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CANADIAN FISHERIES' EXPEDITION, 1914-15

C.2 BIOLOGY OF ATLANTIC WATERS OF CANADA

CANADIAN FISH-EGGS AND LARVÆ

BY

ALF DANNEVIG

Of the Flödevig Sea-Fish Hatchery, Arendal, Norway

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I. INTRODUCTION.

When Dr. Hjort invited me to undertake the work of dealing with his valuable material of fish eggs and young from the Canadian waters, I was fully aware of the many difficulties which the task would involve. The determination of ova and young from a quarter of the globe where many species of fish exist, whose young stages have not been described, is naturally no easy matter, more especially when only preserved material is available, and it will, as a rule, be obvious from the outset that complete success must be out of the question. The object of the Canadian investigations was, however, principally to ascertain the biological conditions under which the most important species of fish lived and multiplied, so that possible errors in the determination of some few of the less frequently occurring species would be of minor importance. In view of this fact, and with the promise of every assistance from Dr. Hjort and Magister Koefoed, I undertook the task, all difficulties notwithstanding.

As to how far the determination of species has been successful, it is naturally impossible to say at present; future investigations of the same waters will, in all essentials, make this clear. I have thought it proper, however, here to make a few introductory observations as to certain particular difficulties which may be imagined as having given rise to erroneous determinations.

The transatlantic literature on the subject being somewhat scanty, I have had recourse more especially to descriptions of European species, and it might therefore seem not unlikely that related western forms could have become confused with or mistaken for these; but regarding the young of species found on both sides of the Atlantic, however, and where good descriptions of the young stages are available, this source of error does not apply.

A considerable number of forms have been drawn with great accuracy by Mr. Rasmussen, these including both species previously described and drawn, and also other lesser-known species. I have not thought it advisable to give any description of such forms on the basis of the preserved material, more especially since this would lie outside the scope of the present work.

As regards the determination of the ova, this is naturally more or less uncertain, since the eggs of many species are indistinguishable one from another until the embryos are well developed. In some few cases, on the other hand, the ova may be accurately determined from the time of spawning. It will, moreover, be justifiable to presuppose relation between ova of like appearance in one and the same sample, where some are newly spawned and others with the embryo sufficiently developed to permit of certain determination.

The present material of ova and young was collected by means of a silk net (1m. diameter) and preserved in 4 per cent formal. The duration of the surface hauls varied somewhat, as a rule between ten and fifteen minutes; the depths, as stated for the vertical hauls, are also in some cases only approximately correct, owing to difficulties in the working of the net.

Similarly, the records as to quantity should not be taken too strictly, these being for like reasons only approximate figures. The proportional quantitative values, however, as between eggs at different stages of development, may be taken as fairly reliable.

The material was collected in the course of five different cruises, of which two made on board of C.G.S. *Acadia* covered a zigzag course between the southern point of Nova Scotia and Newfoundland, the first extending from May 29 to June 4, the second from July 21 to July 29.

In the gulf of St. Lawrence, two cruises were made with the C.G.S. *Princess* from June 9 to June 15 and August 3 to August 12; here also, the SS. N° 33, in addition to its ordinary fishery operations, collected a number of samples during the period from June 1 to August 18.

Fig. 1.

Before proceeding to the treatment of the material, I should mention that a quantity of ova and young had already been determined by Dr. Hjort in Canada, while Mr. K. E. Ofoed also has kindly determined a number of Atlantic fish, and has further assisted me in doubtful cases with other forms.

II. THE MATERIAL COLLECTED.

In the plankton samples, ova and young of thirty-six species of fish have been determined, representing twenty families in all.

The species will be dealt with in the following pages in systematic order, having regard to their occurrence within the area investigated, their geographical distribution generally, and certain features in their biology and reproduction.

1 FAM. LABRIDÆ.

Ctenolabrus adspersus (Walbaum).

(Plate II, Figs. 1 and 2; Table IIa.)

Fig. 1.

Fig 3.

Fig. 4.

The young stages of this species have been shown by Agassiz (On the Young Stages of some Osseous Fishes, Part III, *Ctenolabrus coeruleus* DeKay, pl. XIII, and XIV). I have not, however, been able to identify the species with certainty from these drawings, but as the larvæ agree very well with the young stages of the related European form *Labrus rupestris*, I have had no hesitation in ascribing the Canadian material to *Ctenolabrus adspersus*.^{*} According to Professor Ehrenbaum's "Nordisches Plankton," the larvæ of *Tautoga onitis* are very similar to those of this species, but as *Tautoga* is a southern form, there can hardly be any question of confusion with the present species.

As will be seen from the illustrations, the Canadian form differs from the European in having a very distinct massing of pigment at the posterior basis of the dorsal fin.

The diameter of the ova is the same in both species, viz., 0.8—0.9 mm.

The distribution of *Ctenolabrus adspersus* ranges from Labrador to Sandy Hook (Jordan and Evermann); it is a distinctly coastal form, especially affecting rocky bottom. *Ctenolabrus adspersus* is summer-spawning; on the first cruise of the *Princess* (June 9 to June 15) but not more than twenty-one eggs of this species were taken. On the second cruise (August 3 to August 12), on the other hand, numerous larvæ were found, and only very few eggs, most of those found being in a very advanced stage of development.

^{*} *Tautogolabrus adspersus* Walbaum.

As will be seen from the chart, ova and young were only found at the stations nearest the coast, especially in the gulf of St. Lawrence along Prince Edward Island and Cape Breton.

The material of this species from the *Acadia* amounts to some few eggs and young taken at Sable island and farther in near the Gut of Canso.

The size of the young varied between 3 and 9 mm.; (see also tables).

2. FAM. CARANGIDÆ.

Capros aper (Lacépède).

Of this species, only one specimen (total length 6 mm.) was taken, this being from the *Acadia*, Station 44, where it was brought up in a vertical haul from 150-0 m. Although Jordan and Evermann do not mention this species as occurring in American waters, I have been obliged to ascribe this specimen to the species in question. *C. aper* is also found, by the way, in the eastern Atlantic right up to the coasts of England, and it also penetrates into the Mediterranean.

3. FAM. SCOMBRIDÆ.

Scomber scombrus (Linnæus).

(Plate I, Fig. 3; Table IIb.)

Of this species, quite a considerable quantity both of ova and young were collected, especially by No. 33, and on the second cruise of the *Princess*.

Jordan and Evermann give the distribution of the mackerel along the American coast as from Labrador to cape Hatteras, and it is therefore remarkable that its ova and young should here have been found almost exclusively in the southern portion of the gulf of St. Lawrence. The cruises of the *Acadia* furnished but three eggs from stations outside Nova Scotia, and neither the *Princess* nor No. 33 found ova or young of mackerel in the northern part of the gulf.

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Fig. 5.

Fig. 6.

Fig. 7.

It would seem that the mackerel here when spawning keep to the shallower waters in towards Prince Edward Island. It is also interesting to note that while the first stations on the first cruise of the *Princess* inside and west of Prince Edward Island furnished purely arctic species, the hauls made a week later, on the eastern side of the island, brought up the first mackerel eggs.

The mackerel's spawning season appears to extend over a considerable period, from middle of June (first cruise of the *Princess*) to some way on in August.

The size of the mackerel ova will be seen from the table; it will be noted that the diameter varies greatly, a phenomenon which is also well-known in European waters.

MM.	<i>Princess</i> . Station 26.	<i>Princess</i> . Station 30.	<i>Princess</i> . Station 31.	"33." Station 29.
1'00..	....	....	23	
1'05..	....	9	47	
1'10..	....	16	34	1
1'15..	1	1	1	4
1'20..	8	....	....	12
1'25..	11	....	....	8
1'30..	5	....	....	

The diameter of the oil globules was about 0.03 mm.

Mackerel larvæ were taken only during the second cruise of the *Princess*, for the most part from Prince Edward Island, and out towards the edge, where stations 28 to 34 gave 40 larvæ between 3 and 8 mm.

In addition, a single larva of 9 mm. was taken at station 45, this being the only mackerel larva found on the north side of Cabot strait. At Stations 49 and 50—between Prince Edward Island and Cape Breton—six larvæ ranging from 4 to 6 mm. were found.

4. FAM. PEDICULATI.

Lophius piscatorius (Linnæus).

Of this species, only a single specimen, of 11 mm., was found (*Acadia*, station 47). *L. piscatorius* has a very wide distribution on both sides of the Atlantic; according to Jordan and Evermann, it ranges from Nova Scotia as far as the Barbadoes; only in deep water, however, is it found so far south.

5 FAM. SCORPAENIDÆ.

Sebastes marinus (Linnæus).

(Plate I, Figs. 4, 5, 6, 7; Table IIc.)

Young of *Sebastes* were found in all the deeper parts of the areas investigated, save at the outermost stations of the *Acadia*.

Fig. 8.

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Fig. 9.

Fig. 10.

It would appear to be most numerous above the deep channel south of Anticosti; the *No. 33* took here 325 young in a single haul. On the slope towards Newfoundland also, it is numerous. (*Princess* station 45.)

On the second cruise of the *Acadia*, also, by the way, it was found in remarkable quantities on the banks off Nova Scotia; this fact may be ascribed to the existence of large depressions in the banks, or possibly to the nature of the currents.

Sebastes marinus is found throughout the northern seas between America and Europe, both on the slopes of the banks and pelagically above the greater ocean depths. Jordan and Evermann note it as occurring on the American side from Greenland along the coast as far as midway off New Jersey; from Maine and farther south, however, in deep water only.

These writers affirm that Goode and Bean found spawning *Sebastes* late in the summer off the coasts of New England, at a depth of 100 to 180 fathoms and state that there is no "reason to believe that the young rise to the surface."

According to Dr. Bigelow, adult *Sebastes* are also found in quite shallow water (about 10 fathoms) in the gulf of Maine—a very remarkable phenomenon, since *Sebastes* is otherwise both south of this (Jordan and Evermann) and farther north, chiefly encountered at medium depths.

6. FAM. COTTIDÆ.

Cottus scorpius (Linnaeus).*Cottus bubalis* (Euphrasen).*Icelus bicornis* (Reinhardt).

Three species belonging to this family are represented in the material, numbering six specimens in all, these being taken, without exception, from the waters near Prince Edward island and Magdalen island.

C. scorpius, No. 33, station 14, one specimen of 10 mm.; station 17, one of 11 mm. This species is found on both sides of the Atlantic, and extends some considerable distance to the northward, as far as Spitzbergen.

According to Jordan and Evermann, it occurs to the southward along the coast as far as Eastport, Maine. In the European waters, *C. scorpius* deposits its egg capsules in midwinter, and the young are subsequently encountered as plankton in the spring. It is noted, however, that in this species, internal fertilization may take place, and that the ova may therefore be in a far advanced stage of development before being spawned; this occurs especially in the northerly waters.

C. bubalis (Euph.) Two specimens from No. 33, station 17—both of 6 mm.—agree very well with the larvæ of *C. bubalis*, and have been ascribed to this species, although Jordan and Evermann regard it as doubtful whether *C. bubalis* occurs on the western side of the Atlantic.

Icelus bicornis (Reinhardt) was taken at Princess station 7 (14 mm.) and another of 10 mm. at No. 33 station 15.

This species is an arctic circumpolar form, penetrating, however, southward along the east coast of America as far as Cape Cod. Both the specimens here taken were found in comparatively shallow water.

7. FAM. AGONIDÆ.

Agonus decagonus (Schneider).

One specimen of 24 mm. was taken by the *Princess* at station 7, and strangely enough, at the surface. *A. decagonus* is otherwise found for the most part at some considerable depth, down to a couple of hundred fathoms, and in very cold water about 6° C. As to its propagation, little is known.

Aspidophoroides monopterygius (Bloch).

One specimen of 15 mm. taken by the *No. 33* at station 21 (C. Gaspé) should probably be referred to this species. In point of habitus, it is very like *Agonus decagonus*, but differs from this in having but one dorsal fin. On the other hand, it has very spinous scales, and differs in this from *A. monopterygius*; possibly, however, this may be a larval character.

8. FAM. BLENNIIDÆ.

Chirolophis sp.

(Plate II, Fig. 8; Table II d.)

Two species belonging to the family Blenniidae were found, of which the one could not be determined with certainty.

This was found (no less than sixty-three specimens) throughout the whole of the gulf St. Lawrence, and out towards the Newfoundland banks. The number of vertebrae, about 13 + 42 or a total of about 55, agrees very well with that of *Chirolophis galerita* (L.) Walb. It differs slightly, however, from this in the shape of the head and intestines, while the pigmentation appears to be of more or less the same character.

It was taken in sizes ranging from 8 to 13 mm. and was most numerous during the time extending to July 15.

Stichæus punctatus (Fabricius).

(Plate II, Fig. 9.)

Of this species, two specimens measuring 30 and 40 mm., respectively, were taken. *Stichæus punctatus* is an arctic fish; it is recorded as penetrating as far southward as Newfoundland. The specimens in question were taken at the surface, station 89 (*Acadia*) i.e., down towards Nova Scotia.

9. FAM. CRYPTACANTHODIDÆ.

Cryptacanthodes maculatus (Storer).

(Plate II, Fig. 10.)

This species was taken in a vertical haul (80 to 0 m.) at the *Princess* station 5. Only one specimen, of 38 mm. Found from Labrador to Long Island sound—but not common. (Jordan and Evermann.)

10. FAM. ANARRHICHADIDÆ.

Anarrhichas latifrons (Steenstrup).

Two specimens of *A. latifrons* were taken, one of 21 mm. in a surface haul (*Princess* station 3) and one of 25 mm. in a vertical haul 125 to 25 m. (*Acadia* station 35). These were so far developed as to be distinguishable by the position of the vomerine teeth. An arctic fish, extending southward along the east coast of America to Banquerean.

11. FAM. CALLIONYMIDÆ.

Callionymus sp.

A fish larva of 6 mm. taken in a vertical haul 150 to 0 m. *Acadia* station 44, strongly resembles the European *Callionymus* species, but lacks the notochord otherwise so prominent in these species. The formation of the fin rays, however, was so far advanced that possibly the notochord may have been reduced.

