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USSR Ichthyoplankton Investigations on Flemish Cap, 1978-83

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Abstract

Eggs and/or larvae of 41 species of fish were found in ichthyoplankton samples from spring and early summer surveys of Flemish Cap in 1978-81 and 1983. Redfish larvae were abundant during most of the surveys, but Atlantic cod and American plaice were relatively scarce. Redfish spawning was noted first on the northwestern and northeastern areas at depths of 350-800 m where water temperatures were 4° to 6°C. The abundance of redfish larvae increased during late April to early May. Spawning evidently was completed by late May, but the occurrence of newly-hatched larvae in late July indicated that some redfish may spawn during the summer. Upon rising to the near-surface layer after extrusion, the larvae drift eastward and southward from the spawning areas on the western and northern parts of the bank. Redfish larvae were found throughout the entire area in May with occasional concentrations entrained over the shallow central area of the bank by the anticyclonic gyre. Destruction of the gyre may be responsible for transporting large numbers of redfish larvae away from the Flemish Cap, as seems to have occurred in the spring of 1983. The scarcity of Atlantic cod and American plaice eggs made it impossible to discuss the patterns of egg and larvae distributions in relation to larval drift and variations in abundance, but the occasional presence of eggs over oceanic depths mainly to the south and southeast of Flemish Cap implies the loss of recruitment to the stocks. Strong year-classes of redfish, Atlantic cod and American plaice are unlikely to occur in years when the anticyclonic gyre is very weak or non-existent.

Introduction

Coordinated international investigations have been conducted on Flemish Cap since 1978 in an attempt to determine the causes of fluctuations in abundance of the major fish resources of the area. Flemish Cap is located to the east of the Grand Bank and is separated from it by a deepwater channel. The pattern of water circulation on Flemish Cap (Buzdalin and Elizarov, 1962; Kudlo and Burmakin, 1972; Hill *et al.*, 1975; Borovkov and Kudlo, 1980, MS 1981) predetermines the routes of passive migration of eggs and larvae and is responsible for the occurrence of isolated populations of Atlantic cod (*Gadus morhua*), Atlantic redfishes (*Sebastes* sp.) and American plaice (*Hippoglossoides platessoides*) in the area (Postolaky, 1962; Templeman, 1962, 1974, 1976; Serebryakov, 1967, MS 1978; Cross and Payne, 1978). The apparent isolation of the fish populations on Flemish Cap prompted the Standing Committee on Research and Statistics of the International Commission for the Northwest Atlantic Fisheries (ICNAF) to examine the feasibility of choosing Flemish Cap as an area for research on the reasons for fluctuations in year-class strength of cod and redfish (ICNAF, 1975). The ICNAF Environmental Working Group on the Flemish Cap Project met at Murmansk in May 1977 and developed a coordinated international research program, which was approved for execution at the 1977 Annual Meeting (ICNAF, 1977). At a later meeting of the Canadian Planning Group on the Flemish Cap Project, several hypotheses relevant to the influence of four principal factors (environmental conditions, predation, food availability, and state of the spawning population) on fluctuations in year-class abundance of cod and redfish were discussed, and the practical aspects of program realization were worked out (Akenhead, MS 1978).

Some results of the coordinated surveys in the Flemish Cap area have been published (Borovkov and Kudlo, 1980; Anderson and Akenhead, 1981), presented in preliminary reports (Postolaky, MS 1980; Kudlo and Borovkov, MS 1980; Anderson, MS 1982a, MS 1982b) or summarized (Konstantinov, MS 1980; Anderson MS 1983). This paper contains the results of ichthyoplankton surveys on Flemish Cap in 1978-83 by USSR research vessels from the Polar Research Institute of Marine Fisheries and Oceanography (PINRO), Murmansk.

Materials and Methods

The ichthyoplankton surveys on Flemish Cap were conducted in spring and early summer of 1978-81 and 1983 on a standard grid of stations. Two or three surveys were conducted annually. Ichthyoplankton was sampled with a conical plankton net (80 cm diameter opening and 0.5 mm mesh gauze). Three methods of towing were usually employed at each station: vertical haul from bottom (or 500 m) to surface, oblique haul from 25 or 50 m to surface, and near-surface haul (Table 1). The net was retrieved at 1 m/sec during the vertical hauls. Sampling at each station also included determination of temperature and salinity profiles from the surface to near-bottom depths.

In 1978, the near-surface and oblique hauls were made simultaneously with the vessel moving at a very low speed (0.1 knot) for 10 min. The nets were fastened to the same wire at 50 m apart. The near-surface net was towed with the upper edge of the hoop just below the surface. The other net, with a 20-kg weight, sampled at 25 m and obliquely to the surface as it was retrieved.

In 1979 and 1980, apart from the vertical and near-surface hauls, the 50-m depth level was sampled at each station during a 10-min haul at 2.5–3.0 knots and obliquely to the surface as the net was retrieved. In 1981, sampling consisted only of vertical hauls from the bottom (or 500 m) to the surface with the 80-cm conical net.

In 1983, the first two surveys employed the 80-cm conical net for the three types of hauls. During the third survey, the conical net was used for the vertical and near-surface hauls, and a 61-cm paired bongo sampler was used for the oblique hauls from 25 m to the surface.

Ichthyoplankton samples were preserved in 2-4% formalin and initial processing was carried out on the ship during the cruises. The ichthyoplankton was sorted under a binocular microscope, and the eggs and larvae were identified on the basis of egg and larval identification keys (Ehrenbaum, 1905-1909; Pertseva, 1936; Rass, 1949; Russell, 1976; Serebryakov, MS 1980). Developmental stages of eggs were determined according to Rass (1946). Larvae were measured as total length to the nearest millimeter.

Data from the vertical hauls, which were standard on all cruises with the 80-cm conical plankton net, were used to determine the numbers of eggs and larvae in the water column under one square meter (m^2) of the surface at each station for plotting on the distribution maps. Total abundance of redfish larvae was determined by applying the stratification method of Buchanan-Wollastone (1926). The data from the vertical and other hauls at each station were used to show the species composition of all fish eggs and larvae in the plankton samples and the length frequencies of redfish larvae.

Results and Discussion

Species composition of ichthyoplankton

More than 26 species of fish had been reported to occur in ichthyoplankton samples from Flemish Cap (Serebryakov, MS 1978). Sixteen species were recorded during a survey by the Polish research vessel *Wieczno* in April 1978 (Grimm *et al*., MS 1980). During the 13 surveys in 1978–81 and 1983, the eggs and/or larvae of at least 41 fish species (belonging to 16 families) were recorded (Appendix Tables A, B, C and D). Larvae that were recorded for the first time on Flemish Cap include the wolffishes *Anarhichas denticulatus* and *A. lupus*, the argentine *Nansenia groenlandica*, the gonostomatid *Maurolicus muelleri*, the congrid *Conger conger*, and the stichaeid *Leptoclinus maculatus*. The prevalence of cusk (*Brosme brosme*) eggs in

TABLE 1. Time and extent of ichthyoplankton surveys on Flemish Cap in 1978–81 and 1983.

