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Reproduction of Deepwater Redfish *Sebastes mentella* on the Flemish Cap Bank

by

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Abstract

Based on the data from research in 1983-2002, the results from the study of deepwater redfish sexual maturation, of the annual cycle of gonad development, the sex ratio and reproduction of the deep-water redfish *Sebastes mentella* Travin 1951 occurring on the Flemish Cap Bank (Div. 3M) are presented.

It was established that males insignificantly prevailed over females in catches. The total sex ratio was close to 1.

In the period of research all over the Flemish Cap Bank most of fish were immature. The greatest portion of mature redfish was registered in 1983 and amounted to 82.0%.

The results of redfish sexual maturation rate study on Flemish Cap indicated that males with the length of 19 cm and females as long as 20 cm aged 5 were first occurring as mature individuals. Mass maturation of fish takes place under the length of 28-32 cm, when they are 9-12 years old. A complete maturation of redfish comes at age 18 and under the length of 39 cm.

It is shown on the basis of analysis that the peak of larva extrusion is observed in March-April. The extrusion takes place on the Flemish Cap Bank slopes, at 300-750 m depths, with water temperature of 4-5ºC.

The mass copulation comes about in September-November, when the bulk of mature males are at maturity stages V and VI.

Introduction

Deepwater redfish (*Sebastes mentella)* is widely distributed at the coast of the North America. The results of examination of the number of sea redfish vertebrae showed that *S .mentella* predominated in waters between the Baffin Island and Greenland, in the Labrador area and deepwater parts of Subarea 3 (deeper than 300-400 m) (Ni, MS 1981). The results of Russian investigations into *S. mentella* and *S .fasciatus* on the Flemish Cap Bank indicated that in catches at 370-554 m depths *S. fasciatus* only accounted for 3.7% (Vaskov, MS 2001). In Div. 3M, at the depths of more than 554 m, the catches only consisted of *S. mentella* (Barsukov *et al.*, 1990).

Despite the redfish from the Flemish Cap Bank has become an important commercial species and the object of different researches since 1956, its sexual maturation and seasonal variations of gonad state and reproduction status practically have not been considered. In literature sources there's a small amount of data on reproduction and sex composition of deepwater redfish as on the Flemish Cap Bank as in the adjacent areas of the Notre Dame (Div. 3K),

St. John's (Div. 3L) and the South Labrador (Div. 2J). The surveys were, basically, aimed at studying areas and periods of extrusion of larvae by deepwater redfish females.

This paper analyses dynamics of sexual maturation and reproduction of the deepwater redfish. The main goal of the paper is to reveal and specify regularities and characteristics of this species sexual maturation on Flemish Cap.

Material and Methods

The present paper gives the results from investigations of deepwater redfish *Sebastes mentella* (Travin, 1951) caught in the directed fishery and during the research surveys on Flemish Cap in 1981-2002. The ichthyological material on deepwater redfish was collected in accordance with methods applied in PINRO and NAFO. The data on catches by midwater and bottom trawls from 127-1 250 m depths were used. Their length-age composition, sex ratio, the portions of immature and mature individuals within the range of fish distribution were analyzed. The material to read age (scales) was collected proceeding from the calculation – 5-10 males and females for each size-group. The size group for redfish of the Northwest Atlantic was taken as 1 cm. The data on age were calculated for all the length frequency. When determining maturation the maturity scales developed by V. P. Sorokin (Sorokin, 1958, Sorokin, 1960) were used. Mass maturation meant that 50% of fish became mature. The analyzed ichthyological data are shown in Table 1.

Results and Discussion

Sex ratio. During the surveys on the Flemish Cap Bank in 1983-2002 the total sex ratio was close to 1. The number of males insignificantly exceeded that one of females and amounted to, mainly, 1.1:1 and only in 1999 the portion of males was 1.9:1 (Fig. 1).