12. FAM. CYCLOPTERIDÆ.

Liparis sp.

Liparis major (Gill).

(Table IIc.)

Of the Liparidæ taken, three specimens from No. 33 station 57 were ascribed to *Liparis major* (vide Jordan and Evermann). They had a total length of 25 to 30 mm., but were not in good preservation, and the determination is therefore somewhat uncertain. *L. major* is an arctic fish, extending from the White sea to Greenland, but, has, according to Jordan and Evermann, not been encountered on the coast of America.

The remaining Liparidæ it was found impossible to determine as to species; in all, sixteen were taken on all cruises.

13. FAM. PLEURONECTIDÆ.

Pleuronectidæ do not occur in any great number in the material, with the exception of *Drepanopsetta*. There are, however, on the coasts of America, many species of flounder whose eggs and larval stages have not been described, that on this point, more especially as regards the ova, errors may have occurred in the determination.

The larvae recorded under the different species are so like the European that, as a rule, there was no difficulty in deciding; several species, moreover, have been figured. If we consider, however, the insignificant number of unknown flounder larvae (of which part could not be determined owing to accidents in the preservation) it would hardly seem likely that any great number of unknown eggs would be liable to confusion with other species. Of unknown Pleuronectidae the following were taken:—

		Length.
Acadia station 4, 150—0 m l	Pleuronectes?	5 mm.
" " 38, 100—0 m l	"	6 "
No. "33" station 39, vertical 1	"	4 "
No. "33" station 49, vertical 6	"	6-7 6-7 6-7 "

To these should be added one specimen of 4 mm. length from the *Princess* station 18; probably belonging to the genus *Bothus*.

P. limanda (?) L.

A quantity of ova of this species was found on the first and second cruises of the *Acadia* (above the banks off Nova Scotia and Newfoundland).

Station	At Surface.	In Vertical Hauls.
29	5 eggs.	5
30	3 "	8
36	1 "	
61	5 "	
62	42 "	
80	2 "	
82		

The diameter of the eggs was about 0.9 mm. and the embryos revealed typical Pleuronectid characters, though none were so far advanced as to permit of their being ascribed with certainty to *P. limanda*; they undoubtedly belong, however, to a closely related form.

According to Jordan and Evermann, this species also is stated as apparently not found off the coasts of North America.

P. microcephalus (Donovan) = *Microstomuskilt* (Walbaum).

At *Acadia* station 84, a larva of 6 mm., taken in a surface haul, must be referred to this species.

P. (Glyptocephalus) cynoglossus L.

(Plate II, Fig. 11)

Of this species, the following specimens were taken:—

<i>Princess</i> station 34—Oblique: 1: ca. 6 mm.
" " 49—Surface: 2: 8-10 mm.
" " 50—40-0: 1: 7 mm.
<i>Acadia</i> " 83—Surface: 4: 6-8 mm.

There were thus taken eight larvae in all, but eggs of this species were not found; these probably did occur in the samples, but must then in some way have been overlooked. *P. cynoglossus* spawns in European waters from May to September; the ova have a diameter of 1.07 to 1.25 mm., and are otherwise distinguishable by their slightly tri-ped structure.

P. cynoglossus belongs to the North Atlantic; on the American side it extends as far as Cape Cod; lives in comparatively deep water, preferably with sandy bottom.

Ancylosetta (*Notosema* sp.)

(Plate II, Fig. 12.)

A specimen of 7 mm. from Acadia station 44 (surface). Belongs to the warm seas.

Drepanopsetta (*Hippoglossoides*) *platessoides* (Fabricius).

(Plate II, Figs. 13, 14, 15; Table III.)

Fig. 11.

Fig. 12.

Fig. 13.

Eggs and larvae of *Drepanopsetta* have a wide distribution, especially over the banks. The ova are very often found together with cod eggs, and were especially numerous on the first cruises.

June 9 to June 15, <i>Princess</i>	I	gave 609 eggs + 5 larvae.
August 2 to August 12, <i>Princess</i>	II	" 1 " + 7 "
May 25 to June 4, <i>Acadia</i>	I	" 1,952 " + 7 "
July 21 to July 29, <i>Acadia</i>	II	" 35 " + 28 "

To these should be added the hauls made by the *No. 33*, which contain ova of *Drepanopsetta* in considerable quantities until July 10. The spawning time must thus be regarded as over by middle of July, which is somewhat late in comparison with the European waters. (In the North sea, spawning takes place from January to May.) The ova of *Drepanopsetta* are very easily distinguishable by the large perivitelline cavity, and by their considerable size.

Measurements from the *No. 33* station 16 give the following numbers of eggs for each size (diameter in mm.) :—

2.1 mm.	1
2.2 "	3
2.3 "	10
2.4 "	1
2.5 "	7

As will be seen from the above, the diameter varies up to 4/10 mm.

Larvæ of *Drepanopsetta* were found especially on the cruises of the *Acadia* and *Princess* in July-August; they occur but sparsely, save at stations 81 and 83 (Newfoundland banks), where they were more numerous. The length of the larvæ varied between 5 and 20 mm.

Distinction is made between two forms of *Drepanopsetta*; *D. platessoides*, the more arctic, which also extends down along the coast of America, and *D. limandoides*, the European form.

Drepanopsetta lives preferably on sandy bottom, on the banks, but can also, at certain times of the year, move down into the deep water of the channels, where it then lives on soft bottom.

11. FISH GADIDÆ.

Gadus aglefinus (Linnaeus).

Gadus callarias (Linnaeus).

Onos sp.

Onos cimbrius (Linnaeus).

Merluccius merluccius (Linnaeus).

(Plate III, Figs. 16 to 22; Table IIg to III.)

The gadoids play the most important part in the material collected; ova and young of this family were found in all the areas examined and on all the cruises made. On consulting the chart, however, it will at once be noticed that the different species have each their own area of distribution, and only occasionally overlap.

The ova of cod and haddock cannot be distinguished one from another with full certainty in the earlier stages. True, those of the haddock are, as a rule, some tenths of a millimetre larger than those of the cod, but both species vary so greatly as to overlap in this respect. I have, however, always counted such eggs as could be determined with certainty (i.e. those with developed embryo) in each sample, on the basis of which it is justifiable to reckon the proportion between the two species, also as regards the earlier stages, at any rate with a considerable degree of exactitude.

DIAMETERS in millimetres for Eggs belonging to the genus *Gadus*, from different Canadian localities.

	May 30.	June 9.	June 11.	June 15.	August 4.	August 5.
	"Acadia" Sta. 6.	"33" Sta. 10.	"Princess" Sta. 10.	"Princess" Sta. 26.	"Princess" Sta. 31.	"Princess" Sta. 36.
	<i>Gadus</i> sp. ^a <i>G. aglefinus</i>	<i>Gadus</i> sp.	<i>Gadus</i> sp.	<i>Gadus</i> sp.	<i>Gadus</i> sp. ^a <i>G. callarias</i>	<i>Gadus</i> sp.
mm.						
1.15	...	...	...	...	1	1
1.20	1	1	...	1	4	2
1.25	14	4	1	...	35	21
1.30	23	7	6	10	13	27
1.35	28	10	7	9	44	18
1.40	33	15	6	5	41	9
1.45	8	1	2	...	6	...
1.50	4	...	...	...	1	...

^a With diagnostic pigmentation of the species.

As will be seen from the table, the ova of cod and haddock have a diameter of 1.15 to 1.50 mm.; a number of safely determinable cod eggs 1.25 to 1.35, and haddock eggs 1.30 to 1.45 mm.

With regard to the pigmentation, the larvae of cod should most properly be taken as belonging to the type described by Schmidt from the southern part of the North sea; it may perhaps be designed as a warm-water type, with extremely faint pigment. *Vide* fig. 17, and, for comparison, also fig. 16, which shows a more northerly type. As no larva of this type was available suitable for illustration purposes in the material, one from Norway has here been used.

On looking through the tables, we find a single haddock egg in the gulf of St. Lawrence, and no haddock larvae; the material from here can therefore, practically speaking, be taken as belonging to *Gadus callarias*.

Fig. 14.

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Fig. 15.

Fig. 16.

Only on the cruises of the *Acadia* arose any risk of confusion with haddock, and here, more especially in the case of the southerly stations, where examples of haddock ova were in the majority.

The charts show very distinctly the distribution of the cod eggs. We find them always over the banks, and as a rule in greatest numbers where the banks shelve down, but never distributed over great depths.

Cod larvae occur very sparsely; only on the Newfoundland banks have we at Station 83 a fairly good yield of 216, the sizes here varying between 3 and 10 mm. and ranging for the greater part between 4 and 6 mm., i.e., comparatively newly emerged fry.

Haddock larvae were found only on the cruises of the *Acadia*, especially the second, off Nova Scotia and on the Newfoundland banks. They are very few in number; only sixteen for both cruises together. The size varied between 3 and 15 mm.

Cod and haddock have, as we know, a very wide area of distribution in the northern hemisphere. The haddock ranges from the bay of Biscay as far as Spitzbergen; on the American side, where, by the way, it is not so numerous, down to Cape Hatteras.

In European waters, the haddock spawn from January to June

The cod has more or less the same distribution as the haddock, penetrating, however, also down into the Pacific. It spawns at the same time. Spawning has,

moreover, been recorded in August on a single bank of the North sea. The spawning takes place for the most part on the banks, where the temperature keeps at about 4° C., and it is generally supposed that the cod, for this reason, move down from the Polar seas to the southward, in order to spawn on the Norwegian coastal banks about Lofoten, which are washed by the temperate waters of the Gulf Stream. Cod held in captivity seldom spawn in water below 2° C.

The spawning in Canadian waters evidently extends over a very long period. On the first cruises of the *Acadia* and *Princess*, May 29 to June 16, free larvæ of cod were found, while on the last cruises, July 21 to August 12, ova were still obtained in early stages. This is doubtless due to the extraordinary conditions of temperature in these waters.

Of the *Onos* eggs and larvæ, most no doubt, belong to *O. cimbrius*, Plate III, figs. 21 to 22, but as pigmentation, especially of the larvæ, varies somewhat, I could not feel certain that all belonged to this species. A number of *Onos* eggs from the *Acadia* captures certainly belong to another species.

Fig. 17.

Fig. 18.

Fig. 19.

The diameter of the eggs is between 0.8 and 0.9 mm. as regards those from the gulf of St. Lawrence. At the *Acadia* Station 47, however, the diameter was 0.70 to 0.75 mm.

Onos cimbrius is widely distributed both in European and American waters. It does not, however, penetrate so far to the northward as the cod; lives mainly on soft bottom in fairly deep water, near the coast. It spawns more especially in May (Europe).

As regards its distribution in the gulf of St. Lawrence we notice that it is especially numerous about Prince Edward Island and towards Anticosti; always close to land or above the more shallow banks.

Ova of *Merluccius* were found in considerable quantities on the second cruise of the *Acadia*, especially above the banks off Nova Scotia.

Fig. 20.

A number of measurements made give the following results:—

0.750 mm	6 eggs.
0.750 "	28 "
1.000 "	5 "

Merluccius merluccius is not noted in Jordan and Evermann's "Fishes of North America." The ova, however, certainly agree very well with the European form. Larvæ of this species were not found, but some few eggs in a fairly advanced state of development.

Of the American forms, *M. bilinearis* (Mitchill) is the species most closely resembling the European, and the ova should probably be ascribed to this species.

In European waters, *Merluccius* is of very common occurrence in the Mediterranean and off the coasts of England; it extends, however, up as far as Norway and Iceland.

In the Mediterranean, it spawns in the spring months; in the more northerly waters, during summer.

15. FAM. AMMODYTIDÆ.

Ammodytes tobianus (Linnaeus).

(Plate III, Figs. 23 and 24; Table IIj.)

A. tobianus was found in greatest numbers on the first cruise of the *Acadia*, eighty-nine specimens being secured.

The second cruise of the *Acadia*, the cruise of *No. 33*, and the first cruise of the *Princess*, furnished together only thirteen specimens; the second cruise of the *Princess*, none.

It would seem to be found especially above the banks, but has also occasionally been encountered over the deep channels, and closer in to land. The length varies from 7 to 25 mm, the different sizes apparently occurring together.

A. tobianus has a wide European area of distribution, extending from Spain to Finnmarken, the White sea, Iceland, and Greenland.

It is probably identical with *A. americanus*, DeKay, which species, according to Jordan and Evermann, ranges from Newfoundland to Cape Hatteras.

The European form spawns in the autumn at about 20 metres depth, where the ova are attached to grains of sand.

The eggs may be hatched during the course of the winter; not until spring, however, are the larvæ found in any considerable numbers among the plankton, where they are then often encountered in enormous quantities.

16. FAM. TETRAGONURIDÆ.

Tetragonurus curieri (Risso).

(Plate III, Fig. 25.)

One specimen of this Atlantic species, measuring 76 mm, was taken at *Acadia* station 56; (210 to 140 fathoms).

T. curieri is especially numerous in the Mediterranean and adjacent portions of the Atlantic; according to Jordan and Evermann, it has only once previously been taken off the coast of America. It keeps chiefly to deep water, feeds on medusæ, and its flesh is said to be highly poisonous.

17. FAM. GASTEROSTEIDÆ.

Gasterosteus aculeatus (Linnaeus),
= *G. bispinosus* (Walbaum).

The three specimens of this species taken would seem to be full-grown, living pelagically in the neighbourhood of land.

Their total length was 65, 44, and 38 mm. they were taken in surface hauls, at Princess stations 28 and 29, and No. 33 station 13.

G. aculeatus has an extraordinarily wide area of distribution in the northern hemisphere, and is found down along the coast of America as far as New York. It also penetrates up into the rivers.

18. FAM. SALMONIDÆ.

Mallothus villosus (Müller).

(Plate III, Figs 26 and 27; Table II k)

Fig. 21.

This arctic circumpolar species often occurs in great numbers down towards Finnmarken and Newfoundland. In North America waters it is found as far down as Cape Cod.

In Norwegian waters, it spawns along the coast from April to June, depositing its eggs in great quantities, chiefly on sandy bottom, at depths to about 100 metres.

