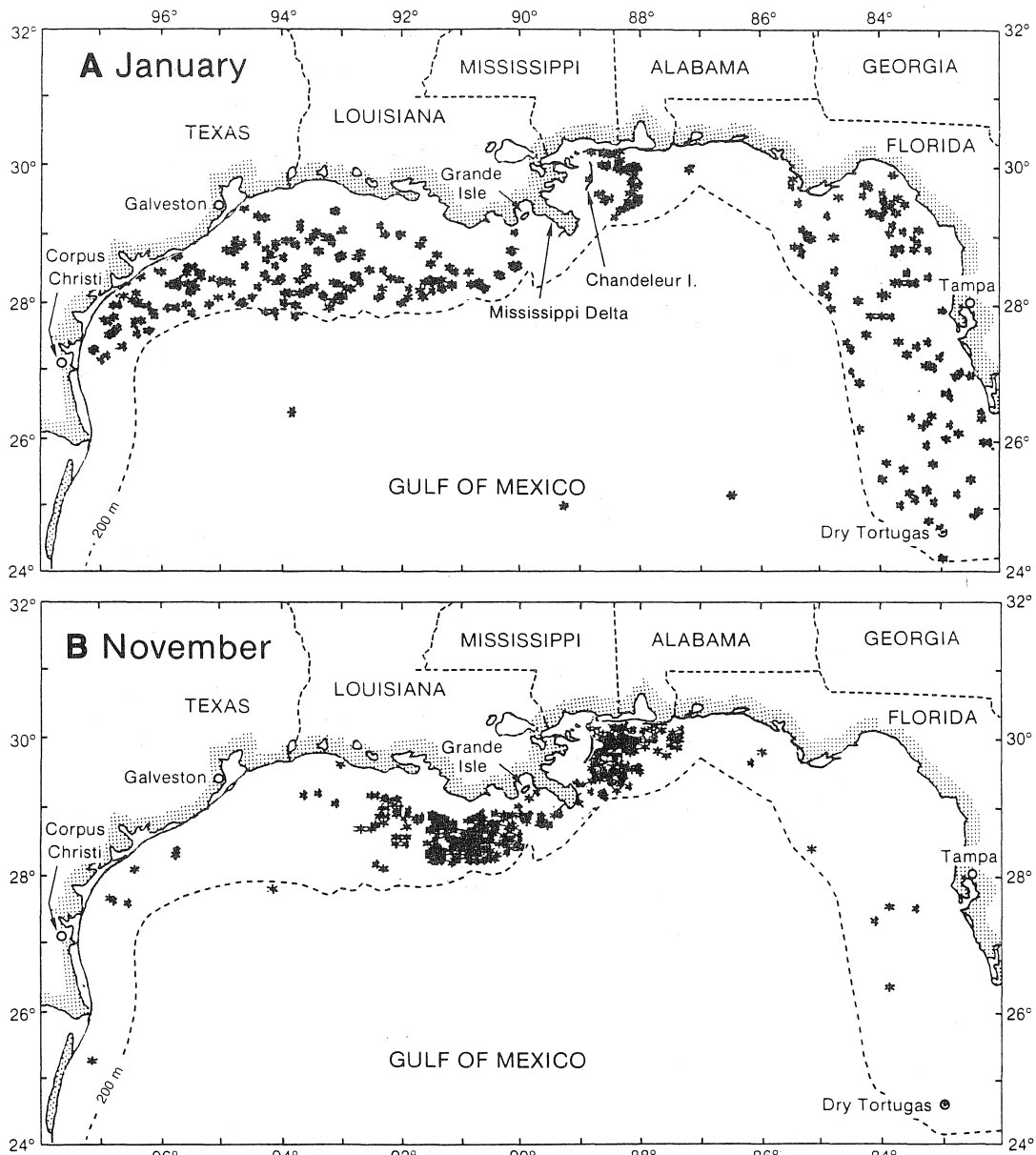


Fig. 1. Distribution of catch records for longfin squid (*L. pealei*) in the Gulf of Mexico during (A) winter and (B) summer and autumn.

squid may be because they are few in number but more likely because they inhabit the outer edge and upper slope of the shelf (Fig. 4) and thus have not been taken in the conventional Gulf fisheries. No apparent seasonal differences in migrational patterns or numbers are discernible from the available data. In some months there are catch records to the east of the Mississippi River delta and inshore, but these may be misidentifications or, as seems more likely from spot checks of preserved samples, small juveniles. Adults seldom leave the edge of the shelf and its cooler waters (Table 1).

Summary

The shelf waters of the Gulf of Mexico are partitioned among the four types of squid with respect to depth and temperature preferences, but there is considerable overlap in the ranges of these parameters for all species except perhaps for *Illex* sp. (Table 1). The partitioning would probably be even greater, if all of the records were for positively identified adults. Studies of the squid fishery in the western Gulf show these same general patterns (Hixon *et al.*, 1980), except that their shallower records of brief squid reflect a bay fishery.