The ratio of mature and immature redfish. In the period of investigations, all over the Flemish Cap Bank, the most of fish were immature (Fig. 2). The greatest portion of mature redfish was registered in 1983 and amounted to 82.0%. The greatest reduction in the number of mature fish was recorded in 1996-1999. Fluctuation of year-to-year mature and immature fish ratio variability was of the same character in both males and females, except for some years (Fig. 3 and 4).

Sexual maturation rate. The analysis of redfish sexual maturation on Flemish Cap showed that males and females first occurred as mature fish after they had reached the length of 19 cm and 20 cm, respectively, at the age of 5. (Fig. 5 and 6). Mass maturation (50%) of females takes place, when they are as long as 28-29 cm and aged 9-10 (Tables 2 and 3). All the fish become mature under the length of 39 cm and at the age of 18 years old.

As compared to the Barents Sea and the Irminger Sea, on the Flemish Cap Bank, the redfish mature at earlier age. According to the data of S. P. Melnikov (Melnikov, MS 1998; Melnikov, 1999; Melnikov and Bakay, MS 2002), in the Irminger Sea, males having the length of 28 cm at age 7 and females being as long as 29 cm aged 8 are first found as mature individuals (Tables 4 and 5). In the Barents Sea, the length of redfish males, under which the fish first mature, is 27 cm, the age – 7 years. These parameters for females are 29 cm and 9 years (Shestova, 1976). On Flemish Cap 50% of males enter maturity, when they are as long as 34 cm at the age of 12 years old. Half of females reach maturity under less length and at earlier age.

Annual cycle of gonad development. The annual cycle of fish gonad development is closely connected with the life cycle. According to V. A. Chekhova (Chekhova, 1971), this cycle is divided into the following periods for the Flemish Cap Bank redfish:

1. Extrusion of larvae and the start of summer feeding (March-June).
2. Summer feeding and mating (July-October).
3. Wintering and female maturation (November-February).

The results of observations showed that in February the prespawning development of larvae was coming about in the bulk of redfish mature females and the gonads were at stage VI (Fig. 7). In March-April, the peak of larva extrusion in females is observed. In May and later, the extrusion in only an insignificant part of females is noticed. The period of redfish larva extrusion is quite prolonged, therefore, the females with postspawning stages (IX-II) occurred till

September. A small portion of fish mated in July, when some males with testes at stage V-VI were found. Based on the development of gonads, the main process of copulation takes place in autumn-winter, from September to November, when the majority of mature males have stages V and VI.

In the southern Labrador (Div. 2J), the mass extrusion of redfish larvae comes about in April-May (Fig. 8) (Nikolskaya, 1979). Starting from the analysis of male maturity stages, in this area mass coupling takes place in July-December. According to T. L. Nikolskaya (Nikolskaya, 1982), in the Notre Dame Bay area (Div. 3K), the mass extrusion of larvae in redfish females comes about in May. Also in May, the main spawning is observed in the St .Johns area (Div. 3L) (Travin, Pechenik, 1962). The Irminger Sea redfish have the primary extrusion of larvae from the middle of April to the middle of May and the coupling is observed from the late August to November (Shibanov *et al*., MS 1995; Melnikov *et al*., MS 2001).

Thus, on the Flemish Cap Bank, the main extrusion of larvae by redfish females takes place in March-April, earlier than in the other areas.

The area of larvae extrusion. In line with the data from the investigations, the extrusion of redfish larvae comes about on the slopes of the Flemish Cap Bank under the water temperature of 4-5ºC (Travin, Pechenik, 1962) The analysis of redfish maturity stages and its distribution by depths showed that most of females with maturity stages VIII-IX were recorded at 300-600 m depths (Chekhova, 1971). In the period of ichthyoplankton surveys in 1978-1985, the primary concentrations of redfish larvae 4-15 mm in length were, basically, distributed along the slopes, all over the bank, over 300-600 m depths (Serebryakov *et al*., MS 1984; Akhtarina and Chechenin, MS 1985, MS 1986). In some years, the dense concentrations of redfish larvae were also recorded over the Beothuk Knoll Bank. In accord with the research data for 1983-2002, the majority of females having gonad maturity stage VII-IX in April-May, were from the southwestern slope of the Flemish Cap Bank and occurred within the range of 400-750 m.

