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Results of Investigations on Deep-sea Redfish

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Introduction

Redfish (Sebastes mentella Travin) is one of the main commercial objects in the Northwest Atlantic (Table 1).

As Table 1 shows, the intensive fishery for redfish in the Labrador and Newfoundland areas started developing in 1952 and in 1959 reached its maximum - about 300,000 tons. Since 1960 the catch has decreased in amount more than four times.

Many investigators state a very important fact that, while the banks are being exploited the size composition of redfish changes insignificantly. Templeman believes that this fact may be explained by the peculiarities of redfish distribution by depths as the fishery is carried out on stocks only at certain depths where the groups of fish of similar sizes concentrate.

Taaning, taking into account the data on wide distribution of larvae and young redfish in the open part of the ocean and beyond the limits of the continental slope and also the single specimens of adult redfish caught above the ocean depths, hypothesized the presence of great concentrations of pelagic redfish of commercial sizes. These hypotheses greatly affected the trend and course of investigations.

Successful attempts were made to find redfish concentrations in the slope area at depths greater than those where the fishery was previously carried out.

During the last two years, vessels of the German Democratic Republic and Polish People's Republic periodically carried out a fishery for redfish at great depths in the North Newfoundland area.

As Voss and Draffehn ("Fischereiforschung", Heft 1, 1963) report, in July-August 1963, the vessels of GDR and PPR made large catches of redfish on the eastern slope of Ritu Bank at 600-800 m. From 17-31 July, the average daily catch by Polish vessels was 33.4 tons and from 1-11 August 21.6 tons. Redfish were large (mode 41-43 cm) and immature.

Results

In 1962-63, the Murman research-scouting vessels regularly made hauls at depths of 500-700 m but, due to insufficient and scattered data, no important results on the deep-sea distribution of redfish during these years were obtained.

In 1964, the investigations on redfish at great depths were carried out on a large scale. In June 1964, fish concentrations at 600-800 m in the North Newfoundland area were found by the side-trawler POBEDA (the vessel of side-trawling). Concentrations of relatively large redfish were met north-east of Ritu Bank at 600-700 m (near-bottom temperature was 3.7°C). Catches ranged up to 5 tons per two hours trawling. At 700 m, catches decreased to 1 ton. Research in the area continued from 16-18 June during which time the size of the catches did not change.

Similar redfish concentrations were found by the scouting vessel NOVOROSSIISK at 500-600 m on northeastern Hamilton Bank (South Labrador) in July. In October-December 1964, the vessel POBEDA again made a number of deep-sea hauls in the South and North Newfoundland areas; at that time as in summer the concentrations of large redfish were found on the slope. In all areas, samples were taken for determination of size composition, maturity and age of redfish. The results of analyses are represented in Fig. 1-2 and Tables 2-3.

For comparison of the biological indices of deep-sea redfish data characterizing redfish encountered at shallow depths in the neighbouring areas are given. The sampling locations are shown in Fig. 1.

By their appearance the deep-sea redfish almost do not differ from the common beaked redfish. However, as a result of a dissection it was found out that the deep-sea redfish differ greatly from redfish caught at shallow depths: redfish taken at depths above 500 m on Hamilton Bank and at depths above 600 m in the Ritu Bank area were immature (except for a very few specimens) and without any indications of ripening gonads. The determination of sex of redfish without dissection is more difficult than in fish caught at shallower depths.

Length frequencies of deep-sea redfish are rather long (from 28-50 cm) and little like the size composition of mature redfish taken in the shelf area (Figs. 1-2, B, C) - the prevailing sizes in both cases are 35-45 cm. However, there are no differences in sizes of males and females caught at great depths, their size curves almost coincide (Fig. 2, C, E). The similar coincidence of size-frequencies is observed while studying the concentrations of redfish wintering at usual depths and including immature females, immature and ripening males, that is, that part of the redfish stock which remains in the wintering areas after the mature fishes migrated to the spawning areas (Fig. 2, A).

