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On Population Structure of Roundnose Grenadier (Coryphaenoides Rupestris Gunnerus, Macrouridae) in the North Atlantic

by

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ABSTRACT

Roundnose grenadier, widely distributed in the North Atlantic, is a valuable commercial species. Its population structure is studied poorly. At present it is believed that the roundnose grenadier eggs and larvae are spread all over the fish range, i.e. that a united population, in Dobzhansky-Mayr's sense, exists. Two main hypotheses concerning the status of groups of roundnose grenadier inhabiting the continental slope of Canada were substantiated. According to one of them, young fish feeding in the Labrador Current waters grow but loose their ability to reproduce and form the deadlock population. The other hypothesis states that the Northwest Atlantic is the area for the young fish feeding from where maturing fish migrate to underwater mountains of the North Atlantic Ridge.

Further studies into routes and scales of expected return migration of maturing fish from feeding areas to spawning ones as well as ichthyoplankton investigations along the routes of

egg and larval drift are needed.

INTRODUCTION

The roundnose grenadier (Coryphaenoides rupestris G.) is a widely distributed and abundant species of the North Atlantic. In the Northeast Atlantic the fish are found in the north as far as Finnmarken, off Iceland and at the south-western coast of Greenland. At the Scandinavian Peninsula they are distributed southwards to Skagerrak and Boguslen. They are also reported from the south-west of Ireland and from the Hatton and Rockall Banks. In the Northwest Atlantic they are found in the area from the Baffin Island to the Cape Hatteras and on the Corner Elevation. In the central part of the area they are frequent over underwater mountains of the Reykjanes and North Atlantic Ridges from Iceland to 38°N and farther south (Andriyashev, 1954; Zilanov, Troyanovsky, Shepel, 1970; Parin, Neyman, Rudyakov, 1985; Pshenichny, Kotlyar, Glukhov, 1986; Parr, 1946; Leim and Scott, 1966; Wheeler, 1969; Geistdoerfer, 1977; Gordon, 1978; Erich, 1983). The fish range is shown in Fig. 1. The dwelling depth is 180-3000 m, the soil preferred is stony and light (Leim and Scott, 1966; Geistdoerfer, 1977; Sahrhage,1986). Water temperature ranges from 1.1 to 8.0°C (Zakharov, Mokanu, 1970; Parsons, 1975; Gordon, 1979). Parin and Golovan (1976) described the species as bathial-pelagic.

Roundnose grenadier have a long life cycle: occasionally specimens aged 29 years 130 cm long with the weight of 3 kg were found (Savvatimsky, 1971; Parsons, 1975; Magnusson, 1975, 1979; Geistdoerfer, 1977; Kosswig, 1980; Atkinson, 1980). Multi-aged population structure (Table 1) and late maturation are typical of roundnose grenadier.

According to our data, some specimens begin to mature at ages 6 to 7 years. Thus, more than 50% of 12-13 year old fish become mature (Table 2).

Fishery for roundnose grenadier over the continental slope of Canada began in 1967. The maximum catch here approached 79 thou. t. Commercial concentrations of the fish were also reported from continental slopes of Ireland, Scotland, the Faroes, from the Norwegian coast and its deep fjords, underwater mountains of the North Atlantic Ridge (Pshenichny, Kotlyar, Glukhov, 1985; Kosswig, 1983; Glukhov, Pavlov, Shibanov, 1983; Eliassen, 1983; Ehrich, 1983; Post, 1982; Schöne, 1983; Rätz, 1984).

Rational exploitation of any species is impossible without estimation of its population structure. Even the first investigators of the roundnose grenadier biology suggested the schemes of the fish intraspecific structure in the North Atlantic. In spite of numerous works on estimation of the relationship between the groups of roundnose grenadier from different parts of the range, this problem cannot be regarded solved.

The scientists who studied the population structure of roundnose grenadier may be divided into two main groups of opposite standpoints: supporters of the population unity of the species and existence of the full, closed migration cycle in the North Atlantic, and those of the population disconnection and formation of deadlock groups of roundnose grenadier in the Northwest Atlantic, the absence of return ontogenetic migrations of maturing fish from feeding grounds to spawning ones.