Year	Dates of sampling	Number of stations	Sampling gear	Number of hauls: Vertical	Surface	0–25 (m)	0–50 (m)
1978	25 May-02 Jun	39	CN-80	45	38	38	—
	17-29 Jul	45	CN-80	58	38	38	—
1979	07-20 Apr	42	CN-80	55	40	—	40
	03-10 May	42	CN-80	53	39	—	39
1980	19-31 Mar	54	CN-80	53	48	—	48
	02-12 May	56	CN-80	53	48	—	48
	31 May-11 Jun	61	CN-80	61	55	—	55
1981	22 Mar-05 Apr	47	CN-80	47	—	—	—
	23-30 Apr	48	CN-80	48	—	—	—
	21-30 May	48	CN-80	48	—	—	—
1983	08-22 Mar	38	CN-80	37	31	36	—
	16-29 Apr	80	CN-80	80	80	79	—
	24-31 May	41	CN-80	41	41	—	—
			Bongo-61	—	—	—	41

various developmental stages, particularly stage I, indicated that this species spawns on Flemish Cap.

Of the commercially-important species on Flemish Cap, redfish larvae represented the most abundant component of the ichthyoplankton during the seasons and years in which the surveys were conducted. American plaice eggs and/or larvae were found in the ichthyoplankton samples during most of the surveys, and their numbers generally exceeded the numbers of Atlantic cod eggs and larvae, which were unexpectedly scarce.

Atlantic redfish (*Sebastes* sp.)

Although two species of redfish (*Sebastes mentella* and *S. marinus*) are known to occur on Flemish Cap, the redfish larvae were not classified by species and are presented in this paper as *Sebastes* sp., because of the difficulty and considerable effort that would be involved in their separation (Serebryakov, MS 1978; Templeman, 1980; Magnusson, 1981; Penney, MS 1982).

Larval distribution and abundance. Redfish larvae were observed in each of the three surveys that were conducted in March (1980, 1981 and 1983). Larvae were found over the southwestern slope of Flemish Cap in 1980 and 1981, with maximal densities of 60 and 78 larvae/m^2 respectively (Fig. 1B, C), and at a station on the northern part of the bank in 1983 (Fig. 1A). From the March surveys, the estimated abundance of larvae over the entire area was 0.25×10^{12} in 1980 and 0.19×10^{12} in 1981, in contrast to 0.06×10^{12} in 1983 (Table 2).

Distribution of redfish larvae in the early April 1979 survey (Fig. 1D), apart from the greatly increased densities, was similar to that in late March 1980, with maximal values (180–200 larvae/m^2) over the southwestern slope. Other concentrations with values exceeding 100 larvae/m^2 were observed over the northwestern and southeastern areas of the bank. Overall abundance at that time was estimated to be 1.62×10^{12} larvae (Table 2).

In the second half of April, surveys were conducted in 1981 and 1983. In 1981 (Fig. 1F), the greatest

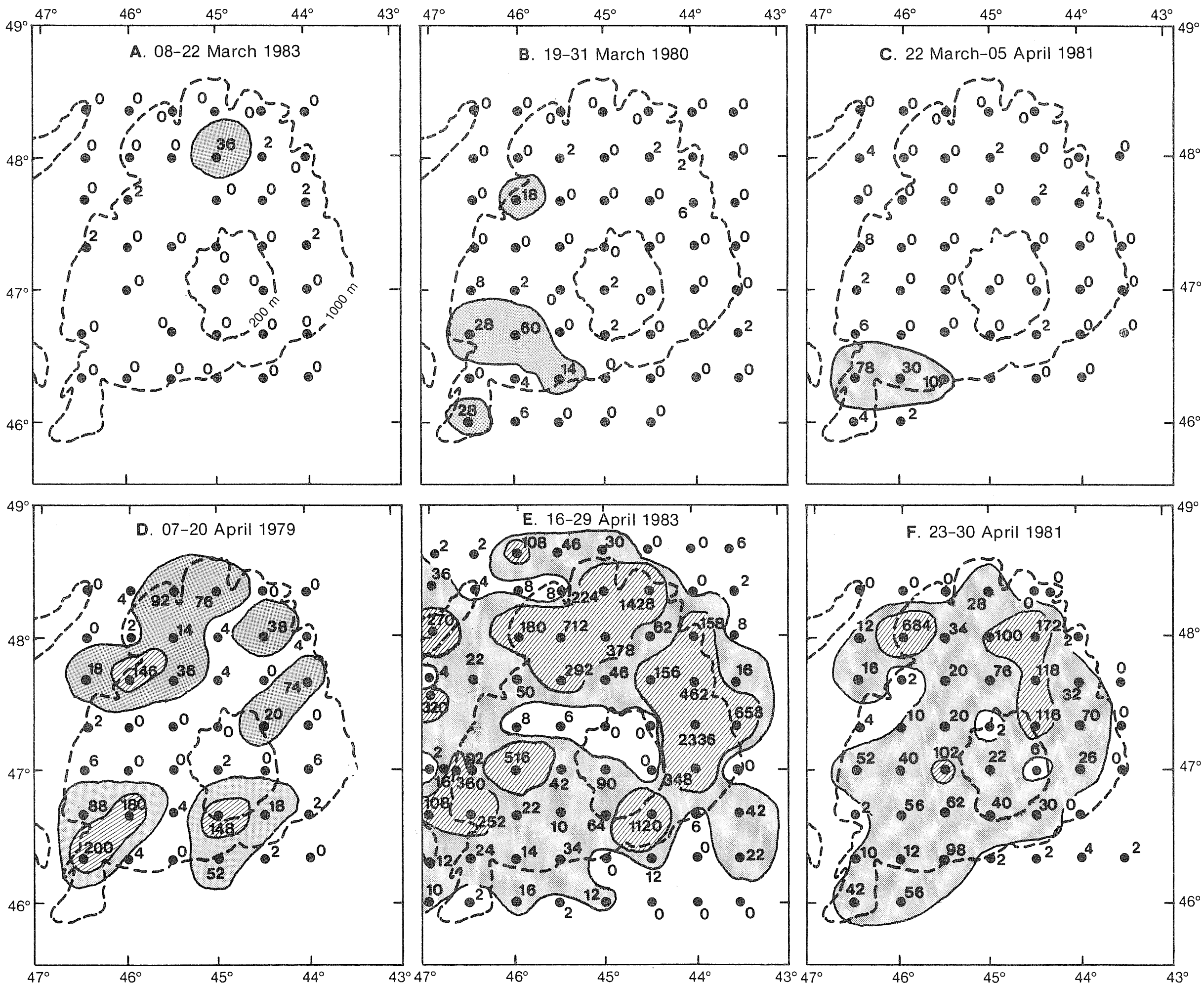

Fig. 1. Distribution and abundance (number/m^2) of redfish larvae in 13 ichthyoplankton surveys on Flemish Cap, 1978–81 and 1983, arranged in order of monthly dates from March to July.

Fig. 1. (cont'd) Distribution and abundance (number/m²) of redfish larvae in 13 ichthyoplankton surveys on Flemish Cap, 1978–81 and 1983, arranged in order of monthly dates from March to July.

concentrations of redfish larvae occurred at one station (>600/m^2) on the northwestern slope and at several stations (100–172/m^2) on the northeastern slope of Flemish Cap over depths of 300–1,000 m. In 1983 (Fig. 1E), great numbers of larvae (>1,000/m^2) were observed on the northeastern, eastern and southeastern areas, with somewhat smaller concentrations on the southwestern slope. Overall larval abundance in 1983 (15.37×10^{12}) was five times greater than in 1981 (3.03×10^{12}) (Table 2).

TABLE 2. Estimated abundance of redfish larvae in the surveyed area and range of water temperature during ichthyoplankton surveys of Flemish Cap, 1978-81 and 1983.

