

Ichthyoplankton of Slope and Gulf Stream Waters off Nova Scotia in Late Autumn 1974

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Abstract

Ichthyoplankton, collected in the Gulf Stream frontal zone off Nova Scotia in late autumn 1974, was represented by 22 families. The larvae of some species of these families have not been previously found in the area. Myctophid larvae were the most abundant and were represented in many samples. Zoogeographical structure of the ichthyoplankton community and the larval distribution of some groups are briefly discussed.

Introduction

The study of ichthyoplankton in the Gulf Stream is of great interest, because data on the species composition and distribution of the ichthyofauna allow evaluation of the effects of the Gulf Stream on the dispersal of eggs and larvae of shelf and oceanic fishes with respect to drift rates away from the areas inhabited by the adult populations. Such information is useful in assessing peculiarities of recruitment to populations which live on the continental shelf and slope adjacent to the Gulf Stream in the western North Atlantic. The Gulf Stream has been shown to be a transporter of eggs, larvae and juveniles of some fish species whose entire life cycle is primarily associated with shelf waters (neritic species) and other shelf species whose initial stages of development occur in oceanic waters (nerito-oceanic species) (Anderson, 1957; Berry, 1959; Gehringer, 1959; Caldwell, 1962; Smith *et al.*, 1975; Evseenko, 1976; Powles, 1979).

A comparison of data on distribution and abundance of eggs and larvae in shallow shelf waters with those in waters associated with the Gulf Stream would allow the designation of species to an ecological group, such as neritic or nerito-oceanic. This is important in studying the population dynamics of fish populations, because the recruitment (and hence abundance) of nerito-oceanic species would be expected to fluctuate to a greater extent than that of neritic species (Evseenko, 1982).

The species composition and seasonal dynamics of Gulf Stream ichthyoplankton have not been intensively studied. Most of the available information relates only to the occurrence of the larvae of some shelf species (see authors cited above) and of some oceanic fishes (e.g. Ege, 1930; Rofen, 1966) within the influence of the Gulf Stream system. The paper by Markle *et al.* (1980), who reported new and rare records for the Scotian Shelf of larvae of tropical and subtropical spe-

cies, is a valuable contribution to knowledge of Gulf Stream ichthyofauna. A major difficulty in studying Gulf Stream ichthyoplankton is the great diversity of tropical and subtropical forms, most of which are as yet unknown at their early stages of development. This paper presents the results of a study on ichthyoplankton in the Gulf Stream frontal zone seaward of the Scotian Shelf.

Materials and Methods

The ichthyoplankton material, which forms the basis of this paper (see Appendix), was collected during a survey of the research vessel *Belogorsk* in the area seaward of the Scotian Shelf from 14 November to 2 December 1974. Sampling was conducted at 70 stations (Fig. 1) with a small Bongo sampler having a mouth opening of 20.5 cm in diameter and a mesh size of 0.714 mm. An oblique haul from 100 m to the surface

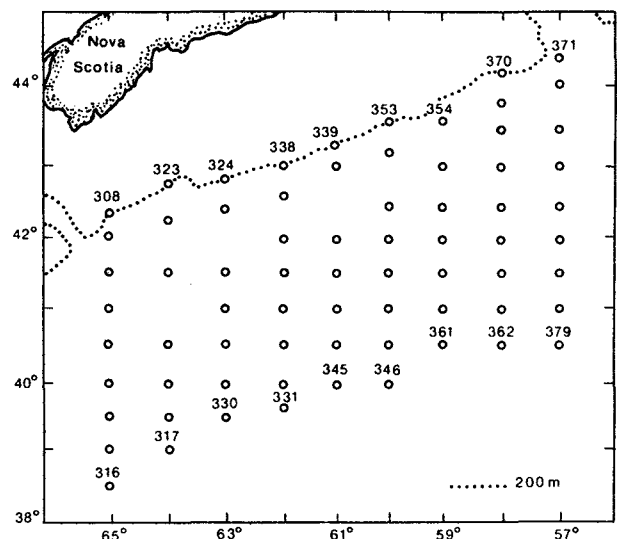


Fig. 1. Ichthyoplankton stations completed by the *Belogorsk* during 14 November-2 December 1974.

for 20 min was made at each station at a towing speed of approximately 3.5 knots (108 m/min). The volume of water filtered during the hauls, estimated by flowmeter, ranged from 43.3 to 79.0 m³ (average 61.1 m³). Ichthyoplankton was found in samples taken at 31 of the stations surveyed. Data on hydrological and hydrobiological conditions during the survey were reported by Noskov *et al.* (MS 1977).

The samples were initially preserved in 4% formalin. In the laboratory, the eggs and larvae were later identified and the stages and phases of larval development determined by the methods proposed by Rass (1949). Larvae were stained with alizarin, according to the method of Yakubovsky (1970), to facilitate the counting of vertebrae and fin rays. The symbols used in the text for identification of the morphometric and meristic characteristics of the larvae are as follows: TL = total length, SL = standard length, HL = head length, PAL = preanal length, BD = body length, and ED = eye diameter. The illustrations of larvae were drawn with the aid of a Promar projecting microscope.

Family Congridae

Gnathophis bathytopos Smith and Kanazawa 1977

1 larva: 24.0 mm SL (sta. 326)

The larva has properties characteristic of *G. bathytopos* described by Smith (1979), namely, the snout is elongated and pointed, there is a crescent-shaped patch of black pigment under the eye, pigment extends ventrally along the length of the gut, and 132 or 133 myomeres are evident.

Family Gonostomatidae

Vinciguerria powerlae (Cocco 1838)

2 larvae: 9.8 mm SL (sta. 312); 10.6 mm SL (sta. 359).

Identification of the larvae was based on the description given by Ahlstrom and Counts (1958). The species is found in the eastern North Atlantic south of 43°N (Witzell, 1973) and has been recorded only off Bermuda and in the Gulf of Mexico in the western Central Atlantic. Grey (1964) found larvae off Bermuda. The two larvae noted above are presumably the first larvae caught so far north of the northern fringe of the Gulf Stream off the Scotian Shelf in the Northwest Atlantic.

Gonostoma elongatum Günther 1878

3 larvae: 7.0 mm SL (sta. 317); 9.3 mm SL (sta. 320); 9.6 mm SL (sta. 315).

The specimens fit the description of the species given by Jespersen and Tåning (1926). In the western Atlantic, *G. elongatum* has been observed off the east coast of the United States (41°N), near Bermuda and southward to at least the northeast coast of South America (Grey, 1964). A single specimen has been reported from the southwestern edge of the Grand Bank at 44°08'N, 52°50'W (Leim and Scott, 1966). Larvae have been found off Florida, eastward to the Leeward Islands in the western Central Atlantic (Grey, 1964) and on Georges Bank in the Northwest Atlantic (Joakimsson, MS 1978). The three specimens noted above are the first larvae of the species caught off the Scotian Shelf.

