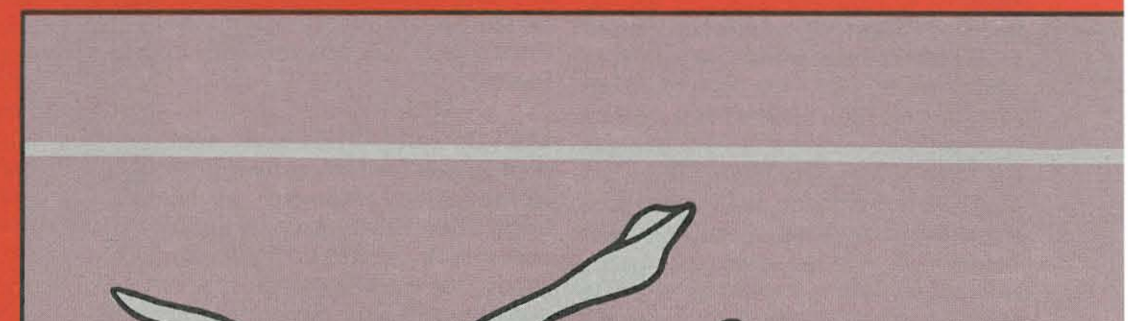
UNDERWATER WORLD



Squid

Fisheries and Oceans Pêches et Océans

Canada

SQUID

Squids represent a major fishery resource widely distributed throughout the oceans of the world. Of the several hundred species harvested around the world, only the short-finned squid *(Illex illecebrosus)* has been of major commercial importance to the fishery in Atlantic Canada. This species is common throughout areas of the Maritimes and Newfoundland (Fig. 1). The long-finned squid *(Loligo pealiei)* also occurs, but only in very low abundance, in Atlantic Canadian waters. It is occasionally caught over the southwestern areas of the Scotian Shelf and the Bay of Fundy, and more frequently on Georges Bank.

Until the early 1970s, squid were pursued largely for bait, primarily around Newfoundland. However, an international Illex fishery was developed off the coast of North America in the 1970s. Japan, the world's foremost harvester and consumer of squid, spearheaded this effort, followed by the Soviet Union and a number of other countries.

Landings of squid from Canadian waters climbed rapidly until they peaked in 1979 at about 162,000 tons. They then dropped dramatically as squid disappeared from the fishing areas until, in 1984, only 409 tons were brought in (Table 1).

The highly cyclical nature of this resource, with its large fisheries impact, has quickly brought the biological and management problems into focus, and has inspired a number of government and non-government research initiatives.

Fig. 1 Distribution from Labrador to Cape Cod and main fishing areas

Description
Squid belong to the *Class Cephalopoda* of the *Phylum Mollusca.* There are approximately 650 recognized species of cephalopods alive today and more than 10,000 fossil forms. Cephalopod translates literally into "head footed" (Fig. 2) which explains why squid, as well as the nautilus, cuttlefish and octopus among others, with their arms and tentacles attached directly to their heads, are so named.

People are often surprised to learn that the rapidly-swimming squid, with no external shell, is related to molluscs such as clams, oysters and snails. In fact, squid have a small internal shell called a pen which extends along the back of the body and acts as a support to the soft, muscular body.

Short-finned squid reach a body or "mantle" length of more than 30 cm and a total length of more than 60 cm. The cigar-shaped body has two triangular fins at the rear, and a funnel and distinct head with eight sucker-equipped arms and two tentacles, on the other end. They have large, well-developed eyes and a strong parrot-like beak. Squid use their fins for swimming in much the same way fish do, and the funnel for extremely rapid "jet" propulsion forward or backward. The squid's capacity for sustained swimming allows it to migrate long distances as well as to move vertically through hundreds of metres of water in its daily feeding.

The short-finned squid generally has a mixed, iridescent coloration of milky white and rusty brown. The colour changes rapidly as the squid expands or contracts the colour cells in its skin as a camouflage or in response to attack.

Distribution and Migration
The short-finned squid ranges from Greenland to Florida, with fishable concentrations found from the Gulf of St. Lawrence and Newfoundland to Cape Hatteras (Fig. 1). Abundance and distribution vary greatly, both seasonally and annually.

From April through June, young squid migrate from the Slope Water beyond the edge of the Continental Shelf onto the Grand Banks, the Scotian Shelf, Georges Bank and the mid-Atlantic Bight shelf area (Fig. 3). The age of these squid is estimated at three to six months.