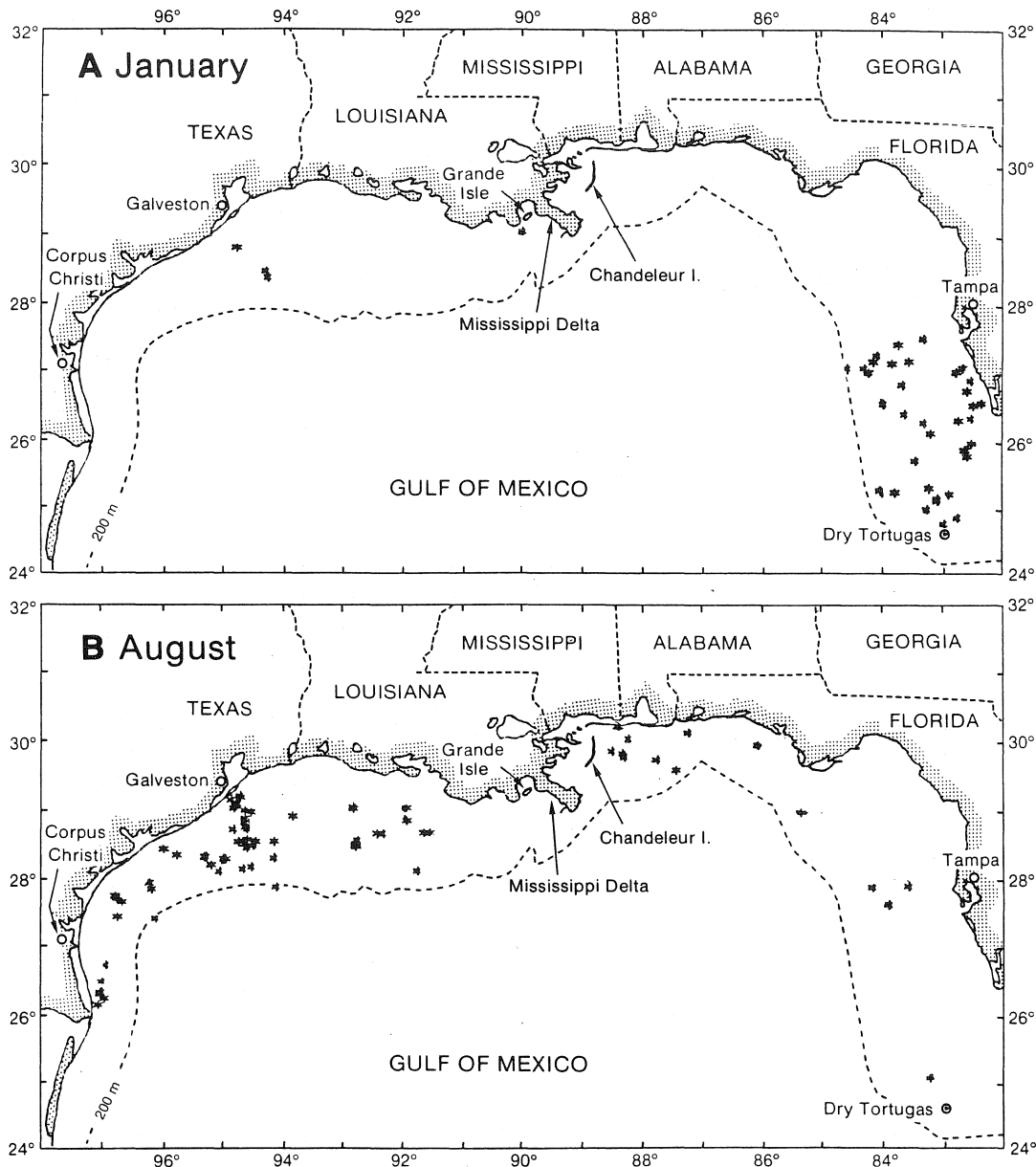


Fig. 2. Distribution of catch records for arrow squid (*D. plei*) in the Gulf of Mexico during (A) winter and (B) spring and summer.

Brief squid and arrow squid tolerate or prefer warmer water than the other species, and they constitute the populations of the inner half of the shelf. Brief squid are prevalent in estuaries and shallow coastal waters and on the inshore shrimp grounds, whereas arrow squid do not enter estuaries or shallow inshore waters except as strays. Longfin squid, essentially a temperate and cold-water species, live in slightly cooler and deeper waters of the outer half of the shelf. Shortfin squid prefer colder water and live along the upper slope where temperatures are 7° to 14°C.

Brief squid, with a wide temperature range, maintain the same distribution throughout the year. Arrow

squid, a truly tropical species, move southward to the southern part of the Gulf or out of the Gulf in the colder months. Longfin squid move a little further offshore and shortfin squid move a little deeper in summer in order to maintain their preferred temperatures.

Atlantic Coast South of Cape Hatteras

There are far fewer records of squid catches along the Atlantic coast of the United States than in the Gulf of Mexico, but the available records indicate more substantial catches and analyses of stomach contents of predators indicate the presence of substantial stocks.