Cyclothone braueri Jespersen and Tåning 1926

1 juvenile: 18.0 mm SL (sta. 329).

This species is widely distributed in the Atlantic and has been observed in the western Atlantic from 65°N in Davis Strait southward to 43°S (Mukhacheva, 1974).

Family Sternoptychidae

Sternoptyx diaphana Hermann 1781

1 larva at metamorphic stage: 7.4 mm SL (sta. 310).

Identification of this specimen was based on information in the paper by Badcock and Baird (1980). The most northern records of *S. diaphana* in the Northwest Atlantic were specimens taken near LaHave Bank on the Scotian Shelf (42°46'N, 63°22'W) (Schultz, 1961). The larva noted above was caught near the northern limit of the distribution of the species in the western North Atlantic.

Family Melanostomiidae

Genus ? Species ?

1 larva: 9.1 mm SL (sta. 333).

The body is long, narrow and slightly compressed laterally. The head is long and the upper profile of the snout is slightly concave. There are 7 teeth on the premaxillary, 10 teeth on the maxillary and 17 teeth on the dentary. The teeth 2-3, 4-5, 6-7 and 9-10 on the upper jaw are doubled. The pectoral fins are located near the ventral margin of the trunk. The number of myomeres is 66. The anus is located at the level of myomere 60. The end of the anal fin is located at myomere 64. The urostyle is curved. The formation of 12-13 dorsal and 14-15 anal fin rays is evident. The first ray of the anal fin is located at the level of the fifth ray of the dorsal fin. Dorsal and ventro-lateral rows of melanophores are distributed along both sides of the body.

The dorsal row, consisting of large stellate melanophores (one for each myomere), begins over the medulla oblongata and extends to the urostyle. The ventro-lateral row consists of pigment stripes, extending along the myosepta of myomeres 4–64, each stripe being formed usually by 3–4 (seldom 2) melanophores. Groups of small melanophores are also present on other parts of the body, particularly in the folds of the dorsal fin, on the gut and rectum and on the throat.

The larvae of most of the Melanostomiidae species are not yet known, and their identification even to the generic level is difficult. It can only be noted that the character of the pigmentation on the captured larva (presence of dorsal and ventro-lateral rows of melanophores, and the configuration, size and location of the pigment cells in these rows) coincides with the description given by Beebe and Crane (1939) for a 25-mm SL specimen of *Echiostoma barbatum* (= *E. tanneri*).

Family Chauliodontidae

Chauliodus sloani Bloch and Schneider 1801

1 larva: 25.0 mm SL (sta. 320).

Identification of the specimen is based on the description of Belyanina (1977). This species is widely distributed in tropical and temperate waters of the world's oceans. In the Northwest Atlantic, it has been reported from various parts of the Grand Bank as far north as 48° N and from the Laurentian Channel near St. Pierre Bank (Leim and Scott, 1966), and larvae have been recorded from the open areas of the western North Atlantic (Belyanina, 1977).

Family Synodontidae

Trachinocephalus myops (Forster 1801)

1 larva: 19.7 mm SL (sta. 343).

The body is very elongated and slightly compressed laterally (Fig. 2). The preanal part of the body is much longer than the postanal section (PAL = 74.6% SL). The head is relatively small (HL = 11.7% SL) but the eyes are quite large (ED = 37.0% HL). The angle of the mouth extends posteriorly to a point below the middle of the eye. There are 6 teeth on either side of the upper and lower jaws. The anal fin has 13 pterygiophores and the caudal fin has 18 rays. Pectoral fin rays were not fully formed. The number of myomeres (56) corres-

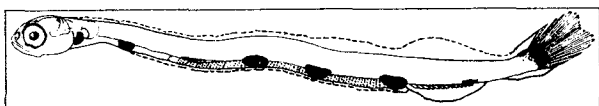


Fig. 2. *Trachinocephalus myops* larva, 19.7 mm SL (Station 343).

ponds to that of vertebrae, there being 39 in the preanal and 17 in the postanal parts of the body. Six large pigment spots lie at regular intervals along both sides of the body between the head and the anus (the third one being damaged), and a very large melanophore is located near the posterior end of the anal fin. The locations of the pigment spots (except the first one near the base of the pectoral), relative to the myomeres are as follows: the second spot is at the level of myomeres 6–8, the third spot at myomeres 12–14, the fourth spot at myomeres 19–23, the fifth spot at myomeres 26–28 and the sixth spot at myomeres 34–38. The large melanophore near the posterior part of the anal fin is at the level of myomeres 44–46. In addition, a stellate melanophore lies over each hemisphere of the mid-brain on the top of the head, and the bases of rays 1–16 of the caudal fin and the adjacent part of the caudal peduncle are pigmented intensively by small melanophores, forming a crescent-shaped band.

The identification of Synodontidae larvae is difficult before the pectoral and anal fins are completely formed. The primary features of the larva described above (i.e. 6 preanal spots, 56 vertebrae, and rudiments of more than 12 anal-fin rays) are characteristic of larvae of both *Synodus foetens* (L.) and *T. myops* (Forster). However, according to Mansueti and Hardy (1967), larvae of *S. foetens* have no melanophores on their occiput and the lobe of the caudal fin has different pigmentation. Therefore, this larva is considered to be *T. myops*. Moreover, its features correspond to the description of larvae of this species from the Central Atlantic (Rudomyetkina, 1980).

T. myops is widely distributed in tropical waters of the world's oceans. In the western North Atlantic, the species has been found northward to Cape Cod (Anderson *et al.*, 1966), and juveniles have been reported from the Scotian Shelf (Markle *et al.*, 1980), presumably carried there by incursions of Gulf Stream water.

Family Notosudidae

Scopelosaurus sp.

1 larva: 17.8 mm SL (sta. 374).

The body is long, narrow and slightly compressed laterally. There are 55 vertebrae, 13 preanal, 22 from the anus to the origin of the anal fin, and 20 from the origin of the anal fin to the urostyle. The anal fin has 15 rays, and the caudal fin has 20 rays, one being much less developed than the others. Rays were not formed in the other fins. There is no pigmentation on the body except in the caudal region (Fig. 3), where several small stellate melanophores are located in the middle part of rays 9–11 and one is seen on the upper fleshy lobe of the caudal fin.