The newly emerged larva is about 7 mm. long. Of *M. villosus*, a considerable number were collected, especially around the coasts of Newfoundland; it occurs more sparsely out towards Labrador and down in the direction of Prince Edward Island.

The size of the larva varies between 7 and 42 mm., the great majority, however, being between 10 and 20 mm.

19. FAM. STOMIATIDÆ.

Stomias boa (Risso).

Cyclothone sp.

Stomias boa (one specimen of 30 mm. taken at the surface, *Acadia* station 49) is a cosmopolite, belonging to the warm seas of the world.

Of *Cyclothone*, five specimens were taken, ranging from 7 to 16 mm.; these were not determined as to species.

Two specimens from the surface, 8 to 16 mm. *Acadia* station 16.

Three specimens, vertical haul, 200 to 0, 7-8 and 10 mm., *Acadia* station 13.

The genus *Cyclothone* comprises several bathypelagic species from various warm and temperate seas of the world.

20. FAM. SCOPELIDÆ.

Scopelus sp.

Omosudius elongatus (A. Brauer).

Myctophum glaciale (Reinhardt).

M. boreali (Coeco).

M. punctatum (Rafinesque).

M. humboldti (Risso).

(TABLE III)

Fig. 22.

A large number of *Scopelidae* were taken at the outermost Acadia stations. It was found impossible to determine species in the majority of examples, the preservation being frequently imperfect. *Omosudis elongatus* was taken at three of the Acadia stations.

Station 16.....	200—0 m. 2 species 25 to 36 mm.
" 57.....	150—50 fms. 1 species 105 mm.
" 75.....	180—0 fms. 1 species 45 mm.

This species belongs to the warmer portions of the Atlantic and Pacific.

M. glaciale (one specimen of 15 mm. from Acadia station 45, 150 to 0 m.) This species is of common occurrence on the east coast of America, but is also found throught the whole of the North Atlantic. Also taken off the coast of Greenland.

M. benoiti, one specimen, 15 mm., from Acadia station 16 (surface haul). Belongs chiefly to the warm Atlantic waters; also penetrating into the Mediterranean.

M. punctatum, one specimen, 23 mm., from Acadia station 16, 200—0 m.

This species has frequently been taken up towards Newfoundland. (A Brauer.)

M. humboldti, one specimen, 31 mm., from Acadia station 11 (surface haul).

Found in all warm seas

III. DISTRIBUTION OF EGGS AND YOUNG IN THE WATERS INVESTIGATED.

It is a well-known fact that certain species have their more or less definite spawning grounds, or, at any rate, are to be found during the spawning season, at places where certain physical conditions prevail, these conditions being, presumably, such as are best adapted to the propagation of the species in question.

When spawning, our most important food fish assemble upon grounds of restricted area, where they can not only tolerate in the greatest number; it is therefore of considerable importance, for the fisheries, to ascertain the position and extent of such grounds. This may be done by netting experimental hauls to secure the spawning fish, or, far more easily, by plankton hauls, from the results of which it will be seen where the newly spawned eggs and young are to be found, whence we can determine the locality of the spawning grounds. This latter method has been largely employed in the international investigations in European waters, and has led to the charting of the spawning grounds of the different species.

If we now consider the results of the various cruises in Canadian waters, it may be seen that the eggs and young of each species have one or more principal areas of distribution, diminishing in frequency to either side of such areas; further, that certain species generally occur together, others again being invariably found apart.

This distribution is dependent upon the different circumstances under which the fish spawn, and we shall see that each species is always encountered under certain conditions, wherefore a certain degree of regularity may be shown to exist in their occurrence. The eggs and young of littoral fish are found close to land, or over the shallow banks; the banks have their own particular young-fish fauna, and the deeper waters, again, theirs. To these must be added a fourth group, to wit, that of the pelagic species, such as the mackerel; in the case of these, the question of depth is less important, and their eggs may therefore be found scattered throughout all areas, so that they may be taken together with the卵 of the three first groups. An interesting phenomenon, however, is the fact that both eggs and young of practically all our principal species of fish have a pelagic stage, during which they are to be found near the surface, without regard to whether they were spawned there or at greater depths. In the case of most species, both eggs and young are so balanced as to float in ordinary sea water, and when spawned deep down will, owing to their own buoyancy, rise to the surface, where their development then proceeds. The young will thereafter, as their growth advances, again move down to greater depths, or in towards land, passing from a pelagic habit of life to a more or less pronounced bottom stage.

A. THE GULF OF ST. LAWRENCE.

The various cruises furnish a number of instances showing how the character of the fauna changes as we pass from the vicinity of the coast outwards, or from colder to warmer waters, and *vice versa*.

As already mentioned, the gulf St. Lawrence was investigated by the *Princess*, June 9 to June 15 and August 3 to August 12, with some occasional work done by the *N. J. 33* from June 1 to August 18; this latter cruise may be disregarded in the present chapter, both on account of the length of time covered, and also because the voyage was not planned according to the special lines of our present purpose. The route followed on such cruises is, it should be noted, of great importance both for the investigation of the different localities, and also for the collective survey of the waters as a whole.

The cruises of the *Princess* (vide chart, p. 4) both proceeded from Prince Edward Island over to the eastern point of Newfoundland, continuing up to Labrador, and thence eastward to Newfoundland, then following the coast southward, past Cape Breton, and back to Prince Edward Island. Glancing now at the hauls made at the different

stations, we find close to land (stations 3 and 4) very few larvae; only one or two specimens of the arctic species *Anarhichas latirostris* and *Mallotus villosus*; moving out over the banks, we encounter *Drepanopselta* and *Codax callarius*, with some few ova of *Onos cluibrinus*, besides some arctic fish, viz., *Ichthys bicornis* and *Aygonus decagonus*. At station 9, near the edge, *G. callarius* and *Drepanopselta* are again less numerous; we find, however, instead, the young of *Sebastes marinus*. Stations 10, 11 and 12 above banks east of Anticosti reveal once more a true bank fauna, *Drepanopselta* and *G. callarius*.

Stations 13 and 14, up towards Labrador, furnished but a poor yield; the stations nearer Newfoundland, however, are again seen to be rich in eggs of *Drepanopselta* and *G. callarius*, with some few *Sebastes* in the vicinity of the deeper channels. Here, on the slope towards Newfoundland, lie the richest stations of the whole cruise; stations 17 and 18, for instance, furnished each over 1,000 cod eggs in surface hauls alone, besides a considerable number of *Drepanopselta* ova. Moving southward along the coast, the hauls are still rich as regards these species, and at station 19, close in to land, we encounter, for the first time, ova of the southerly form *Chenolabrus adspersus*. Above the deep channel in Cabot Strait, *Sebastes* predominated. Not until station 21 is reached do we again meet with the banks fauna, *G. callarius* and *Drepanopselta*, which are thenceforward of common occurrence throughout the remainder of the cruise back to Prince Edward Island. The last stations, south of Cabot strait, also furnished quite a respectable yield of newly-spawned mackerel eggs, which was not a little surprising in view of the fact that the hauls made but a few days previously on the opposite side of Prince Edward Island had yielded nothing but more or less arctic species.

The August cruise of the *Princess* (vide chart, p. 4) covered, roughly speaking, the same ground as the first. Close in to land, the yield consisted mainly of eggs and young of *Onos* and *Chenolabrus*, until we reach the banks, when cod and mackerel make their appearance. These latter increased in numbers as the outward voyage proceeded, the *Onos* and *Chenolabrus* gradually disappearing. Above the deep channel, *Sebastes* predominated; some few mackerel larvae were also found. On the Anticosti bank, we find cod eggs once more, and the same alternation of cod above the banks, *Sebastes* over the channels, is continued all the rest of the way to Newfoundland, and thence southward to Prince Edward Island. Station 15, however, near the southwest point of Newfoundland, also furnished a rich yield of the arctic species *Mallotus villosus*, evidently indicating the existence of a cold current near at hand; on the southern side of Cabot strait, however, eggs of mackerel and *Chenolabrus* were again encountered.

As will be seen from the foregoing, the gulf of St. Lawrence may be divided up into several zones, each with its own characteristic young-fish fauna. In the first place, a line drawn from Cabot strait to Anticosti will form the northern limit of occurrence for the southern forms found in the gulf, such as mackerel, *Onos* and *Chenolabrus*. Only at one or two of the more southerly stations situated near the coast of Newfoundland were some few specimens of these species found.

Northern species, however, may also be found south of this line, occurring more particularly in the southwestern portion of the gulf, west of the Magdalen islands. For the rest, the character of the young fauna varies with the depth; we find *Chenolabrus* and *Onos* near land, and close to quite shallow banks the bank forms consisting of *G. callarius* and *Drepanopselta*, while above the deep channels *Sebastes* is found. The mackerel, again, is encountered throughout all areas, subject to the restriction noted above.

B. THE WATERS OUTSIDE NOVA SCOTIA AND THE NEWFOUNDLAND BANKS

The cruises of the *Acadia* (vide chart, p. 4) reveal a similar grouping of the different species, according to depth, distance from land, and geographical position.

On the May cruise, the stations from Halifax out over the banks past Sable Island yielded eggs of cod and haddock, several species of flounder, *Ammodytes*, and a very small number of *Ulenolabrus* above the shallower grounds near Sable Island. Outside the banks we find *Sebastes*, but farther out again the yield becomes extremely poor until the outermost station (station 16), where a number of pelagic Atlantic forms were found. On reaching the Newfoundland banks, we find once more cod, *Ulenolabrus* and *Ammodytes*; above the deeper portions towards Cape Breton and Cabot strait, *Sebastes* is of more or less frequent occurrence.

The second cruise of the *Acadia* shows small yields at the start, off the southern point of Nova Scotia; strangely enough, however, we here find *Sebastes* at comparatively slight depths. This is probably connected with the fact that *Sebastes* in these southern waters (Bay of Fundy and New England waters) spawns in more or less shallow water. On the slopes, where the depth increases, we find numerous eggs of *Merluccius*; farther out, the Scopelidae play a more prominent part. Ova of cod and haddock are now but sparsely found at all stations outside Nova Scotia; on the Newfoundland banks, however, they are once more encountered in great numbers, stations 81 to 83 being particularly rich. Eggs of *Ulenolabrus* also are fairly numerous here, while the arctic capelin bears witness to the vicinity of the polar current. From the banks over to Cape Breton, *Sebastes* is again more frequently found, *Oncos* (hardly however, *Oncos imberbis*) only in very small quantities, *Ulenolabrus* only at station 91, quite close to land. We see, then, that in this area, likewise, distinction may be made between several different kinds of fauna. Up towards Newfoundland, we have—according to European terms—eggs and young of boreo-arctic fish, on the banks off Nova Scotia a boreal bank fauna, while out over the great depths, especially to the southward, the Atlantic species predominate.

On comparing the stock of young in these two areas; the gulf, and the waters outside Nova Scotia, we find that the gulf should most properly be regarded as a coastal water, where littoral and coastal forms are found in great numbers; we find the usual high degree of variation in temperature between summer and winter, with corresponding variation in the fauna between northern and southern forms; purely Atlantic species, however, do not appear in the hauls.

An interesting feature, by the way, is the fact that the mackerel is not represented at all in the *Acadia* material (but few eggs on the first cruise); while the greater portion of the *Ammodytes* taken during the investigations was furnished by the *Acadia*. It is remarkable also, that none of the cruises furnished a single herring larva, despite the fact that the herring occurs in nearly every part of the areas investigated.

IV. BIOLOGICAL CONDITIONS.

Modern marine research has shown us that life in the sea is to a high degree dependant upon hydrographical conditions: current, temperature, and salinity. We should, therefore, in seeking to explain the peculiar phenomena encountered with regard to the propagation of the fish in Canadian waters, base such endeavours upon the hydrographical data furnished by the expedition. These are, however, not yet compiled, in order and completeness, and we must for the present content ourselves with recalling the more prominent features. It will be obvious from the outset that an area subjected to such markedly contrasted influences as those of the Labrador current and the Gulf Stream must present many remarkable features both as regards fauna and biology, and it is only by bearing in mind the peculiar hydrographical conditions that we can explain the otherwise surprising data furnished by the Canadian Hydrographical Expedition with regard to the propagation of the most important species. On comparing the Canadian with the European waters in this respect, several peculiarities will at once be noticed, especially the pronounced transposition and extension of the spawning season, which here takes place in the case of several

species, among those pre-eminently which on the eastern side of the Atlantic are counted as spring-spawners. A prominent example is that of the cod (in addition to haddock and *Drepanopsetta*) which spawns in considerable numbers in the gulf of St. Lawrence right on into the month of August, whereas in the Norwegian waters, its spawning is over in May. As a consequence of this, we may, in the gulf of St. Lawrence, find one and the same plankton haul to contain both newly-spawned cod eggs and newly-hatched mackerel young.

That cod and mackerel should find suitable spawning conditions in the same water and at the same time is remarkable indeed; in European waters, the spawning of these two species differs widely, both as regards time and place. What is more, it is only exceptionally that the mackerel come so far north as to touch the principal spawning grounds of the cod at all. The explanation may not unnaturally be imagined to lie in the abrupt changes of temperature encountered in the Canadian waters. The same natural conditions, which cause Atlantic warm-water forms to meet, off the coasts of Newfoundland, with representatives of the arctic fauna, might well account for the fact that in the gulf of St. Lawrence, the cod of the far north are able to live and propagate there simultaneously with the more southerly mackerel. If we take a temperature series from the surface downwards in the gulf of St. Lawrence during summer, we find, within a vertical range of less than 100 metres, a difference in temperature equivalent to that one entered outside Newfoundland by sailing from the Gulf Stream over into the Labrador current, while on the eastern side of the Atlantic, such difference will involve a distance as from the North Sea to Spitzbergen.

In the gulf of St. Lawrence, then, we find the different water layers varying so greatly in temperature as to offer favourable conditions here for cod and mackerel. That both species should live in the same stratum there is no reason to believe; on the contrary, it must be presumed either that the one or the other is able to seek out the more suitable water layer, or that it is, also, less favourable, or that they are, owing to certain biological features, more or less passively led to frequent such strata as are by nature best adapted to their needs.