Analysing the redfish mean sizes according to age-groups (Tables 2-3), one can conclude that male and female redfish have almost no differences in their growth rate. It is known that the growth rate of redfish taken at shallower depths decreases with the approach of maturity, e. g. the growth rate of males at about 12 years of age starts to drop behind that of females. Such a conformity was not observed in the growth of deep-sea redfish. Average sizes of males and females almost in all size-groups investigated are equal. In general, the growth of deep-sea redfish differs little from that of redfish caught at shallower depths. The growth of females taken at different depths is approximately similar. The males offer some exception. Their growth rate is rather different. The average sizes of deep-sea redfish males are 1.5-2 cm more than those of redfish of similar age taken at shallower depths.

The age composition of redfish in deep-sea concentrations is rather various and much like the age composition of redfish in the feeding concentrations observed at shallower depths - in both cases the 13-23 age-classes prevail.

It should be noted that due to the low transparency of scales, the determination of age of deep-sea redfish is more difficult than the age determination of redfish taken at shallower depths.

Discussion

Thus, the sharp difference between the deep-sea redfish and redfish at shallow depths as shown by the degree of ripeness of gonads, the peculiarities of growth rate and a number of other factors, indicate the isolation of this redfish group from the redfish caught at depths of 200-500 m and in some areas down to 600 m and more.

The absence of any signs of the ripening of gonads even in large specimens makes the problem of reproductive ability of these redfish doubtful.

As known, mass natural hybridization takes place in the South Labrador and North Newfoundland areas (author's observations in 1957-64). The different intermediate forms of redfish are often found in large quantities in commercial catches especially taken on the oceanic shelf in the Belle Isle area. By their appearance, some forms are much like Sebastes marinus marinus, others the beaked redfish. Nevertheless, the differences between all these forms and typical forms of both species (Sebastes marinus marinus and Sebastes marinus mentella) are evident.

As known, because the strong flow of the cold Labrador Current occupies the great water layers and extends far into the ocean, the severe hydrological regime is observed on the Labrador shelf. It is quite natural that because of the low near-bottom temperatures, the usual area of occurrence of Sebastes marinus marinus (depths of 100-300 m), can be displaced to greater depths in the area of distribution of beaked redfish where their mixing is observed. This fact may be one of the causes of the mass hybridization of redfish.

The main mass of hybrids caught at depths of 200-450 m and investigated by the authors were quite fecund and able to hatch.

It is known that in many cases the hybridization of closely related species does not lead to sterility. On the contrary, forms are born which are more viable and have a fast growth rate and are quite reproduceable.

Nevertheless, thinking over the hard-to-explain phenomenon of deep-sea immature redfish, one can suppose that the natural hybridization observed mostly in the areas of Labrador and North Newfoundland can ultimately create a form which is not able to be reproduced and which is localized in some parts of the slope.

However, it is not excluded that redfish observed at great depths may represent a form of common beaked redfish which ripen later. To solve this problem, extended investigations revealing the nature of these redfish are necessary.

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TABLE 1. THE YIELD OF REDFISH (000'S TONS) TAKEN BY ALL COUNTRIES IN THE LABRADOR AND NEWFOUNDLAND AREAS.

YEARS	1952	1953	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963
YIELD	46.2	45.6	37.2	17.6	29.8	57.7	236.3	298.9	182.2	115.5	69.0	74.8

TABLE 2. GROWTH RATES OF MALE AND FEMALE REDFISH AT TWO DEPTH RANGES IN THE SOUTH LABRADOR AREA.

AGE (YEAR) DEPTH(M)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	TOTAL
	500-600 ♂♂	-	-	-	-	-	34.7	36.1	36.6	37.5	39.0	39.4	39.8	41.2	42.0	42.0	43.0	-	-	-	-
405-440 ♂♂	-	-	29.3	32.0	32.5	33.2	34.4	35.9	36.6	37.6	38.7	39.4	40.8	41.5	41.0	41.0	45.0	-	-	-	182
500-600 ♀♀	-	-	-	31.0	-	32.0	35.4	36.7	37.3	39.2	39.8	40.2	41.8	44.7	44.0	43.8	45.0	48.0	-	-	103
405-440 ♀♀	27.0	29.0	29.0	31.0	31.4	34.3	35.1	36.3	37.5	39.1	40.8	39.5	40.7	42.2	41.0	43.3	45.0	-	-	-	102

TABLE 3. GROWTH RATES OF MALE AND FEMALE REDFISH AT TWO DEPTH RANGES IN THE NORTH NEWFOUNDLAND AREA.

