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Strandings of Shortfin Squid, *Illex illecebrosus*, in New England in Fall 1976

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INTRODUCTION

The shortfin squid, *Illex illecebrosus*, was unusually abundant in inshore waters of northern New England and eastern Canada in the summer and fall of 1976. During the fall of that year, beginning in about mid-October, massive strandings of live individuals of this species took place along the eastern and southeastern shores of Cape Cod Bay (Fig. 1).

While strandings of shortfin squid have been reported before, the extent and nature of the 1976 strandings made this an unusual occurrence. We therefore looked into the matter in an effort to learn something about the numbers of squid involved and possible reasons for the strandings. What follows is a report of findings, including notes on biology, distribution, and behavior of this squid.

Although there is another common squid in the New England area, the longfin squid, *Loligo pealei*, only the shortfin squid (Fig. 2) is known to strand en masse. Only the shortfin squid was seen in the 1976 strandings.

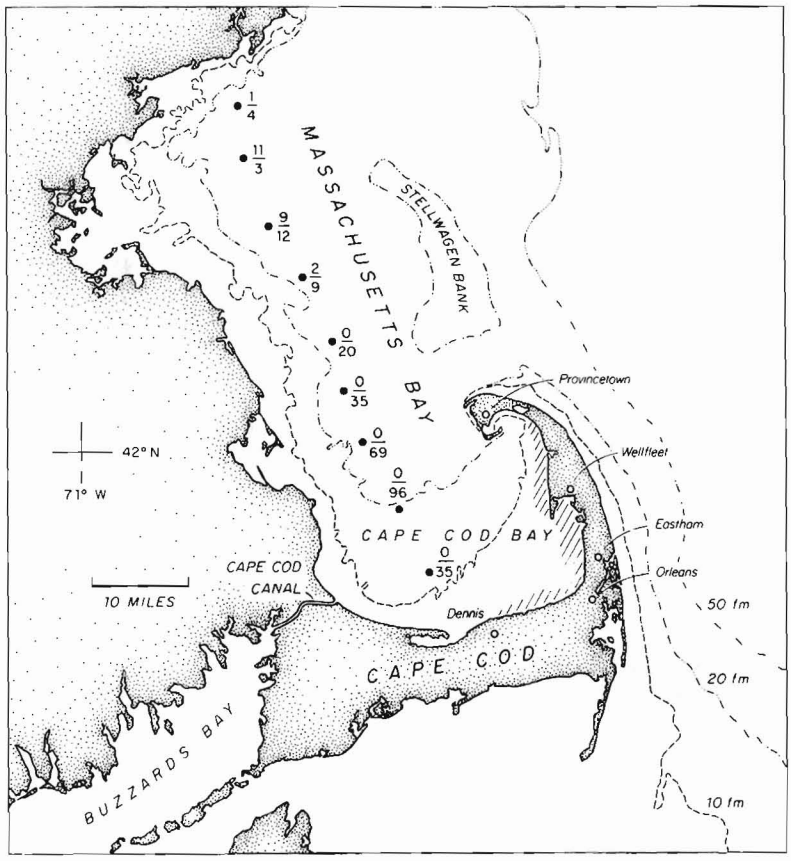
DISTRIBUTION AND FISHERY

The shortfin squid is distributed in considerable abundance from about Cape Hatteras to Labrador in offshore waters, where it lives from late fall to spring. With vernal warming it moves into more coastal waters, particularly in the area between Cape Cod and Newfoundland, where it remains until temperatures drop in the fall. Little is known of its breeding habits, except that it spawns at some time during its offshore phase, probably in winter or spring and beyond the continental shelf edge. It appears likely that it dies after spawning (Squires, 1967; Mesnil, 1977).

The principal fishery in the New England area is while the species is on offshore grounds and somewhat concentrated along the outer edge of the continental shelf. Most of the catch is by foreign trawlers. The total reported catch by all countries in areas off New England and Middle Atlantic states in 1975 was about 15,000 metric tons (ICNAF, 1977).

The inshore fishery for shortfin squid during summer and fall months has been primarily a Canadian one, particularly in coves and bays of Newfoundland. In recent years prior to 1976 it

Figure 1.—Shore area of greatest strandings (shaded) of short fin squid in Cape Cod Bay during fall 1976, and numbers of this squid caught per ½-hour tow at otter trawl stations in fall 1975-76 *Albatross IV* cruises. The number above the line at each station is the number caught during Cruise 75-12 (22-23 Oct. 1975); the number below the line at each station is the number caught during Cruise 76-09 (21-22 Nov. 1976).