Mid-date of cruise	Year of survey	Number of stations	Survey abundance ($N \times 10^{12}$)	Temperature at 50-m depth (min-max, °C)
15 Mar	1983	38	0.06	0.7 to 6.3
25 "	1980	54	0.25	1.3 to 7.5
29 "	1981	47	0.19	0.2 to 9.0
14 Apr	1979	42	1.62	1.8 to 8.0
18 "	1983	71	15.37	-0.2 to 5.3
27 "	1981	48	3.03	1.9 to 6.1
07 May	1979	42	4.38	0.1 to 9.1
08 "	1980	56	3.54	0.7 to 10.5
25 "	1981	48	0.79	1.7 to 7.7
27 "	1983	40	1.59	-1.3 to 11.3
29 "	1978	39	1.46	1.1 to 10.3
06 Jun	1980	61	2.89	1.3 to 6.3
20 Jul	1978	45	0.08	0.1 to 14.6

In the first half of May, surveys were conducted in 1979 and 1980. In 1979 (Fig. 1G), the greatest concentrations of redfish larvae (>100/m^2) were found at several stations over depths of 300–400 m in the northern and northeastern area, at two stations over 200–300 m in the southwestern area and at one station in the southeastern quadrant where the depth exceeded 1,000 m. In 1980 (Fig. 1H), the greatest concentrations of larvae were found in a wide band from north to south on the eastern half of the bank. Numbers of larvae in the surveyed area were estimated to be 4.38×10^{12} in 1979 and 3.54×10^{12} in 1980 (Table 2).

In the second half of May, surveys were conducted in 1978, 1981 and 1983. In 1978 (Fig. 1K), maximal numbers of redfish larvae (>100/m^2) occurred to the north, east and south of the shallow central area, with lesser concentrations (10–100 m^2) over a broad area. In 1981 (Fig. 1I), larvae were distributed mainly within the 400 m isobath to the west and north of the central area. In 1983 (Fig. 1J), small concentrations occurred to the west and north of the central area, but a station over the 800 m isobath on the southeastern slope yielded 800 larvae/m^2. Overall abundance in late May of these years ranged from 0.79×10^{12} to 1.59×10^{12} larvae (Table 2).

During the June 1980 survey (Fig. 1L), redfish larvae (>10/m^2) were distributed widely throughout most of the Flemish Cap area and over depths exceeding 1,000 m on the northeastern and southeastern slopes. Maximal densities (>100/m^2) occurred at one station on the southwestern slope and at another on the central plateau. During the July 1978 survey (Fig. 1M), small concentrations were found on western and eastern Flemish Cap over depths of 300–400 m. Overall abundance was estimated to be 2.89×10^{12} larvae in early June 1980 and 0.08×10^{12} larvae in July 1978 (Table 2).

Size distribution of larvae. Redfish length distributions during the March and early April surveys (Fig. 2A, B, C, D) indicate that the larvae in March 1983 were newly-extruded and that those in late March and early April with modes at 7 or 8 cm were recently extruded. In the late April surveys (Fig. 2E, F), the mode was at 9 cm in 1981 but only at 7 cm in 1983 when the greatest concentrations were observed (Fig. 1E). In the early May surveys of 1979 and 1980 (Fig. 2G, H), 8–9 cm larvae were dominant in both years, whereas 9–11 cm larvae (mode at 10 cm) were the prevailing groups in the late May surveys (Fig. 2I, J, K). However, in early June 1980 (Fig. 2L), the mode was lower at 9 cm. In late July 1978, both recently-extruded (6-8 cm) and larger (9–15 cm) larvae were represented in the catches (Fig. 2M).

Spawning. A fairly accurate picture of redfish spawning areas and times on Flemish Cap may be obtained by examining the larval distribution maps (Fig. 1), larval length frequencies (Fig. 2), distributions of spawning females (Fig. 3), and data on relative abundance of larvae during the various surveys. Evidently, redfish began spawning about mid-March in the southwestern Beothuk Knoll area, as well as on the northwestern and northern slopes of Flemish Cap, where newly-extruded larvae (Fig. 1A, B, C) and spawning females (Fig. 3A) were found. In April, spawning females were distributed practically everywhere on the slopes of the bank in 600–1,000 m (Fig. 3B). Peak spawning probably occurred from mid-April to early May, as indicated by the abundance and widespread distribution of larvae during the surveys in this period (Fig. 1D, E, F) and the prevalence of newly-hatched (5-7 mm) larvae in April and recently-hatched (7-9 mm) larvae in early May (Fig. 2). Spawning evidently occurred on all slopes of Flemish Cap, but larvae were extruded most intensively on the southwestern, northwestern and northern slopes. The scarcity of small larvae in the late May samples indicated that spawning was over by that time. However, some spawning occurred in July, as evidenced by the bimodal nature of the length frequency and the prevalence of 6-8 mm larvae in the late July sample (Fig. 2M). Extrusion of larvae probably occurs in depths of 350-800 m where water temperatures are 4° to 6°C.

After extrusion in March–April, redfish larvae move to the upper water layers (<50 m) and drift with the currents. They drift eastward from the spawning grounds on the southwestern slope and southeastward from the spawning grounds on the northwestern and northern slopes. These directions of drift can be inferred from changes in length composition of larvae on different parts of the bank during the same survey (Fig. 4) with larger larvae in the eastern than in the western quadrants, and from shifting of the patches of