The hypothesis of the population subdivision of the North Atlantic roundnose grenadier is based on the availability of statistically reliable difference between some indices: growth rate, relative weight of cerebrum and its sections, shape and size of otoliths, some morphological features, phenotype frequency of esterases, myogens and other biochemical indices, stability of the length-age and sex composition of catches from certain areas, peculiarities of the

fish parasitofauna (Troyanovsky, 1973; Savvatimsky, 1979, 1982; Dushchenko, 1979, 1982; Grigoryev, 1972, 1982; Logvinenko et al., 1963; Szurs, 1975, 1980).

In the last years the discussion was centred round the possibility of return spawning migration of maturing fish from the young fish settling areas in the Northwest Atlantic to spawning grounds.

The hypothesis of the grenadier eggs and larvae transport by the strong current system from reproductive areas and their spreading all over the North Atlantic is rather popular nowadays, though not confirmed by facts. Currents are often considered of special importance for settling of deepwater fishes (Alekseeva, Alekseev, 1984; Hureau, Geistdoerfer, Rannou, 1979). The grenadier eggs are pelagic and have oil balls. Marshall (1965) supposed that grenadiers spend and fertilize eggs at the bottom, then the developing eggs ascend to upper layers. The larvae have greatly elongated fin rays which favour their soaring in water. While growing the larvae and fry descend. In this period they settle passively in the vast area of the North Atlantic. It may be that eggs and larvae of roundnose grenadier are transported by the current system from spawning grounds in the North Central and Northeast Atlantic to the Northwest Atlantic, towards the Baffin Island and Labrador. The increase in the size of young fish from east to west speaks for the dispersion of young fish all over the area. It is known that grenadier fingerlings 7-8 cm long are found along the whole continental slope of Canada (Grigoryev, 1972), larvae 3.5 mm long - off Greenland (Jensen, 1948) and in the Northwest Atlantic (Johnsen, 1927; Merrett, 1978). Their dispersion is promoted by the North Atlantic cyclonic gyre (North Atlantic - Irminger - East Greenland - Baffin Island - Labrador Currents) (Fig. 2).

In fact, all the investigators, independently of the group they belong, agreed that intensive transport of eggs and larvae, in other terms, the exchange of genofond between the groups from different parts of the range, suggest the existence of a united self-reproducing North Atlantic population in Dobzhansky-Mayr's sense (Dobzhansky, 1951; Mayr, 1974).

The fishery in the North Atlantic is based exclusively on immature fish, while in the east mature specimens are found everywhere. Some scientists believe that the fish spawn in the Northwest Atlantic at great depths not accessible to fishing gears (Grigoryev, 1972; Pechenik, 1970; Pechenik, Troyanovsky, 1969, 1970; Savvatimsky, 1969), and possibly at quite a distance from continental slopes (Savvatimsky, 1982). There is a hypothesis that the transport of eggs and larvae of grenadier from the moderate climatic zone of Atlantic to the waters formed under the effect of the cold Labrador Current, resulting in the appearance of a deadlock non-reproducing population in the Northwest Atlantic depending on the recruitment from the outside (Dushchenko, 1985).

G.P.Zakharov and I.D.Mokanu (1970), S.G.Podrazhanskaya (1971) supposed the possibility of spawning migrations of roundnose grenadier from the Northwest to the Northeast Atlantic by the northern route along the continental slopes of Canada, Greenland and Iceland. A.V.Zubchenko (1976) suggested a different scheme of migrations. In his opinion, roundnose grenadier, while growing, migrate northwards from the Canadian coast to the North Newfoundland and Flemish Cap Banks and then to underwater mountains of the Reykjanes Ridge to spawn. Supporters of these hypotheses stated that in a genetically united population of roundnose grenadier there existed a functional subdivision of the range into growing and reproductive parts and, consequently, a closed ontogenetic migration cycle (Zubchenko, 1976, 1981; Zakharov, Mokanu, 1970; Alekseev, 1982, 1984; Alekseeva, Alekseev, 1984; Podrazhanskaya, 1971).