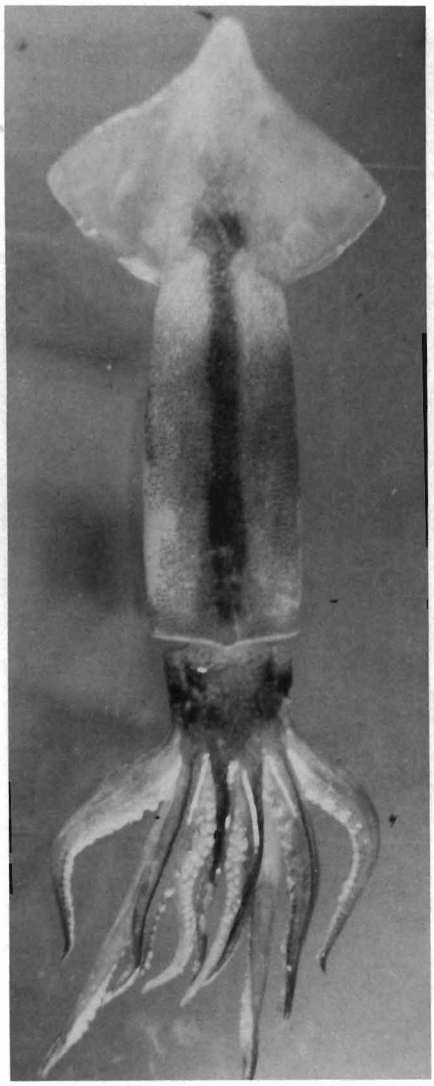


Figure 2.—An adult shortfin squid, *Illex illecebrosus*. (Photo by D. Flescher, NMFS).

generally has not been found in large numbers inshore in New England. In the summer and fall of 1976 this squid was exceptionally abundant inshore from Newfoundland to Cape Cod. Fishermen along the northern New England coast frequently commented that they had never seen so many. A small fishery developed for it and about 230 tons were landed at various ports, including Gloucester and Provincetown, Mass. (Prybot, 1977). There have been no reported U.S. landings of this species in recent prior years.

The unusually high abundance of this squid in Canadian waters is reflected in the inshore Newfoundland catch of 9,800 tons in 1976, compared with 3,200 tons in 1975; however, there were no known large strandings on Canadian shores in 1976[1].

Reports from commercial fishermen indicated that shortfin squid became abundant in Cape Cod Bay (Fig. 1) in late July. It later was abundant enough so that several thousand pounds sometimes were taken in a single otter trawl haul in this area. Commercial catches in Cape Cod Bay had declined greatly by late November.

RESEARCH VESSEL CATCHES

Some idea of relative abundance between fall 1975 and fall 1976 in Cape Cod and Massachusetts Bays can be gathered from otter trawl catches during routine surveys by the NOAA RV *Albatross IV* (Fig. 1). As the data show, no shortfin squid were caught in Cape Cod Bay in 1975, while they were numerous, up to 96 individuals per one-half hour tow, in 1976.

The catch per tow of shortfin squid on Georges Bank, in the Gulf of Maine, and off southern New England on this same cruise (*Albatross IV*, Cruise 76-09) also was a good deal higher in fall 1976 than in earlier surveys. The usual catch in past fall surveys has been about 1 kg per tow, while in 1976 it averaged about 10 kg per tow.

The temperature preference of shortfin squid around coastal Newfoundland is about 7°-15°C, although they are trawled offshore on the bottom at colder temperatures of about 1°-9°C (Squires, 1957). The bottom temperatures at the Cape Cod Bay *Albatross IV* stations 21-22 November 1976, were about 8°-9°C and, therefore, within the normal range for this squid.

STRANDING REPORTS

The first reports of the strandings in 1976 were from the Cape Cod Bay shore of Eastham, Mass. (Fig. 1). The strandings began about mid-October, were heavy through much of November, and tapered off in early December. The great majority of the strandings occurred along the eastern and southeastern shores of Cape Cod Bay, from Provincetown to Dennis, Mass. (Fig. 1). This is a shallow part of the Bay, with sandy bottom and wide tide flats. Local residents informed us that the stranding squid swam directly to the shore and beached themselves or were stranded by the ebbing tide. When tossed back into the water the squid immediately swam back to the beach. Our many visits to the stranding areas from mid-November to early December confirmed these observations. From all accounts, the strandings came in waves, with many thousands or hundreds of thousands of squid stranding on one day and perhaps a few on the next.