AGE (YEAR) DEPTH(M)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	TOTAL
	630-655 ♂♂	-	-	33.0	-	33.0	34.0	35.8	36.5	37.2	38.5	39.4	40.6	41.9	42.1	43.2	44.0	44.5	-	-	-
235-240 ♂♂	-	-	28.0	30.0	32.0	32.3	35.0	35.4	36.3	38.0	38.3	38.0	40.0	-	-	-	-	-	-	-	40.0
630-655 ♀♀	-	-	33.0	-	33.0	33.5	35.8	37.4	37.7	38.8	40.1	40.7	42.2	43.0	42.3	43.4	44.8	45.7	-	-	166
235-240 ♀♀	-	-	-	28.3	32.0	33.5	35.3	36.4	37.7	37.9	40.0	40.3	41.3	41.5	43.0	44.2	45.3	44.5	48.0	-	187

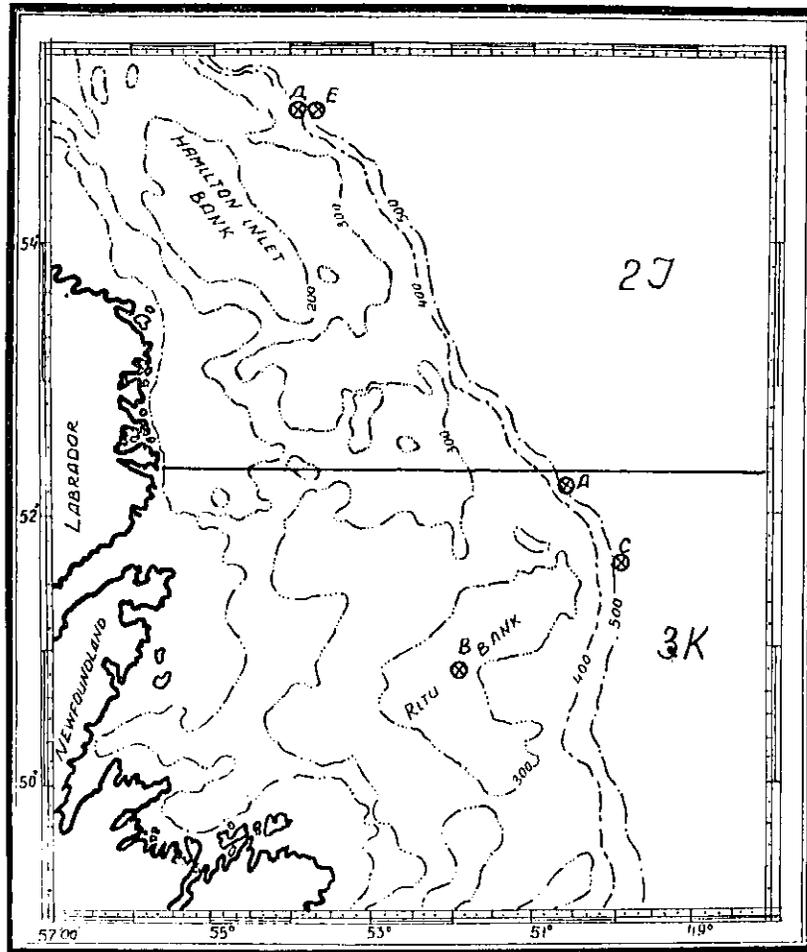


Fig. 1. Localities of collection of biological samples of A - wintering concentration of redfish, B - spawning concentration, C - deep-sea concentration, D - feeding concentration (mixed), E - deep-sea concentration

