

ICHTHYOFAUNA RESEARCH ON UNDERWATER MOUNTAIN WITHIN THE NORTH-ATLANTIC RIDGE AND ADJACENT AREAS

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ABSTRACT

From the mid-1970s to the late 1980s the active fishery researches aimed at revealing the fishery potential of ichthyofauna associated with the North-Atlantic ridge and adjacent areas were carried out by AtlantNIRO and Zaprybpromrazvedka. These researches included species composition and zoogeographic structure of ichthyofauna associated with the North-Atlantic ridge and other underwater mountains.

In the work the data on ichthyofauna species composition of the northern part of the North-Atlantic ridge (43-57°N, 28-34°W), Corner Mountains (34-35°N, 48-52°W), underwater mountains (guyots) southwards of Azores (28-32°N 30-34°W) and Rockall underwater mountains are presented based on considerable sampling material (about 200 species).

Peaks of high mountains (minimum depths up to 300 m), located eastwards of the Mid-Atlantic ridge (Rockall and the underwater mountains southwards of Azores), are inhabited by the bottom ichthyofauna associated with European and North-African shelf. In this area the East-Atlantic species significantly prevail as compared to amphi-Atlantic and common tropical. On the Rockall plateau boreal and boreal-tropical European species prevail, while on the underwater mountains southwards of Azores the north-subtropical, boreal-subtropical and common tropical East-Atlantic species typical of the self of the Southern Europe and North-west Africa predominate. At mesobenthonic depths (more than 500m) the pattern of zoogeographic structure changes with ichthyofauna species composition variations. Ichthyofauna acquired similar pattern irrespective of the geographical location on the Mid-Atlantic ridge westwards or eastwards of it. Everywhere at these depth levels common tropical, amphi-atlantic and boreal-subtropical species predominate considerably. The number of East-Atlantic species is insignificant as compared to the above categories, though the increase of the East-Atlantic species is observed at the slope of the Rockall plateau and underwater mountains southwards of Azores, as well as the increase of common tropical species in Corner Mountains and the Mid-Atlantic ridge. The West-Atlantic fauna component on the peaks and slopes of researched mountains is small, and even on Corner Mountains located westwards of the Mid-Atlantic ridge the proportion of East-Atlantic species is twice more than West-Atlantic species (8:4). At mesobenthonic depths (more than 500m) in all areas the bathyal-pelagic fishes considerably predominate as compared to the bottom ones both by species diversity and biomass.

INTRODUCTION

The history of detailed researches of underwater mountains ichthyofauna even in sufficiently researched Northern Atlantic Ocean numbers to no more than 30 years. In literature only scarce data on individual specimens catches over some underwater mountains can be found with the exception of the Rockall mountains relatively suitable to trawling (Blacker, 1962) and the Meteor guyot (Maul, 1962; Ehrich, 1977).

The gaps in the underwater mountains fauna researches as compared to the shelf and bathyal faunas are basically related to the late detailed researches of the open ocean bottom relief as well as to the technical problems arising during trawling over the rough relief of various underwater mountains.

Theoretical and practical interest to thalassabathyal ichthyofauna researches appeared in the former USSR following the publication of the article by Andriyashev (1979) devoted to some problems of the marine bottom ichthyofauna vertical zoning. His ideas were later developed by N.V.Parin (1982, 1987).

From the mid-1970s to the late 1980s the scientists of Atlantic Scientific Research Institute of Marine Fisheries and Oceanography (AtlantNIRO) and Zaprybpromrazvedka carried out intensive fisheries researches to reveal fishery potential of ichthyofauna associated to the North-Atlantic Ridge and adjacent underwater mountains. One of these researches was devoted to the species composition and zoogeographic structure of ichthyofauna associated to the North Atlantic Ridge and other underwater mountains (Kukuev et al., 1980; Guschin, Kukuev, 1981; Kukuev, 1982; 1991; Scherbachev et al. 1985).

MATERIAL AND METHODS

In this work the data on ichthyofauna species composition in the northern part of the Mid-Atlantic Ridge (43-57° N, 28-34° W), the Corner Mountains (34-35° N, 48-52° W), underwater guyots southwards of Azore (28-32° N, 30-34° N) and the Rockall underwater mountains (Fig. 1) were presented on the basis of extended factual material (about 200 species (table 3). The material were collected mainly with the pelagic trawl over the underwater mountains peaks and slopes up to the depth of 1500 m and in the expeditions carried out from 1974 to 2000. Only in R/V "Vityaz" cruise in 1982 the trawlings with the bottom trawl "Sigsby" were made to the foot of the Great Meteor Mountain (the depths about 4000 m).