DISCUSSION

The known data on the population structure of roundnose grenadier in the North Atlantic do not solve the problem. Intensive dispersion of eggs and larvae from spawning grounds all over the area proves the fact that in the North Atlantic a united population with the regular exchange of genofond between its parts exists. In fact, there are no data on migration of adult, maturing fish from feeding grounds in the Northwest Atlantic to spawning grounds in the east. Nevertheless, common laws in formation of ranges and life cycles of the North Atlantic species suggest the existence of functionally subdivided range and return migrations of maturing fish. Yu.Yu. Marti who analysed migration cycles of the North Atlantic fish species stated that "return migration of growing fish, an indispensable consequence of passive settlement, may exist only in the areas where there is a drift of young fish. There are no return migrations where there is no drift" (1962).

Supporters of the hypothesis on the settled way of life of roundnose grenadier believe that the available statistically reliable differences by relatively numerous biological indices confirm convincingly the correctness of their opinions and that roundnose grenadier form within their range settled populations the spatial distribution and recruitment of which are determined to a great extent by the circulation of waters in the North Atlantic.

The investigations of the eel Anguilla rostrata (Koehn, Williams, 1978; Alekseev, 1984) reveal a good example of non-random distribution of genetically different fish within the limits of the population range. The necessity appears to study the species structure by means of not only separation of special morphological, biochemical and other features but also by determination of functionally differentiated ranges, peculiarities of the reproductive cycle and

mechanisms of reproductive isolation of supposed groups, in other terms, ecologic-physiological analysis of parameters determining the specific character of their reproduction (Alekseev, Alekseeva, 1984; Alekseev, 1984; Batalyants, 1984). It is necessary to proceed with the investigations into ways and scale of eggs and larvae transport from spawning grounds to different areas of the North Atlantic, seasons and routes of expected return migrations of maturing fish from the Northwest Atlantic to spawning grounds.

Special sampling of ichthyoplankton on drift routes of grenadier eggs and larvae is needed. Vertical tows up to 1500 m depth would be reasonable. At the first stage ichthyoplankton sampling should cover possibly larger area, stations being not thick. Series of stations should be made in the area between the southern extremity of the Grand Newfoundland Bank, southern slopes of the Flemish Cap and Mid-Atlantic Ridge as well as between Greenland and Baffin Island, Greenland and the Reykjanes Ridge. It would be reasonable to make one section east of the North Atlantic Ridge perpendicular to general direction of currents. The period from October to April is favourable for these works.

The most probable routes of the fish return migrations from the North Atlantic to Mid-Atlantic Ridge lie through the Flemish Cap - Miln Mountains, Gauss - Gibbs Ridge and from the Baffin Island through Greenland and Iceland towards underwater mountains of the Reykjanes Ridge. Biological data sampling in the above areas at the depths approaching 2000 m will help to settle the problems.

Taking into account difficulties in studying the population structure of roundnose grenadier in relation to their deepwater dwelling it is reasonable to unite the efforts of scientists to exchange the research results.

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Table 1. Age composition of roundnose grenadier in the Reykjanes area in 1982-84 (%)

Age	Males			Females		
	1982	1983	1984	1982	1983	1984
3	-	-	-	-	-	0,1
4	-	-	-	-	-	-
5	-	-	-	-	-	-
6	-	-	-	-	-	-
7	0,1	-	-	0,3	-	0,1
8	0,3	-	0,1	0,2	-	0,2
9	0,1	-	0,8	0,7	-	0,5
10	0,5	0,6	1,5	1,0	-	1,9
11	1,7	1,0	2,9	1,9	1,1	2,1
12	3,8	2,2	6,7	4,3	1,0	3,3
13	6,4	4,9	7,7	4,3	2,7	4,2
14	9,6	7,4	12,7	5,4	2,9	4,0
15	10,6	7,5	14,8	6,1	5,5	4,4
16	11,0	12,8	12,8	6,2	5,6	2,8
17	8,4	11,5	6,4	3,6	7,4	1,0
18	5,6	7,3	4,5	1,9	4,6	1,5
19	2,4	4,6	1,8	1,0	4,6	0,4
20	0,9	1,7	0,5	0,5	1,9	0,1
21	0,5	0,4	-	0,5	0,7	-
22	-	0,1	0,3	-	-	-
23	0,1	-	-	-	-	-
Mean age	15,3	15,3	14,7	14,5	16,3	13,7
No. of spec.	1528	518	806	941	319	291

Table 2. Maturity rates of the roundnose grenadier females in the North Atlantic Ridge area