In June, the greatest concentrations occur along the edge of the Scotian Shelf, usually between Emerald and LaHave Banks and in some years, along the entire edge of the Shelf. They also occur along the edge of Georges Bank

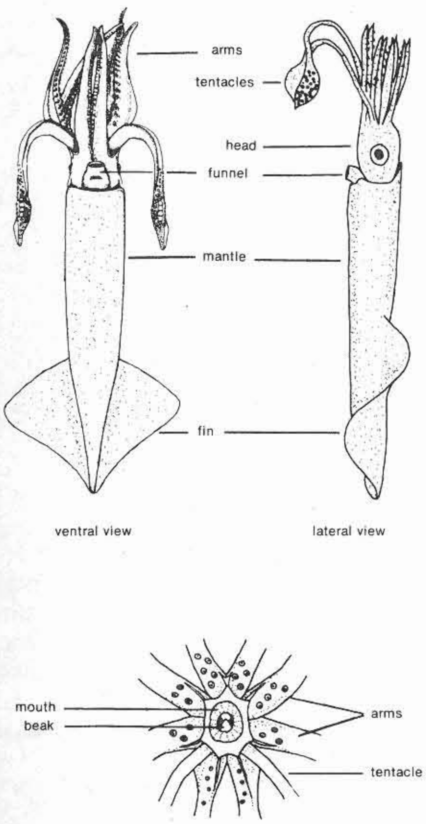


Fig. 2.

and the southwestern edge of the Grand Banks.

Through July, August and September, the distribution extends to cover large areas of the Continental Shelf and, some years, to the Gulf of St. Lawrence.

Distribution in both the offshore and inshore areas is believed to be strongly influenced by environmental conditions, with water temperature being a major factor. Evidence suggests that highest concentrations occur where bottom temperatures exceed 6°C. There seems little doubt that temperature at intermediate depths as well as other biological factors such as predator and prey abundance and their distribution also play an important role.

Abundance peaks in September, then drop dramatically in October and November as the larger, maturing squids start to leave the shelf. During autumn, the distribution area recedes to about that of early summer.

Evidence from tagging indicates that when short-finned squid leave the shelf areas, they go southwest. (The longest recorded distance covered by a squid according to the tag recovery program is 2,000 km by a specimen tagged in Notre Dame Bay, Newfoundland and captured 107 days later southwest of Maryland).

Table 1. Catches (metric tons) of short-finned squid in Canadian and U.S. waters between 1971 and 1984.

Year	Newfoundland Sub Area 3	Scotian Shelf Sub Area 4	United States Sub Area 4	United States Sub Area 6	Total
1971	1,607.0	7,299.0	11,368.0	-	20,274
1972	26.0	1,842.0	26,111.0	22,579.0	50,558
1973	620.0	9,239.0	5,646.0	3,235.0	18,740
1974	17.0	385.0	4,927.0	10,373.0	15,702
1975	3,751.0	13,945.0	6,966.0	7,979.0	32,641
1976	11,257.0	30,510.0	13,945.0	10,991.0	66,703
1977	32,748.0	50,726.0	3,265.0	21,618.0	108,357
1978	41,369.0	52,688.0	4,332.0	13,236.0	111,625
1979	88,832.0	73,259.0	2,091.0	15,250.0	179,432
1980	34,779.0	34,826.0	632.0	17,232.0	87,469
1981	18,061.0	14,142.0	1,978.0	13,596.0	47,777
1982	11,164.0	1,744.0	517.0	17,671.0	31,096
1983	-	422.0	329.0	10,428.0	11,179
1984	5.0*	404.0*	-	-	-

*provisional

It is believed that the adults migrate to a spawning area near Cape Hatteras or even further south over the Blake Plateau off southeastern United States. While Larvae and small juveniles had been found previously over the Blake Plateau and in the mid-Atlantic Bight area, it was not until 1979 that a joint Canadian/Soviet research team found some larvae and large numbers of juveniles extending hundreds of kilometres between the Scotian Shelf edge and the frontal zone of the Gulf Stream. Since then, joint Canadian/Japanese/Soviet research surveys have documented the annual occurrence of larvae and juveniles extending more than 1,500 km along the Gulf Stream frontal zone and shoreward in the Slope Water off the edge of the Continental Shelf. It appears that the Gulf Stream, flowing like a meandering river that sometimes reaches a velocity of 5 to 7 km per hour (120 to 170 km per day), transports them rapidly northeastward from the southern spawning areas.

In late spring and summer, these juvenile squid complete the cycle by migrating shoreward and onto the Continental Shelf.

Life History

Short-finned squid are believed to live no more than 12 to 18 months, migrating southwestward from the adult feeding areas to an imprecisely known spawning area where, after spawning, they die.