It is a well-known fact that certain species of fish, such as cod, herring, and mackerel, vary their habitual position to some extent in the water. Cod and herring now at times move to shallower waters in deep water, and in the southern Norwegian waters the mackerel is known to move farther towards the coast until the surface temperature is about 10°C. It has, however, generally been recognized that some of the drift-net fishermen even vary with the seasons, in order to be sure of not lying out their nets in a cold current.

Among the biological features which must be taken into account in this direction, we should first of all remember that the cod is a bottom fish, belonging essentially to the stratum near the surface, where its food is found, and where its spawning takes place. The mackerel, on the other hand, is a pelagic species, frequenting, at any rate during the spawning season, the upper water layers. Indeed, until the ice is spun, the mackerel hardly seems able to penetrate down beyond some 20 metres depth.

On glancing at a temperature series from the *Princess* station 39, where ova of cod and mackerel were found in one and the same sample, the phenomenon will easily be explained.

0 m	10° 1	20° 27
10 "	15° 7	20° 23
25 "	10° 52	21° 97
40 "	7° 62	22° 99
50 "	5° 57	23° 97
60 "	6° 452	25° 40

If we now apply to these figures what we know of the biology of the cod and mackerel, it will be justifiable to conclude that the mackerel keep to the upper layers — down to about 25 m. — where the temperature is favourable to its needs, while the cod seek the lower strata, finding there more suitable conditions in this respect.

The yield of cod and mackerel eggs at this station gives the following numbers:—

	Cod.	Mackerel.
At surface,	3 eggs.	172 eggs, 14 larvae.
" 20.0 metres,	12 "	8 " 3 "
" 60.0 "	25 "	1 "

Mackerel eggs and young are by far most numerous at the surface (in the horizontal hauls) the cod eggs, on the other hand, being found in greatest numbers farther down (vertical hauls). Naturally, however, this cannot be taken as indicating that the mackerel eggs were spawned near the surface, and the cod eggs lower down. The vertical position of fish ova in the layers is determined by the specific gravity of the former as compared with that of the water, and they will, under normal conditions, be found in water of specific gravity equal to their own. The specific gravity of ova, however, is not a constant magnitude; that of cod eggs, for instance, which normally varies but very slightly, may be affected by a low degree of salinity in the water, which has the effect of gradually reducing the weight of the eggs. If exposed to strong sunlight, again, or to comparatively high temperature, they will sink, even in water of high salinity; and the same applies to newly hatched young. This last is a very well-known phenomenon in marine hatcheries; I am, however, unable to give any definite figures, having had no opportunity this season of making experiments in this direction.

The specific gravity and variation of same—in cod eggs at Flödevigen will be seen from the following experiments (Dahl & Dannevig; Undersökelse over nyttan av Torskutækningi Ostlandske fjorde, Bil. 1, p. 28).

The roe and young were placed in three separate receptacles in order to determine their approximate specific gravity.

- I. Sp. gr. 1.019 at + 5.4° (sp. gr. *in situ*, 1.01796).
Ova, about one-third floating, others suspended, the remainder at the bottom.
Young, most at bottom, some suspended and at surface.
- II. Sp. gr. 1.020 at + 5.4° (sp. gr. *in situ*, 1.01897).
Ova, more than half floating, the remainder at the bottom or suspended.
Young, about half floating, the rest at bottom or in suspension.
- III. Sp. gr. 1.022 at + 5.4° (sp. gr. *in situ*, 1.020965).
Ova, practically all floating.
Young, practically all floating.

Station 30, above-mentioned, the specific gravity of the water near the surface oscillates about the value for specific gravity of cod eggs as noted in Norway; we might therefore have expected to find a greater number of ova at the surface. That this was not the case should possibly be ascribed to the influence of the high temperatures there prevailing.

We find, then, that the simultaneous spawning of cod and mackerel in one and the same water may be explained as due to conditions of temperature. And consequently, we cannot, in Canadian waters, distinguish between winter and spring-spawning fish, as is generally done in Europe; if any such biological distinction is to be made, it must be based upon the limits of temperature between which spawning takes place, a method which would of course be equally justifiable on the eastern side of the Atlantic.

The question arises, however, whether the temperature of the water really does exert such influence upon the spawning of the fish; whether other causes might not be imagined, and the explanation above suggested be found insufficient.

In this connection, it will be natural to recall the annual periodicity in the development of the sexual organs, which might be supposed to proceed independently of all external factors. It has, however, repeatedly been found, by investigation in

other spheres, that where regularity of the seasonally varying physical conditions in animals or plants ceases, the annual period disappears, or becomes irregular and indistinct.

The influence of temperature upon the daily intensity of the spawning may easily be observed in a hatchery, at any rate where a spawning basin is employed. Also the degree to which spawning depends upon temperature is in particular most easily noticeable where the latter factor ranges between 0° and 15°, to a lesser extent when between 15° and 20°. Other influences may make themselves felt, for instance of the amount and more or less regular distribution of the food, fish spawning largely when well fed. This may, however, possibly be due to purely physical conditions, at any rate, as long as the amount of food consumed is sufficient for nourishment, as the expansion of the stomach will exert a pressure upon the ovaries. Furthermore, the salinity of the water may be supposed to have some effect though this will scarcely be of any importance as long as the variation involved is not too great.

FIG. 23.

The curves here shown are based upon daily observations at the hatchery of Flödevigen during the spring of 1909, and indicate the fluctuations in temperature and spawning throughout the essential part of the spawning time. In order to present the clearest possible survey, I have here marked off, not the daily values, which vary considerably, but a mean value calculated each day from the observations of that date plus those of the two previous and the two subsequent days, i.e. a movable mean extending over five days.

V.—POSSIBILITIES OF DEVELOPMENT, AND RELATIVE FREQUENCY OF THE DIFFERENT STAGES.

In the foregoing chapters, we have dealt with the spawning of the different species in relation to depth, temperature and season. It now remains to consider how the development of the eggs in the separate species takes place, and what chances there are for their being hatched.

From the figures in table II, we obtain the following numbers of eggs and larvae for the six most commonly occurring species:—

	Ova	Larvæ
<i>Clupeoides</i>	434	318
<i>Scomber</i>	5,575	47
<i>Drepanopsitta</i>	2,369	47
<i>Gadus callarias</i> and <i>G. aeglefinus</i>	15,988	293
<i>Otos</i>	2,975	92
<i>Merluccius</i>	8,821	0

It will be seen that the gadoids here predominate, and among these, as we have already seen, the cod is of most frequent occurrence. Ova of *Merluccius* are also very

numerous, but the material of these is of a somewhat casual character, being derived from only a few stations, where they must, however, have been present in great numbers.

The proportion between ova and young varies greatly; in the case of *Utenolabrus*, we have nearly as many larvae as eggs while of *Merluccius*, on the other hand, only eggs were found.

Such a table cannot, however, be used without reserve as a means of calculating the percentage hatched for the different species; the period of time required for development of the ova will need to be taken into consideration, as also the age of the young when captured. With most species it is true these points are insufficiently known, but in the case of the cod we have knowledge sufficient for a satisfactory discussion of the question despite the difficulties involved in following the development of ova under natural conditions.

We know, of course, that the destruction of cod eggs and of the early stages of young must be enormous; were this not so, the sea would soon become over-populated with cod. As to the particular stage of development at which the germ is especially liable to destruction, however, we know, unfortunately, all too little.

Professor Apstein has, in his work entitled "Die Verbreitung der pelagischen Fischeier und Larven in der Beltsee und den angrenzenden Meeresteilen," 1908-09, dealt with these questions, and calculated that 72 cod eggs are required to produce one larva. This applies, of course, only to the waters investigated by him, and similarly, here only for a single year.

THE CANADIAN WATERS.

During the actual collection of the material, Dr. Hjort already noticed that there was a very great majority of newly spawned eggs, the later stages of development, and the larvae, being far more rare. This was especially noticeable on the cruises of the *Princess*. Wishing to go closely into this question, I have, in determining the ova, noted throughout the number of eggs belonging to earlier and later stages; in the smaller samples all the ova were examined, in the case of the larger, only a representative portion was measured off and investigated, the figures thus obtained being then utilized for calculation of values for the whole.

In order to keep the work within a reasonable scope, distinction has here been made between three stages only; the first being the "germinative disc" stage, before the formation of the embryo (figs. 1-2), the second from the early pigmented embryo to well-developed pigmentation (figs. 3-4), and the third with pigmentation characteristic of the species (figs. 5-6). These stages correspond to Apstein's figs. 1-9, 10-18 and 19-22, from which these text figures have been taken.

EMBRYONIC DEVELOPMENT OF EGG OF COD.

This system of division is based on no other principle than that of obtaining, as easily as possible, a survey of the numerical values at the different stages, these last being so selected as to be distinguishable with no great difficulty when slightly magnified, and without regard to whether one stage may be of longer duration than another.

Apstein's tables show, for instance, that my "germinative disc" stage embraces 31 per cent of the total period of development in the ovum; stage II, 46 per cent, and stage III, only 23 per cent.

Taking the material consisting of ead eggs from the cruises of the *Princess* we find, for all hauls made, the following figures:—

	First cruise.	Second cruise.
Stage I	4,315	1,394
" II	749	319
" III	13	33
Larvæ	6	6

We find then, on both cruises, an over-dubbing majority of ova in the early stages. How is this to be explained? Is it to be taken as entirely due to mortality or destruction by some means, or do other factors here exert their influence, rendering the immediate impression produced by the above incorrect?

As we shall see, a table of this sort should be treated with the greatest caution. The proportion between the different stages is not only dependent, for instance, upon mortality, but also to a high degree upon the time at which the investigations were made; in addition to which, we have also to consider the position of the stations in relation to the spawning grounds.

When the investigations are carried out early in the spawning season, then naturally there will be a very high percentage of newly-spawned ova, and no late stages. Investigations later in the season, on the other hand, will give the opposite result.

A few rich hauls made on the exact spot where spawning takes place will give a different result to that obtained from hauls made out over the greater depths where

the fish do not spawn; the few eggs, found outside the banks, will have been carried thither by the current, and the longer they have been adrift since leaving the spawning grounds, the farther will their development have advanced. On the spawning grounds, therefore, we must expect to find newly-spawned eggs in the majority; outside these localities, the later stages will predominate.

The investigations in the gulf of St. Lawrence are, however, to a very great extent free from these sources of error. It will be seen from the table that the spawning was in full progress during the first cruise of the *Princess* in June, and that so few late stages were found, may be explained as due to the fact of the hauls in question being made comparatively early in the season. On the August cruise of the *Princess*, however, this objection is no longer valid; the number of ova has greatly decreased, the season being now nearing its close, and a far greater quantity of eggs in the later stages might have been expected.

On going through the tables for the cruises of the *Princess* it will further be noticed that the proportion between newly-spawned ova and those in the later stages is approximately the same at all stations, only exceptionally do we find the later stages in the majority. No single station is so rich in newly-spawned ova as to exert a dominant influence upon the result as a whole, and there is thus no reason to question the representative value of the material on this head.

As regards the number of larvae, this will always be subject to considerable error, as the larvæ are more or less endowed with power of motion, rendering capture more difficult, in addition to which, their age is often difficult to determine. Comparison between ova and young will therefore be subject to greater uncertainty than that between ova at different stages.

One thing we can, however, state with certainty: that the number of larvæ taken in the gulf of St. Lawrence was remarkably small.

In the case of the *Acadia*, the proportion between the different stages is somewhat better; here, however, we must consider cod and haddock together as one, these two species being indistinguishable one from another in the early stages of the ova.

	Acadia I.		Acadia II.	
Stage I	1717		397	
Stage II	2183		197	
Stage III	641	142	431	72
Larvæ	784		291	
Larvæ (cod)	44	5	260	275
Larvæ (haddock)	11		15	

For these cruises, the results are as might have been expected, the May cruise showing a comparatively large number early stages, with some advanced and a few larvæ, while that of July has many later stages and still more larvæ.

Before proceeding to consider the possible explanation of this great difference between the occurrence of early and later stages in the Gulf of St. Lawrence, it may be of interest to compare the conditions in Canadian waters with those observed on the principal spawning grounds of the cod in European waters, viz:—

LOFOTEN.

The material upon which the following discussion will be based consists of but a few samples from the otherwise extensive mass of material collected by Dr. Hjort during the winter and spring of 1913, the remainder having not yet been completely depth with as regards the stage of development of the ova. (Vide also Johan Hjort: Fluctuations in the great Fisheries of Northern Europe.)

The investigations, besides rendering possible a comparison between the wastage per cent in the two waters, further afford an excellent illustration of what has been mentioned in the foregoing as regards the extent to which the respective numerical value of the different stages depends on time and place of sampling.¹

Fig. 25.

By way of illustrating these conditions under varying circumstances, I have chosen a section across the Vestfjord, as marked on the chart, and as the surface hauls (1 m. net, 5 min.) give the greatest amount of material, I have employed these only.

Six stations are noted on the chart, all from April 23 to April 24, 1913, the total number of eel eggs per 5 mins. surface haul being appended in each case. It will be noticed that station 65, on the edge, has a pronounced maximum, with 9,800 eggs in a single haul, after which the number rapidly decreases to either side, as we leave the spot where the principal spawning presumably took place. During the actual investigations it was frequently noted that the greatest numbers of eggs were taken on the fishing grounds themselves, where the fish were most densely congregated. The number diminishes gradually right over towards station 61, on reaching which we again find ourselves near the edge. Here we might thus again have expected to find a maximum; as a matter of fact, however, there was evidently very little spawning, if any, on these grounds. The banks here, by the way, are of very restricted extent, the bottom sloping abruptly down from land to a great depth.

With regard to the proportion between the different stages at each of these stations, we find the following figures (per cent):—

	Station 64	Station 65	Station 66	Station 63	Station 62	Station 61
I.	25	63	32	30	40	28
II.	55	20	53	57	20	16
III.	20	7	15	13	30	26

From this it will be seen that the earliest egg stages are found in the highest proportion at the very places where the total number was greatest; the more advanced

¹ The investigations extended throughout the whole of the spawning season, comprising also both the bank grounds and the greater depths. The same places were, moreover, investigated several times during the season, partly with the closing net, and partly with an ordinary surface net.

stages, on the other hand, being of great relative frequency as the distance from the spawning grounds increases.