Based on the data available, in Div.3K, the mass extrusion of larvae comes about under 3-5ºC at 300-800 m depth along all the continental slope in May (Nikolskaya, 1982). Abundant aggregations of spawning redfish were recorded there at 51º37’9N, 50º21’W.

In the Reykjanes Ridge area the larva extrusion was observed over 250-1 050 m depths, under the temperature of 5-6ºC (Shibanov *et al*., MS 1995; Melnikov *et al*., MS 2001).

Thus, the extrusion of larvae by redfish females on Flemish Cap and in the mentioned above areas takes place within the similar range of depths and temperature.

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Table 1. Amount of ichthyologic material examined.

Type of research	Number, fish
Mass measurements	350112
Analysis of sexual maturity	17797
Age	1852

Table 2. Sexual maturity of deepwater redfish on Flemish Cap by size groups, %.

Length, cm	Males	Females
19	5.0	0
20	12.4	10.8
21	10.3	8.7
22	20.0	10.9
23	25.9	8.5
24	31.9	18.7
25	24.6	26.3
26	25.9	24.5
27	26.5	33.3
28	32.9	63.1
29	41.5	54.4
30	40.0	61.8
31	37.5	62.2
32	41.9	62.4
33	42.1	58.9
34	49.6	60.3
35	43.3	63.1
36	62.5	62.2
37	62.2	67.0
38	76.7	93.7
39	100.0	100.0
40	100.0	100.0
41	100.0	100.0
42	100.0	100.0
43	100.0	100.0
44	100.0	100.0
45	100.0	100.0
46	100.0	100.0

Table 3. Sexual maturity of deepwater redfish on Flemish Cap by age groups, %.

Age, years	Males	Females
5	7.6	5.2
6	16.4	10.1
7	26.9	19.5
8	27.6	32.9
9	31.8	55.6
10	36.9	61.0
11	36.6	61.1
12	49.0	56.0
13	46.3	60.7
14	50.0	57.9
15	59.3	62.5
16	84.0	80.0
17	94.7	86.4
18	100.0	100.0
19	100.0	100.0
20	100.0	100.0
21	100.0	100.0
22	100.0	100.0

Table 4. Sexual maturity of deepwater redfish in different areas of the North Atlantic in relation to fish size.

Area	Size at maturity, cm					
	First maturing		50 %		100%	
	Males	Females	Males	Females	Males	Females
Flemish Cap	19	20	34	28	39	39
Irminger Sea	28	29	32	33	38	41
Barents Sea	27	29	32	33	39	41

Table 5. Sexual maturation of deepwater redfish in different areas of the North Atlantic in relation to fish age.

Area	Age at maturity, years					
	First maturing		50 %		100%	
	Males	Females	Males	Females	Males	Females
Flemish Cap	5	5	12	9	18	18
Irminger Sea	7	8	10	10	16	17
Barents Sea	7	9	11	12	17	19

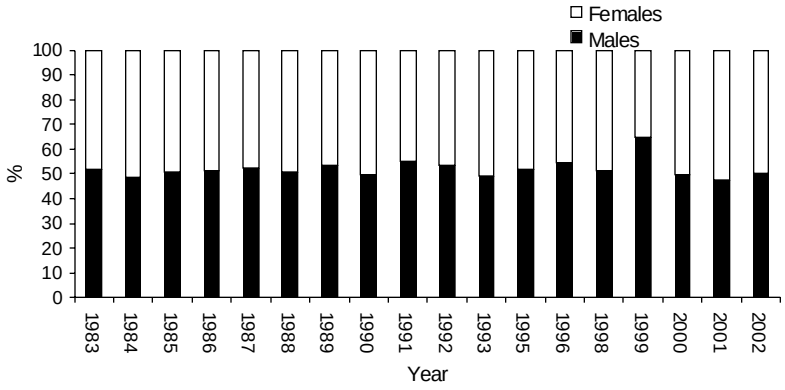

Fig. 1. Sex ratio of deepwater redfish on Flemish Cap in 1983-2002.