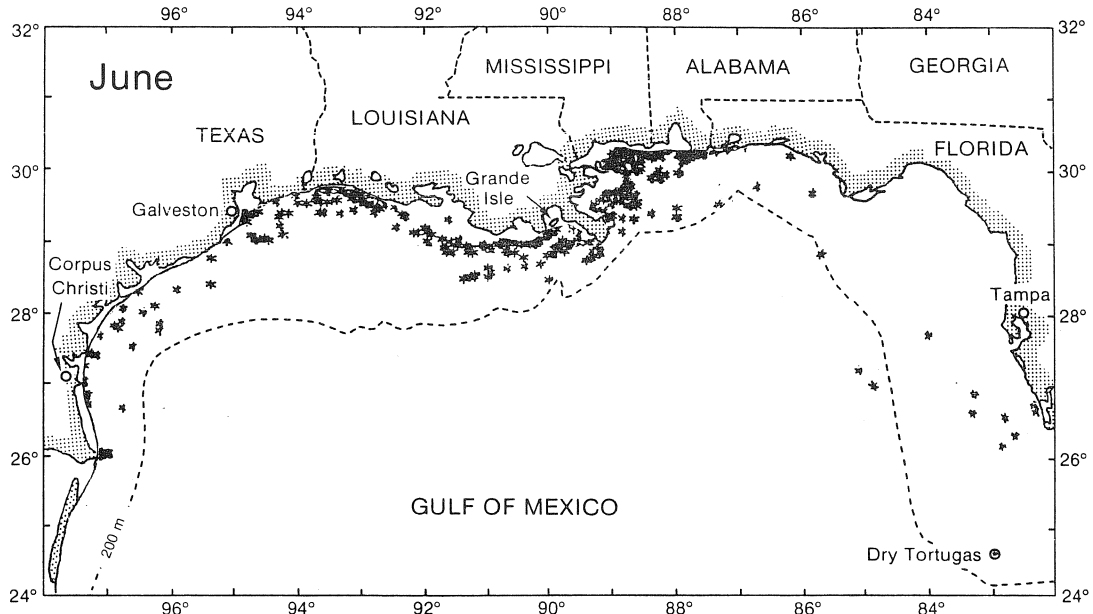


Fig. 3. Distribution of catch records for brief squid (*L. brevis*) in the Gulf of Mexico in summer and generally reflecting distribution throughout the year.

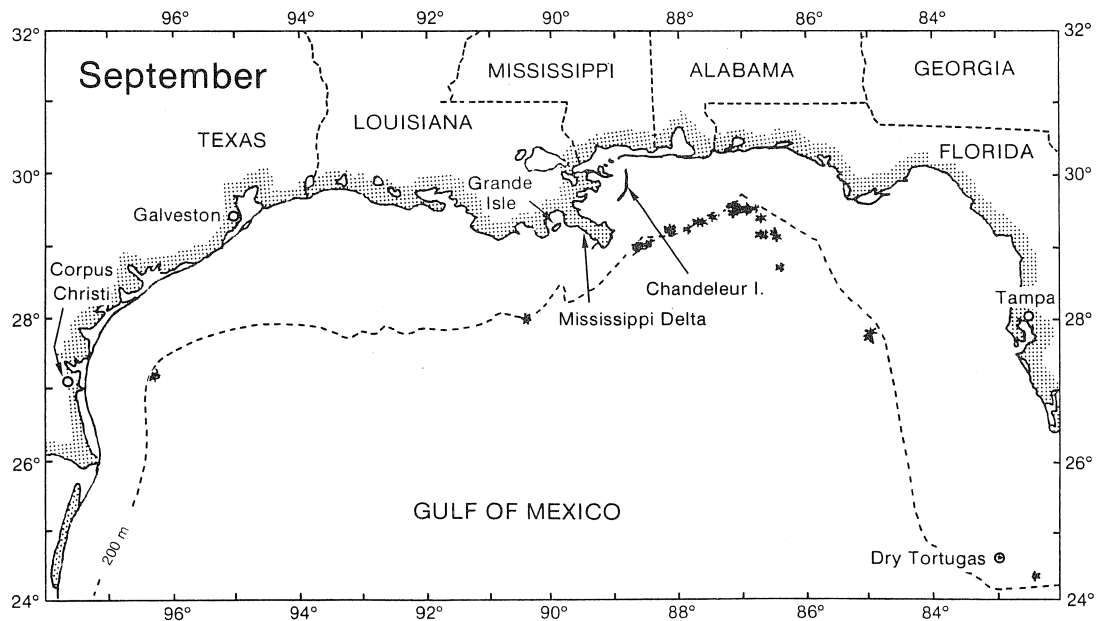


Fig. 4. Distribution of catch records for shortfin squids (*Illex* sp.) in the Gulf of Mexico in early autumn.