Fig. 26.

Station 62 differs slightly from the remainder, inasmuch as we here find a greater number of newly spawned eggs than was to be expected. Evidently, the current must have brought down the newly spawned eggs from the banks southwest of the station. The current at this spot can at times be very strong, and in this very direction. The numbers, however, both at stations 62 and 61, are not sufficiently great to furnish an exact picture of the stock there.

The curve for the later stages (III) shows throughout what might theoretically have been expected, the later stages themselves being proportionately fewest where most eggs were found. The curve rises as we move away from the spawning banks, as far as station 62, falling again over towards the land, thus indicating that we are once more approaching grounds where, in some slight degree, spawning takes place.

As we have seen, the proportion between the different stages varies greatly at different places, even for samples taken on one and the same day; the variation is, however, sufficiently regular to permit of our forming some opinion as to the cause. The example here shown is taken from a locality where the contrast is marked; great quantities of cod spawning within a restricted area, close to the very deep water where cod never spawn, but in which a certain quantity of eggs may be found, having been carried thither by the current. A different state of things would necessarily be encountered where the spawning takes place sparsely over areas of wide extent, especially if forming part of a restricted region of sea; at such places, there would never be the great difference between the relative frequency of the stages at the various stations.

Stations 64-65 and 66 were also previously investigated, viz.: 25/2-12/3 and 29/3. Not until the last-mentioned date however, were cod eggs found in great numbers; the principal spawning was then just commencing. At these three stations (30-31-32) (29/3) we find the following yield for the different stages (here stated in %).

	No.	I.	II.	III.
Station 20 (= Station 64)	23,600	93%	7%	0
Station 31 (= Station 65)	19,400	50%	50%	0
Station 32 (= Station 66)	2,340	25%	75%	0

The principal spawning this time takes place farther in on the banks; we find, however, again the same feature as before noted; where the eggs are found in

greatest numbers, there also the number of those newly spawned is at a maximum, its minimum falling there where the yield as a whole is poorest. We notice, moreover, that advanced stages are not yet present in the samples, this being doubtless due to the fact that the season is only just commencing.

If we now consider the results from Canada in conjunction with this sample from the *Isoteterus* material, we obtain a table for comparison of the stages of development in the eggs from the different waters.

	1906		Atlantic I		Princess I		Atlantic II		Princess II		3337	
	99	100	99	100	99	100	99	100	99	100	99	100
Stage I	62	48	43	35	84	86	52	68	64	84	95	83
Stage II	38	49	56	65	16	14	48	30	36	15	5	11
Stage III	0	3	2	0	0	0	0	2	0	1	0	6

From this it will be seen that the gulf of St. Lawrence is considerably behind the other localities with respect to the occurrence of later stages, both in the case of the earlier investigation and those made subsequently (*Princess I*, *Princess II*, and *Atl. 3337*). The ova have here evidently a far poorer chance of being developed and hatched than in the other places; in the gulf of St. Lawrence the eggs must, at any rate occasionally, be liable to a high degree of mortality, either due to the hydrographical conditions or to their being preyed upon with unusual intensity.

The task of solving this question must be left to future investigations; I may, however, in conclusion, set forth such material as we have available for the consideration of what factors should be regarded as detrimental to the development of cod eggs and the growth of the young.

VI. INFLUENCE OF TEMPERATURE AND SALINITY UPON THE DEVELOPMENT OF EGGS AND GROWTH OF THE YOUNG.

In order to ascertain what effect the low bottom temperatures might possibly have upon the development of the ova in the gulf of St. Lawrence, Dr. Hjort approached Dr. Johansen and Dr. Krogh, of Copenhagen, who had previously at the Zoo physiological Laboratory there, carried out a whole series of experiments with hatching of eggs at constant temperatures, with the request that they would repeat their investigations having the special object at present in view.

We are aware that cod in the gulf of St. Lawrence spawn near the bottom, i.e. in water frequently below 0°; the inherent upward tendency of the ova then lifts them to the water layers above, where they develop at considerably higher temperatures.

Dr. Johansen and Dr. Krogh then commenced experiments with fertilization of ova at low temperatures, from 0° to +2° C., the eggs being thereafter either maintained at various low temperatures or gradually transferred to warmer water, up to 6.6° C.

According to Dr. Johansen, the results showed:—

1. That fertilization can take place at a temperature between +0.6° and +2° C.
2. That full development can be obtained by ova fertilized at such temperature and thereafter exposed for nine days to a temperature between +0.5° C. and +1.4° (mean value +1°), and afterwards transferred to warmer water (e.g. 0° to 3.3° C.).
3. That full development can be attained by ova fertilized at 0° C. and constantly kept in water at that temperature.

The mortality observed in the course of these experiments was considerable; as, however, these were carried out under conditions which in several respects must be less favourable than those prevailing in the sea, we should not, as Dr. Johansen also points out, attach too much weight to this. Even at the most favourable temperatures, the mortality was, in the apparatus employed by Dr. Johansen and Dr. Krogh, still considerable.

Dr. Johansen's experiments show, however, that the low temperature at the bottom in the gulf of St. Lawrence where the cod are to be found during spawning time, cannot be regarded as a general hindrance to the development and hatching of the ova.

With regard to the influence of high temperatures upon the development of the ova, we may refer to the experiments previously made by Johansen and Krogh (The Influence of Temperature and certain other Factors upon the Rate of Development of the Eggs of Fishes; Publications de Circumstance No. 68). These show that cod eggs may be hatched in water up to 12° C. H. C. Dannevig (late Director of Fisheries for Australia) has even hatched them in water at 11° C. Scottish Fishery Board, 13th Report for 1891.)

At Flødevigen, where several hundred million cod eggs are annually hatched, low temperatures (down to 0° C.) the lowest figure at which we have worked never seem to have any detrimental effect; the most favourable temperature would seem to be about 3-5° C., while temperatures up to 8° or 10° occasion a higher degree of mortality. As the quantity of ova in the apparatus is very great, the direct cause of such mortality might possibly be lack of oxygen, or poisoning, despite the fact that the water is constantly renewed.

That the young can thrive at considerably higher temperatures in a greater mass of water is shown by an experiment which I made in the culture-basin at Flødevigen during May and June, 1909. The basin is situated in the open air; it measures 31 by 22 by 5 m. and is used in the hatching operations as a water reservoir for the apparatus. It is supplied with sea water by means of a steam pump, and in order that the water may be constantly renewed, as well as for other reasons, the water for the hatching apparatus is always drawn from here.

On the 25th of May, 1909, the hatching experiments were brought to a close, and the circulation of the water consequently ceased, about 100,000 young cod, from one to two days old, were liberated in the basin. The eggs from which these young were hatched had been spawned at about 7° C., and the development had taken place in the course of about nine days at temperatures between 7.0° and 9.5° C. At the time of liberation, the water in the basin at 3 m. depth had a specific gravity of 1.026 at 9.5° C. The young could now be seen every day in the water, at first near the surface, and later swimming for the most part in great shoals in the intermediate water layers.

On the 16th of June, I noted in my journal that up to fifty young could be counted at one time. On that day also, feeding was commenced with finely chopped *Mytilus edulis*. The water in the basin, by the way, was extremely rich in plankton, especially larvae of molluscs and crustaceans, which, with some few copepods, made up the stomach contents in such of the young fish as were examined. On the same day, the water in the basin had reached a temperature of 20° C. at the surface, with a maximum, at 1 m. of 21.4° C., and a bottom temperature of 21.1° C.

On the 18th of June, eight fish were taken up and measured; they showed the following lengths: 25, 25, 27, 24, 24, 23, 23, 22 mm. The fish were by this time moving nearer the bottom.

The weather now set in colder for a time, with cloudy sky, and the temperature of the water sank somewhat. On the morning of the 21st, the surface showed 18.9° C.; maximum of 19.5° at 2 m. On that day, fresh sea water was pumped in (temperature 8.3° C.) and in the evening, after the surface water had been drawn off, and replaced by a new supply, the surface temperature was 19.1°, this being the maximum, while at 3.4 m. a minimum of 15.7° C. was recorded.

On the 20th June, pumping was renewed, but as the young were considerably fewer, and always at the bottom, the experiment was brought to a close. The temperature of the air had, during the last part of the time, been very high, with sun-shine and slight wind.

This experiment shows therefore that the young can thrive, and even grow very rapidly, at temperatures up to 24° . The increment of growth from May 25, when the length was 3 to 4 mm, until June 18, amounts to about 20 mm, or about 0.8 mm. per day.

From the measurements available for growth of young in a free state, the latter would seem to grow less rapidly, presumably about 0.5 mm. per day.

Among other causes which might be imagined as affecting the development of ova, we may reckon the salinity of the water.

If eel spawn in water of lower salinity than that which corresponds to the specific gravity of the eggs, then these latter will necessarily sink to the bottom and be destroyed. And again, if eggs should by any means be transferred from water of their own specific gravity to considerably fresher water, the mortality here likewise would be very great.

As an illustration of the manner in which fresh water can affect the ova, the following data from an experiment which I carried out in March, 1909, at the hatchery may be quoted.

About twelve hours after fertilization, eggs were distributed in four glasses containing water of different specific gravity, and at approximately the same temperature. The glasses were placed in a cold room—temperature of air about 0° C. The water was not changed, only aerated from time to time with a large pipette.

The cleavage and the development generally were observed under the microscope. After the lapse of twenty hours some samples were taken and transferred to fresh sea water in order to ascertain whether the development could there proceed normally.

In the case of sample IV, this was repeatedly done.

The result of the experiment will be seen from the following table:—

Date.	Number of eggs.	I	II	III	IV
		Sp. Gr. 1.0247 T. 22° C.	Sp. Gr. 1.029 T. 20° C.	Sp. Gr. 1.015 T. 18°	Sp. Gr. 1.001 T. 16°
March 19, 2 p.m.	10	All alive.	All alive.	All alive.	All alive.
" 7 p.m.	5				
" 10 p.m.	8				
March 20, 10 a.m.	26				Development often abnormal.
" 21, 10 a.m.	44				Some dead.
" 23, 4 p.m.	98				More dead.
" 24, 10 a.m.	116				Few alive.

A similar experiment with newly hatched young in water of:—

I	Sp. gr.	1.0242	at	T.	20° C.
II	"	1.029	"	"	22° "
III	"	1.015	"	"	25° "
IV	"	1.010	"	"	25° "
V	"	1.008	"	"	27° "

gave the following results:—

I. All the young suspended; after the lapse of an hour some few at the bottom, after four hours the majority near bottom, but all living. After the lapse of 105 hours, some few were dead, but the remainder stood out well until the experiment was concluded after 148 hours.

II. All on the bottom by the end of an hour, some endeavouring to rise. Same course as previous sample, only slight mortality after eighty hours, until about half died by the end of 112 hours.

III. Some few suspended after a quarter of an hour, but at the end of an hour all at the bottom. Some few died after the lapse of forty-ix hours, mortality then increasing rapidly until all were dead by the end of 138 hours.

IV. All on the bottom after a quarter of an hour, some trying to work upwards. Some few died after four hours, more after twelve hours, the remainder with irregular pulsation of the heart. After thirty hours, many dead, and by the end of fifty-two hours from the commencement, none were left alive.

V. Some few died in the course of the first seven hours, and all within thirty-four hours from the start.

From the result of these experiments we may be justified in supposing that a stay of any duration in brackish water will be detrimental to eggs and young; this will, however, only occur under quite peculiar conditions, and can be of no importance with regard to the open sea.

Other factors which might be supposed to have some effect upon the development of the ova are: lack of fertilization, action of bacteria, and internal causes (natural death).

Prof. Apstein has, in his investigations in the Belt Sea and the western Baltic, shown that considerable quantities of dead—or as he considers, unfertilized—ova occur in the plankton samples. In his work above quoted, "Die Verbreitung der pelagischen Fischeier und Larven in der Beltsee und den angrenzenden Meeresteilen 1908-09," we find the following table for dead ova (p. 231):

Per cent dead.	<i>Pleuronectes platessa</i> .	<i>Pl. flesus</i> .	<i>Pl. limanda</i> .	<i>Gadus callarias</i> .	<i>Clupea sprattus</i> .
Vertical.	35	21.9	27.7	11.3	31.7
Surface.	38.5	41	3.7	29	49.6
Deep water.	20.6	19.8	17.5	12.7	30.3
Mean.	28.4	20.9	20.4	12.8	31.9
Dead.	1	1	1	1	1

These figures, however, appear abnormally high, for it must be remembered that dead ova—at any rate those of cod and plaice—are only exceptionally found suspended in the water, sinking otherwise very soon to the bottom, they would consequently only appear in plankton samples by mere accident. Unfertilized cod eggs may remain suspended for about two days; those of the plaice somewhat longer.

As to how far unfertilized or dead eggs appear in the samples from the Canadian waters, I am unable to say on the basis of the preserved material; the question would have to be dealt with by means of fresh plankton samples.

That cod eggs should be subject to "natural death" in any considerable degree is hardly probable; if such were the case, the mortality figures at the hatchery would be far higher than they are.

When working under normal conditions, solely with a view of obtaining the greatest possible amount of living young, and without regard to what quantity may be lost, the mortality percentage at Flodevigen amounts annually to something like 12 per cent for the entire period of hatching, including unfertilized eggs.

The figures for the three last years are as follows:—

	Per cent.
1912.	12.5
1913.	13.8
1914.	11.9

These percentages are calculated from very large quantities, in 1913 for instance, 1,222 litres, about 550 millions of eggs, and they do not vary greatly from year to year. When much brackish water occurs on the coast, the mortality may increase considerably; this is, however, rarely of long duration. Similarly, if the weather for any length of time is dark and cloudy, the eggs may become entirely overgrown with bacteria, from which, however, they may be freed by being placed in a bath with water of high salinity. As to the degree of influence exerted by these bacteria (*Leptothrix*) in a natural state I can say nothing from experience; possibly the conditions at the hatchery may be especially favourable to them.