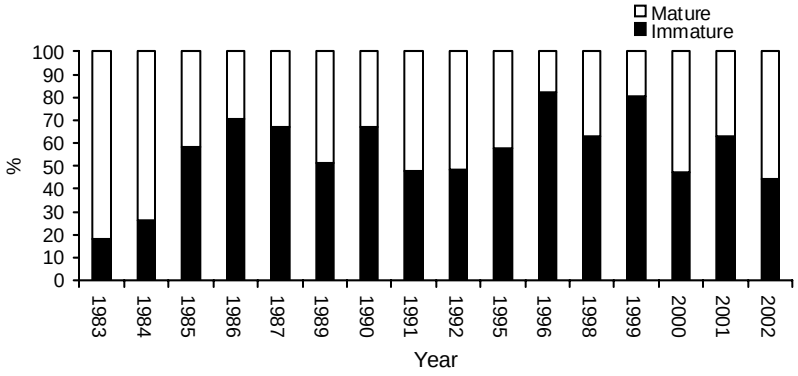

Fig. 2. Percentage of mature deepwater redfish on Flemish Cap in 1983-2002

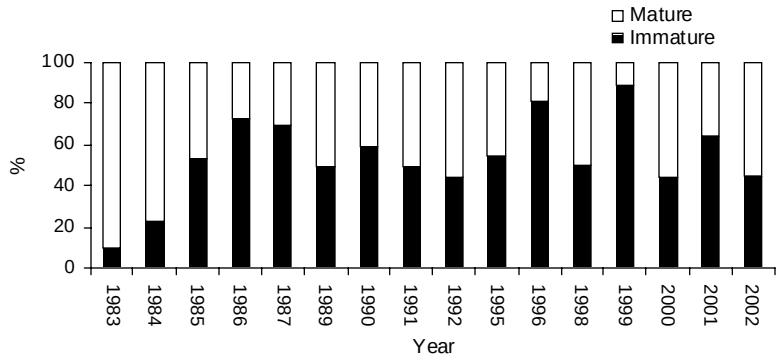

Fig. 3. Percentage of mature males of deepwater redfish on Flemish Cap in 1983-2002

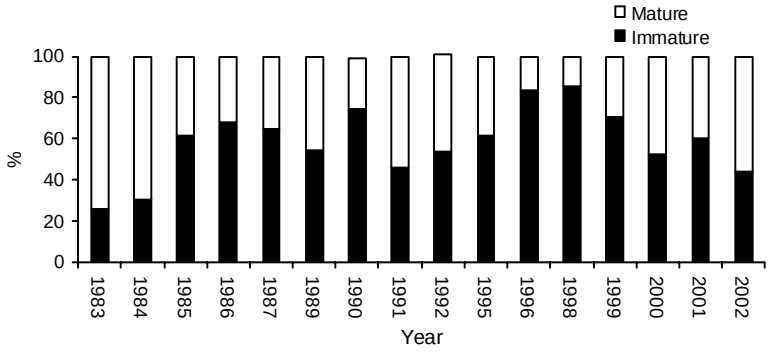

Fig. 4. Percentage of mature females of deepwater on Flemish Cap in 1983-2002.

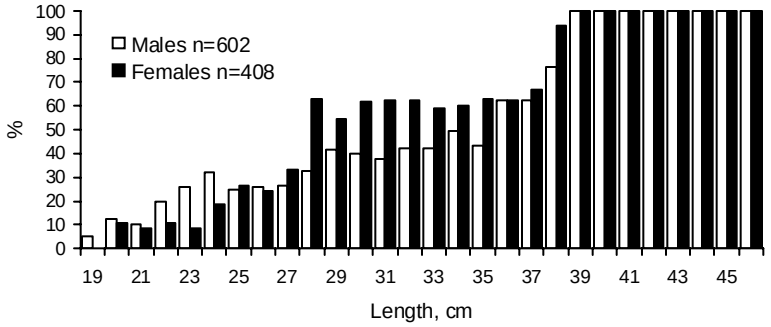

Fig. 5. Redfish maturation in different size groups.