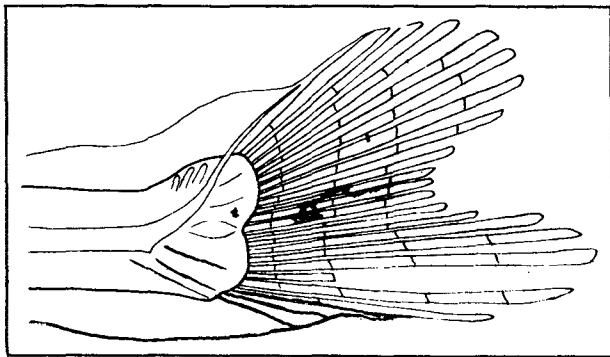


Fig. 3. Caudal fin of *Scopelosaurus* sp. larva, 17.8 mm SL (Station 374).

Four species of the genus *Scopelosaurus* inhabit the waters of the western North Atlantic, namely *S. mauli*, *S. smithii*, *S. lepidus* and *S. argenteus*, whose larvae have been described by Bertelsen *et al.* (1976). The larvae described above differs from the larvae of the first three species by the character of its caudal pigmentation. It is somewhat similar to *S. argenteus* by the presence of one pigment spot on the peduncle of the caudal fin, but larvae of *S. argenteus* have no pigment on the rays of the caudal fin. Therefore, the species name of the larva described above is presently uncertain.

***Scopelosaurus mauli* Bertelsen, Krefft and Marshall 1976**

7 larvae: 6.5 mm, 11.0 mm, 18.5 mm SL (sta. 334); 7.5 mm SL (sta. 335); 10.7 mm SL (sta. 320); 11.7 mm SL (sta. 333); 12.6 mm SL (sta. 377).

This species is found in tropical and subtropical waters of the western Atlantic, being most abundant between 10°N and 40°N (Bertelsen *et al.*, 1976). The larvae, noted above, were caught between 40°30'N and 41°30'N near the northern limit of the distribution of the species in the western North Atlantic.

Family Myctophidae

***Hygophum macrochir* (Günther 1864)**

1 larvae: 5.7 mm SL (sta. 317).

Identification of this species was based on the description by Moser and Ahlstrom (1974). *H. macrochir* is a tropical species, which is more numerous in the eastern than in the western waters of the Atlantic. Data given by Nafpaktitis *et al.* (1977) indicate that this species has not been reported north of the Bahama Islands in the western North Atlantic. Larval distribution in the Atlantic is unknown, but the specimen noted above was caught far north of the range of the adult habitat.

***Hygophum hygomi* (Lütken 1892)**

8 larvae: 4.2 mm, 8.5 mm SL (sta. 333); 3.5 mm, 4.0 mm SL (sta. 335); 4.8 mm SL (sta. 343); 5.3 mm SL (sta. 330); 5.5 mm SL (sta. 317); 6.4 mm SL (sta. 360).

Larvae of this species were first described by Tåning (1918). Data on morphology of larvae have been reported by Moser and Ahlstrom (1974) and Pertseva-Ostroumova (1974). *H. hygomi* is a semi-subtropical species (Nafpaktitis *et al.*, 1977), but there is no information on distribution of its larvae in the western North Atlantic. The 8 larvae noted above were caught near the northern limit of the distribution range of the species.

***Hygophum reinhardtii* (Lütken 1892)**

1 juvenile: 24.5 mm SL (sta. 359).

The species is an inhabitant of tropical and subtropical waters (Nafpaktitis *et al.*, 1977). The juvenile captured off the Scotian Shelf is apparently a northern range record for the species in the western North Atlantic.

***Benthosema glaciale* (Reinhardt 1837)**

2 juveniles: 13.0 mm SL (sta. 333); 22.0 mm SL (sta. 352).

This is a subpolar-temperate species and is probably the most abundant of the North Atlantic myctophids (Nafpaktitis *et al.*, 1977).

***Diogenichthys atlanticus* (Tåning 1928)**

2 larvae: 4.9 mm SL (sta. 377); 8.5 mm SL (sta. 330); 1 juvenile: 21.5 mm SL (sta. 311).

Larvae of this species have been described in detail by Moser and Ahlstrom (1970). It is common in the Northwest Atlantic but is unevenly distributed in subtropical and tropical regions (Nafpaktitis *et al.*, 1977). There is no information on distribution of larvae in the Northwest Atlantic. The specimens noted above were caught in the northern part of the range of the species in the western North Atlantic.

***Myctophum nitidulum* Garman 1899**

1 larva: 6.7 mm SL (sta. 318).

Identification of this larva was based on the description by Moser and Ahlstrom (1970). The species inhabits tropical and subtropical waters (Nafpaktitis *et al.*, 1977) and it occurs south of Nova Scotia in the Northwest Atlantic. Larvae have previously been found in the vicinity of Georges Bank (Joakimsson, MS 1978).

***Myctophum selenops* Tåning 1928 ?**

1 larva: 9.7 mm SL (sta. 334).

The body of this larva (Fig. 4) is deep (BD = 28.9% SL) and the head is large (HL = 33.0% SL). The upper profile of the head is slightly concave. The eye has a conical mass of pigmented choroid tissue. The mouth is large with conical teeth. There are 12 large teeth on each side of the upper jaw and 16 smaller teeth on each side of the lower jaw, with teeth 3, 4, 6 and 12 from the symphysis of the lower jaw being larger than the others. The length of the maxillary is 62.5% HL. The preanal length is 63.0% SL. All fins are completely formed, the number of rays being dorsal 14, anal 18, pectoral 17 and ventral 8. The first ray of the dorsal fin is much shorter than the others and the last two are very close together. The anal fin begins in line with rays 8–9 of the dorsal fin. There are 33 rays in the caudal fin (19 principal, 7 superior procurent and 7 inferior procurent). There are 34 vertebrae, 13 being preanal and 21 postanal. Pigment occurs only on the head and the pectoral fins. A row of small melanophores is located on the anterior part of the upper jaw, 5 on the left side and 6 on the right. Other melanophores occur on the forward part of the head over the eye, one is found on the upper jaw in front of the choroid tissue of the eye, one above the posterior end of the upper jaw, and three on the gill cover, the upper one being branched. A large melanophore is located on the lobe of the pectoral fin, and smaller ones are present at the bases of most pectoral fin rays.

Larvae from the Indian and Pacific oceans identical to the above-noted specimen were described by Pertseva-Ostroumova (1974) and referred to as *Gonichthys barnesi* Whitley (?), but such identification by these authors is erroneous because these larvae have 34–36 vertebrae, in contrast to 40–41 vertebrae in species of the genus *Gonichthys*, and should tentatively be referred to *M. selenops*. Furthermore, Pertseva-Ostroumova (1974) also described *Myctophum selenops* (?) larvae from the Indian and Pacific oceans, and, judging from the data of Moser and Ahlstrom (1974), their larvae should be related to *Myctophum obtusirostre*. The 9.7 mm larva described above is very similar to those of *M. selenops* described by Moser and Ahlstrom (1974), but, because there are

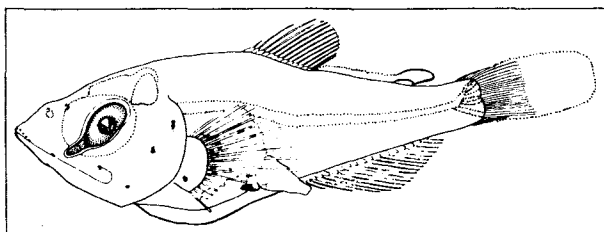


Fig. 4. *Myctophum selenops* (?) larva, 9.7 mm SL (Station 334).

differences in the pigmentation of the jaws, the larva is only tentatively referred to this species.