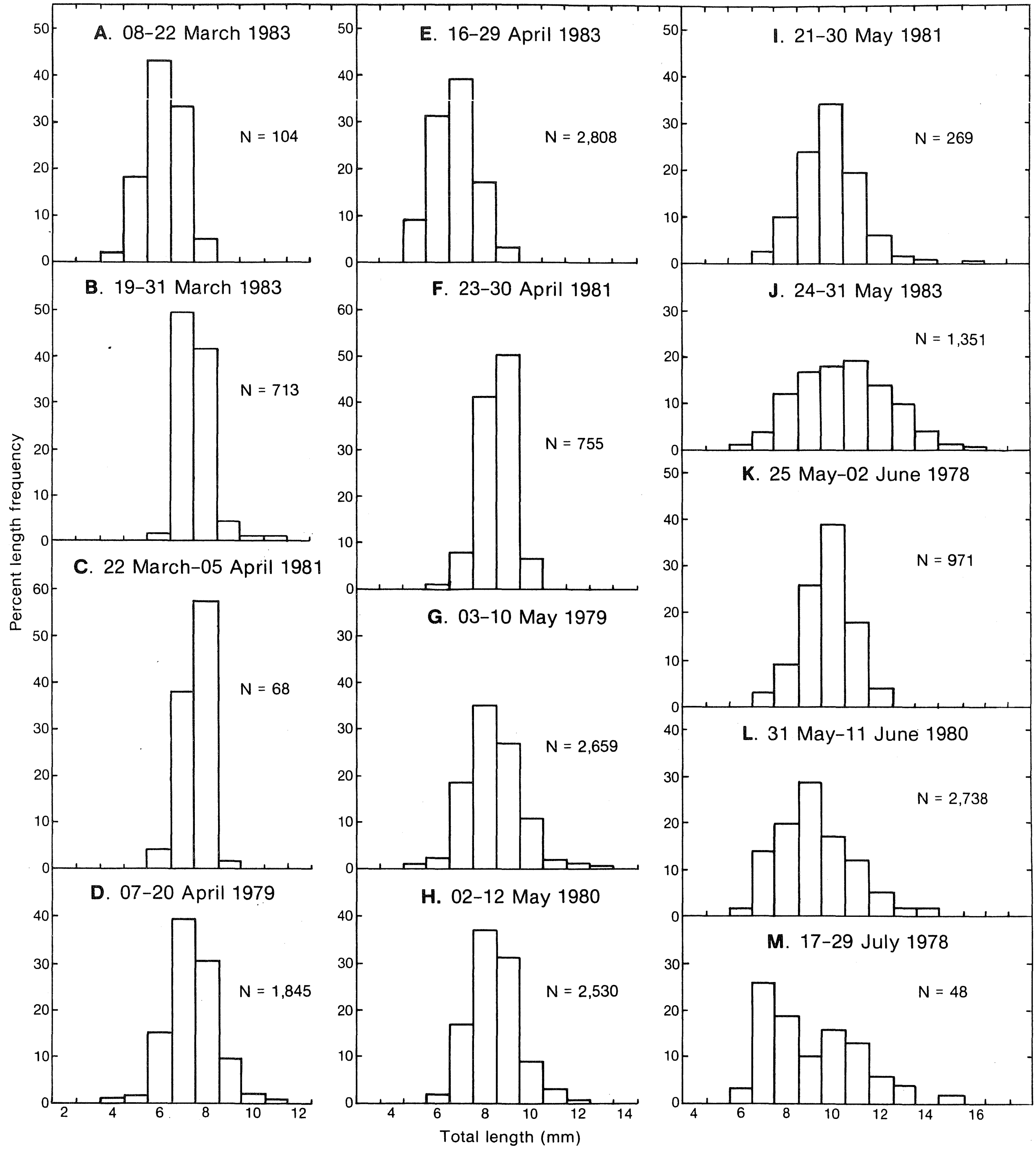

Fig. 2. Length distributions (%) of redfish larvae in 13 ichthyoplankton surveys on Flemish Cap, 1978-81 and 1983, arranged in order of monthly dates from March to July.

highest larval concentrations (Fig. 1). In May, redfish larvae were usually distributed over the entire bank, their drift having been facilitated by the anticyclonic gyre. Patches of relatively high concentrations of large larvae (>9 mm) were observed over the shallow central area of the bank in late May and early June (Fig. 1, 2).

Not all situations fit this pattern of larval redfish distribution and drift on the Flemish Cap. For instance in late May 1983 (Fig. 1J), larval density was 800/m^2 at a station near the 1,000-m isobath on the southeastern slope. These larvae were mostly 9-12 mm (Fig. 2J) and had probably drifted there from the northern slope

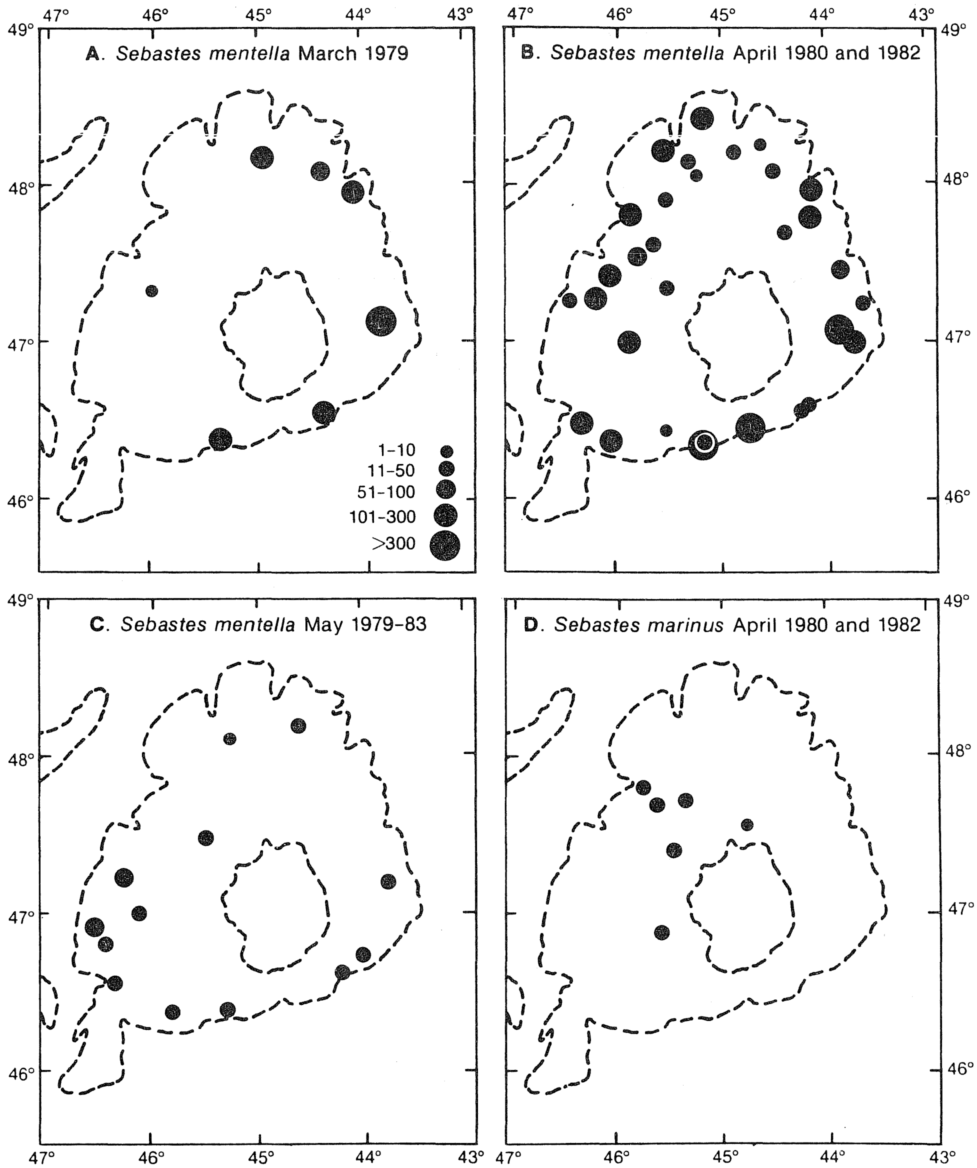

Fig. 3. Distributions of spawning female redfish (*Sebastes mentella*) in (**A**) March 1979, (**B**) April 1980 and 1982, (**C**) May 1979-83, and *Sebastes marinus* in (**D**) April 1980 and 1982, based on number per hour during bottom-trawl surveys on Flemish Cap.

where they were extruded. The possibility of ichthyoplankton extrusion from Flemish Cap has been noted by others (Serebryakov, 1967, MS 1978; Templeman, 1976; Kudlo and Borovkov, 1977; Kudlo and Boytsov, 1979). Kudlo *et al.* (1984), in discussing the stability of the anticyclonic quasi-steady gyre in the Flemish Cap area, distinguished four types of water circulation on the bank, two of which were associated with the presence of the anticyclonic gyre and the other two with an eastward meandering flow across the bank. The frequency of the "meandering flow" types was 33% in 27 oceanographic surveys during 1977–82. The occurrence of ichthyoplankton concentrations on the southeastern slope of Flemish Cap may be the result of an eastward or southeastward drift of larvae from spawning areas on the western and northern slopes during periods when the anticyclonic gyre is very weak or non-existent and the meandering easterly flow is prevalent. Under such conditions, large numbers of larvae would be transported away from Flemish Cap, thus accounting for considerable variability in year-class strength. In years when the anticyclonic gyre persisted during the spring and summer months, there would be the tendency for the eggs and larvae to be retained on the bank.