As regards the growing up of the young, we have here to consider another factor, viz., that of nourishment. That this is of great importance to the growth of the young is certain, and possibly the most critical period of all in this respect is the time when the young first commence to take food; they do not live long without nourishment after the yolk-sac has been consumed.

In the spring of 1914, a number of newly hatched young were placed under observation at Flakøgen for the purpose of ascertaining when they commenced to take food, and what such then consisted of. The investigations were carried out by Prof. H. H. Gamm, and led to the result that the young did not take any food until the yolk-sac had been absorbed, and that on commencing to feed, they appeared from the first to prefer nutritive matter, such as mollusc larvae, nauplii, etc., seeming, strangely enough, to despise the innumerable diatom forms which are likewise present in the water.

Such food as was pumped in with the sea water was alone available to the young fish; but as the greater part of the plankton was retained in the apparatus, the nutritive matter was fairly concentrated there.

As to the influence exerted by conditions of nourishment upon the growing of the young in a natural state, this question has not yet been investigated, and it will probably form one of the earliest subjects for future fishery investigations.

It is, we may say, of prime importance in every way to ascertain what factor or factors normally hinder the growth of our most important fish in their development, to discover at what stage the destruction occurs, and by what means it takes place.

This will have to be done by investigation of the propagation of fish in the sea, and by experiment, and artificial culture, both branches of the work proceeding in conjunction.

It is from such a point of view that I have in the foregoing pages endeavoured to treat the material of fish eggs and young collected by the Canadian expedition. Unfortunately, however, we still know far too little of these questions, and my work can therefore only be regarded as furnishing, in this respect, a preliminary survey of the complicated, yet highly interesting, conditions which prevail on the Atlantic coast of Canada.

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Med.)

"Princess" I.	Date.	<i>Malloctus villosus.</i>	<i>Agonotus decagonus.</i>	<i>Icterus bicolor.</i>	<i>Anarrhichas latifrons.</i>	<i>Cypracanthodes maculatus.</i>	
							81 31 17 17 53 139
Station 3—	June 9						
Surface							
20 0							
Station 4	June 9						
Oblique		1					
Station 5	June 10						
Surface							
30 0							
Station 6	June 10						
Surface							
60 0							
Station 7	June 10						
Surface			1	1			
80 0							
Station 8	June 10						
Surface							var.
40 0							
80 0							
Station 9	June 11						
Surface							1
80 0							
100 0							
Station 10—	June 11						
Surface							1
100 0							
Station 11	June 11						39
Surface							
50 0							
Station 12—	June 11						
Surface							31
100 0							
Station 13—	June 11						
100 0							
Station 14	June 11						6
Surface							
35 0							1
Station 15—	June 12						
Surface							3
80 0							
Station 16—	June 12						
Surface							
100 0							
Station 17—	June 12						
Surface							2
100 0							
Station 18	June 12						
Surface							
50 0							
Station 19	June 13						
Surface							
80 0							
Station 20	June 13						
Surface							
100 0							
Station 21	June 13						
100-0							
Horiz. 8 20							

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C
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21
12

25

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TABLE Ia,^a[illegible]

[illegible]

TABLE 16.

"Princess" L.	Date.	<i>Mallotus villosus</i>	<i>Azonus decagranis</i>	<i>Forbes lucinus</i>	<i>Anardinus lucinus</i>	<i>Cryptanthobolus muralis</i>	<i>Chirolophis</i> sp.	<i>Protoparques tra- pidocephalus</i>	<i>Onos</i> sp.	<i>Gadus</i> sp.	<i>G. callarias</i>	<i>G. aeglefinus</i>	<i>Leparis</i> sp.	<i>Sebastes marinus</i>	<i>Ammodytes tobianus</i>	<i>Ctenolabrus ad-jarsus</i>	<i>Scomber scombrus</i>
								Egg	Egg	Egg						Egg	Egg
Station 3— Surface	June 9																
20 f.																	
Station 4— Oblique	June 9		1														
Station 5— Surface	June 10							1		2							
30 f.																	
Station 6— Surface	June 10							1	1	23							
60 f.										24							
Station 7— Surface	June 10			1	1			7		700							
80 f.								3		51							
Station 8— Surface	June 10							5	5	79	2						
10 f.								1	1	21							
80 f.																	
Station 9— Surface	June 11								10	1				1	1		
80 f.										1				17			
100 f.										3				17			
Station 10— Surface	June 11							18	5	93				1			
100 f.										3							
Station 11— Surface	June 11						16	18		32							
50 f.								2		8							
Station 12— Surface	June 11							3		10							
100 f.										7							
Station 13— 100 f.	June 11						2										
Station 14— Surface	June 11												1				
35 f.																	
Station 15— Surface	June 12							17		24						2	
80 f.								3		11							
Station 16— Surface	June 12							5	1	51						1	
100 f.										3							
Station 17— Surface	June 12							9		124							
100 f.								1	2	127							
Station 18— Surface	June 12						3	369		1162							
50 f.								2		34							
Station 19— Surface	June 13							15		890						20	
80 f.								5		50							
Station 20— Surface	June 13										4			4			
190 f.														33			
Station 21— 100 f.	June 13													10			
Station 22— 50 f.	June 13									1							
Station 23— 100 f.	June 13													18			
Station 24— Surface	June 15						1	27		60							162
30 f.								10		9			1				27
Station 25— Surface	June 15						2	1		58							21
60 f.								2		16							15
60 f.										17							8
Station 26— Surface	June 15							7		175						1	80
40 f.								10		43							5
		1	1	1	1	1	24	609	5	20	5127	6		2	108	4	318

TABLE 16.

Charadrius sp.	Pro. pat. spec. (to platysomus)	Onos sp.	Gadus sp.	G. callarias.	G. aeglefinus.	Lepomis sp.	Sebastes marinus.	Ammodytes volanus.	Chenolabrus ad-persus.	Xenodermus scaberrimus.
Egg.	Egg.	Egg.	Egg.						Egg.	Egg.
	1		2							
	4	1	233							
			24							
	7		700							
	3		55							
	5	5	79	2						
	4	1	21							
		10	4				4	1		
			1				17			
	4		3				17			
	18	5	93				1			
			3							
16	18		32							
	2		8							
	37		16							
			7							
2						1				
	17		24						2	
	3		11							
	5	1	51					1		
			3							
44	9		1124				7			
	1	2	127							
3	309		1162							
	2		34							
	15		890						20	
	5		50							
				4			4			
							33			
							10			

(RTM ed.)

Chirolophus sp.

81
31
17
17
53

(10)

N.e.

1

1

29

31

6

1

2

2

9	06
001	02

Station 35
Horiz. 6 15m
Station 36
Horiz. 8 20

July 7					
July 8					

TABLE 1c.

"Acadia" 11	Date.	<i>Malloctes villosus</i> .	<i>Stichæus punctatus</i> .	<i>Drepanopsetta platensis</i> .	<i>Onch. sp.</i>	<i>Gadus sp.</i>	<i>G. callarias</i> .	<i>G. aeglefinus</i> .	<i>Pleuronectes sp.</i>	<i>P. cynoglossus</i> .	<i>P. microcephalus</i> .	<i>P. limanda</i> .	<i>Leparis sp.</i>	<i>Seriastes marinus</i> .	<i>Ammodytes tobianus</i> .	<i>Ctenolabrus adspersus</i> .	<i>Lopholophus pacificus</i> .	<i>Callionymus sp.</i>	<i>Myoxocephalus merluccius</i> .	<i>Caligus asper</i> .	<i>Ancylorhynchus sp.</i>	<i>Tetracurus curvieri</i> .	<i>Myctophum glaciale</i> .	<i>Seriolus sp.</i>	<i>Stomatias fuscus</i> .	<i>Onchodidion sp.</i>	Remarks.
			Egg	Egg	Egg											Egg		Egg									
Station 37— Surface— 20-0 50-0 100-20	July 21																										
Station 38— Surface— 100-0 150-0	July 21								1																		
Station 39— Surface— 25-0 100-0	July 21																										
Station 40— Surface— 125-0 125-0	July 22																										
Station 41— Surface— 100-0 200-0	July 22																										
Station 42— Surface— 200-0	July 22																										
Station 43— Surface—	July 22																										
Station 44— Surface— 50 fms— 150-0	July 22																										
Station 45— Surface— 50-0 fms— 150-0	July 23																										
Station 46— Surface— 150 fms— 150-0	July 23																										
Station 47— Surface— 50 fms— 70-0	July 23																										
Station 48— Surface— 25 fms— 150-0	July 23																										
Station 49— Surface— 70-0 fms— 70-0 fms	July 23																										
Station 50— Surface— 50-0 fms— 80-0 30-30	July 23																										
Station 51— Surface— 70-0 fms— 70-30	July 23																										
Station 52— Surface— 50-0 fms—	July 24																										
Station 53— Surface— 50-0 fms—	July 24																										
Station 54— Surface— 70-0 fms— 150-0 fms	July 24																										
Station 55— Surface— 50-0 fms— 150-0 fms	July 24																										
Station 56— Surface— 140-0 fms— 210-140 fms	July 24																										
Station 57— Surface— 50-0 fms— 150-50	July 24																										
Station 58— Surface— 30-0 fms— 85-0 100-30	July 24																										
Station 59— Surface— 25-0 fms—	July 25																										
Station 60— Surface— 50-0 fms—	July 25																										
Station 61— Surface—	July 25

MICROCOPY RESOLUTION TEST CHART

ANSI and ISO TEST CHART No. 2

1.0

1.1

1.25

1.4

1.6

2.5

2.2

2.0

1.8

1.6

1.4

1.25

1.1

1.0

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1

Chlorophyll sp.

1

Prime 46	Station Number N 53	Date	<i>Mallotus villosus</i>	<i>Aspidophontodes monoporygius</i>	<i>Leclius bicornis</i>	<i>Cottus capensis</i>	<i>Cottus labialis</i>	<i>Chondrophus sp.</i>
		Year						
	Station 3	June 1.						
	Horiz. 10-9							
	15-20							
	Station 4	June 2.						
	Horiz. 10-9							
	Station 5	June 3.						
	Surface							
	Station 6	June 8.						
	Surface							
	Station 7	June 9.						
	Surface							
	Station 8	June 9.						
	Surface							
	Station 9	June 9.						
	Surface							
	Station 10	June 9.						
	Surface							
	10-10							
	25-40							
	35-25							
	Station 11	June 9.						
	Surface							
	Station 12	June 9.						
	Surface							
	Station 13	June 9.						
	Surface							
	Station 14	June 10.				1		
	Surface							
	Station 15	June 10.				1		1
	Surface							
946F	265	June 10.						1
	Surface							
	Station 17	June 10.	3			1	2	1
	Surface							
	Station 19	June 24.						
	Surface							
	Station 21	June 25.		1				
	Surface							
	Station 22	June 25.						2
	Surface							
	Station 23	June 25.						
	Surface							
	Station 25	June 24.						
	Surface							
	Station 26	June 26.						
	Surface							
64								
4	1	Horiz. 15-30m.						
		Station 29	June 30.					
		Surface						
		Station 35	July 7.					
		Horiz. 6-15m.						
9	95	Station 36	July 8.					
004	95	Horiz. 8-20						

Prime	41	Depth	Mall-cus Villages	Properties & photocopies	Other
			Egg	Egg	
Station 27		August 3		8	
30.0				3	
Station 28		August 3		23	
Surface				3	35
30.0					
Station 29		August 4		11	25
Surface					8
30.0					
Station 30		August 4		2	5
Surface					1
30.0					
Station 31		August 4			
Surface					
30.0					
Station 32		August 4			3
Oblique					
30.0					1
80.0					
Station 33		August 4			
Oblique					
30.0					
80.0					
Station 34		August 5	12		
Oblique			3		
30.0					
Station 35		August 5			
Oblique					
30.0					
130.0					
Station 36		August 5		1	
Oblique					
30.0					
Station 37		August 5			
Oblique					1
30.0					
80.0					
Station 38		August 5			
Oblique					
30.0					
130.0					
Station 39		August 5			
Surface				1	1
Oblique					
30.0					
130.0					
Station 40		August 5			
Oblique					
30.0					
70.0					
Station 41		August 6			
Oblique			1		
30.0					
130.0					
Station 42		August 6		1	
Oblique					
30.0					
100.0					
Station 43		August 6			
Oblique					
30.0					
130.0					
130.0					
Station 44		August 6			
30.0					
130.0					
Station 45		August 12			
Surface			75		
Oblique			265	2	
30.0			30		
130.0			30		
Station 46		August 12			
Surface					
30.0					
130.0					
Station 47		August 12			
Surface					
30.0					

TABLE 14.

Thais sp.	Gadus sp.	G. callus	G. a. 2. 3. 4.	E. cyathoglossus	Liparis sp.	Stelastes notatus	Chaetostomus aculeatus	Chondrus adpersus	Scomber scombrus	Bethune
Egg.	Egg.	Egg.	Egg.	Egg.	Egg.	Egg.	Egg.	Egg.	Egg.	Egg.
3							17 25			
23 3	35						1 11 1	2 53		1
11	25 8						1 8	33 5	5 ...	1
2	5 1	3 12 25					1 23 1	172 8 1	14 3	
		200 46 61						105 2 2		
	3	31						2 11	6	
	1	135 51 574				1			5	
									2 7	
					1	10				
						2		...	...	1
						11				
		79 25			1	8				
		81				1				
		12								
						5 1 5				
1						2				
						2				
	102									
							57 1 2			
		1 2					1			
							17 3			
							4			
							2			
							38 20 12			1
		4					2			
							8 1 4			
							3			
							2			

	Mo	Di	Tri	Qu
	Page	Page	Page	Page
Station 27	August 3			
Surface				8
30.0				3
Station 28	August 3			
Surface				23
30.0				3
Station 29	August 4			
Surface				11
30.0				
Station 30	August 4			
Surface				2
30.0				
Station 31	August 4			
Surface				
30.0				
Oblique				
Station 32	August 4			
Oblique				
30.0				
80.0				
Station 33	August 4			
Oblique				
30.0				
80.0				
Station 34	August 5			
Oblique		12		
30.0				
130.0		3		
Station 35	August 5			
Oblique				
30.0				
140.0				
Station 36	August 5			
Oblique			1	
30.0				
Station 37	August 5			
Oblique				1
30.0				
80.0				
Station 38	August 5			
Oblique				
30.0				
130.0				
Station 39	August 5			
Surface				
Oblique			1	1
30.0				
130.0				
Station 40	August 5			
Oblique				
30.0				
70.0				
Station 41	August 6			
Oblique			1	
30.0				
140.0				
Station 42	August 6			
Oblique			1	
30.0				
100.0				
Station 43	August 6			
Oblique				
30.0				
30.0				
130.0				
130.0				
Station 44	August 6			
30.0				
130.0				
Station 45	August 12			
Surface		75		
Oblique		265	2	
30.0		30		
130.0		30		
Station 46	August 12			
Surface				
30.0				
130.0				
Station 47	August 12			
Surface				
30.0				
130.0				
130.0				
Station 48	August 12			
Surface				
30.0				
130.0				
Station 49	August 12			
Surface				
30.0				
70.0				
Station 50	August 12			
Surface			2	
30.0			1	
40.0				
	117	1	7	51

[illegible]

11-10-11

10

TABLE Ic.