Age	Percentage of mature females	No. of fish
7	6,I	I
8	I4,I	I0
9	I8,8	I7
I0	27,I	5I
II	43,9	I44
I2	48,3	253
I3	55,5	349
I4	62,8	443
I5	69,6	577
I6	74,8	558
I7	79,4	530
I8	83,I	403
I9	88,0	36I
20	9I,3	22I
2I	95,7	93
22	99,0	53
23	I00	II
24	I00	5

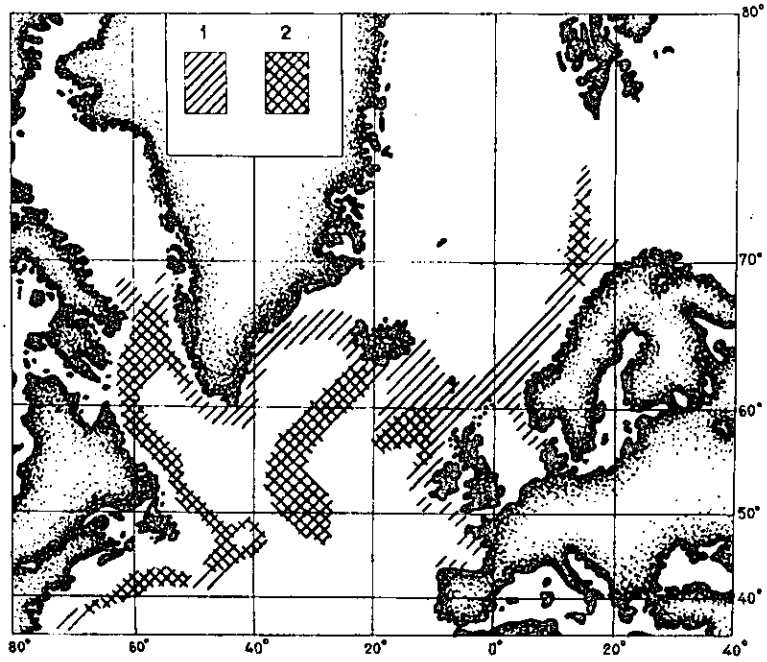

Fig. 1. The roundnose grenadier range

1 - limits of the range;
2 - commercial concentrations

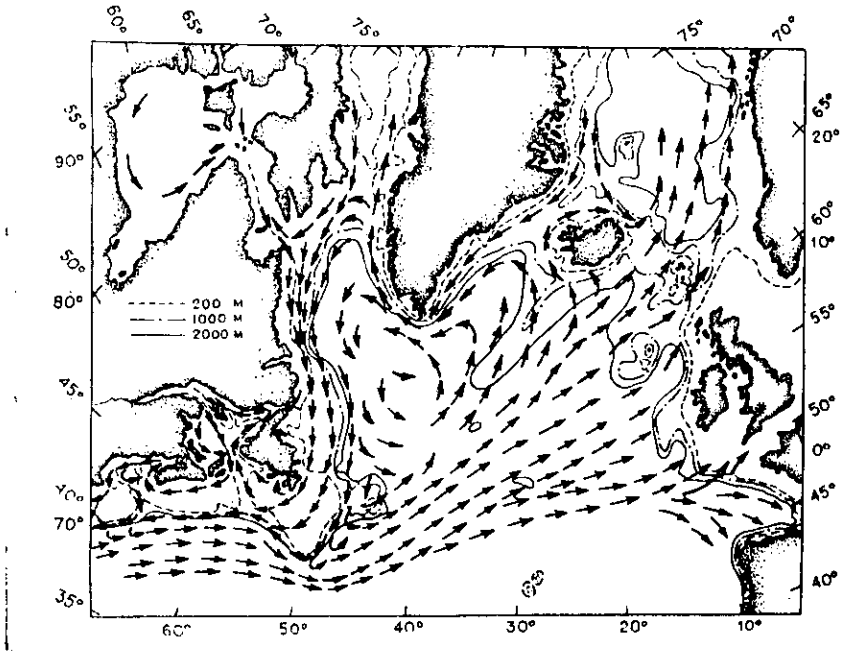

Fig. 2. General scheme of the North Atlantic Currents (Templeman, 1967)