Atlantic cod (*Gadus morhua*)

Distribution of eggs and larvae. The number of cod eggs in the Flemish Cap ichthyoplankton samples from

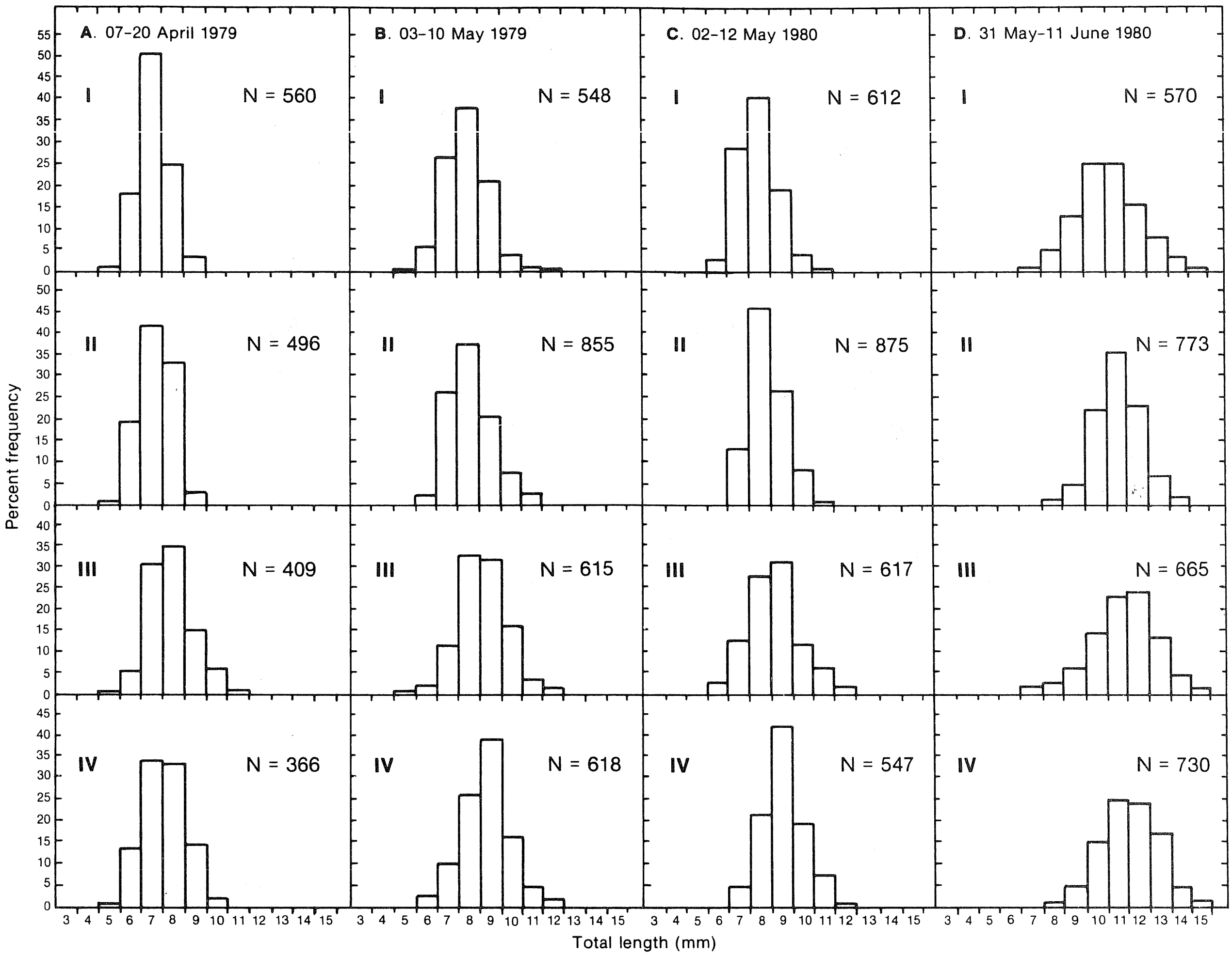

Fig. 4. Typical length distributions (%) of redfish larvae by quadrants (I, northwest; II, southwest; III, northeast; IV, southeast) from representative surveys on Flemish Cap.

each of the 13 surveys was very low (Fig. 5), the largest catch being 36 eggs/m^2 on the western part of the bank in March 1980 (Fig. 5C). Cod eggs (34/m^2) were also found on the southwestern area in March 1981 (Fig. 5D), with smaller numbers along the western part of the bank to the northwestern slope. Cod eggs were not observed during the March 1983 survey (Fig. 5E). During the April surveys, cod eggs were not found in 1979, and only small numbers occurred in 1981 and 1983, with widespread distribution over the bank (Fig. 5D, E). Scattered eggs were observed in May 1980 and 1983 (Fig. 5C, E) and some were found in July 1978 (Fig. 5A). In 1980 and 1981, some cod eggs were found at stations over oceanic depths south and west of the Flemish Cap.

Cod larvae were very scarce during the surveys, the largest catch being 12/m^2 in May 1979 over the southwestern slope. In April, May and June, the few larvae were distributed within the 400 m isobath and were closer to the shallow central area in the progressively later surveys.

Spawning. The distributions of cod eggs (Fig. 5) and spawning females (Fig. 6) confirms the previously-published data which show that cod spawning on Flemish Cap occurs mainly in March (Mankevich, 1962; Postolaky, 1963; Serebryakov, 1965, 1967; Templeman, 1976). In 1983, the peak of spawning may have shifted to April (Fig. 5E). However, the scarcity of cod eggs and larvae in all surveys made it impossible to discuss the patterns of egg and larval distributions in relation to larval drift and variability in seasonal and annual abundance. A noteworthy observation in 1980 and 1981 was the occurrence of eggs outside the 1,000-m isobath to the west and south of the bank (Fig. 4C, D) as a result of current movements. This has been mentioned previously (Serebryakov, 1962, 1965, 1967, MS 1978) and seems to be an important factor in determining success and failure of year-classes.

American plaice (*Hippoglossoides platessoides*)

Distribution of eggs and larvae. Although American plaice eggs were observed occasionally on the

