Fisheries and Oceans
Pêches et Océans

Underwater World

Marine Fish Eggs and Larvae

Canada

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Introduction

Marine fisheries are of great importance to many Canadians. For instance, in 1982, the fish landings from the southern Gulf of St. Lawrence in New Brunswick contributed more than $67 million (fisherman's landed value) to the economy of that province, not counting the spinoff to processing and retail sales, vessel construction and fishing gear manufacture. Sales of Canadian fish — fresh, frozen, smoked and pickled — go to North America, Central America, Europe and, to a lesser extent, other areas. Sales were more than $210 million for New Brunswick alone in 1982.

To maintain a continuing supply of marine finfish for market, annual broods or year-classes must be sufficient to maintain the fishery for each species. Most marine fishes spawn once a year. An important task of fishery biologists is to assess the spawning success of commercial species. One period in which success of year-classes of marine fish can be assessed is the egg stage and the ensuing larval stage. To determine the effectiveness of these assessments, marine biologists, in recent years, have concentrated efforts on marine fish egg and larval surveys.

Egg and larval surveys can determine the distribution of the eggs, larvae and juveniles of marine fish species, the distribution of spawning adults, and the main spawning areas for important commercial species. They also examine the relative abundance of various species of fish eggs and larvae found each year and their relation to future year-class strengths in the various fisheries. In addition, they shed light on the effect of changing environmental factors such as water temperature, salinity, depth, current drift, predation and chemical pollution on year-class strengths.

Methods of Sampling

Surveys of the distribution and abundance of marine fish eggs larvae and juveniles were carried out in the Gulf of St. Lawrence during the years 1965-75 and on the Scotian Shelf from 1976-82. The Gulf of St. Lawrence series comprised a total of 35 cruises over the period, each of 10 to 12 days between May and October, due mainly to sea ice and bad weather conditions in other months. The 37 Scotian Shelf cruises, each of 10 to 12 days, were conducted in all seasons of the year. Charts of typical cruise grids are shown in Fig. 1 and 2.

Different types of towed plankton nets were used to sample the fish eggs and larvae. A combination of four types of net tows on a sampling station virtually guaranteed that all species of eggs and larvae present would be sampled. The types were:

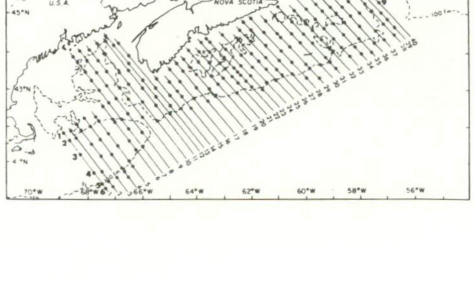
1. A *1 m* net towed at 2½ knots for eggs and slow-moving larvae at any depth, but usually at or near the surface (Fig. 3).
2. *Neuston* net towed at 5 knots at the surface for larvae and early juveniles living there (Fig. 4).
3. *Isaacs-Kidd* net towed at 5 knots mainly used for catching pelagic larvae and juveniles from sea bottom to surface in an oblique tow (Fig. 5).
4. *Bongo* nets towed at varying speeds (2 to 5 knots) for catching pelagic and surface eggs and larvae in oblique or horizontal tows (Fig. 6).

Occasionally smaller, fast-towing (5 knots) nets were used in series on an oblique wire to check depth distributions of some species.

After the four nets (meter, neuston, Isaacs-Kidd, Bongo) had been towed on a station for an appropriate period of time, usually one half hour, they were washed down with saltwater hoses and the plankton contents removed from the terminal containers. The samples were preserved in labelled bottles in 5 per cent formalin for future study. Associated measurements on towing depth, water flowmeter readings, water quality and weather observations were recorded.

Fig. 1 Typical fish egg and larval survey grid for a cruise in the southern Gulf of St. Lawrence. Stations are shown as black dots.

Fig. 2 Survey grid for Scotian Shelf and Georges Bank. Stations are shown by black dots.



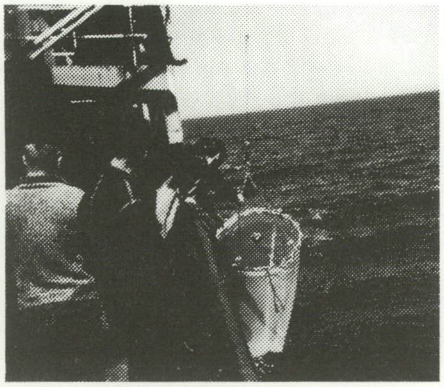


Fig. 3 Meter net being hauled aboard. Note flowmeter in center of mouth of net.