Longfin squid (*Loligo pealei*)

There is no active fishing for longfin squid south of Cape Hatteras, and the available data are too meager to indicate abundance or areas of concentration. The plot for July (Fig. 5) seems to indicate a rather wide distribution. The records from the area north of Cape Hatteras represent catches by fishing vessels from the United States and some other countries. From the data on temperature and depth of capture, longfin squid

seem to live in somewhat deeper and cooler water along the Atlantic coast than in the Gulf of Mexico (Table 1).

Arrow squid (*Doryteuthis plei*)

This tropical species does not appear in the South Atlantic Bight (north Florida to South Carolina) until the water warms up in early summer (June) when they become scattered along the coast (Fig. 6A). They are

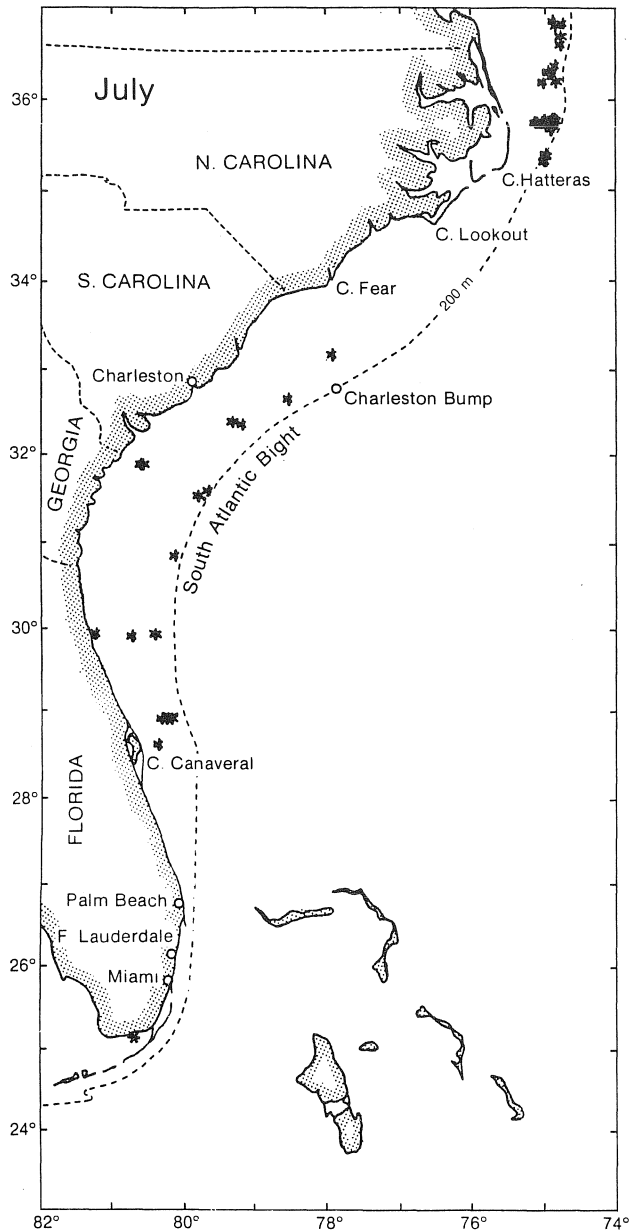


Fig. 5. Distribution of catch records for longfin squid (*L. pealei*) along the Atlantic coast from Cape Hatteras southward in summer.

plentiful just south of Cape Hatteras in September (Fig. 6B) but they disappear from the area shortly thereafter. There are few catch records of this species, and almost none have accompanying data on depth and temperature. There is little doubt, however, from examination of various squid collections, that large numbers of *Loligo* sp. records from the region refer to immature specimens of *D. plei*. According to J. D. Whitaker (pers. comm., see Acknowledgements), small arrow squid occur as far north as 33° 40' but the adults move southward when the water cools in the autumn.

Brief squid (*Lolliguncula brevis*)

This species is common along the Atlantic coast and is regularly caught in the shrimp fishery. Catches are common around Cape Canaveral during the winter and progressively farther northward to Cape Hatteras during the spring and summer. Catches from estuaries and inshore waters in October (Fig. 7) may reflect inshore movement for spawning. Along the Atlantic coast, this species seems to live in somewhat cooler and deeper waters than in the Gulf of Mexico (Table 1), but this may reflect more offshore trawling in the Atlantic region.

Shortfin squid (*Illex illecebrosus* and *I. coindeti*)

These species are grouped because many records are misidentifications, and there is added confusion with the occurrence of the sharptail shortfin species (*I. oxygonius*) in the region. No particular seasonal pattern of distribution is evident along the Atlantic coast. All catches were made along the 200-m isobath or deeper, reflecting exploratory trawling by fishing vessels (Fig. 8). Most of the catches off South Carolina were in the area of upwelling and its related high productivity, which indicates the effect of the Charleston Bump on the flow of the Gulf Stream. Preferred depths and temperatures varied little from those in the Gulf of Mexico (Table 1).

Summary

The scarcity of catch records makes it difficult to determine the distribution of arrow squid along the Atlantic coast. The range seems to extend northward to about Cape Hatteras during the summer and early autumn, but they are probably present in insignificant numbers during the rest of the year. Information on shortfin squids is complicated by misidentification of species, but confirmed identifications of southern shortfin squid (*I. coindeti*) from stomach contents of predators indicate that they are common from Miami southward and are relatively uncommon north of Cape Canaveral.