***Notolychnus valdiviae* (Brauer 1904)**

1 juvenile: 13.9 mm SL (sta. 378).

This species is distributed in tropical and subtropical waters, and, according to Nafpaktitis *et al.* (1977), it has been recorded in the Gulf Stream off eastern Canada.

***Diaphus rafinesquii* (Cocco 1838)**

3 larvae: 4.7 mm SL (sta. 315); 5.5 mm SL (sta. 335); 5.6 mm SL (sta. 320).

The larvae of this species were described by Tåning (1918). Although this species is widely distributed in the North Atlantic between 20° N and 50° N (Nafpaktitis, 1968), larvae have not been previously recorded from the area of investigation off Nova Scotia.

***Diaphus* sp.**

1 larva: 6.1 mm SL (sta. 317).

The structure and pigmentation of this larva are similar to those of *D. rafinesquii*, but it differs from them by the presence of 4 melanophores (instead of 2) located parallel to the edge of the caudal lobe on the caudal fin rays.

***Bollinichthys indicus* (Nafpaktitis and Nafpaktitis 1969)**

1 juvenile: 13.5 mm SL (sta. 343).

Although this species is classed as subtropical, it occurs also in significant numbers in temperate regions of the open North Atlantic (Nafpaktitis *et al.*, 1977).

***Ceratoscopelus maderensis* (Lowe 1839)**

4 larvae: 7.5 mm SL (sta. 317); 7.6 mm SL (sta. 323); 8.1 mm, 9.7 mm SL (sta. 320).

Larvae of this species were described by Tåning (1918). According to Nafpaktitis *et al.* (1977), it is a temperate and semi-subtropical species. Several specimens were found in the stomachs of Atlantic cod, *Gadus morhua*, caught in the Laurentian Channel off Cape Breton, Nova Scotia (Leim and Scott, 1966), and the species has been observed near Iceland at 50° N (Bolin, 1959). Larvae have been reported from Georges Bank (Joakimsson, MS 1978).

***Ceratoscopelus warmingii* (Lütken 1892)**

1 juvenile: 20.7 mm SL (sta. 360).

This species is common in tropical and subtropical waters, but it may also be found in slope waters of the

continental shelf in the Northwest Atlantic where it is transported by warm-core Gulf Stream eddies (Nafpaktitis *et al.*, 1977).

Family Paralepididae

Notolepis rissol krøyeri (Lütken 1892)

3 larvae: 7.0 mm SL (sta. 310); 9.5 mm SL (sta. 377); 13.6 mm SL (sta. 358).

This species is widely distributed in the North Atlantic. Larvae have been described by Ege (1930), and data on the distribution of larvae, juveniles and adults have been summarized by Rofen (1966).

Family Scomberesocidae

Scomberesox saurus (Walbaum 1792)

1 egg: 2.35 mm diameter (sta. 333).

This egg was in developmental stage III or IV, with the embryo covering about two-thirds of the yolk sac. Eggs and larvae of this species have been described by Nesterov and Shiganova (1976), who indicated that the northern limit of egg and larval distribution in the North Atlantic corresponds approximately with the 16.5°C isotherm on the surface. The occurrence of this egg at 40°30'N probably represents a northern range record for eggs of *S. saurus*. There are numerous reports of adults being caught in Canadian waters around Newfoundland and Nova Scotia (Leim and Scott, 1966).

Investigations on the biology and distribution of the species in the Northwest Atlantic were reported by Dudnik *et al.* (1981).

Family Bregmacerotidae

Bregmaceros maclellandi Thompson 1840

2 larvae: 4.7 mm SL (sta. 326); 7.6 mm SL (sta. 335).

Identification of these larvae were based on the description by Belyanina (1974). In the western North Atlantic, it is distributed northward to about 40°N (D'Ancona and Cavinato, 1965), but no larvae have been previously recorded from Gulf Stream waters off eastern Canada.

Family Macrouridae

Genus ? Species ?

1 larva: 1.44 mm HL (sta. 326).

This larva was damaged, its tail broken, and part of the ventral section of the body missing. The preanal

part of the body is deep and the postanal part thin and long (Fig. 5). The anus is at the level of myomeres 10–11. There are 11–12 small teeth on each side of the upper jaw and 14 teeth on each side of the lower jaw. The right ventral fin has 6 rays, the third and fourth being longer than the others. Other fins have not yet formed. The upper part of the head and the postorbital area are covered with diffused black pigment. The dorsal part of the peritoneum is highly pigmented, and there are some pigment accumulations near the lower edge of the cleithrum and at the anterior part of the ventral fin. Three large melanophores are present near the posterior end of the body, two dorsally and one ventrally.

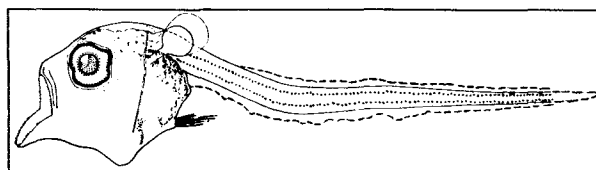


Fig. 5. Macrouridae larva, 1.44 mm HL (Station 326).

The larva described above has 7 branchiostegal rays. The same number of rays is found in the species of 11 genera of macrourids (Marshall and Iwamoto, 1973), most of which inhabit tropical and subtropical waters. Six macrourid species have been reported from Canadian Atlantic waters (Leim and Scott, 1966). These are *Trachyrhynchus murrayi*, *Coelorhynchus carminatus*, *Macrourus berglax*, *Coryphaenoides rupestris*, *Malacocephalus occidentalis*, and *Nezumia bairdi*, but only the last two have 7 branchiostegal rays. If the larva described above resulted from spawning off Nova Scotia or the northeastern United States, it can be referred to as *M. occidentalis* or *N. bairdi*. However, this larvae has 6 ventral fin rays, whereas *M. occidentalis* has 8 rays and *N. bairdi* has 7 (rarely 6) rays in the ventral fin (Marshall and Iwamoto, 1973). Therefore, the larva may be referred very tentatively to *N. bairdi*.