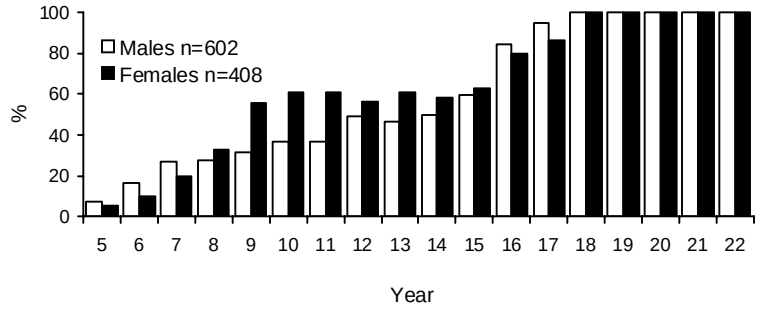

Fig. 6. Redfish maturation in different age groups

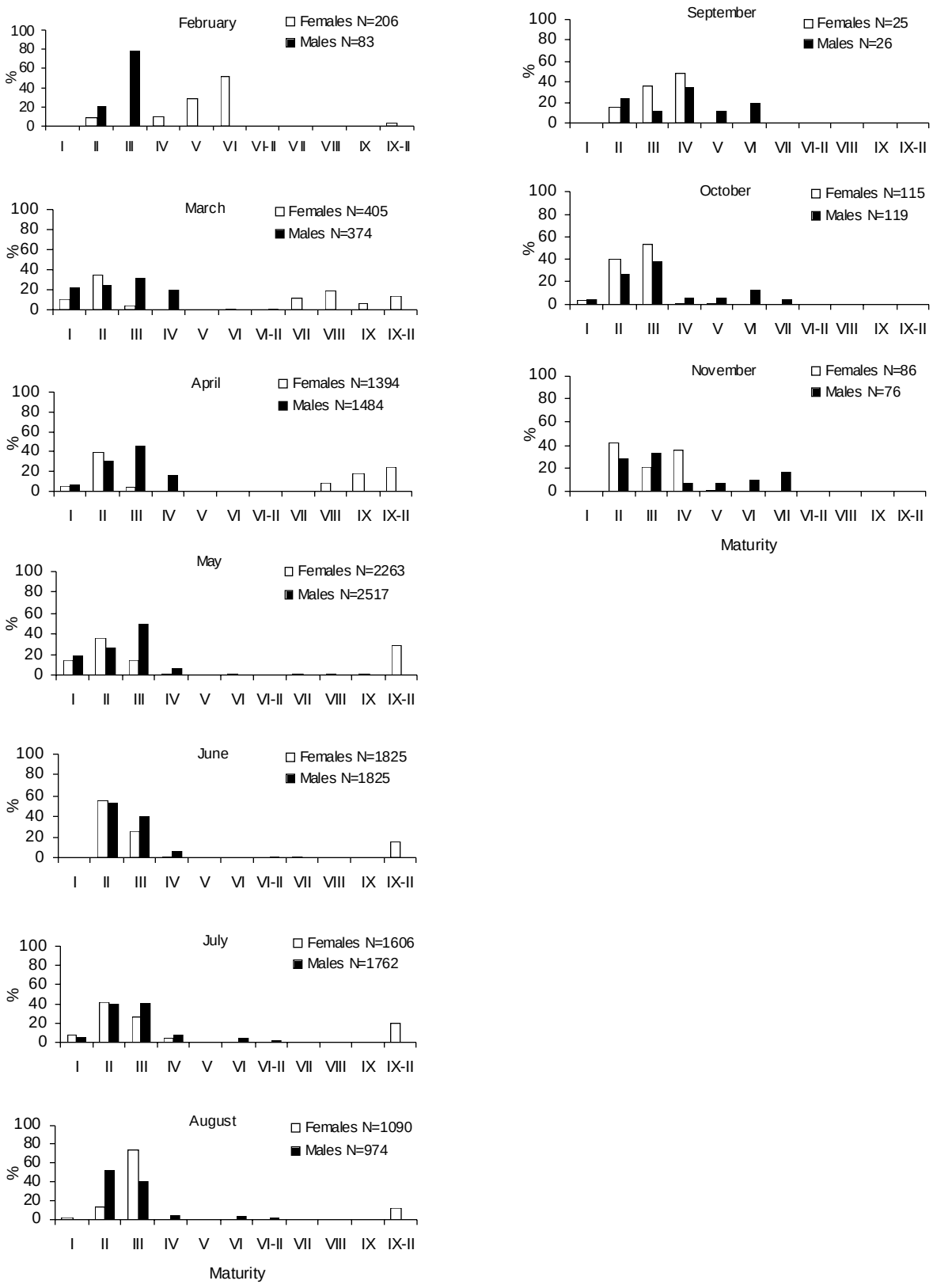

Fig. 7. Redfish maturity stages on Flemish Cap by months in 1983-2002.