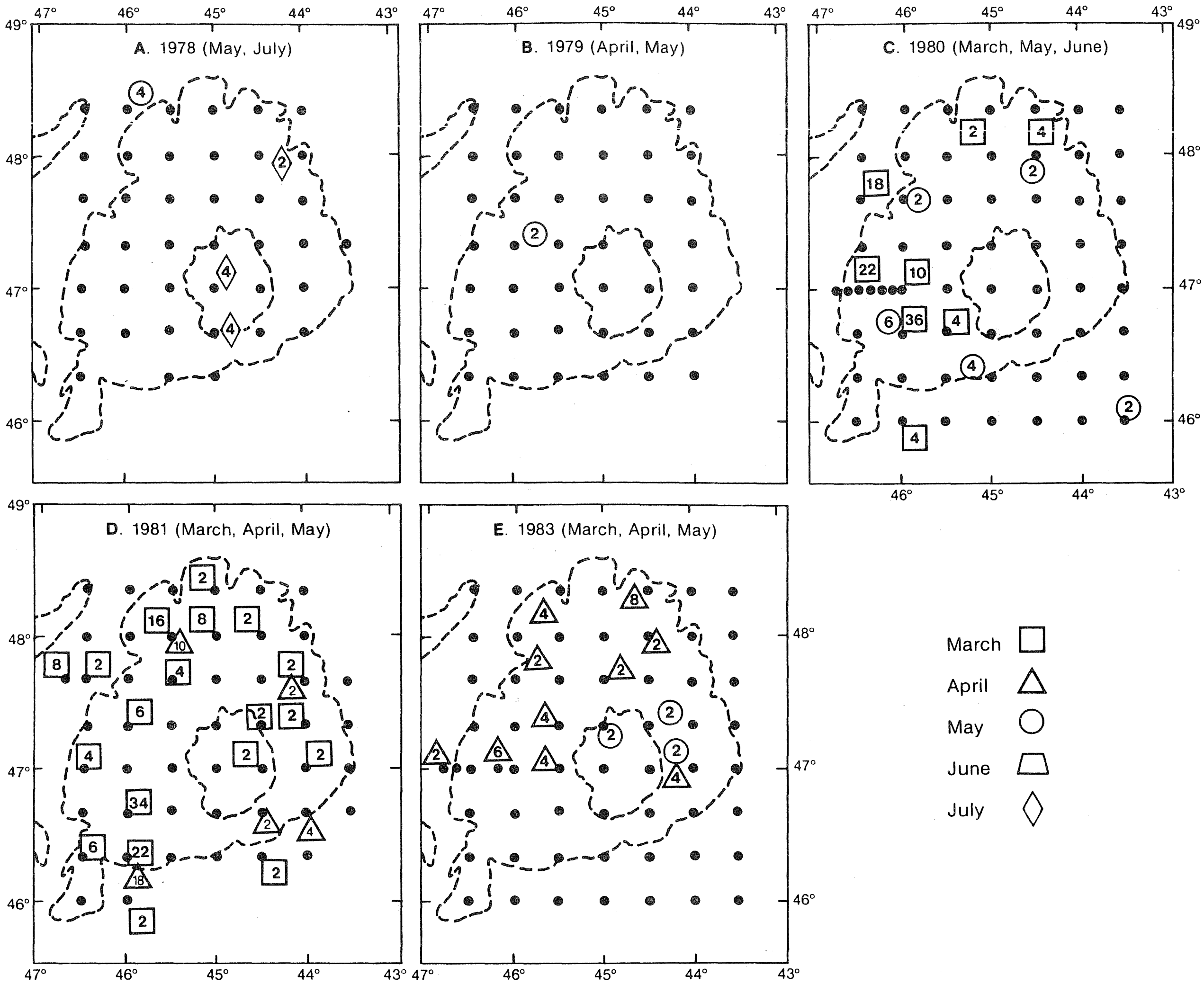

Fig. 5. Distribution and abundance (number/m²) of Atlantic cod eggs in ichthyoplankton surveys on Flemish Cap, 1978–81 and 1983.

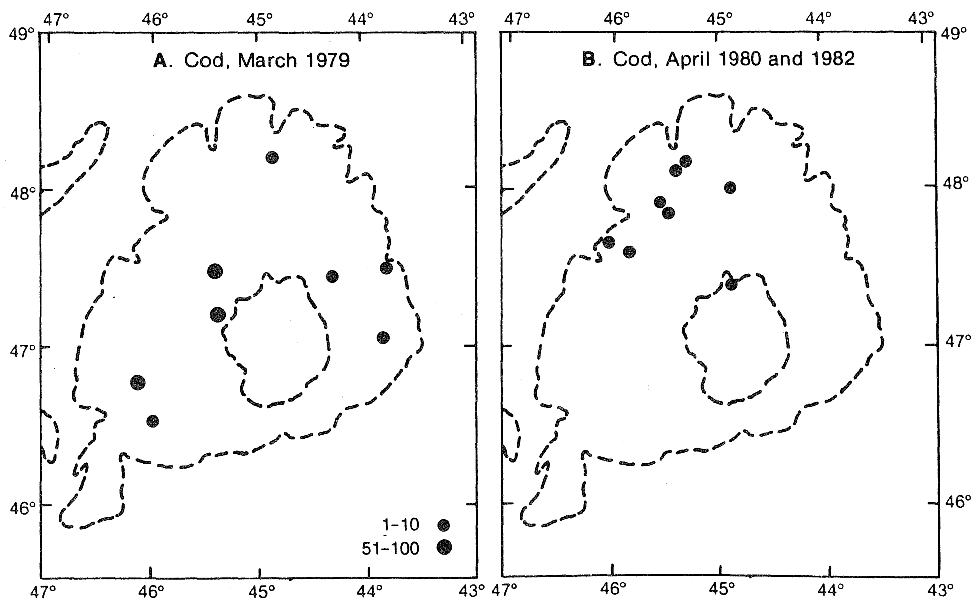

Fig. 6. Distribution of spawning female Atlantic cod in (**A**) March 1979 and (**B**) April 1980 and 1982, based on number per hour during bottom-trawl surveys on Flemish Cap.

central part of Flemish Cap in March and April (Fig. 7), they were chiefly found in May on the central plateau and over the western half of the bank. Maximal densities (larvae/m^2) were 36 in May 1978, 52 in May 1979, 22 in May 1980, 12 in April and May 1981 and 50 in April 1983. A few eggs were found over oceanic depths southeast of the bank in 1979. Larvae were taken only twice during the surveys.

Spawning. The distributions of American plaice eggs (Fig. 7) and spawning females (Fig. 8) indicate that most of the spawning on Flemish Cap occurs in May. Extrusion of eggs evidently takes place on and near the shallow central area, as has been noted previously by others (Nevinsky and Serebryakov, 1973; Templeman, 1976; Serebryakov, MS 1978). However, the numbers of eggs and larvae from the 1978–83 surveys were too small to draw any conclusions on the peculiarities of production and early ontogenesis of American plaice on Flemish Cap. The differing patterns of water circulation (Kudlo *et al.*, 1984) influence the distribution of eggs and larvae, many of which drift away from the bank (e.g. Fig. 7B) under certain hydrographic conditions.

Conclusions

From the ichthyoplankton surveys of Flemish Cap during the spring and early summer months of 1978–81 and 1983, eggs and/or larvae of 41 fish species were identified. The major component of the ichthyoplankton samples was redfish (*Sebastes* sp.) larvae, with eggs and larvae of Atlantic cod and American plaice being comparatively scarce.