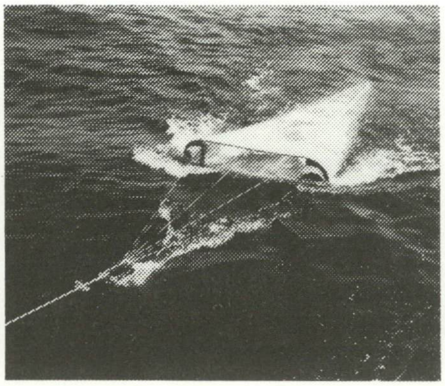


Fig. 4 Neuston net being towed

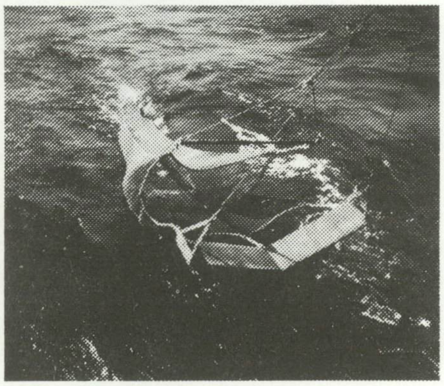


Fig. 5 Isaacs-Kidd net being set for a tow

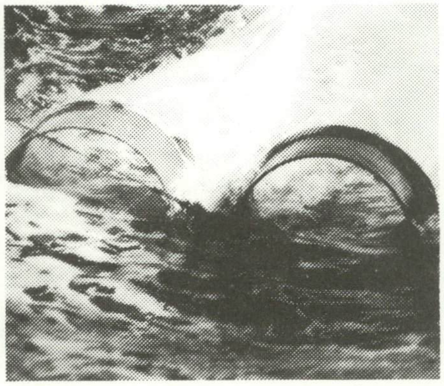


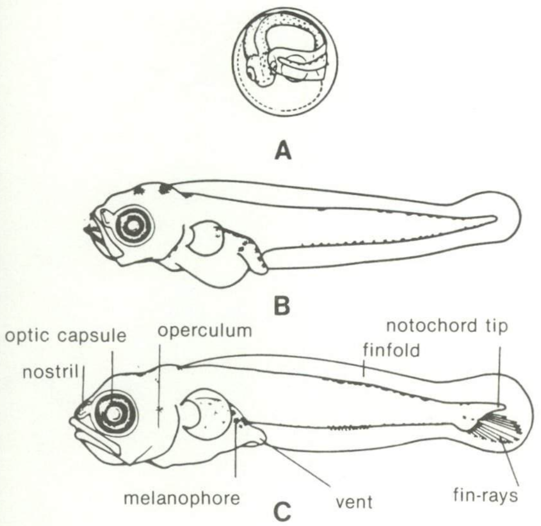
Fig. 6 Bongo nets setting out for a tow

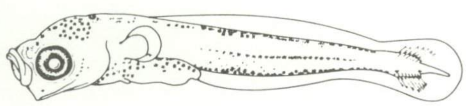
The samples were taken back to the lab after the cruise for sorting and identification. Analysis of the fish species has been limited to the bony fishes, class Pisces (Osteichthyes) eliminating the sharks, rays, lampreys, hagfishes and chimaeras (the cartilaginous fishes) which were scarce in the plankton catches.

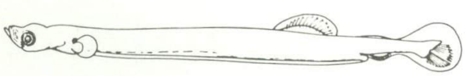
The Early Development of Fishes

Most fishes, the mackerel as an example, start out life as eggs within which fish embryos develop (Fig. 7A). Some eggs hatch within hours while others require days or even weeks. Most fishes hatch out of eggs as mobile embryos (Fig. 7B). The bodies and internal organs are completely transparent except for special spots of black or brown; but sometimes other colours are present, such as reds, whites, greens and blues. These baby fishes are without bones, fins or scales and range in length from about 5 to 12 mm (about the size of a pesky mosquito). Slowly they develop fins and other adult features. In fact, baby fishes possess very different morphological, physiological, ecological and behavioural characteristics from their adults. No other vertebrate order (amphibians, reptiles, birds or mammals) have their babies displaying such widely diverse anatomical features or occupying so many different habitats (both marine and freshwater). They develop into juveniles or fry in several weeks but do not become sexually mature for several years.

Many of the larval fishes seen swimming near the surface in Atlantic maritime waters are somewhat similar to larval mackerels. The external anatomical features shown here are specific for the mackerel but are similar to those of other fishes. Most internal organs are not shown because these illustrations were drawn from preserved specimens whose muscle tissues have turned from transparent (when alive) to whitish and opaque (when preserved), obscuring some of the detail. The body (Fig. 7C) of the larval mackerel is slightly elongate, tapering gradually from its head to its tail, but definitely not as elongate and slender as adult mackerel. Its mouth can open. A pair of nostrils lay forward of the eyes. An eye comprises a central spherical lens and a surrounding black, doughnut-shaped optic capsule. At the back of the head is the gill cover or operculum which covers the developing gill. The finfold is a transparent membrane which extends around the tail part of the larva. The only fins present at this time include paired pectoral fins and part of the developing caudal fin. Fin-rays are beginning to form in the ventral part of the caudal fin. The intestine is tubular and short and ends at the anus or vent. The tip of the notochord is visible above the developing caudal fin. The notochord is a pliant, rodlike structure which lies in the same position and acts like the backbone of larval fishes. The small canal in the middle of the vertebrae in adult fishes represents the location of the remnant of the notochord. The air bladder or swim bladder is egg-shaped, filled with a gas and has an egg-shaped spot of pigment above it. Black pigment (melanophore) spots which occur on various parts of the body make up the pattern of pigmentation.