Herring gulls and great black-backed gulls were present in large numbers and were actively feeding on the squid. They showed a preference for freshly beached squid, and when the squid were abundant they ignored those that had been on the beach for a day or two. The latter were eaten when freshly beached squid were in short supply. The gulls frequently ate only the head, tentacles, and internal parts of the squid, leaving the mantles. Mantles were eaten also on those days when few squid were stranded, and it is unlikely that many of these remained on the beaches for more than a few days.

We also saw crows near stranded squid on a few occasions, and it is likely that they also consumed some of the squid.

Aerial observations, which we made in November, showed that the squid on the beaches had a patchy distribution (Figs. 3-7). On some beaches there was only a thin line of them at the high tide mark, and on others there frequently were large patches, particularly in the Eastham and Wellfleet areas. In some cases the patches apparently resulted from wind and tide concentrating the dead squid along the sides of jetties and groins. In such patches there sometimes were many thousands of squid, often lying two and three deep on the beach.

[1]Pers. commun. from C. C. Lu, Memorial University of Newfoundland, St. John's, Newfoundland, Canada, and from A. C. Kohler, Fisheries Research Board of Canada, St. Andrews, New Brunswick, Canada.

In one medium-sized patch that we measured we estimated that there were 50,000-75,000 dead squid, most of which were mantles only. Other, smaller concentrations were seen in some tidal marshes, where squid had been caught up in the marsh grass.

While the numbers of stranding squid had dropped greatly by the end of November, a few still were being reported as late as the second week in December. Small strandings may have taken place later than this, but large amounts of ice along the eastern shore of Cape Cod Bay then made observations difficult. As mentioned earlier, the commercial catch of this squid was down by late November, and so the number of squid in the Bay probably had been greatly reduced through strandings, fishing mortality, and migration to offshore grounds.

During one aircraft flight we checked a stretch of beach on the seaward side of Cape Cod, from Wellfleet to Provincetown (Fig. 1), and saw no stranded squid. We did have one report of a few beached squid being seen on the seaward side of Orleans, however, so apparently some limited stranding occurred there. Also, there were a few squid reported on the beach on the western side of Cape Cod Bay in November. In addition, a few were reported on Buzzards Bay beaches, near the western end of the Cape Cod Canal, which connects Buzzards Bay and Cape Cod Bay, in early December. These latter probably were swept from Cape Cod Bay through the canal by the strong tidal currents there. Despite these instances, however, all reports and our own observations indicate that the vast majority of strandings occurred in eastern and southeastern Cape Cod Bay.

The size composition of beached squid was similar to that of those caught aboard the *Albatross IV* in November 1976 (Table 1). Both male and female squid were among those beached. Examinations of gonads of several individuals indicated that they were not yet sexually mature, but that development was underway. Squid of the sizes found are the adults which would spawn offshore in the following winter or early spring (Mesnil, 1977).

Figure 3.—Stranded shortfin squid on First Encounter Beach, Eastham, Mass., 17 Nov. 1976.

PAST STRANDINGS

The stranding of shortfin squid is not uncommon, and it has been reported in the past, although reasons for stranding are obscure. Bigelow (1926) reported seeing stranded squid "in windrows on the flats in August and September," on islands at the mouth of the Bay of Fundy. He stated that, "for some inscrutable reason the squid, once aground, seems forced by instinct to drive farther and farther ashore—throw it out ever so often into deeper water." Verrill (1882) reported that squid of this species "often get aground on the sandflats at Provincetown, Mass., in the night," possibly when in pursuit of prey fish. He suggested that small mackerel sometimes hug the shore to escape squid and that this might sometimes bring the squid into shoals where they strand, "for when they once touch the shore they begin to pump water from their siphons with great energy, and this usually forces them farther and farther up the beach."

Table 1.—Size frequency distributions of shortfin squid in 1976 from otter trawl catches in Cape Cod and Massachusetts Bays (see Figure 1 for locations) and from samples collected on the beaches of Cape Cod Bay.