Redfish spawning seemed to start on the southwestern slope in the vicinity of Beothuk Knoll and to occur later along the northwestern and northeastern slopes. Extrusion of larvae evidently began about mid-

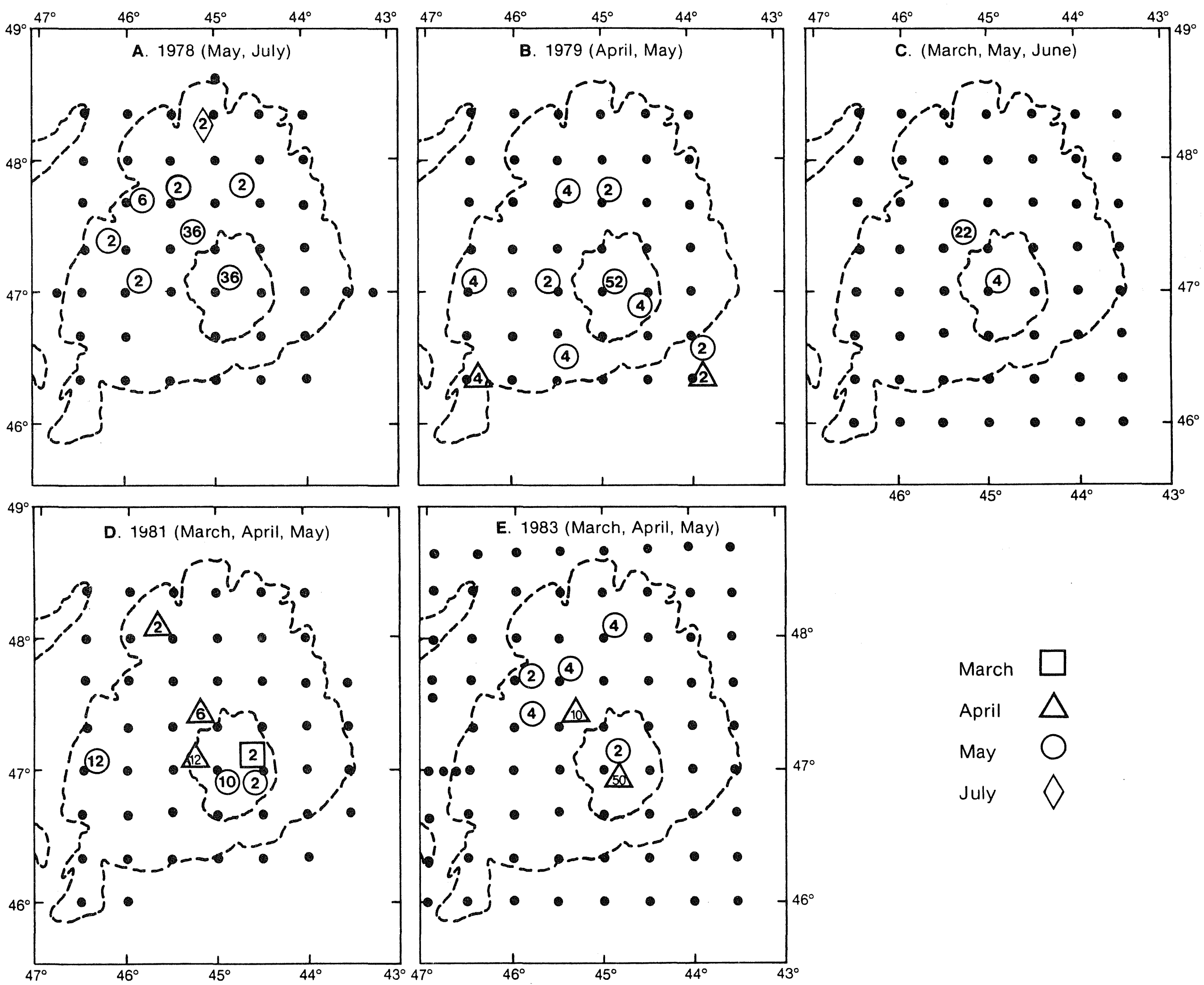

Fig. 7. Distribution and abundance (number/m^2) of American plaice eggs in ichthyoplankton surveys on Flemish Cap, 1978-81 and 1983.

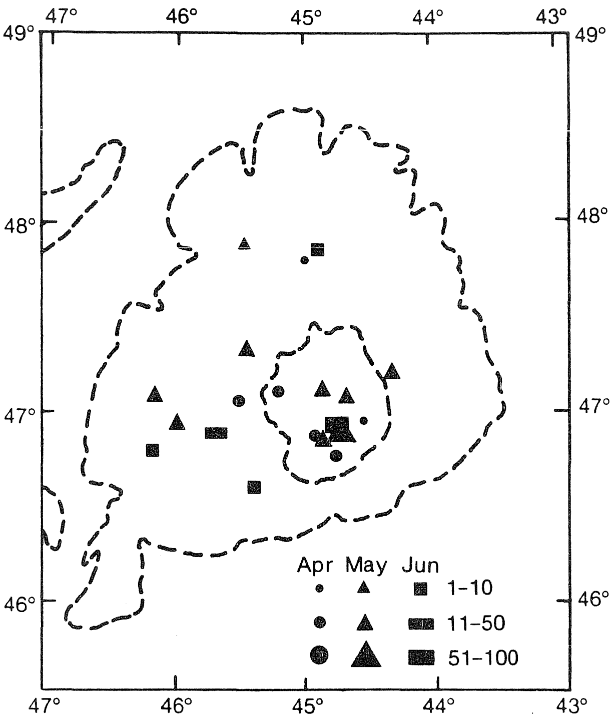

Fig. 8. Distribution of spawning female American plaice, based on number per hour during bottom-trawl surveys on Flemish Cap, 1979-81 and 1983.

March in depths of 350-800 m where water temperatures were 4° to 6°C. The abundance of larvae increased from March to April and reached a maximum in late April. Major spawning was essentially finished in May, but there was evidence of a small amount of spawning in July.

The extruded larvae which rise to the near-surface layer (10-20 m) may be entrained by the anticyclonic gyre and transported to the shallow central area of the bank. However, under certain hydrographic conditions (e.g. breakdown of the anticyclonic gyre), the larvae may drift eastward or southeastward from the western and northern spawning grounds respectively and be transported away from the Flemish Cap. This is likely to have occurred in May 1983. The stability of the anticyclonic gyre and favorable environmental conditions may be responsible for year-class success in the redfish, cod and American plaice populations on Flemish Cap, and good year-classes are unlikely when the gyre is weak or non-existent.

The ichthyoplankton studies on Flemish Cap have demonstrated the feasibility of the surveys to elucidate the causes of fluctuations in year-class abundance of redfish. In order to estimate abundance of the redfish populations, standard ichthyoplankton surveys should be carried out from mid-April to mid-May, practical methods for identification of *Sebastes* sp. larvae should be developed, and data should be collected on the maturation and fecundity of individual redfish by species and age-group.

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Appendix

TABLE A. Species composition of ichthyoplankton on Flemish Cap from surveys in 1978 and 1979.