The lists of all species found were checked using reports CLOFNAM (1973) and FNAM (1984). The areas of all species occurrence were referred to 3 groups: east-atlantic, west-atlantic and amphiatlantic (for both ocean coasts). Within each group the species distribution areas were classified by fauna types or components based on latitudinal indications: boreal, low-boreal, boreal-subtropical, boreal-nothal-subtropical, wide-tropical. For the purpose of comparison to the continental bathyal fauna, the fauna similarity coefficient by Preston (1962) was applied. The areas topology was described taking into account the works on bathyal fishes distribution (Golovan, 1978) and invertebrates (Zezin, 1976; Nesis, 1982). The latitudinal distribution of epi- and mesobenthonic fishes of the Northern Atlantic thalassobathyal zone is shown on Fig. 2. The terminology of underwater mountains ichthyocene vertical zoning was obtained from A.P.Andriyashev (1979) and N.V.Parin (1982, 1987).

RESULTS

Physical-geographic review of researched underwater mountains in the Northern Atlantic Ocean

In this work the species composition and zoogeographic structure of the bottom and near-bottom-pelagic ichthyocenes are considered in 4 thalassobathyal zones located in the temperate and subtropical Northern Atlantic Ocean with different minimum depths, location relative continents, isolation from them and associated with waters of different biological productivity. Their brief characteristics below are based on the works by Ilyin (1976), Litvin (1980), Gershanovich, Muromtsev (1982).

Relatively shallow Rockall mountains (minimum depths 160-500 m) represent the lowered continental edge, separated from the East Ireland slope with relatively narrow depression with a flat surface and few outcrops of rocks. The Rockall mountains are located within the modified waters of the North-Eastern Atlantic Ocean, while its western areas are affected with the North-Atlantic current.

The North-Atlantic Ridge (NAR) and Reykjanes Ridge between 45-55° N and 28-34° W consists of conic mountains with pointed peaks at the minimum depths of 800-1000 m. This area of NAR is separated with a wide water zone both from European and American coasts. It is located within the Northern subpolar cyclonic circulation. Its southern part is affected with the North-Atlantic current.

The Corner Mountains (34-35° N, 48-52° W) is referred to the block-volcanic type. It is far away from the North America slope and has the intermediate location between the Bermuda elevation and the western flank of NAR (separated from them with a wide deep-water area). Conic and pointed peak Corner Mountains depths do not exceed 700-1000 m to the ocean surface.

In the eastern flank of NAR between 28-34° N the ridge of steep mountains so called Azore Banks: Atlantis, Playto, Great Meteor, Yer and others with flat peaks (guyots) are located. The minimum depths over these peaks do not exceed 250-300 m (usually less). The Corner Mountains and Azore Banks are within the northern periphery of the Northern subtropic anticyclonic circulation. The first area is affected with Golf Stream and the second – with the Canarian Current.

Ichthyofauna of the northern NAR and Reykjanes Ridge

In the area of NAR and Reykjanes Ridge 68 species of bathyal fishes belonging to 35 families were found (Guschin, Kukuev, 1981; Kukuev, 1990). Underwater mountains of NAR area considered are inhabited mainly by non-deepwater ichthyocene species (mesobenthonic, mesobenthopelagic). The mesobenthopelagic (bathyal-pelagic) ichthyocene is the most diversified (Table 1). Like the water column over the circumcontinental bathyal area, this ichthyocene includes nektonic and macroplankton groups. The nektonic group consists of 44 species of the following common mesobenthopelagic families **deep-water sharks** Chlamydoselachidae, Pseudotriakidae, Scyliorhinidae, Squalidae, **smooth-heads** Alepocephalidae, **morid fishes** Moridae, **grenadiers** Macrouridae, **rocklings** Ophiidae, **berycid** Berycidae, **roughies**, **redfishes** Trachichthyidae, **oreos dories** Oreosomatidae, **wreckfishes** Polyprion americanus, **black cardinal** Epigonus telescopus, **gempylid fishes** Gempylidae, **black scabbard fish** Aphanopus carbo etc. The macroplankton group of bathyal-pelagic species includes 17 species common in mesopelagic zone of subtropical and tropical areas belonging to mesopelagic families: *Xenodermichthys copei*, *Searsia koefoedi*, *Barbanthus curvifrons*, *Holtbyrnia anomala*, *H. macrops*, *Sagamichthys schnakenbecki*, *Normichthys operosus*, *Maulisia maui*, *M. microlepis*, *Maurolicus muelleri*, *Astronesthes*

gemmifer, *Radinesthes decimus*, *Melanostomias spilorynchus*, *Gonostoma denudatum*, *Sudis hialina*, *Ceratoscopelus maderensis*, *Lampadena urophaos atlantica*.