Spawning females create large, clear, almost neutrally-buoyant egg masses by releasing a gel-like substance with the fertilized eggs (Fig. 4). The gel reacts with seawater to form a globular-shaped egg mass, up to 1 m in diameter, containing about 100,000 eggs of about 1 mm in diameter (Fig. 5). Hatching time varies with temperature, but generally takes about two weeks. The larvae that emerge are roughly the same size as the eggs and are called "rhynchoteuthion" because of the distinctive proboscis on the head from which the tentacles will develop (Fig. 5). After a period of growth and development, the larval squid becomes a juvenile about

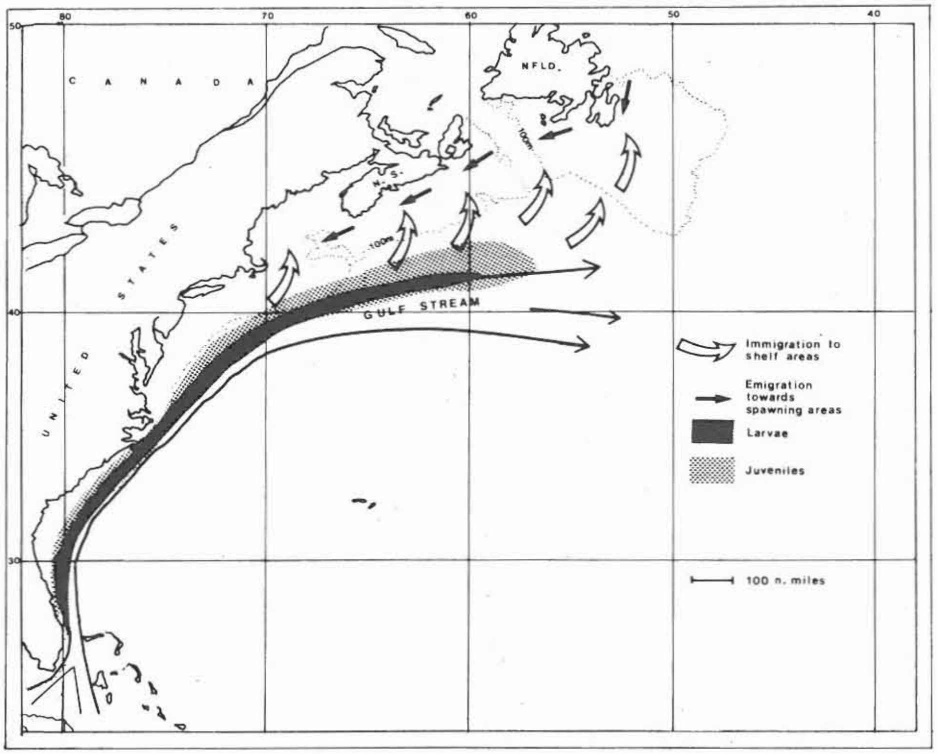


Fig. 3 Florida to Newfoundland Gulf Stream; larval/juvenile distribution; migration routes

6 mm in mantle length with adult features. By this time, the proboscis has split to form the two tentacles, and the other eight arms have grown larger.

The juvenile *Illex* live in the Gulf Stream frontal zone and the Slope Water off the edge of the Continental Shelf until they reach about 10 cm in mantle length and move into the adult feeding areas on the Shelf. Little is known of juvenile growth rates, but the adults grow rapidly adding roughly 1.5 mm in mantle length per day, to reach a maximum size of 25 to 30 cm in mantle length in October or November.

Adults eat voraciously, consuming a variety of crustacea and fish. Smaller squid tend to feed more heavily on small crustacea such as euphasids, turning more to fish and fellow squid as they mature. The extent of cannibalism among squid is unclear, but it would appear that the larger specimens are the most inclined to eat their own species.

Squid are also a food source for a variety of fish, marine mammals and birds. Some of the better-known predators are pilot whales, dolphins, shearwaters, fulmars, gannets, gulls, tunas, swordfish, haddock, cod, pollock and sharks.

Squid spend the daylight hours near the bottom of the ocean, seeming to prefer areas where the bottom temperature is 6 to 7°C or greater. At night they tend to disperse upward, a behaviour characteristic which is vital to squid jigging in offshore areas. Generally, a vessel will locate its fishing area, start jigging in the early evening and continue through to early morning.

Squid travel in schools, often consisting largely of one sex. For example, some inshore schools have been found to be 95 per cent female. There is also a tendency toward a general shift in sex ratio among the population as a whole, with males predominating in the late spring and early summer, and females in the fall. This could be attributable to cannibalism by the females which are generally larger than the males, and to earlier emigration from the shelf to the spawning area by the more sexually mature males.

The Fishery

The squid fishery in Atlantic Canada is both inshore, largely prosecuted with traps or by jigging from small dorys off Newfoundland, and offshore, primarily by foreign trawlers on the Scotian Shelf (Fig. 6). Newfoundland's inshore bait fishery has operated for more than 100 years and, until the mid 1960s, contributed at least 90 per cent to Atlantic Canada's squid catch. In 1970, the first international catches of squid from the Scotian Shelf were reported by the USSR and Japan. From then on, the nature of the entire squid fishery in Atlantic Canada began to change. Between 1970 and 1974, the average annual catch was about 4,500 metric tons caught in 1983 and 409 tons in 1984.