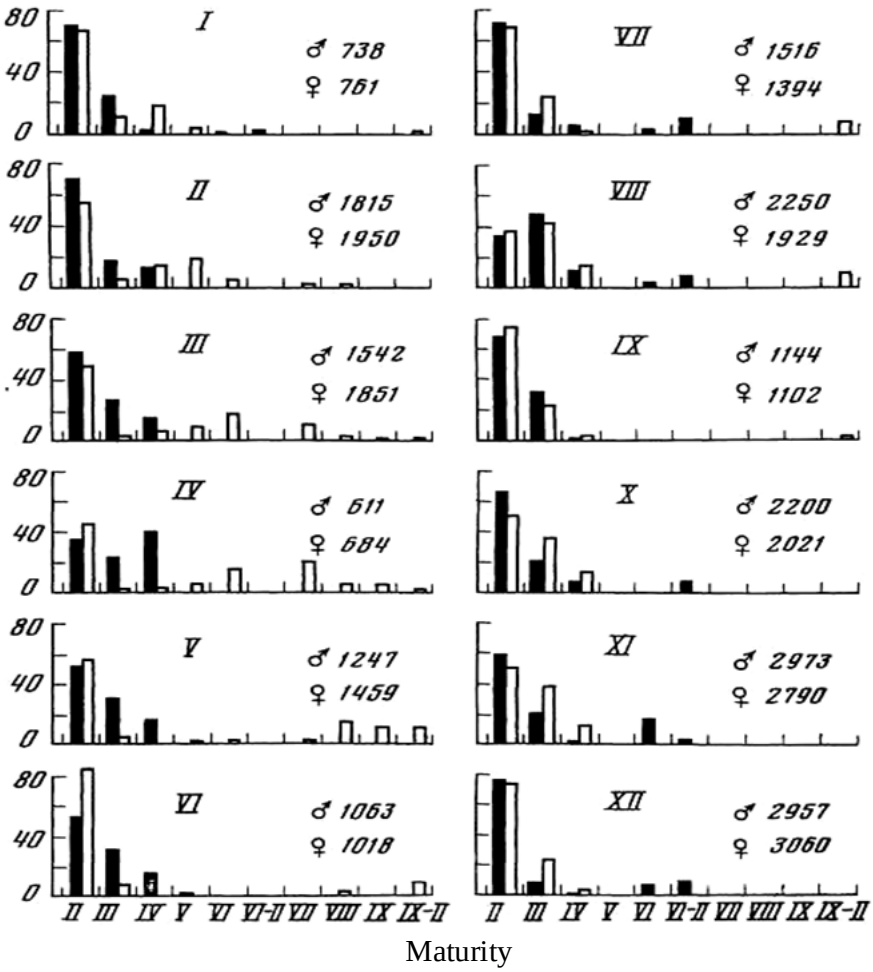

Fig.8. Number of deepwater redfish at different stages of gonad maturity in Div. 2J by months in 1965-1975 (black columns – males, the white ones – females) (Nikolskaya, 1979).