From the south to the north the number of macroplankton group species gradually decreased and northwards of 52-55° N it is represented by only 9 species: *X. copei*, *H. anomala*, *S. schnakenbecki*, *N. operosus*, *M. muelleri*, *A. gemmifer*, *R. decimus*, *M. spilorynchus*, *C. maderensis*. Many listed macroplankton species are observed over NAR farther northwards than over the continental slope. It can be assumed that environment conditions over such underwater mountains are most favourable to the bathyal-pelagic fishes, the main food item of which is macroplankton (Guschin, 1982), and that the species diversity and biomass of these species is higher as compared to the bottom (mesobenthonic) fishes.

In few successful bottom catches some species representing the bottom (mesobenthonic) ichthyofauna were caught, including: *Raja (Rajella) kukujevi*, **chimaeras** *Hydrolagus pallidus*, **long-nosed eel** *Synaphobranchus kaupi*, **spiny eels** *Notacanthus hemnitzii*, *N. bonapartei*, **grenadiers** *Macrourus berglax*, *Coelorhynchus occa*, *Coryphaenoides guentheri*, **cusk, torsk** *Brosme brosme*, **northern wolffish** *Anarhichas denticulatus*, etc.

In zoogeographic analysis of thalassobathyal ichthyofauna in the area considered 68 mesobenthonic and mesobenthopelagic species caught between 45-58° N were used. Most species (about 70%) were amphiatlantic. Only 28% of all species found belong to the east-atlantic species (Fig. 3.I). The west-atlantic endemic component is extremely small. It is represented only by 1 species of deep-water cat shark *Parmaturus manis*, 2 recently described species being probably the endemics of NAR – white ray *Raja (Rajella) kukujevi* (Dolganov, 1985) and shark *Scymnodalatias garricki* (Kukuev, Konvalenko, 1988). The most species are characteristic of the continental slope of subtropical Northern Atlantic Ocean, while only some species caught northwards of 49-52° N belong to the boreal and arctic-boreal faunas.

The east-atlantic group includes species with primarily temporal-subtropical latitudinal distribution areas. The amphiatlantic group is represented by species with boreal, subtropical and wide-tropical latitudinal distribution areas. The subtropical species were observed only in the south of the area (up to 48° N). On the contrary boreal species are found northwards of 52° N. In general, mesobenthonic and mesobenthopelagic ichthyofauna of NAR is of amphiatlantic type, though it is more closely related to the eastern Atlantic. Proportions of different zoogeographical groups of species is shown on Fig. 3.I.

The bottom and near-bottom-pelagic ichthyofauna of the Rockall Mountains

At the depth up to 1000 m about 70 species of 30 families were found (Blecker, 1962; Kukuev, 1990; Kukuev, Kurov, 2001). Relatively shallow areas of the Rockall Mountain (up to 200 m) represent the biotope (thalassosublithoral), inhabited by bottom and near-bottom-pelagic species common also in the shelf sublithoral zone of the European coast. Here 23 species (5 near-bottom-pelagic and 18 bottom) were found. Bottom-pelagic (*Squalus acanthias*, *Argentina sphyraena*, *A. silus*, *Gadus morhua*, *Pollachias virens*, *Trisopterus minutus*.) Bottom (*Raja circularis*, *R. oxyrinchus*, *Phycis blennoides*, *Molva molva*, *Raniceps raninus*, *Callionymus maculatus*, *Eutrigla gurnardus*, *Arnoglossus imperialis*, *Hyppoglossoides platessoides*, *Microstomus kitt*). The overwhelming majority of this biotope species (about 80%) belong to the east-atlantic fauna and only 20% is represented by the amphiatlantic species (Fig. 3.II). The east-atlantic group of thalassosublithoral ichthyofauna is represented by low-boreal, boreal, boreal-subtropical and wide-tropical east-atlantic species. The amphiatlantic ichthyofauna is represented by only 5 boreal species. At mesobathyal depths 41 species were found (13 bottom and 28 near-bottom-pelagic). Bottom – (**skates** *Raja clavata*, *R. bathys*), **chimaeras** (*Chimaera monstrosa*, *Hydrolagus mirabilis*, *Harriotta raleighana*), **angler** (*Lophius piscatorius*), **gray sole** (*Glyptocephalus cynoglossus*), **long-nosed**