Family / Species	25 May-2 Jun 1978					17-29 Jul 1978					7-20 Apr 1979					3-10 May 1979				
	Eggs by stage				Larvae	Eggs by stage				Larvae	Eggs by stage				Larvae	Eggs by stage				Larvae
	I	II	III	IV		I	II	III	IV		I	II	III	IV		I	II	III	IV	
Ammodytidae																				
Ammodytes dubius	—	—	—	—	4	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Anarhichadidae																				
Anarhichas denticulatus	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—
Anarhichas lupus	—	—	—	—	1	—	—	—	—	—	—	—	—	—	1	—	—	—	—	2
Argentinidae																				
Argentina silus	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Nansenia groenlandica	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Congridae																				
Conger conger	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—
Cottidae																				
Myoxocephalus scorpius	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—
Triglops murrayi	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—
Gadidae																				
Brosme brosme	14	7	1	—	—	—	—	—	—	—	—	—	—	—	—	53	9	4	—	—
Gadus morhua	1	1	9	—	—	9	15	6	—	—	2	1	—	—	11	5	—	—	—	18
Melanogrammus aeglefinus	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	1	—	—	—
Molva molva	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—
Rhinonemus cimbrius	4	—	—	—	—	—	—	—	—	—	—	—	—	—	4	—	—	—	—	3
Urophycis chuss	—	—	—	—	—	—	—	—	—	—	3	—	—	—	20	—	—	—	—	10
Gonostomatidae																				
Cyclothone sp.	—	—	—	—	7	—	—	—	—	14	—	—	—	—	2	—	—	—	—	12
Maurolicus mulleri	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1
Myctophidae																				
Benthosema glaciale	—	—	—	—	5	—	—	—	—	16	—	—	—	—	69	—	—	—	—	9
Pleuronectidae																				
Glyptocephalus cynoglossus	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—
Hippoglossoides platessoides	127	172	33	4	—	—	—	—	1	—	3	—	1	—	—	100	61	1	—	—
Hippoglossus hippoglossus	—	—	—	—	—	—	—	—	—	—	7	2	—	—	—	1	2	4	—	—
Limanda ferruginea	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	1	2
Scorpaenidae																				
Sebastes sp.	—	—	—	—	3518	—	—	—	—	111	—	—	—	—	23154	—	—	—	—	56901
Stichaeidae																				
Leptoclinus maculatus	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	4
Lumpenus lumpretaeformis	—	—	—	—	—	—	—	—	—	—	—	—	—	—	3	—	—	—	—	1
Lumpenus sp.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	1

TABLE B. Species composition of ichthyoplankton on Flemish Cap from surveys in 1980.

Family / Species	19-31 Mar 1980					2-12 May 1980					31 May-11 Jun 1980				
	Eggs by stage				Larvae	Eggs by stage				Larvae	Eggs by stage				Larvae
	I	II	III	IV		I	II	III	IV		I	II	III	IV	
Ammodytidae															
Ammodytes dubius	—	—	—	—	—	—	—	—	—	8	—	—	—	—	—
Anarhichadidae															
Anarhichas lupus	—	—	—	—	—	—	—	—	—	4	—	—	—	—	—
Anarhichas minor	—	—	—	—	—	—	—	—	—	2	—	—	—	—	2
Argentinidae															
Argentina silus	—	—	—	—	—	—	—	—	—	2	—	—	—	—	2
Bathylagidae	—	—	—	—	—	—	—	—	—	2	—	—	—	—	—
Cottidae															
Myoxocephalus scorpius	—	—	—	—	3	—	—	—	—	—	—	—	—	—	—
Gadidae															
Brosme brosme	—	—	—	—	—	16	2	1	6	—	—	—	—	—	—
Gadus morhua	13	11	29	2	1	21	16	4	3	—	—	—	—	—	4
Molva molva	4	—	—	—	—	2	3	9	—	10	2	1	2	1	—
Rhinonemus cimbrius	—	—	—	—	—	2	—	—	—	6	4	1	2	—	3
Urophycis chesteri	—	—	—	—	2	—	—	—	—	1	—	—	—	—	3
Urophycis tenuis	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1
Urophycis sp.	—	—	—	—	—	—	—	—	—	4	—	—	—	—	6
Gonostomatidae															
Cyclothone sp.	—	—	—	—	5	—	—	—	—	7	—	—	—	—	5
Maurolicus mulleri	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—
Myctophidae															
Benthosema glaciale	—	—	—	—	5	—	—	—	—	21	—	—	—	—	24
Diogenichthys atlanticus	—	—	—	—	—	—	—	—	—	16	—	—	—	—	—
Notoscopelus sp.	—	—	—	—	2	—	—	—	—	—	—	—	—	—	—
Osmeridae															
Mallotus villosus	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—
Pleuronectidae															
Hippoglossoides platessoides	59	22	—	—	—	185	66	9	2	—	1	—	—	—	—
Scombridae															
Thunnus atlanticus	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—
Scorpaenidae															
Sebastes sp.	—	—	—	—	6368	—	—	—	—	33639	—	—	—	—	28533
Stichaeidae															
Lumpenus lumpretaeformis	—	—	—	—	4	—	—	—	—	1	—	—	—	—	1
Unidentified stichaeids	—	—	—	—	—	—	—	—	—	—	—	—	—	—	3

TABLE C. Species composition of ichthyoplankton on Flemish Cap from surveys in 1981.

Family / Species	22 Mar-5 Apr 1981					23-30 Apr 1981					21-30 May 1981				
	Eggs by stage				Larvae	Eggs by stage				Larvae	Eggs by stage				Larvae
	I	II	III	IV		I	II	III	IV		I	II	III	IV	
Gadidae															
Brosme brosme	—	—	—	—	—	1	—	1	—	1	1	—	—	—	—
Gadus morhua	27	26	13	3	—	7	6	4	1	5	—	—	—	—	2
Melanogrammus aeglefinus	—	2	—	—	—	1	—	1	—	—	—	—	—	—	—
Gonostomatidae															
Cyclothone sp.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2
Myctophidae															
Unidentified myctophids	—	—	—	—	1	—	—	—	—	1	—	—	—	—	6
Pleuronectidae															
Hippoglossoides platessoides	1	—	—	—	—	8	2	—	—	—	12	—	—	—	—
Scorpaenidae															
Sebastes sp.	—	—	—	—	77	—	—	—	—	1096	—	—	—	—	285
Stichaeidae															
Chirolophus ascani	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1

TABLE D. Species composition of ichthyoplankton on Flemish Cap from surveys in 1983.

Family	8-22 Mar 1983					16-29 Apr 1983					24-31 May 1983				
	Eggs by stage				Lar-	Eggs by stage				Lar-	Eggs by stage				Lar-
Species	I	II	III	IV	vae	I	II	III	IV	vae	I	II	III	IV	vae
Ammodytidae															
Ammodytes dubius	—	—	—	—	—	—	—	—	—	11	—	—	—	—	3
Anarhichadidae															
Anarhichas minor	—	—	—	—	1	—	—	—	—	1	—	—	—	—	—
Chauliodontidae															
Chauliodes sloani	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—
Gadidae															
Brosme brosme	1	—	—	—	—	11	4	—	1	—	8	1	—	—	—
Gadus morhua	30	46	17	6	—	31	23	6	14	19	—	3	4	1	3
Pollachius virens	—	—	—	—	—	—	—	—	—	3	—	—	—	—	2
Urophycis chuss	—	—	—	—	—	—	—	—	—	2	—	—	—	—	—
Gonostomatidae															
Cyclothone braueri	—	—	—	—	15	—	—	—	—	—	—	—	—	—	1
Unidentified gonostomatids	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1
Myctophidae															
Benthosema glaciale	—	—	—	—	27	—	—	—	—	16	—	—	—	—	21
Ceratoscopelus maderensis	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—
Myctophum punctatum	—	—	—	—	—	—	—	—	—	1	—	—	—	—	1
Protomyctophum arcticum	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—
Unidentified myctophids	—	—	—	—	1	—	—	—	—	—	—	—	—	—	9
Pleuronectidae															
Hippoglossoides platessoides	6	—	—	—	—	366	400	20	3	789	—	7	5	—	9
Limanda ferrunginea	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Scombridae															
Scomber scombrus	—	—	—	—	—	—	—	—	—	45	—	—	—	—	—
Scorpaenidae															
Sebastes sp.	—	—	—	—	115	—	—	—	—	11428	—	—	—	—	4993
Sternoptychidae															
Argyropelecus olfersii	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1
Stichaeidae															
Lumpenus lumpretaeformis	—	—	—	—	1	—	—	—	—	1	—	—	—	—	1