Family Scorpaenidae

Scorpaena sp. ?

1 larva; 7.5 mm SL (sta. 317).

Identification was difficult due to the poor condition of the larva, but, on the basis of the descriptions by Moser *et al.* (1977), it apparently belongs to the genus *Scorpaena*.

Family Labridae

Genus ? Species ?

1 larva: 5.5 mm SL (sta. 328).

The body of this larva is deep (32.6% SL) and markedly compressed laterally (Fig. 6). The anus is

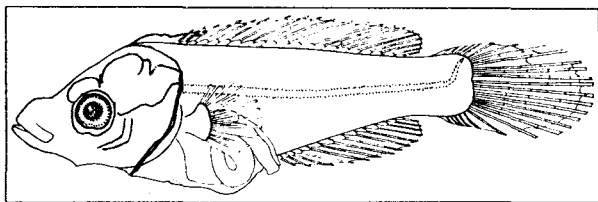


Fig. 6. Labridae larva, 5.5 mm SL (Station 328).

situated slightly posterior to the middle of the body (PAL = 59.0% SL). The head is large (HL = 34.6% SL), the upper profile of the snout is concave, and the mouth is small. The dorsal and anal fins are long and contain 21 and 14 rays respectively. The pectoral fin is fan-shaped with 13 rays. Rudiments of the ventral fins are evident below the bases of the pectorals. The caudal fin has a total of 26 rays. There are 26 myomeres, 8 preanal and 18 postanal. The intestine is in the form of a loop, on top of which is the airbladder. The only melanophores present are small ones located in the membrane between the first and third rays of the dorsal fin.

Most of the Labridae inhabit subtropical and tropical waters. The early stages of their development have not been extensively studied, and identification of the larva described above is difficult even at the genus level.

Family Scaridae

Genus ? Species ?

4 larvae: 6.4 mm SL (sta. 327); 7.5 mm SL (sta. 310); 8.1 mm SL (sta. 333); 8.3 mm SL (sta. 330).

The body is compressed laterally (Fig. 7) but it is not deep (BD = 17.3% SL). The anus is located approximately in the middle of the body (PAL = 52.0% SL). The head is small (HL = 24.0% SL), the tip of the lower jaw extends forward, and the eyes are oval-shaped (0.35 × 0.55 mm). Underlying the eye is a mass of choroid tissue pigmented by branched melanophores. The dorsal fin is long with 10 spines and 9 soft rays. The anal fin has 2 spines followed by 11 rays. The last ray of the anal fin is in line with the last ray of the dorsal fin. There are 27 rays in the caudal fin, 14 of them being principal rays. The pectoral fin has 12 rays. There are 25 vertebrae, 9 preanal and 16 postanal. The intestine is slightly curved, and the very short rectum extends to the anus almost perpendicular to the intestine. A small airbladder is located in the body cavity over the posterior end of the intestine. The rectum and the adjacent part of the airbladder are covered with melanophores. A row of 13 clearly defined melanophores extends ventrally along the postanal section of the body. Also, there are small melanophores on the tip of the lower jaw and one is located on the base of the pectoral fin.

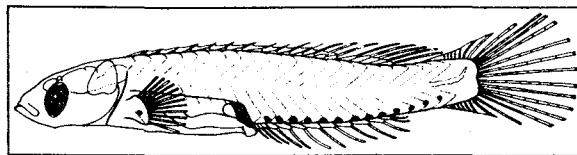


Fig. 7. Scaridae larva, 7.5 mm SL (Station 310).

Each of the larvae studied has 9 preanal and 16 postanal vertebrae, a characteristic of three genera of Scaridae inhabiting the western North Atlantic (Schultz, 1958), namely, *Sparisoma*, *Cryptotomus* and *Nicholsina*. Because of similarity in meristic features, larvae of these genera are very difficult to differentiate. However, the four larvae noted above are very similar to those of *Cryptotomus ustus*, described by Regan (1916) and later by Aboussouan (1969).

Family Callionymidae

Callionymus agassizi Goode and Bean 1888

1 larva: 6.0 mm SL (7.5 mm TL) (sta. 327).

The body of this larva is deep (Fig. 8A). The head is large (HL = 36.6% SL) and depressed. The eyes are large (ED = 36.4% HL) and are very close together dorsally (Fig. 8B). The anus is located slightly posterior to the middle of the body (PAL = 55% SL). The air bladder is visible in the upper part of the abdominal cavity. There is a large bifurcated spine on the preoperculum. The dorsal fin has 10 soft rays in front of which are 4 spines (fourth broken). The anal fin has 9 rays, the first being in line with the third soft ray of the dorsal fin. The pectoral fin has 20 rays and its base is large. The ventral fin, with its base below that of the pectoral fin, has a short spine and 5 long, soft rays. The caudal fin consists of 10 principal rays and 5 procurrent rays (3 above and 2 below). There are 21 vertebrae, 8 preanal

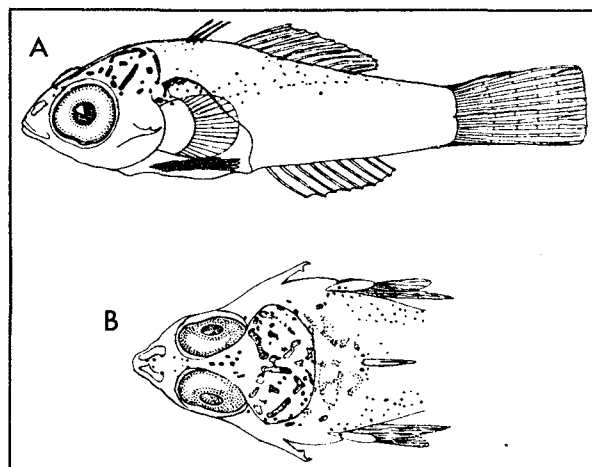


Fig. 8. *Callionymus agassizi* (A) larva, 6.0 mm SL, and (B) dorsal view of head (Station 327).

and 13 postanal. Brown pigmentation occurs mainly on the dorsal parts of the head and the body and on the ventral fins. Intense pigment accumulations on the head form a peculiar design over the hemispheres of the mid-brain. The design is partially repeated behind the brain in the dorsal peritoneum which is transparent through the dorsal tissues (Fig. 8B). Also, pigment cells are present along the anterior margin of the second dorsal spine, one cell is seen on the upper edge of the lobe of the left pectoral fin and two on the lobe of the right pectoral fin.

Larvae of *Callionymus* from the western North Atlantic have not been described, but the presence of a bifurcated spine on the preoperculum of the larva described above and the numbers of rays in the dorsal and anal fins correspond to *C. agassizi* (Jordan and Evermann, 1896).