The distributions of the remaining species are similar to those in the Gulf of Mexico, with the brief squid inshore, the longfin squid on the middle to outer shelf, and the shortfin squid (probably mainly *I. illecebrosus*) along the upper slope. Catch records indicate that the three species, on the average, inhabit somewhat deeper areas along the Atlantic coast (Table 1), with brief squid in slightly cooler waters, longfin squid at significantly lower temperature and shortfin squid at slightly lower temperature than in the Gulf of Mexico. Water temperature is probably the controlling factor for both inshore-offshore and along-shore seasonal distribution of the various species.

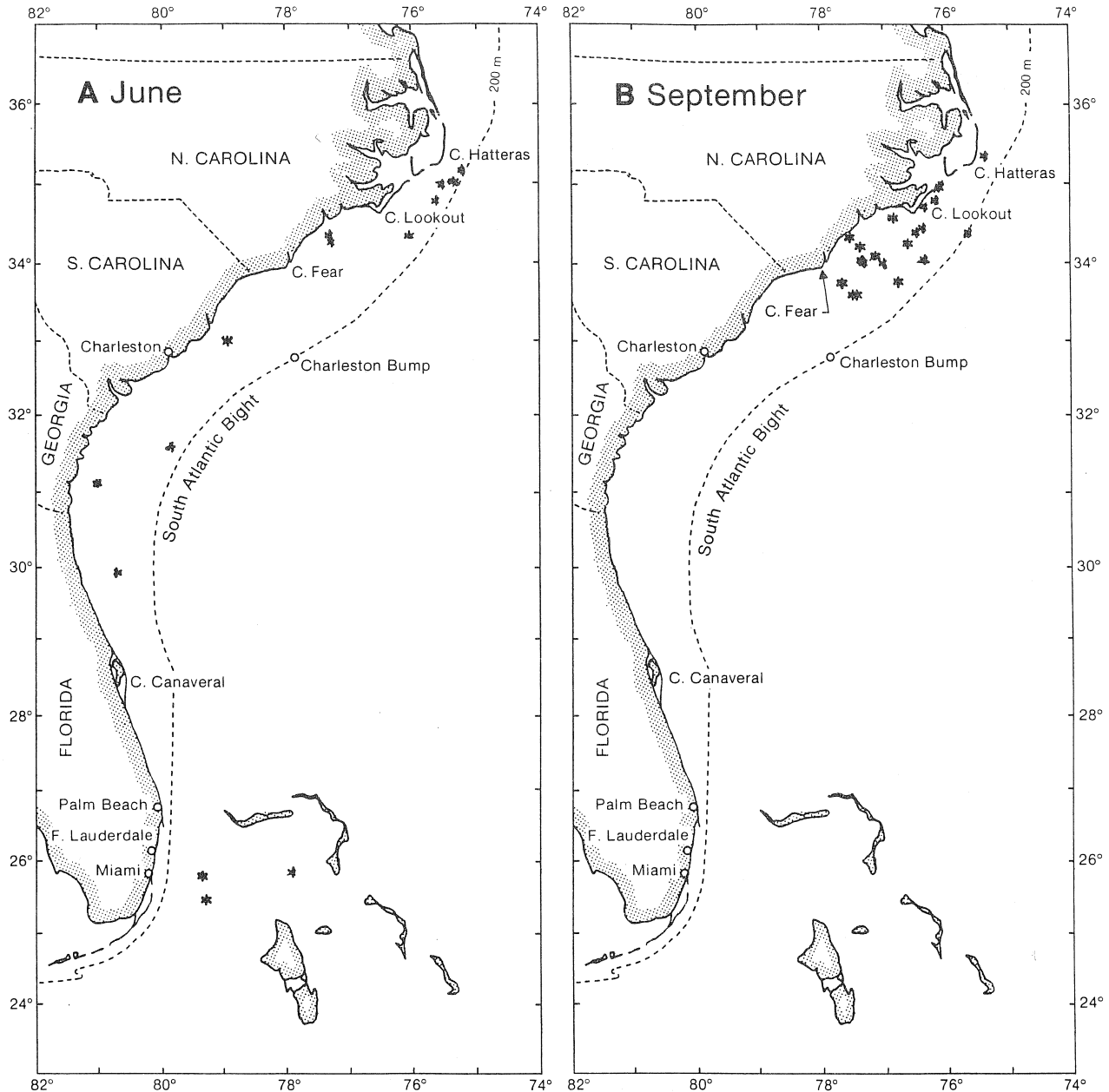


Fig. 6. Distribution of catch records for arrow squid (*D. plei*) along the Atlantic coast south of Cape Hatteras in (A) summer and (B) autumn.