The rapid rise in catch through the 1970s was due partly to the higher concentration of foreign fishing fleets and to the abundance of squid in Atlantic Canadian waters. Good markets in Japan and Europe also spurred the expansion of Newfoundland's inshore fishery which,

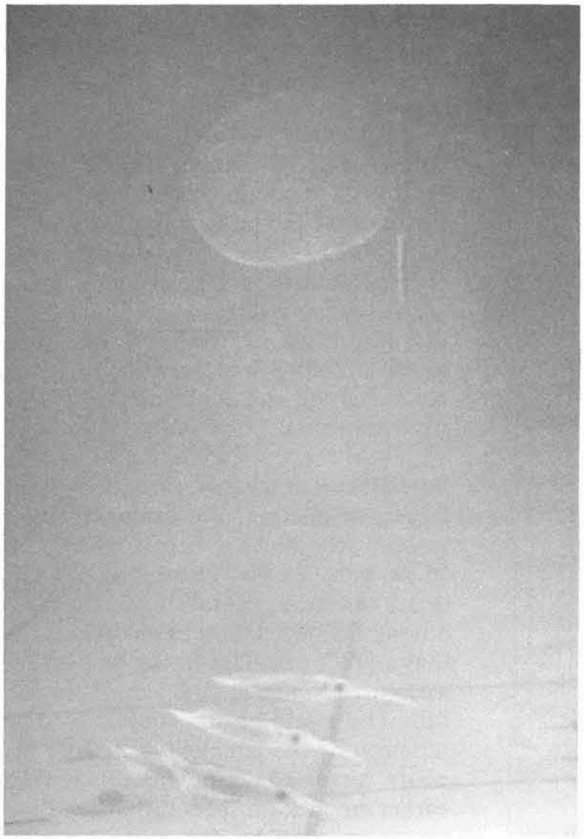


Fig. 4

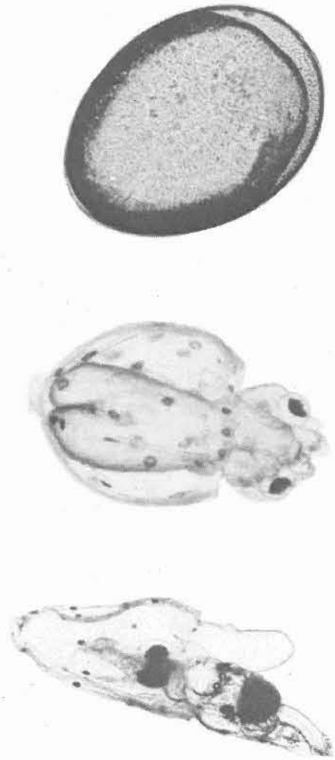


Fig. 5

Fig. 6

until that time, had been conducted largely for bait. The subsequent decline in catch is clearly due to a lower abundance of *Illex* in Canadian waters.

Although the reason for the decline is not known, such yearly fluctuations are common among short-lived species. Subjective reports from the inshore Newfoundland bait fishery dating back to 1879 indicate a continuing series of such large annual and multi-year changes. There is no obvious pattern and there have been a few periods of either high or low abundance lasting as long as five years.

While overfishing must be considered a possible cause of the post 1979 decline, both the strong reproductive capacity of *Illex* and the low catch levels relative to total population make this unlikely. It is more probable that changes in abundance are a reflection of environmental or biological factors — events which influence natural mortality and the distribution of the early life stages.

Research and Resource Management

Unlike other commercially viable species of fish, each generation of squid appears only once in the fishery, which makes it impossible to evaluate and project the likely size of subsequent populations. (For other fish species, this can be done by observing the numbers of smaller fish in both commercial and research survey catches which are going to be partially or fully recruited to the fishery in future years. By estimating current and future mortality rates, both natural and fishing related, it is possible to project permissable future catch levels. As a result of the squid's rapid growth and short life span, this is not possible for the squid fishery.) Consequently, management of the squid resource has been directed primarily at ensuring that exploitation does not reach levels that would unduly jeopardize the reproductive capacity of the stock. In general, this has meant application of conservative Total Allowable Catches (TACs) which do not reflect annual changes in available stock. These TACs, however, are accompanied by regulations on total effort so that in years of low abundance, the TAC will not be caught.

In light of this, much of the recent squid research in Canada has been directed at determining the distribution and abundance of the larval and juvenile stages, and attempting to clarify the role of major oceanographic features such as the Gulf Stream in influencing these aspects of the early life history. It is possible that a better understanding of these phenomena will ultimately allow projection of future abundance levels several months in advance of the fishery. This would permit TAC adjustment before the fishery starts and allow optimal utilization of this valuable resource.

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