***Callionymus bairdi* Jordan 1887 ?**

1 larva: 5.1 mm SL (sta. 310).

The body of this larva is pigmented by branched brown cells. The upper parts of the head and trunk are evenly pigmented with scattered cells. There are 5-6 rows of chromatophores distributed dorsally and 3-4 rows ventrally on the preanal section of the body. The dorsal fin has 3 or 4 spines and 9 or 8 soft rays, and the ventral fin has 1 spine and 4 or 5 soft rays which are short and strongly pigmented. The vertebrate number is 20 or 21.

The presence of pigment ventrally on the postanal part of the body and the absence of pigment designs on the upper part of the head and adjacent trunk area distinguish this larva from the one described previously. According to the number of soft spines in the dorsal fin, the larva could be related to *C. bairdi*, but identification is tentative because the spines on the preopercula, which would allow identification to the species level, have not yet developed.

Family Gobiidae

Genus ? Species ?

1 larva: 6.45 mm SL (sta. 313).

The body is narrow (BD = 16.1% SL) and compressed laterally (Fig. 9). The anus is in the middle of the body (PAL = 50.5% SL). The head is long and

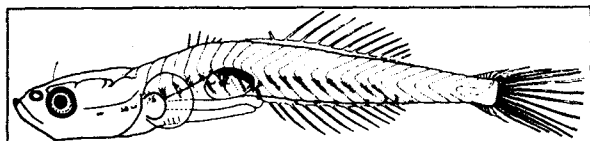


Fig. 9. Gobiidae larva, 6.45 mm SL (Station 313).

narrow (HL = 21.3% SL), and the tip of the lower jaw projects in front of the tip of the upper jaw. The dorsal fin contains 5 spines which are separated from 11 soft rays. The anal fin has 11 rays, and the caudal fin consists of 28 rays (14 principal, 7 superior procurent and 7 inferior procurent). There are 24 vertebrae, 9 preanal and 15 postanal. A large airbladder is situated at the level of myomeres 5-10. Pigmentation occurs almost exclusively on the lower part of the body. Large pigment accumulations are distributed along the myosepta of the first 17 myomeres. Several melanophores are located under the edge of postanal myomeres 3-10 and also on myosepta 3-6 of the postanal myomeres. The upper part of the airbladder is strongly pigmented. The tip of the lower jaw is intensely pigmented, and 3 melanophores under the brain are seen through the transparent operculum.

This larva is different from those of *Gobiosoma* and *Microgobius*, described by Hildebrand and Cable (1930). It refers to one of the subtropical or tropical species of gobies, with a small number of rays in the dorsal fin and whose larvae have not yet been described. Consequently, larva identification below the family level is not yet possible.

Family Gempylidae

***Diplospinus multistriatus* Maul 1948**

1 larva: 4.7 mm SL (sta. 320).

Larvae of this species were first described by Voss (1954) as *Gempylus* "A" (Parin, 1967). They have already been found in the Gulf Stream off Nova Scotia (Evseenko and Serebryakov, 1974).

Family Trichiuridae

***Benthodesmus elongatus simonyi* (Steindachner 1891)**

1 larva: 20.3 mm SL (sta. 326).

The larva has a very elongated, laterally compressed and narrow body (Fig. 10). The head is long (HL = 19.7% SL) and the eye is relatively large (ED = 18.5% HL). The dorsal fin extends almost the length of

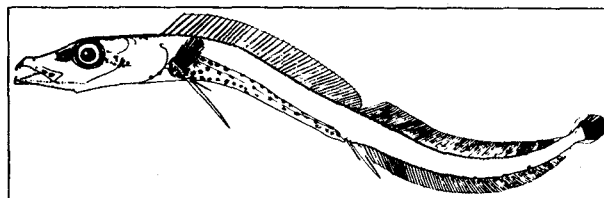


Fig. 10. *Benthodesmus elongatus simonyi* larva, 20.3 mm SL (Station 326).

the body, with 47 spines anteriorly and 91+ soft rays posteriorly. The length of the base of the spiny section is slightly less than that containing soft rays. The anal fin has 2 spines and 87+ soft rays, the former being located under soft ray 2-4 of the dorsal fin. The second anal spine is about twice as long as the first with a smooth edge anteriorly and serrated posteriorly. The pectoral fin has 12 rays, and the ventral fin, located posterior to the base of the pectoral fin, has one long spine serrated at its posterior edge and one short soft ray. The development of soft rays in the dorsal, anal and caudal fins has not yet been completed. The anus is located below the second soft ray of the dorsal fin (PAL = 60.3% SL). Nostrils are located in front of the eyes, and the mouth is large. On each side of the upper jaw, a large fang is located anteriorly, followed by a small fang which is turned inward, and by 9 small teeth. On each side of the lower jaw, there is a large fang anteriorly, followed by 10-12 small teeth.

A continuous row of melanophores runs along the dorsal margin of the body from the forebrain area to soft ray 72 of the dorsal fin. A similar row extends along the ventral margin of the body from the base of the anal spines to ray 39 of the anal fin and continues after interruption to the base of rays 68-70, where the last melanophore is the largest in the row. The anterior part of the intestine is covered with a dense concentration of black pigment. The remainder of the intestine and the abdominal cavity are pigmented by large melanophores. A dense concentration of pigment lies directly in front of the eye, there are some pigment cells behind the eye and on the premaxillary, and a continuous row of small melanophores extends along the side of the lower jaw.

Larvae of *B. elongatus simonyi* have not been previously described. However, the designation of the larva described above to this species is beyond doubt because of several characteristic features, e.g. the number of spines in the dorsal fin, the peculiarities of the ventral rays, and the location of the anal spines (Parin and Bekker, 1972). These authors have indicated that distribution is restricted to waters of the North Atlantic.

Family Bothidae

Citharichthys gymnorhinus Gutherz and Blackman 1970

1 larva: 3.6 mm SL (sta. 343).

Larvae of this species have been described by Tucker (1982) and Dowd (MS 1978). *C. gymnorhinus* has been reported off the Bahamas, Columbia, Florida Keys, Hispaniola, Nicaragua, Panama, Puerto Rico and Tobago (Gutherz and Blackman, 1970), and on the Florida Shelf, off Cuba, Guyana, Venezuela, and the

Virgin Islands (Topp and Hoff, 1972). Larvae of this species have not been previously reported from the open waters of the western North Atlantic.

Bothus ocellatus (Agassiz 1831)

8 larvae: 4.0 mm, 5.5 mm SL (sta. 343); 5.5 mm SL (sta. 320); 6.0 mm SL (sta. 313); 9.0 mm SL (sta. 330); 9.4 mm SL (sta. 374); 9.5 mm SL (sta. 312); 13.0 mm SL (sta. 316).