Mantle length (cm)	Number of Squid	
	Otter Trawl Catches, 21-22 Nov. 1976	Eastham Beaches 23 Nov. to 5 Dec. 1976
18	1	—
19	2	—
20	2	—
21	15	—
22	18	2
23	26	5
24	31	9
25	53	17
26	57	17
27	50	14
28	20	5
29	7	1
Total no.	282	70
Mean length	25.1	25.5

Other strandings have been observed in the Bay through the years. None, so far as is known, was at all comparable in magnitude with the 1976 strandings, and in some cases probably involved only a few hundred or less squid. Some substantial strandings in the Dennis-Eastham area were observed by local residents in the fall of 1959 and continued into February 1960 (Prescott, 1977). Phillip Schwind of Eastham, who operated a charter fishing boat in Cape Cod Bay for many years, told us that he had seen stranding squid in small numbers from time to time. He thought that in some cases they had been driven ashore by striped bass or bluefish. So far as we know, these other strandings all have been shortfin squid.

EXAMINATION OF STRANDED SQUID

In the course of our trips to the stranding areas we collected live and freshly dead stranded squid for studies of pathogens, metal analysis, parasites,

Figure 4.—Stranded shortfin squid at the high tide line along a beach in Wellfleet, Mass., 18 Nov. 1976.

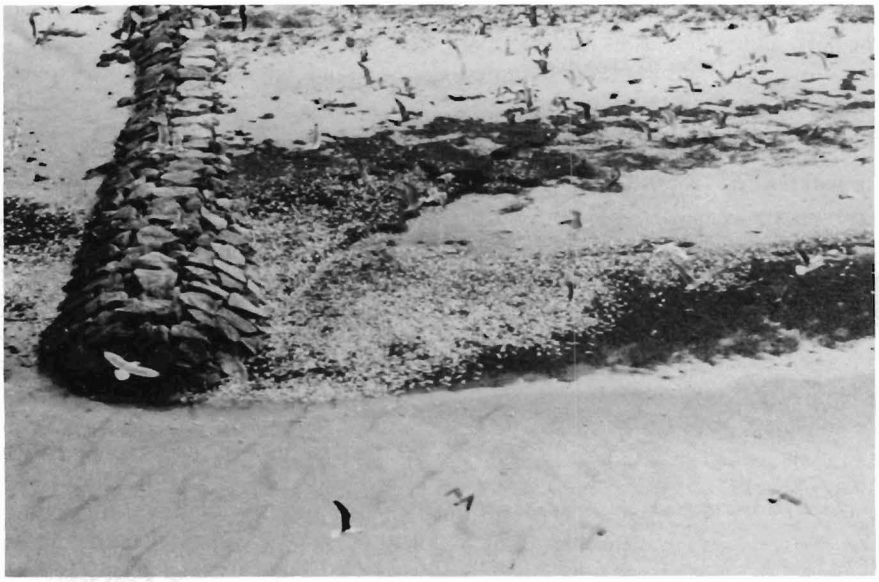


Figure 5.—Heavy concentration of stranded shortfin squid beside a groin, Eastham, Mass., 18 Nov. 1976.

and gut contents. Fred Kern, Northeast Fisheries Center, Oxford, Md., examined a sample of squid for pathogens and found no evidence of any.

Richard Greig, Northeast Fisheries Center, Milford, Conn., ran mercury and other metal analyses on samples of the squid. With the exception of cadmium and copper, which were somewhat higher in the stranded squid, the results were similar to those for the 1972-73 samples caught farther offshore. It is not known if any significance can be attached to the higher levels of cadmium and copper, since the 1976 samples (stranded squid) were based on the entire animals, compared with mantles only for the 1972-73 samples. Studies of metal content are continuing.

We examined 13 of the beached squid for parasites, and found small infestations of cestode (tapeworm) larvae in the gut of 12 of these. This is not unusual. No other parasites were found.

R. E. Bowman, Northeast Fisheries Center, Woods Hole, Mass., examined stomach contents of 19 of the stranded squid. Some of these had full stomachs, and in general, stomach fullness was about the same as that of shortfin squid from past *Albatross IV* collections so it presumably was about normal for this species[2]. Fish remains was the principal food in the stranded squid, about 95 percent by volume, with sand lance, *Ammodytes americanus,* making up most of this portion. Other fish present in the stomachs may have been cunners, *Tautogolabrus adspersus,* and butterfish, *Peprilus triacanthus,* but this is tentative. Fish identification was based on scales, since the food in stomachs is finely chopped. Squid parts were found in a few of the stomachs, which is not unusual since squid are cannibalistic.