<i>Dicranopsetta</i> <i>platycephalus</i>	<i>Ophio</i> sp.	<i>Gadus</i> sp.	<i>G. callarias</i>	<i>Pleuronectes</i> sp.	<i>Leparis</i> sp.	<i>Nezumia</i> <i>marinus</i>	<i>Gasterosteus</i> <i>aculeatus</i>	<i>Annodytes</i> <i>tobianus</i>	<i>Ctenodermus</i> <i>adpersus</i>	<i>Scomber</i> <i>scomber</i>
Egg	Egg	Egg	Egg	Egg	Egg	Egg	Egg	Egg	Egg	Egg
9		60							127	
10		4							82	
3		1703							29	
9		600							5	
7		150								
2		100								
10		154							1	
3		11								
1		3								
		48								
2		150								
10		31								
1		9						1		
8		87							2	
350		520								
136		150								
80		130				1			4	
	1800	90					2			
	6	26							2	
	40	60					1			
	120						5			6
	25									
	100						325			
	110	1								
		4								3800
	192								12	525
		27								456

TABLE II.—Summary of the six most common species of fish. (All the cruises included.)

	Surface.			Vertical hauls. *		
	Germinative disk.	Pigmented embryo.	Larvæ.	Germinative disk.	Pigmented embryo.	Larvæ.
<i>Otenolabrus</i>	245	61	237	70	74	81
<i>Scomber</i>	2178	2231	16	774	392	31
<i>Drepanopsetta</i>	1118	1160	30	46	45	17
<i>Gadus</i>	10167	3528	276	1773	520	17
<i>Onos</i>	1323	1328	39	298	116	53
<i>Merluccius</i>	4496	773	.....	3252	300	.....
	19527	9081	598	6123	14	199

* Here also included some deep horizontal towings by ss. No. 33.

TABLE II a (1).—Egg and Larvæ *Otenolabrus adspersus*.

	Date.	Surface.			Vertical hauls.		
		Germinative disk.	Pigmented embryo.	Larvæ.	Germinative disk.	Pigmented embryo.	Larvæ.
"Acadia" 1	May 29 to June 4.	1	2	.....	5	.....	1
Station 5-8							
"Princess" 1	June 9 to June 15	6	15	.....	21	37	1
Station 19-26							
"Acadia" 11	July 21 to July 29	.....	.....	.....	18	11	79
Station 91							
"Princess" 11	Aug. 3 to Aug. 12	4	33	237	26	26	.....
Station 27-50							
"No. 33"	June 1 to Aug. 18	234	11	.....	70	74	81
Station 5-48							
		245	61	237			

TABLE II a (2).—Egg and larvæ, *Ctenolabrus adspersus*.

	Surface.			Vertical hauls.		
	Germi- nativ- disk.	Pigmented embryo.	Larvæ.	Germi- nativ- disk.	Pigmented embryo.	Larvæ.
"Acadia" I.						
Station 5		1		2		1
" 6	1			3		
" 8		1				
	1	2		5		1
"Princess" I.						
Station 19	5	15				
" 26	1					
	6	15				
"Acadia" II.						
Station 31				21	37	1
"Princess" II.						
Station 27	3	14		17	8	53
" 28	1	10	2	1	3	5
" 29		8	33			1
" 30		1	23			2
" 31						
" 48			75			
" 49			54			18
" 50			50			
	4	33	237	18	11	79
				Vertical and deep horizontal.		
No. "33" —						
Station 5	125	2				
" 6	80	2				
" 7	26	3				
" 8	3	2				
" 10		1				
" 35				12		
" 39				14	26	
" 48		1				
	234	11		26	26	

TABLE II a (3).—Larvæ, *Ctenolabrus adspersus*.

	Length in mm.																
	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	More than 17.
"Acadia" 1																	
Station 5			1														
"Acadia" 11																	
Station 91		1															
"Princess" II																	
Station 28				55													
" 29				38													
" 30			21														
" 31					1	1											
" 48						75											
" 49						54											
" 50						68											

TABLE II b (1).—Egg and Larvæ, *Scomber scombrus*.

	Date.	Surface.			Vertical hauls.		
		Germinative disk.	Pigmented embryo.	Larvæ.	Germinative disk.	Pigmented embryo.	Larvæ.
"Acadia" 1							
Station 3-9	May 29 to June 4	3					
"Princess" 1							
Station 24-26	June 9 to June 16	263			55		
"Princess" 11							
Station 28-50	Aug. 3 to Aug. 12	80	201	16	10	14	31
"33"							
Station 23-49	June 1 to Aug. 18	1,832	2,027		709	378	
		2,178	2,231	16	771	392	31

TABLE 11b (2).—Egg and Larvæ, *Scomber scombrus*.

	Surface.			Vertical haul		
	Germulative disk.	Pigmented embryo.	Larvæ.	Germulative disk.	Pigmented embryo.	Larvæ.
" Acadia " 1	2					
Station 3	1 (?)					
" "	3					
" Princess " 1				27		
Station 24	102			23		
" 25	21			5		
" 26	80					
	203			35		
" Princess " 11.						1
Station 28						1
" 29	2	3				3
" 30	1	171	11		9	6
" 31	75	30		10	5	5
" 32						9
" 33						1
" 34						1
" 45						
" 48	1		2			
" 49	1					1
" 50						
	86	204	16	10	14	31
No. "33"						
Station 23	3	3				
" 29	1,800	2,000		525		
" 35				144	312	
" 36				40	66	
" 39						
" 48	4					
" 49	25	24				
	1,832	2,027		709	378	

CANADIAN FISHERIES EXPEDITION, 1914-15

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TABLE 11 b (3).—Larvæ, *Scomber scombrus*.

		Length in mm.																	
		2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	More than 17.	
Princess 11.						1													
Station 28					1	3	1												
" 29						3	1	1											
" 30			1	8	3	4													
" 31				2		2													
" 32				3		1													
" 33				2	5	1	1												
" 34						1													
" 15									1										
" 19						2													
" 50				2	2														

TABLE 11 c (1).—*Sebastes marinus*.

	Date.	Surface.	Vertical Hauls.
		Larvæ.	Larvæ.
" Acadia " I— Station 11 36	May 20 to June 4	56 (56)	19 (19)
" Princess " I Station 9 23	June 4 to June 15	6 (6)	102 (93)
" Acadia " II Station 37 90	July 21 to July 29	73 (73)	155 (155)
" Princess " II— Station 32 48	Aug. 3 to Aug. 12	50 (50)	170 (165)
No. " 33 "— Station 19 58	June 1 to Aug. 18	337 (37)	
		522 (222)	446 (432)

(1) Numbers measured.

TABLE II c (2).—*Sebastes marinus*.

	Surface.		Vertical hauls.	
	Total number.	Midle length.	Total number.	Midle length.
"Acadia" I—				
Station 11.....	10	7 8	3	8 0
" 26.....			1	8 0
" 31.....	43	8 7	5	8 0
" 32.....	1	8 0	3	7 3
" 34.....	1	8 0	7	8 0
" 35.....	1	7 0		
" 36.....				
	56		19	
"Princess" I—				
Station 9.....	1	8 0	34 (25)	8 3
" 10.....	1	9 0		
" 16.....			7 (7)	8 3
" 20.....	4	7 8	33 (33)	8 4
" 21.....			10 (10)	8 1
" 23.....			18 (18)	8 1
	6		102 (93)	
"Acadia" II—				
Station 37.....	7	7 4	52	7 3
" 38.....	2	6 5	22	7 5
" 39.....			29	7 9
" 49.....	1	9 0		
" 50.....	40	7 6	3	8 7
" 51.....			3	7 0
" 52.....			1	8 0
" 59.....			3	6 7
" 60.....			10	6 4
" 63.....			15	6 5
" 65.....	2	6 5	9	5 3
" 67.....			1	8 0
" 69.....				
" 70.....	1	7 0		
" 72.....	5	7 6		
" 76.....	5	8 2		
" 84.....			2	7 5
" 86.....			4	10 5
" 88.....	9	6 3	1	8 0
" 90.....	1	8 0		
	73		155	
"Princess" II—				
Station 32.....			1 (1)	9 0
" 34.....			21 (21)	9 6
" 35.....			14 (14)	11 7
" 36.....			8 (8)	8 8
" 37.....			1 (1)	9 0
" 38.....			11 (6)	7 0
" 39.....			4 (4)	8 0
" 41.....			36 (36)	10 0
" 42.....			1 (1)	10 0
" 43.....			24 (24)	10 3
" 44.....			2 (2)	8 5
" 45.....	38	8 9	40 (40)	8 7
" 46.....	8	9 6	5 (5)	7 8
" 47.....	3	13 3	2 (2)	12 0
" 48.....	1	8 0		
	50		170 (165)	
No. "33"—				
Station 19.....	2 (2)	7 0		
" 22.....	1 (1)	8 0		
" 23.....	5 (5)	8 0		
" 26.....	325 (25)	8 0		
" 48.....	3 (3)	9 7		
" 58.....	1 (1)	8 0		
	337 (37)			

TABLE II d.—*Chirolophis* sp.

	Surface.		Vertical.	
	Total number.	Length in mm.	Total number.	Length in mm.
"Acadia" I—				
Station 23	1	10		
" 34	5	ca. 19		
" 35	2	ca. 10		
	8			
"Princess" I—				
Station 11	16	ca. 12	2	10-11
" 13	3	8-10		
" 18	1	10		
" 24	2	ca. 8		
" 25				
	22		2	
No. "33"—				
Station 15	6	ca. 12		
" 16	1	12		
" 17	3	11-13		
" 22	2	ca. 8	18	8-10
" 39			1	ca. 12
" 49				
	12		19	

TABLE II e.—*Liparis* sp.

	Surface.		Vertical hauls.	
	Total number.	Length in mm.	Total number.	Length in mm.
"Acadia" I—				
Station 8	1	4	1	3
" 24	1		1	
"Princess" I—				
Station 14	1	5	1	5
" 24				
"Acadia" II—				
Station 81	6	4-7		
"Princess" II—				
Station 36	1	10	1	9
" 50			1	8
	1		2	
No. "33"—				
Station 17	1	4	2	4-3
" 39			3	25-30
" 57				
			5	

TABLE II f (1).—Egg and Larvæ, *Drepanopsetta platessoides*.

	Date	Surface			Vertical hauls.		
		Germi- nativ- disk	Pigmented embryo.	Larvæ.	Germi- nativ- disk.	Pigmented embryo.	Larvæ.
"Acadia" 1							
Station 8 36	May 29 to June 4.	322	734		10	23	7
"Princess" 1							
Station 3 26	June 6 to June 15	260	365	5	29	15	
"Acadia" 11							
Station 49 83	July 21 to July 29	7	25	23		3	5
"Princess" 11							
Station 36 50	Aug. 3 to Aug. 12			2		1	5
"33"							
Station 3 17	June 1 to Aug. 18	529	96		7	3	
		1118	1160	30	46	45	17

TABLE II f (2).—Egg and Larvæ, *Drepanopsetta platessoides*.

		Surface.			Vertical haul.		
		Germi- nativ- disk.	Pigmented embryo.	Larvæ.	Germi- nativ- disk.	Pigmented embryo.	Larvæ.
"Acadia" 1							
Station 8			6				3
" "	19	2					
" "	20	2	5				
" "	21	200	415				
" "	22	1	2				
" "	23	3	13		1	4	
" "	24	6	11		2	1	
" "	25	18	114			12	4
" "	29	2	16			3	
" "	30	7	17		7		
" "	31	18	5				
" "	32		33			3	
" "	32	57	35				
" "	34	2	24				
" "	36	4	18				
		322	734		10	23	7
"Princess" 1							
Station 5			1			1	
" "	6	3	7			2	
" "	7				1	1	
" "	8	3	2	5	3	1	
" "	9						
" "	10	3	15				
" "	11	11	7		2		
" "	12	2	1				
" "	13	22	25		3		
" "	16		5				
" "	17		9		1		
" "	18	189	180		2		
" "	19	20	25		3	2	
" "	24	6	21		4	6	
" "	25		1		1	1	
" "	26	1	6		9	1	
		260	365	5	29	15	

TABLE II f (2).—Egg and Larvæ, *Drepanopsetta platessoides*—Con.

	Surface.			Vertical haul.		
	Germinative disk.	Pigmented embryo.	Larvæ.	Germinative disk.	Pigmented embryo.	Larvæ.
"Acadia" 11						1
Station 49			7		1	
" 81	1	3			2	3
" 82	2	9				1
" 83	4	13	16			
	7	25	23		3	5
"Princess" 11					1	
Station 36						1
" 37						1
" 39						2
" 45			2			1
" 50						
			2		1	5
No. "33"				6	3	
Station 3						
" 4	2	8				
" 5	2	1				
" 6	9					
" 7	1					
" 8	2					
" 9	9					
" 10	1	2		1		
" 11	1	1				
" 12	10					
" 13		1				
" 14	8					
" 15	310	40				
" 16	95	35				
" 17	73	7				
	529	96		7	3	

TABLE II f (3).—Larvæ, *Drepanopsetta platessoides*.