Two of the larvae (9.4 and 13.0 mm) have 26 caudal vertebrae and the others have 25. All of the larvae belong to *B. ocellatus*, according to the data of Jutare (MS 1962). Larvae of this species are widely distributed beyond the shelf waters of the North Atlantic and have been found in Gulf Stream eddies (Evseenko, 1976). Also, numerous collections of *Bothus* sp. have been made on the Scotian Shelf, mostly east of Browns Bank and west of Emerald Bank (Markle *et al.*, 1980).

Family Cynoglossidae

Symphurus sp.

1 larva: 11.7 mm SL (sta. 316).

It was difficult to determine the species of this larva because of damage to the head and the dorsal fin. However, the pigment pattern is similar to that of *S. plaguista* larvae (Olney and Grant, 1976). *Symphurus* larvae have not been previously observed in the open waters of the western North Atlantic, but the report of larvae and juveniles of one species of this genus (*S. minor*) on the Scotian Shelf (Markle *et al.*, 1980) is evidence that such larvae from southern waters drift northward with the Gulf Stream.

Family Antennariidae

Histrio histrio (Linnaeus 1758)

2 larvae: 2.25 mm SL (sta. 329); 2.75 mm SL (sta. 328).

The larvae of this species have been described by Adams (1960), but there are no data on their distribution. The species inhabits tropical waters of the North Atlantic and the Indo-Pacific (Schultz, 1957). In the western North Atlantic, it may range northward, in association with Gulf Stream water, to Georges Bank (Bigelow and Schroeder, 1953) and even farther north-eastward (Leim and Scott, 1966).

Antennarius sp.

2 larvae: 3.7 mm SL (sta. 336); 4.0 mm SL (sta. 343).

The body is almost ball-like, slightly compressed laterally in the caudal region, and covered evenly with large bifurcated spines. The mouth is large, with small

teeth on the lower jaw, and the eyes are large and round. The gill slit, like a round pore, is located under the base of the pectoral fin. Both larvae have rudiments of the ventral fins, and only the soft rays (10–11) are found in the dorsal fin. In both specimens, the anal fin has 7 rays, the pectoral fin 11 rays and the caudal fin 9 rays. The entire body is densely covered with branched, brown pigment cells, with a concentration in the upper part of the peritoneum.

The larvae are very similar to those of *Antennarius* sp. (5.0 and 5.5 mm) from the Indian Ocean (Tsokur, 1972) by the shape and pigmentation of the body and by the shape, size and location of the spines. Identification of the larvae to the species level was difficult because formation of the dorsal fin is incomplete. Also, the paper by Tsokur (1972) is the only one on characteristics of *Antennarius* larvae inhabiting subtropical and tropical waters.

Conclusions

Larvae belonging to 22 families of fishes were represented in the ichthyoplankton samples collected in the Slope and Gulf Stream waters off Nova Scotia in November–early December 1974 (Appendix Tables A and B). Larvae of 10 tropical and subtropical families which normally inhabit continental shelf waters were represented by Congridae, Synodontidae, Scorpaenidae, Labridae, Scaridae, Callionymidae, Gobiidae, Bothidae, Cynoglossoidae and Antennariidae; two families of tropical-subtropical epipelagic fishes were represented by larvae of Gempylidae and Trichiuridae; nine families of deep-water fishes were represented by larvae of Gonostomatidae, Sternoptychidae, Melanostomiatidae, Chauliodontidae, Notosudidae, Myctophidae, Bregmacerotidae, Macrouridae and Paralepididae; and the family Scomberesocidae was represented by an egg. Larvae of several species of these families were taken in the waters off eastern Canada for the first time. Myctophid larvae were the most abundant in the samples. However, the quantity of ichthyoplankton was extremely small, as only 98 larvae and one egg were caught during the entire survey.

The surveyed area is a zone of interaction of water masses of different origins — Gulf Stream, Labrador Current and their modifications (Noskov *et al.*, MS 1977). This determines the zoogeographical structure of the ichthyoplankton in the region. In addition to larvae of tropical and subtropical species, the subpolar-temperate *B. glaciale*, the temperate species *N. rissoi* Krøyeri, and the temperate to semi-subtropical species *H. hygomi*, *C. maderensis* and *D. rafinesquii* were also found there. Such widely distributed oceanic species as *C. braueri* were also encountered.

Comparison of the data on larval distribution with current patterns and temperature distribution (Noskov