George King of Sea Land Aquarium in Brewster, Mass. (just to the east of Dennis), told us that he put some of the live, stranded squid into aquarium tanks there when the water temperature was about 3 °C. Some of these lived for up to 2 weeks. He did not see the squid feed, although he had put food (live mummichogs, *Fundulus heteroclitus*) into the tanks. Charles Wheeler, Northeast Fisheries Center Aquarium, Woods Hole, Mass., told us that 2 weeks is about as long as he has been able to keep longfin squid alive in tanks if they do not feed. He has had no experience with shortfin squid.

Water temperature records for the Cape Cod Bay end of the Cape Cod Canal showed that temperatures there in the late fall of 1976 were colder than normal, but not extremely so. The mean temperatures in October and

[2]Bowman, R. E., Food habits of fish and squid found in the vicinity of the *Argo Merchant* oil spill, August 1977. Lab. Ref. 77-18, Sept. 1977, Northeast Fisheries Center, Woods Hole, MA 02543.

November 1976 were 14.0°C, and 8.3°C, respectively. The 10-year mean (1966-75) for these months was 13.9° and 9.8°.

It may be that late in 1976, when shore waters dropped to near the freezing point, some of the squid suffered temperature shock when approaching the cold water near shore. On 4 December 1976, when we were at a Dennis beach a few squid were stranding. The water temperature there was −1.4°C. Some of the squid were swimming ashore, up near the surface, and appeared to be in good condition, although slow moving because of the cold. Other squid coming ashore were rolling in along the bottom with the waves and quite clearly were near death.

ESTIMATE OF NUMBERS STRANDED

To estimate the extent of strandings, we made two aircraft flights over the stranding areas: one on 18 November 1976, aboard a chartered fixed-wing aircraft, and one on 19 November 1976, aboard a U.S. Coast Guard helicopter. In the course of the flights we covered the Cape Cod Bay shore area from Barnstable Harbor to Provincetown, made relative abundance notes of beached squid on charts of the area, and made a photo record of squid distribution on beaches and in the water at shore edges. The helicopter flight included a touch-down to measure a patch of stranded squid.

It is difficult to quantify the stranding mortality of squid over the period of strandings because of the very limited observations, the patchy distribution of squid, and the continuous loss of squid to gulls and, possibly, to other animals. However, we made an estimate of 1.25 million dead squid present on beaches and in the water at shore edge on 18 November from flight notes, photographs, and subsequent patch measurements on the ground. Considering that heavy strandings were reported over a period of a month, and that stranded squid were regularly eaten by birds, it seems likely that a total of at least 10 million squid stranded.

The mean mantle length of stranded squid was about 25.5 cm (Table 1), and the mean weight for this length was about 340 g. Ten million squid, therefore, would weigh about 3,400 metric tons.

Figure 6.—A heavy concentration of stranded shortfin squid on an Eastham, Mass., beach, 18 Nov. 1976.

Figure 7.—Stranded shortfin squid in a tidal marsh, Wellfleet, Mass., 19 Nov. 1976.

SOME POSSIBLE REASONS FOR THE STRANDINGS

Reasons for the strandings remain unknown. In view of what is reported above, however, concerning the stranding habits of this squid, their high level of abundance in 1976, the lack of pathological findings, that stranded squid were kept alive in tanks for some period, and that the stranding squid were feeding, it appears that the strandings occurred in a natural environmental setting rather than in an environment

stressed by man's impact. The principal impacts in Cape Cod Bay, a relatively unstressed area, are waste heat from a power plant in the Cape Cod Canal and one near Plymouth, and entrainment of marine animals (largely plankton) in water used for cooling at these plants. There is no evidence that these plants are a significant factor in the temperature regime of Cape Cod Bay as a whole.

Regarding natural conditions that might have caused the strandings, one can do little more than speculate at this point. Some of our speculations follow.

We had earlier considered the possibility that the unusually rapid drop in fall temperatures played a direct role in stranding by inducing temperature shock. As noted earlier here, however, strandings already were occurring in mid-October when water temperatures still were mild. It, therefore, does not appear that temperature was the direct cause of strandings, although we do not think one can completely rule it out as a factor.