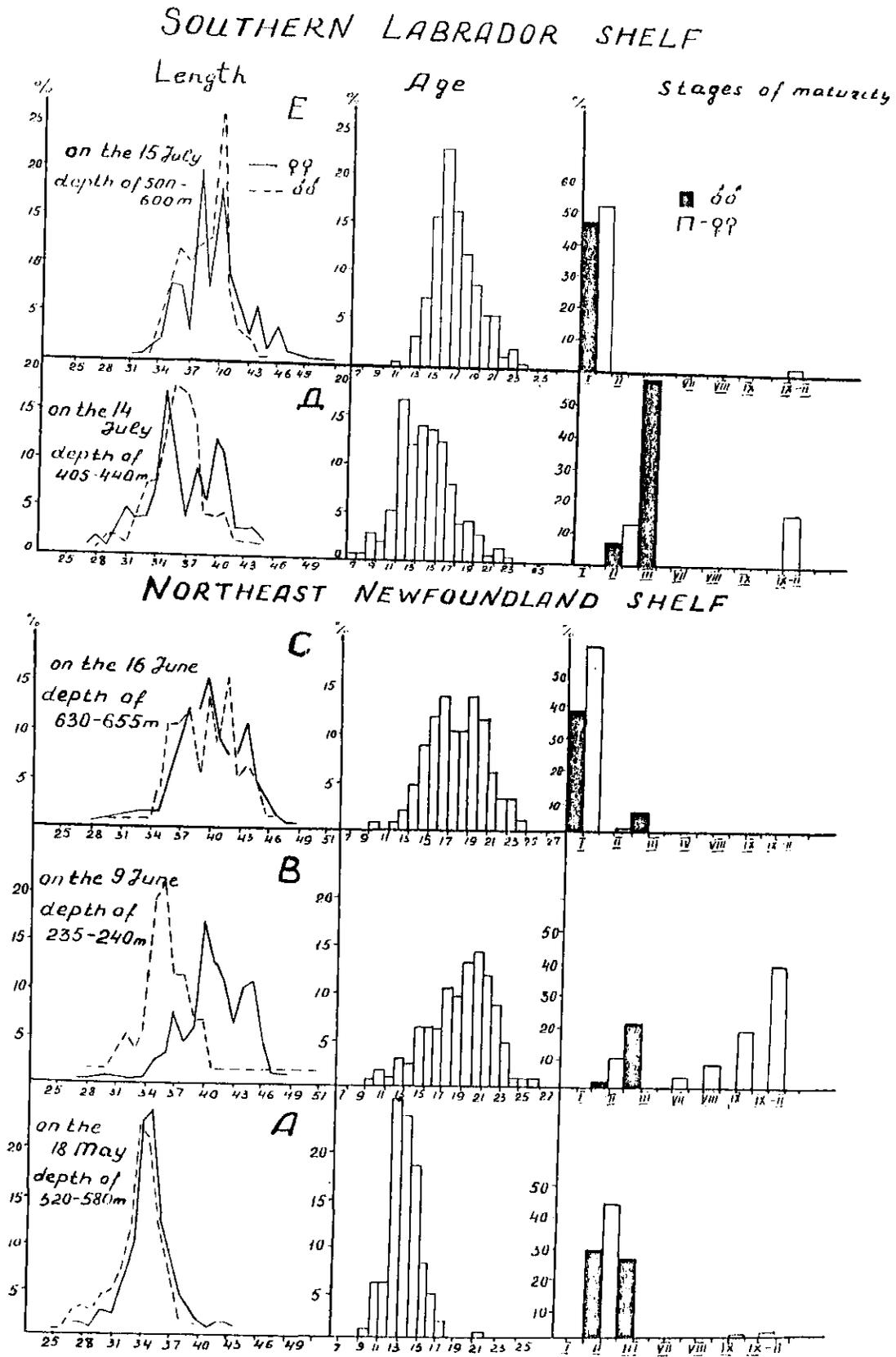


Fig. 2. Biological characteristics of redfish of different concentrations (the maturity stages: I-II - for males and females (immature); III - the stage of ripening; VII-VIII - the pre-spawning stage for females; IX - the spawning stage for females; IX-II- the post-spawning stage for females)