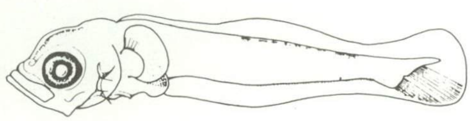


Fig. 7 The early development stages of mackerel
A. Mackerel egg
B. Larval mackerel with a complete fin fold
C. Larval mackerel with fins beginning to develop

Fig. 8 Cod larva

Fig. 9 Herring larva

Fig. 10 Redfish larva

Early Lives of Three Commercial Fishes

A fish begins its life at the moment an egg becomes fertilized. The inner part of the egg divides once and then repeatedly until gradually it becomes a baby fish. This baby fish or larva hatches and begins to search for food and make its way in the ocean. Most energy will be devoted to swimming in order to find enough food to eat and avoid death. Before becoming an adult, the larva will face death time and time again. In fact, only a very small percentage of the larvae born will attain adulthood, maybe one in a thousand, or less.

It is now well known that almost every species of marine (and freshwater) fish has a unique early life history, with obvious differences observable in anatomy, ecology, physiology and behavior. Cod, herring and redfish, representing three important commercial species, show three different contrasting types of life histories. They can be summarized as follows: 1) cod — spawn eggs which drift around near the surface and its babies swim around in rather deep waters; 2) herring — spawn eggs which stick to the bottom rocks and gravel, and its babies swim around in shallow coastal waters; 3) redfish — females release fully formed babies which swim around in deep water.

Atlantic cod: Cod spawn in various places along the coast and at a variety of depths, usually after a short migration. Cod eggs are small (1 to 2 mm), transparent, non-sticky, and tend to float like tiny balloons near the surface. One large female codfish can produce several millions of eggs, so at times cod eggs can be found bobbing around near the surface almost everywhere in the spawning areas. After about a week or two of incubation, these eggs hatch into tiny swimming embryos (about 4 mm). They break through the spherical membrane with their tail first, head and body next and, finally, the large yolk sac pops out. At this time, these larval cod are sometimes transported great distances by ocean currents. Local weather conditions and speed of currents are extremely important in their life.

A cod larva (Fig. 8) is almost completely transparent when alive, except for the black eyes and black pigment spots. They are eaten in large numbers by small fish, shrimp, jellyfish and other small predators. At this age, larval cod swim around singly or in small groups. They begin to feed on various kinds of planktonic invertebrates such as tiny copepods, shrimp and crabs. It is not until several months later that they move to the bottom and feed heavily on the smaller fishes living on or near the bottom.

Atlantic herring: Herring form large schools and then spawn in various sites on the bottom during spring and fall. Most females produce from 50,000 to 150,000 eggs each time they spawn. The eggs are spherical, sticky and coloured by numerous oil globules. They are about 1 mm in diameter, and stick to gravel, broken shells and algae near where they are deposited. The period of incubation varies from one to three weeks, depending upon the stock of herring and the time of year. Larvae lay along the bottom for two to three days before they begin to swim. Yolk sacs remain for three to 20 days, but larvae begin to feed on small planktonic animals before the yolk is absorbed. Most larval herring swim in schools during their early free-swimming existence, but storms and strong currents can break these up. A free-swimming larva is shown in Fig. 9. It is almost completely transparent except for the black eyes and black pigment spots along the belly. As the weeks and months pass, the young herring learn to swim together and develop the large schools that fishermen so eagerly search out.

Redfish: Fertilization of redfish eggs is internal. The eggs, which can be found inside females, are transparent and small (0.15 to 0.25 mm in diameter). Larvae are extruded by females shortly after the eggs hatch. The larvae are usually found in cold, deep waters. They are almost transparent, except for the black eyes and several areas of accumulation of black pigment cells (Fig. 10). Redfish larvae are usually found in immense numbers because adults school together and each female produces about 30,000 larvae. They are eaten in large numbers by small fishes, jellyfish and other small predators. At this age, larval redfish are spread around by ocean currents but they learn quickly to school together. They remain in the deep, open water usually far away from shallow coastal areas.

The Future of Egg and Larval Surveys

Biological knowledge about the eggs and larvae of many important commercial fishes is still elementary. Results from such large-scale surveys as that carried out in the Gulf of St. Lawrence and on the Scotian Shelf during the last two decades have increased the knowledge about the early life stages of some commercial marine fish. Future surveys should be directed towards two general goals: first, to forecast year-class strengths of commercial sizes of important fish species coming into the fishery. The forecast of fish year-class abundance will be valuable information for all fishermen and fishery biologists to plan for better harvesting strategies; second, to conduct basic research on the ecology of eggs and larvae in the total marine environment. Studies on larval feeding, predator and prey relationships in the plankton, causes of mortality of eggs and larvae, and general environment effects on larval growth patterns, all will provide useful information on the well-being of fishes and fisheries.

Further Reading:

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