Discussion

Factors determining occurrence and numbers

Examination of the distribution maps shows certain relationships between squid occurrence and temperature, bottom topography and areas of high productivity. Temperature and depth ranges have already been discussed in the preceding sections. The broad shallow shelf off western Florida seems to be relatively unproductive as far as squid are concerned, and, with only two or three exceptions, no significant numbers of squid are indicated in the region despite a

considerable trawl fishery. On the other hand, the very narrow shelf along southeastern Florida is not particularly good for trawling and the speed of the Florida Current may make jigging difficult. There are few records from this area probably due to the fast current and difficult terrain.

The most prominent feature along the edge of the shelf north of Cape Canaveral is the Charleston Bump, a projection of the shelf into the western edge of the Gulf Stream, and a bump in the surrounding depths (Brooks and Bane, 1978; Bane, 1983; Olson *et al.*, 1983). The Bump, which lies almost directly off

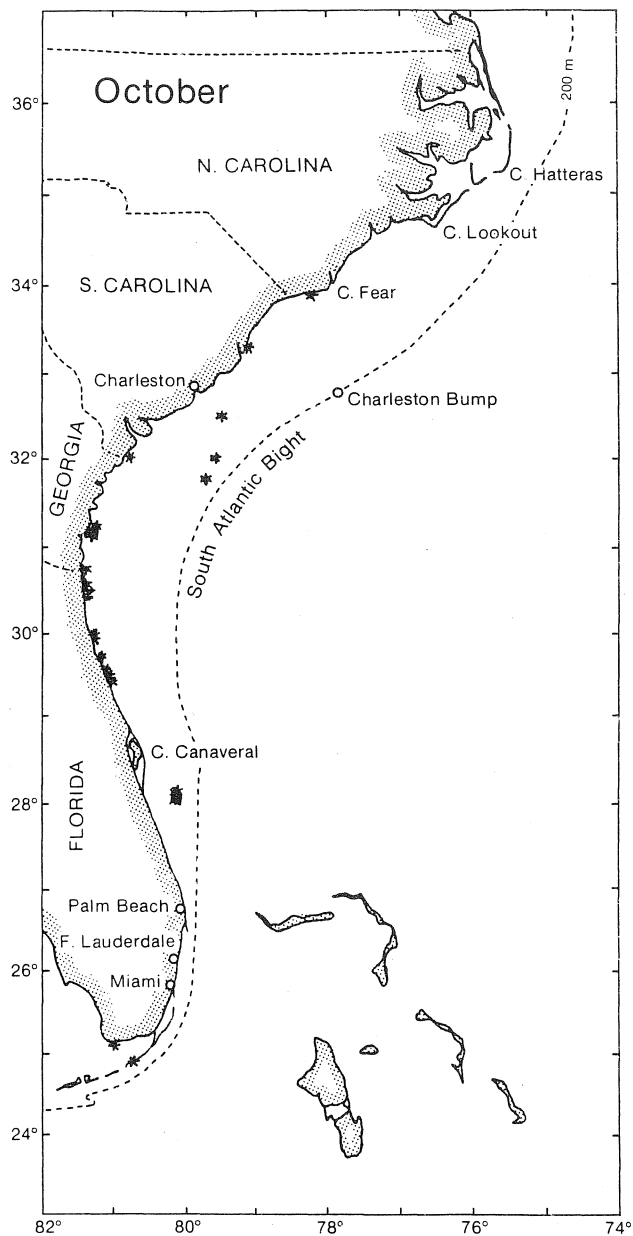


Fig. 7. Distribution of catch records for brief squid (*L. brevis*) along the Atlantic coast south of Cape Hatteras in autumn.

Charleston, South Carolina, between 31° and 32°N, causes an upwelling of enriched, highly productive water downstream to the northeast. Farther northward, the strong Gulf Stream meander caused by the Charleston Bump affects and strengthens the upwellings downstream of Cape Fear, Cape Lookout and Cape Hatteras (Lee, 1984). Additional areas of upwelling are found on both sides of the Mississippi River delta and in the Atlantic coast region from Cape Canaveral to the Florida-Georgia border. Other unpredictable upwellings may also occur along the Georgia-South Carolina region as a result of wind and sea movements (Brooks and Bane, 1983). All of these upwellings of cold, nutrient-rich water result in areas of high productivity which in turn afford feeding grounds for squid

Catch records

The data on the charts are simply records of catches and are not quantitative, although further analysis may provide some quantitative information. It was considered that the plots of catch records might only represent the patterns of research cruises, and, indeed, they do to some extent. However, as noted earlier for the marine resource surveys off western Florida, the sampling frequency is not often reflected in squid catch records. Similarly, the months in which catch records are numerous around the Mississippi River delta do not always coincide with the months when exploratory trawling surveys were conducted. What is significant about the catch records is that squid are consistently found in certain areas and not in others, and this should be an indication of more profitable areas for experimental commercial fishing.