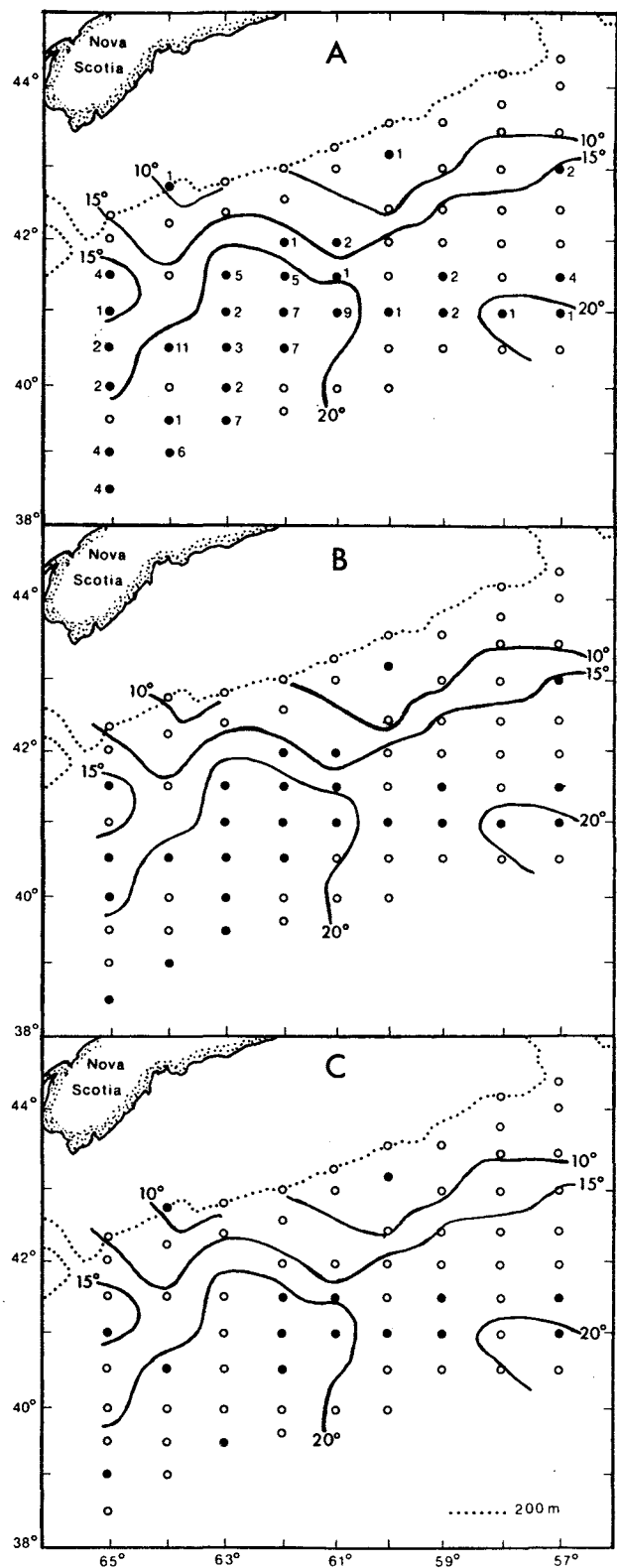


Fig. 11. Distribution of ichthyoplankton in Slope and Gulf Stream waters off Nova Scotia during the survey in late autumn 1974: A, number of specimens caught at each station; B, distribution of larvae of tropical and subtropical shelf species; C, distribution of myctophid larvae. [Closed circles represent positive hauls. Surface temperature isotherms from Noskov *et al.* (MS 1977).]

et al., MS 1977) indicates that the majority of larvae (73 of 98) were found in meanders of the Gulf Stream, the northern boundary of which approximately coincides with the 20°C surface isotherm (Fig. 11A). The majority of the larvae of tropical and subtropical shelf fishes were caught in the area (61° to 64°W) where the surface temperature was higher than 20°C (Fig. 11B), but some of these species were caught beyond the limits of this meander at significantly lower water temperature: Scaridae and *C. bairdi* at 13.0°C (Station 210) and *B. ocellatus* at 15.1°C (Station 374). The distribution of myctophid larvae (Fig. 11C) is somewhat more widespread. They were found in the Gulf Stream meanders at 57° to 58°W and 61° to 64°W, in the frontal zone where the temperature was 16° to 18°C, and in Slope Water less than 10°C at Station 323 (*C. maderensis*) and at Station 352 (*B. glaciale*).

Larvae of fishes inhabiting the Scotian Shelf were absent in the ichthyoplankton samples. This may be due both to the weak transport of larvae from the shelf to the Gulf Stream zone and to the death of larvae before reaching the zone because of the great difference in temperature (10 to 15°) of shelf and Gulf Stream waters, according to the temperature conditions during the survey (Noskov *et al.*, MS 1977).

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APPENDIX

TABLE A. Stations where ichthyoplankton were found during Belogorsk cruise, 1974.

Date	Station No.	Position	
		Lat.	Long.
14 Nov	310	41°30'	65°00'
	311	40°59'	65°00'
15 Nov	312	40°30'	65°00'
	313	40°00'	65°00'
	315	39°00'	65°00'
	316	38°30'	65°00'
16 Nov	317	39°00'	64°00'
	318	39°30'	64°00'
	320	40°30'	64°00'
17 Nov	323	42°47'	64°00'
18 Nov	326	41°30'	63°00'
	327	41°00'	63°00'
	328	40°30'	63°00'
19 Nov	329	40°00'	63°00'
	330	39°30'	63°00'
20 Nov	333	40°30'	62°00'
	334	41°00'	62°00'
	335	41°30'	62°00'
22 Nov	336	41°59'	61°59'
	341	42°00'	61°00'
	342	41°30'	61°00'
25 Nov	343	41°00'	61°00'
	348	41°00'	60°00'
	352	43°10'	60°00'
28 Nov	358	42°00'	59°00'
	359	41°30'	59°00'
29 Nov	360	41°00'	59°00'
	363	41°00'	58°00'
2 Dec	374	43°00'	57°00'
	377	41°30'	57°00'
	378	41°00'	57°00'

TABLE B. List of families, species, number of larvae and station numbers relevant to the ichthyoplankton survey off Nova Scotia in late autumn, 1974.

Family/Species	Number of specimens	Station numbers
Congridae		
<i>Gnathophis bothytopos</i>	1	326
Gonostomatidae		
<i>Vinciguerria poweriae</i>	2	312, 359
<i>Gonostoma elongatum</i>	3	315, 317, 320
<i>Cyclothone braueri</i>	1	329
Sternoptychidae		
<i>Sternoptyx diaphana</i>	1	310
Melanostomiatidae		
Genus ? Species ?	1	333
Chauliodontidae		
<i>Chauliodus sloani</i>	1	320

TABLE B. (continued).

Family/Species	Number of specimens	Station numbers
Synodontidae		
<i>Trachinocephalus myops</i>	1	343
Notosudidae		
<i>Scopelosaurus</i> sp.	1	374
<i>Scopelosaurus maui</i>	7	320, 333, 334 335, 377
Myctophidae		
<i>Hygophum macrochir</i>	1	317
<i>Hygophum hygomi</i>	8	317, 330, 333 335, 343, 360
<i>Hygophum reinhardtii</i>	1	359
<i>Benthosema glaciale</i>	2	333, 352
<i>Diogenichthys atlanticus</i>	3	311, 330, 377
<i>Myctophum nitidulum</i>	1	318
<i>Myctophum selenops</i> ?	1	334
<i>Notolychnus valdiviae</i>	1	378
<i>Diaphus rafinesquii</i>	3	315, 320, 335
<i>Diaphus</i> sp.	1	317
<i>Bolinichthys indicus</i>	1	343
<i>Ceratoscopelus maderensis</i>	4	317, 320, 323
<i>Ceratoscopelus warmingii</i>	1	360
Paralepididae		
<i>Notolepis rissoi krøyeri</i>	3	310, 358, 377
Scomberesocidae		
<i>Scomberesox saurus</i>	1	333
Bregmacerotidae		
<i>Bregmaceros macclellandi</i>	2	326, 335
Macrouridae		
Genus ? Species	1	326
Scorpaenidae		
<i>Scorpaena</i> sp.?	1	317
Labridae		
Genus ? Species ?	1	328
Scaridae		
Genus ? Species ?	4	310, 327 330, 333
Callionymidae		
<i>Callionymus agassizi</i>	1	327
<i>Callionymus bairdi</i> ?	1	310
Gobiidae		
Genus ? Species ?	1	313
Gempylidae		
<i>Diplospinus multistriatus</i>	1	320
Trichiuridae		
<i>Benthodesmus elongatus simonyi</i>	1	326
Bothidae		
<i>Citharichthys gymnorhinus</i>	1	343
<i>Bothus ocellatus</i>	8	312, 313, 316, 320 330, 343, 374
Cynoglossidae		
<i>Symphurus</i> sp.	1	316
Antennariidae		
<i>Histrio histrio</i>	2	328, 329
<i>Antennarius</i> sp.	2	336, 343