Another possible cause might relate to fall entrapment within Cape Cod Bay. There were exceptionally large numbers of this squid in 1976 and they still were abundant in Cape Cod Bay in late November, a time when this species generally is moving offshore for the winter. (Figure 1 shows abundance to have been a good deal higher in Cape Cod Bay than in Massachusetts Bay then.) The geography of Cape Cod Bay is such that it can serve as a trap to many warm-water fish and animals which might move into it in the summer. Some of these apparently fail to exit at autumnal cooling. Some animals may become disoriented or helpless when sufficiently chilled and strand. This apparently is the case with ocean sunfish and a few kinds of sea turtles which commonly strand there in the fall. In the case of squid, disorientation through failure to find exit from the Bay possibly influenced stranding.

As noted, this squid normally moves offshore in the fall and spends the winter in deeper, and warmer, waters off the outer shelf edge and possibly beyond. It begins to arrive on offshore grounds in some numbers in October. This fall migration leads the squid to move in easterly and southerly directions, with movement being triggered by declining water temperatures and perhaps other factors. The stranding squid were moving in these directions. Possibly they were attempting to migrate to offshore areas and were stopped by the barrier formed by outer Cape Cod.

The squid apparently were feeding not long before stranding, for many of their stomachs were full of freshly ingested food which consisted largely of sand lance. It appears possible that the squid might have been pursuing these small fish, a common species of sandy bottoms, became disoriented in the shallow water, and stranded. The feeding on sand lance may have increased in the fall, when some other prey species, such as mackerel, had left the Bay.

It should be mentioned, too, that the prevailing winds of the region are westerlies (southwest, west, and northwest) in the fall and winter. The winds, therefore, were blowing against the shores where the strandings occurred. The fall of 1976 was a particularly windy one, with frequent cold and strong northwest winds. These winds may have been a factor in the strandings, especially after the squid got into shallow water.

It was reported that bluefish, pilot whales, and some larger whales had been seen in Cape Cod Bay during part of the strandings. Some residents of the Bay area thought that the squid might have been driven ashore by these. Bluefish and pilot whales, and also striped bass, prey extensively on squid, and small groups of squid may have been driven ashore by them. It seems unlikely, however, that the massive strandings observed could have resulted from this. Also, it seems that strandings would have occurred in other areas than the one side of the Bay if the squid were driven ashore. In addition, it is unlikely that any large numbers of bluefish or striped bass remained in the Bay after about mid-November, since they move south with declining fall temperatures. The marine mammal report of *Albatross IV* 21-22 November 1976 gave no whale sightings in Cape Cod Bay then, although some were seen outside of the Bay around Stellwagen Bank.

Other theories may evolve from these studies. In the course of looking into the strandings we have established quite a few contacts in the Cape Cod Bay area who will alert us to further squid strandings. The Cape Cod National Seashore personnel, through regular patrols and from information sent in by local residents, maintain good records of strandings. We hope to gather more information on squid behavior and strandings in the future. Perhaps we can then more clearly define the causes of strandings.

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LITERATURE CITED

Bigelow, H. B. 1926. Plankton of the offshore waters of the Gulf of Maine. U.S. Bur. Fish., Bull. 40, Part II, 509 p.

ICNAF. 1977. Normal catches of individual species by division and country, 1975. (Table 3.) Int. Comm. Northwest Atl. Fish., Stat. Bull. 25:36-70.

Mesnil, B. 1977. Growth and life cycle of squid, *Loligo pealei* and *Illex illecebrosus*, from the northwest Atlantic. Int. Comm. Northwest Atl. Fish., Selected Papers 2:55-69.

Prescott, R. 1977. The stranding of *Illex illecebrosus*. Cape Nat. 6(1):17-19.

Prybot, P. K. 1977. Gloucester fishermen find better reception for squid. Natl. Fisherman, Feb, 1977, p. 10A.

Squires, H. J. 1957. Squid, *Illex illecebrosus* (Le Sueur), in the Newfoundland fishing area. J. Fish Res. Board Can. 14:693-728.

————. 1967. Growth and hypothetical age of the Newfoundland squid *Illex illecebrosus illecebrosus* J. Fish Res. Board Can. 24:1209-1217.

Verrill, A. E. 1882. Report on the cephalopods of the northeastern coast of America. U.S. Comm. Fish and Fish., pt. 7, Rep. Comm., 1879:211-450.

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