Catch records of value for determining abundance may be lacking in the literature, but a number of abundance indicators are available from personal observations. H. R. Bullis (pers. comm., see Acknowledgements), observed vast quantities of brief squid off Chandeleur Island, Mississippi, while lift-net fishing for bait on the research vessel *Oregon*. From the lift-net catches, he considered that brief squid formed a layer on the bottom about 15 cm thick. Also, from regular seasonal trawling off Grand Isle, Mississippi, C. E. Dawson (pers. comm., see Acknowledgements) found brief squid in commercial abundance over most of the year. Exploratory fishing off Cape Canaveral during the past 3-4 years has yielded several large catches of shortfin squid, which have been sufficient to raise commercial interest and to cause a trawler to be specially outfitted for squid fishing.

Records of squid as by-catch in the shrimp fisheries indicate that considerable stocks may be available. However, the by-catch data have been misinterpreted in the recent literature (Hixon *et al.*, 1980), with little consideration being given to limitations of gear and fishing techniques. Shrimp trawling is usually done at slow speed during both day and night with a flat trawl on the bottom, and catches of squid are purely incidental. Although squid live close to the bottom during the day, they are diffused throughout the water column at night. They are swift swimmers, and productive trawling is best done with a high-rise type of trawl at 2-3 times the speed of shrimp trawling. Thus, frequent by-catches of squid in shrimp trawling are likely to indicate considerable availability.

School sighting

This is another type of indication about availability and abundance of squid. H. R. Bullis (pers. comm.) reported seeing large numbers of shortfin squid on the surface at night in the Gulf of Mexico. During submersible dives off Fort Lauderdale, on the Atlantic coast of Florida, University of Miami scientists observed, at

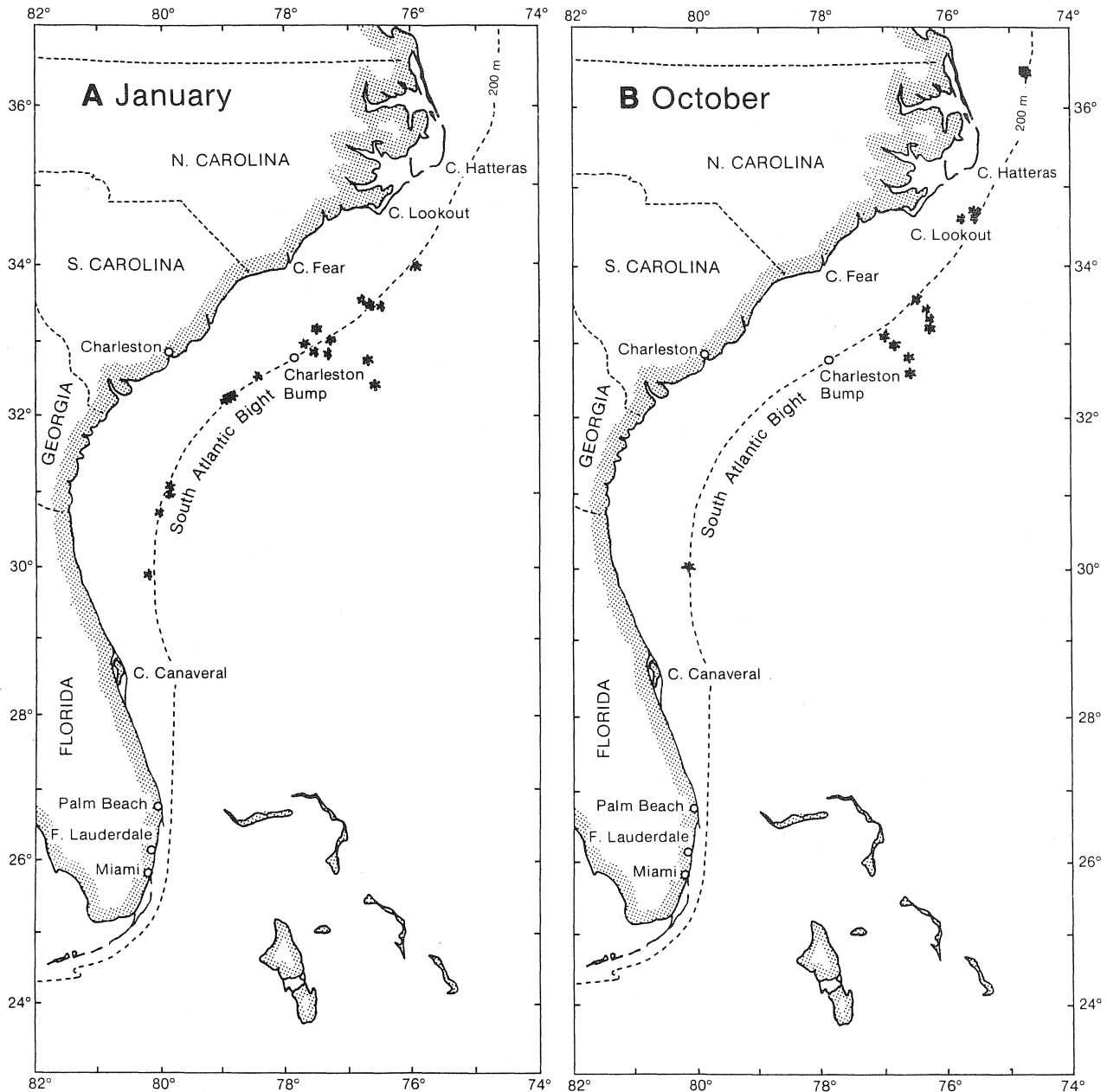


Fig. 8. Distribution of catch records for shortfin squids (*Illex* sp.) along the Atlantic coast south of Cape Hatteras in (A) winter and (B) autumn.