	Length in mm.																
	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	More than 17.
"Acadia" I—																	
Station 8				1	2												
" 25				2	1	1											
"Acadia" II—																	
Station 49											1						
" 81					6							1					
" 82						3											
" 83									1	7							
"Princess" I—																	
Station 8					6												
"Princess" II—																	
Station 37																1	
" 39					1												2 (20 mm.)
" 45																	
" 50				2					1								

TABLE II g (1).—Egg and Larvæ, *Gadus* sp.

	Date.	Surface.						Vertical hauls.					
		Egg.				Larvæ.		Egg.				Larvæ.	
		Germi- native disk.	Pigmented embryo.	<i>Gadus callarias</i> .	<i>Gadus aeglephus</i> .	<i>Gadus callarias</i> .	<i>Gadus aeglephus</i> .	Germi- native disk.	Pigmented embryo.	<i>Gadus callarias</i> .	<i>Gadus aeglephus</i> .	<i>Gadus callarias</i> .	<i>Gadus aeglephus</i> .
"Acadia" I—													
Station 536	May 29 to June 4	1661	2025	59	31	1	...	116	158	5	47	3	1
"Princess" I—													
Station 326	June 9 to June 15	3940	743	9	...	6	...	375	56	3	1	...	...
"Acadia" II—													
Station 49-84	July 21 to July 29	284	187	43	28	250	11	23	10	...	1	10	1
"Princess" II—													
Station 27-50	Aug. 3 to Aug. 12.	310	152	19	...	4	...	1081	188	14	...	2	...
"33"—													
Station 4-58	June 1 to Aug. 18	4032	232	...	...	1	...	178	31	6	...	...	...
		10167	3339	130	59	262	14	1773	443	28	49	15	2

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TABLE II g (2).—Egg and Larvæ, *Gadus* sp.

	Surface.						Vertical hauls.					
	Egg.				Larvæ.		Egg.				Larvæ.	
	Germi- tive disk.	Pigmented embryo.	G. callarias.	G. aegle- finus.	G. callarias.	G. aegle- finus.	Germi- tive disk.	Pigmented embryo.	G. callarias.	G. aegle- finus.	G. callarias.	G. aegle- finus.
"Acadia" I.—												
Station 5	61	4					12				1	
" 6	94	1,250			15	1	66	117		40		1
" 7					ca. 100 damaged eggs, probably haddock.							
" 8	146	137	1		11		23	24	3	6	2	
" 9	1						1	1				
" 19	55	76			3							
" 20	47	32			2							
" 21	850	440	44									
" 22	70	1	1					1				
" 23	60	1										
" 24	4										1	
" 25	20	13	6				7	12	2			
" 29	36	42	6				7	2				
" 30	60	5	1									
" 31	19							1				
" 32		1										
" 33	32	19										
" 34	20	2										
" 36	26	2										
	1,601	2,025	59	31	1		116	158	5	47	3	1
"Princess" I.—												
No. 33.—												
Station	60											
" 5	4											
" 6	1,700	3										
" 7	600											
" 8	150											
" 9	100						60	2				
" 10	153	1										
" 11	150											
" 12	30	1										
" 13	7	2										
" 14	83	4										
" 15	590	20										
" 16	115	35										
" 17	124	6										
" 19	73	17										
" 21	21	5										
" 22	33	27					1	3				
" 26							9	13	5			
" 36							108	13	1			
" 39												
" 48	2											
" 49	116	96			1							
" 57	11	15										
" 58												
	4,032	232			1		178	31	6			
"Acadia" II.—												
Station 49	4			5			3					1
" 59												
" 61	90	20	1									
" 62	105	14	2									
" 63	1											
" 66												
" 68							1	11	1			
" 80	6	13	3		12							
" 81	37	65	11	11	20	6	9	3		1		
" 82	40	71	13	17	3	1	3	5				
" 83	1	4	8		206	1					10	
" 84					9	2						
	284	187	43	28	250	14	23	10		1	10	1

TABLE II g (2).—Egg and Larvæ, *Gadus* sp.—*Con.*

	Surface.						Vertical hauls.					
	Egg.				Larvæ.		Egg.				Larvæ.	
	Germi- nate disk.	Pigmented embryo.	G. callarias.	G. ægle- finns.	G. callarias.	G. ægle- finns.	Germi- nate disk.	Pigmented embryo.	G. callarias.	G. ægle- finns.	G. callarias.	G. ægle- finns.
"Princess" H.												
Station 30	1	2	1				24	11	2			
" 31	118	15					121	17				
" 32							687	71	2			
" 36							88	12	4			
" 37							11	52	3			
" 40							104	13				
" 42							2	1				
" 45					4						2	
" 48	48	89	10				2	10	3			
" 49							9	1				
" 50	113	16	2									
	310	152	19		4		1,081	188	14		2	
"Princess" I.												
Station 5							1		1			
" 6	206	26	1				22					
" 7	618	82					48	112				
" 8	69	10			2		19	2				
" 9		1					1	3				
" 10	49	41					2	1				
" 11	29	3					8					
" 12	9	1					5	2				
" 13	5	18	1				1	5	1		1	
" 16	31	15	2				1	2				
" 17	1,076	54					114	12	1			
" 18	855	307					29	5				
" 19	750	135	5				47	3				
" 20					4							
" 22							1					
" 21	51	9					1	5				
" 25	37	21					30	3				
" 26	158	17					39	1				
	3,910	743	9		6		375	56	3		1	

TABLE II g (3).—Larvæ, *Gadus callarias*.

	Length in mm.																
	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	More than 17
"Acadia" I																	
Station 6		1															
" 8				1	1												
" 25				1													
"Princess" I																	
Station 8				2													
" 20				2			1			1							
"Acadia" II																	
Station 80		4		3	4	1											
" 81					20												
" 82			2		1												
" 83						216											
" 84					9												
"Princess" II																	
Station 15							1	1	1	1	2						
" 33 "																	1 (21 mm)
Station 57																	

TABLE II g (4).—Larvæ, *G. aeglefinus*.

	Length in mm.																
	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	More than 17
"Acadia" I—																	
Station 6		1															
"Acadia" II																	
Station 49							1										
" 59																	
" 68											1						
" 81			3	3													
" 82			1														
" 83			1														
" 84				2													

TABLE II h (1).—Egg and Larvæ, *Onos*.

	Date.	Surface.			Vertical hauls.		
		Germi- native disk.	Pigmen- ted embryo.	Larvæ.	Germi- native disk.	Pigmen- ted embryo.	Larvæ.
"Acadia" I—							
Station 3 29.	May 29 to June 4.	5	1				1
"Princess" I—							
Station 6 17.	June 9 to June 15	15	2		1	2	
"Acadia" II							
Station 47 62	July 21 to July 29	158	35		11		
"Princess" II							
Station 27 50	Aug. 3 to Aug. 12	23	21	35	2	5	52
" 33 "							
Station 19 39	June 1 to Aug. 18	1122	1269	4	194	109	
		1323	1328	39	208	116	53

TABLE II h (2).—Egg and Larvae, *Onos*.

		Surface,		Vertical hauls,			
		Germinative disk,	Pigmented embryo	Larvae,	Germinative disk,	Pigmented embryo	Larvae,
"Acadia" I.							
Station	3	1					
"	5	3					1
"	6						
"	10	1					
"	20		1				
z	29	5	1				1
"Princess" I.							
Station	6		1			1	
"	8						
"	9	10					
"	10	4	1				
"	16	1			1	1	
"	18						
		15	2		1	2	
"Acadia" II.							
Station	37	20	20		10		
"	49	10					
"	56				1		
"	61	120	15				
"	62	8					
		158	35		11		
"Princess" II.							
Station	27	4	4		1	2	
"	28	15	8		1	2	35
"	29	4	7	25			8
"	30		2	5			1
"	31						3
"	32						1
"	34					1	
"	49			1			1
"	50			4			3
		23	21	35	2	5	52
No. "33"							
Station	19	800	1000				
"	24	3	3				
"	25	9	31				
"	26	220	200				
"	27	15	10				
"	28	75	25		110		
"	29			4			
"	35				84	108	
"	39					1	
		1122	1269	4	194	109	

TABLE II h (3).—Larvæ, *Onos*.

	Length in mm.																
	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	More than 17.
"Acadia" I																	
Station 6		1															
"Princess" II																	
Station 28		3	5														
" 29		3	3														
" 30		6															
" 31			2														
" 32			1														
" 33			1	1													
" 49			7														
" 50																	
No. "33"—																	
Station 29			4														

TABLE II i.—Egg and Larvæ, *Merluccius merluccius*.

	Surface.			Vertical haul		
	Germinative disk.	Pigmented embryo.	Larvæ.	Germinative disk.	Pigmented embryo.	Larvæ.
"Acadia" II						
Station 44	2			1		
" 47	1			1000	100	
" 53	2650	350				
" 54	176	12				
" 55	1	1		1		
" 56				541		
" 58	200	5		1800	200	
" 59	750	250				
" 60	400	85				
" 61	300	70				
" 62	10					
	4496	773		3252	300	

TABLE II j.—*Ammodytes tobianus*.

	Surface.		Vertical hauls.	
	Total number.	Length in mm.	Total number.	Length in mm.
"Acadia" 4				
Station 3	2		5	ca 15
" 4	1	ca 25	1	ca 15
" 5			7	15 22
" 8	5	15 20		
" 19	1	ca 15		
" 21	2	12 15		
" 22				
" 23	17	10 18	9	6 10
" 24			3	8 14
" 25			8	10 13
" 26	3	10 15	1	10
" 31	7	8 22	2	12 20
" 32			6	ca 15
" 34	5	12 17	1	12
" 36	46		43	
"Princess" 4				
Station 9	1	15		
" 15	2	7 7		
" 16	1	18		
" 4				
"Acadia" 11				
Station 82	1	15	1	16
" 83	3	12 26		
" 4			1	
No. "33"				
Station 11	2	10-20		
" 17	1	ca 8		
" 21	2	12 13		
" 2				

TABLE II k. —*Mallotus villosus*.

	Surface.		Vertical hauls.	
	Total number	Length in mm.	Total number.	Length in mm.
"Acadia" I— Station 36.....	1	42		
"Princess" I Station 4.....			1	15
"Acadia" II— Station 23.....	12	10-15	1	12
"Princess" II— Station 34.....			15	22
" 41.....			1	16
" 42.....			1	12
" 45.....	ca 75	7-25	ca 325	7-25
	ca 75		ca 342	
No. "33"— Station 17.....	3			
" 58.....	3	ca 8		
	6			

TABLE III.—*Scopelus* sp.

"Acadia" I— Station 16.....	5	8-11	13	7-14
" 17.....			3	6-10
"Acadia" II— Station 38.....			1	7
" 42.....	37	6-9	1	8
" 44.....	4	14-16		
" 45.....	2	5-6	9	6-16
" 46.....	1	8		
" 51.....	1	6		
" 74.....	5	6-12		
" 75.....	1	5	6	3-21
	56		33	

EXPLANATION OF PLATES

PLATE I.

- FIG. 1. *Otenolobus adpersus*, 4.2 mm., Princess Station, 50 (surface).
 " 2. *Otenolobus adpersus*, 8 mm., Princess Station, 50 (surface).
 " 3. *Scomber scombrus*, 6.2 mm., Princess Station, 33 (obl. haul).
 " 4. *Sebastes marinus*, 5.6 mm., Kristiansfjorden July 1913 (taken from the adult fish).
 " 5. a and b, *Sebastes marinus* 8 mm., No. "33" Station, 26.
 " 6. a and b, *Sebastes marinus*, 10.4 mm., Princess Station, 16 (surface).
 " 7. *Sebastes marinus*, 20 mm., Princess Station 11 (30-0).

PLATE II.

- FIG. 8. *Chicalophis* ? , 11 mm., Princess Station 13 (100-0).
 " 9. *Stichæus punctatus*, 30 mm., Acadia Station, 89 (surface).
 " 10. *Cryptacanthodes maculatus*, 38 mm., Princess Station, 8 (80-0).
 " 11. *Pleuronectes cynoglossus*, 16 mm., details lost.
 " 12. *Ancylopsetta* sp., 7 mm., Acadia Station, 44 (surface).
 " 13. *Drepanopsetta platessoides*, Acadia Station, 25 (120-0).
 " 14. *Drepanopsetta platessoides*, 7 mm., Acadia Station, 82 (30-0 fms.).
 " 15. *Drepanopsetta platessoides*, 13 mm., Acadia Station, 81 (surface).

PLATE III.

- FIG. 16. *Gadus callarias*, 3.8 mm., The Flodevig Sea Fish Hatchery.
 " 17. *Gadus callarias*, 4.5 mm., Acadia Station, 8 (vertical).
 " 18. *Gadus callarias*, 11 mm., Princess Station, 20 (surface).
 " 19. *Gadus aeglefinus*, 3.7 mm., Acadia Station, 81 (surface).
 " 20. *Gadus aeglefinus*, 7 mm., Acadia Station, 59 (25-0 fms.).
 " 21. *Onos cimbrius* (?), 4.4 m., Princess Station, 50 (40-0).
 " 22. *Onos cimbrius* (?), 4.6 mm., Princess Station, 31 (oblique).
 " 23. *Ammodytes tobianus*, 7.2 mm., Acadia Station, 23 (70-0).
 " 24. *Ammodytes tobianus*, ca., 15 m., Acadia Station, 82 (30-0 fms.).
 " 25. *Tetragonurus carteri*, 76 mm., Acadia Station, 56 (210-140 fms.).
 " 26. *Mallotus villosus*, 8 mm., Princess Station, 45 (oblique).
 " 27. *Mallotus villosus*, 19 mm., Princess Station, 45 (130-0).

The figures, except those of macroscopical fishes, are drawn from specimens imbedded in glycerine-gelatine, transferred directly from formaline 4 per cent without being cleared or stained. The originals of figs. 3, 4, and 16, however, are borax-stained specimens mounted in Canada balsam.

All drawings from original material by Mr. Thorolv Rasmussen, draughtsman to the Fishery Board of Norway.

All depths in meters, when not otherwise stated.