about 600 m, supposed shortfin squid resting on the bottom and spaced about 1 m apart as far as the submersible travelled (C. R. Robins, University of Miami, Florida, pers. comm.). Also, during submersible dives off Bethel Shoal, thousands of supposed shortfin squid were observed congregated on the bottom, many of them dead. This phenomenon was thought to represent a mating and spawning frenzied, but no egg masses were seen. There are, as yet, no firm data on where, when and how shortfin squid breed and spawn in nature.

Predator stomachs

Studies by University of Miami scientists in the 1950's on the biology of the sailfish (*Istiophorus pla-*

typtus) including analysis of stomach contents and preferred food, indicated that shortfin squid was a part of the diet but not predominantly so (Voss, 1953). More recent studies by scientists of the University of Miami and the State of Florida have shown that the major item of sailfish diet within the Miami-Palm Beach-Stuart area was shortfin squid.

The recent development of a longline fishery for swordfish (*Xiphias gladius*) off southeastern Florida has stimulated studies on the biology of that species and large numbers of stomachs have been collected. Shortfin squid constituted about 90% of the stomach contents in these samples (Toll and Hess, 1981). Identifications were made from whole and partially-digested squid and from their hard parts such as beaks.

According to S. M. Candela (University of Miami, Florida, pers comm.), squid were found in swordfish stomachs throughout the year but primarily from June to November with a peak in July. At times, the stomachs were filled with squid. In many cases where identifications were made on beaks, the shortfin squids (*I. illecebrosus*, *I. coindetii* and *I. oxygonius*) could not be separated.

Areas of greatest fishery potential

From the available data, it appears that certain squid species exist in commercial quantities in various areas of the Gulf of Mexico and along the Atlantic coast of the United States south of Cape Hatteras. To assess these potentials, however, commercial squid fishing gear and methods must be used, because by-catch data from the shrimp fisheries and data from exploratory fishing for other types of animals are not adequate for such an assessment. From the available data, the following species seem to have potential for development of commercial fisheries.

Brief squid appear to be widely distributed throughout the Gulf of Mexico and along the southern part of the Atlantic coast during most months of the year, preferring areas near estuaries, bays and coastal lagoons. During part of the year, they are common along the Texas coast but the major concentrations, as shown by catch records and other observations, are on both sides of the Mississippi River delta, and on the western Florida shelf. On the Atlantic coast, brief squid are common in the South Atlantic Bight north of Cape Canaveral. This species is not yet of much commercial value, although it is sold by supermarkets in Texas.

Longfin squid are distributed on the middle and outer parts of the continental shelf throughout the entire Gulf of Mexico and Atlantic coast areas. In the colder months, they are often found in considerable numbers from Corpus Christi to Florida. They are also numerous on both sides of the Mississippi River delta where there seems to be no seasonal pattern. On the Atlantic coast, they are common in upwelling areas along the edge of the continental shelf from Florida to Cape Hatteras.

Shortfin squid seem to live along the upper slope of the continental shelf in waters where temperatures are 8° to 12°C. These isotherms change constantly with wind, wave or topographically-induced upwellings, and it is in such areas that the major concentrations are likely to be found. From the present data, there appear to be no areas of concentration in the Gulf of Mexico, with the possible exceptions of the north-eastern part of the Gulf and the area along the 200-m isobath near Dry Tortugas. On the Atlantic coast, swordfish stomach data from the area between Palm Beach and the middle Florida keys indicate that large

numbers of *Illex* sp. are prey for swordfish. Currents and bottom topography in this region make trawling difficult or impossible. Other major areas for potential fisheries are in the upwelling areas north of Cape Canaveral, Charleston Bump, Cape Fear, Cape Lookout and Cape Hatteras.

Orangeback squid (*Ommastrephes pteropus*) and **flying squid** (*O. bartrami*) are two other species which have commercial prospects, particularly for the highly specialized tournament bait market. Both of these squid are robust and heavy-bodied, with thick mantles, and they are very similar in appearance. Both are found seaward of the continental shelf and can be attracted to the surface with lights. Both can be readily jigged, but the flying squid have been caught primarily with fine monofilament gillnets. These species, of which the orangeback is more common in the region, are highly desirable for bait due to their large size and robust body, and prices in excess of \$6.00 (US) per squid may be obtained in the tournament fishing bait market. A squid (*Symplectoteuthis oualaniensis*) with somewhat similar appearance is now imported from western South America for this purpose. The orangeback squid is also excellent for human consumption, but it is doubtful that the species occurs in sufficient quantities to become a market squid.

Acknowledgements

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