eel (*Synaphobranchus kaupi*), **grenadiers** (*Coelorhynchus coelorynchus*, *Trachyrhynchus trachyrhynchus*,). The mesobenthic-pelagic ichthyofauna is represented by 3 macroplankton species *Sagamichthys schnakenbecki*, *Xenodermichthys copei*, *Maurolicus muelieri* and 28 nektonic species. In the thalassomzobenthonic zone, unlike thalassosublitheal, the amphiatlantic species represented by wide-tropical, boreal, boreal-subtropical fauna components predominate. The wide-tropical and boreal-subtropical species dominate. In the east-atlantic group the boreal, boreal-subtropical and wide-tropical species predominate (see fig. 3, II). Therefore, the bottom and near-bottom ichthyofauna of relatively shallow Rockall mountains areas is almost totally represented by boreal and boreal-subtropical European species, while the deep-water ichthyofauna of mesobenthonic zone is more than in 50% represented by amphiatlantic species.

Ichthyofauna of the Corner Mountains

Over the peaks of the Corner Mountains 49 mesobenthonic species were found, most of which (46) belong to the bathyal-pelagic ichthyofauna and only 3 species to the bottom one (Kukuev, 1982; 1991). The bathyal-pelagic ichthyofauna is represented by the macroplankton and nektonic groups. The first group consists of 16 species common to the near-bottom water column at the continental slope of the subtropical and tropical Atlantic Ocean: *Normichthys operosus*, *Maulisia maui*, *Sagamichthys schnakenbecki*, *Xenodermichthys copei*, *Astronesthes gommifer*, *A. macropogon*, *Melanostomias spilorynchus*, *Gonostoma denudatum*, *Sudis hialina*, *S. atrox*, *Lampadena urophaios atlantica*, *Melamphaes suborbitales*, etc. Seven out of these species were observed on NAR mountains. The second group consists of 32 species of the families typical of the tropical and subtropical mesobenthic-pelagic zone; such as sharks - Mitsukurinidae Scyliorhinidae, Squalidae, Hexanchidae, **morid fishes** Moridae, **grenadiers** Macrouridae, **berycids** Berycidae, **spinyfins** Dactyloscopidae, **roughies** Trachichthyidae, **ruffs**, **barrel fishes** Centrolophidae, **wreckfishes** Polyprionidae, **black cardinal** Apogonidae, **black scabbard fish** Aphanopus etc.

The bottom ichthyofauna is represented by only 3 species: *Chaunax pictus*, *Ch. nuttingi*, *Sladenia shafersii*. Along side with bathyal species numerous mesopelagic fishes (140 species) typical of the subtropical ichthyofauna of the pen Northern Atlantic Ocean were observed in catches.

In spite of the Corner Mountains location westwards of NAR, the highest number of species 33 (68%) belong to the amphiatlantic group, only 11 (22%) belong to the east-atlantic group and 3 (10,2%) to west-atlantic group (Fig. 3,III). In the amphiatlantic group the most number of species (23) represents the wide-tropical faunal component, 10 species are observed in the subtropic and partially in the temperate waters of the Eastern and Western Atlantic Ocean. In the east-atlantic group various subtropical and wide-tropical species predominated. In the west-atlantic group only 3 species dominated: *Hyperogliphe perciformes*, observed off Florida coast to Hatteras Cape, *Sladenia shafersii* of the family Lophiidae, described earlier based on 2 specimens caught at the bathyal depths of the central America, and a shark *Parmaturus manis*, also found earlier off the North American coast. In general the bathyal ichthyofauna of the Corner Mountains is of amphiatlantic type, though the east-atlantic component considerably prevails over the west-atlantic one. The most species similarity of the Corner Mountain ichthyofauna is observed with the bathyal ichthyofauna of the North-Western Africa and to the less extent with subtropical ichthyofauna of the western Atlantic Ocean.

Ichthyofauna of underwater mountains southwards of Azores

The basic features of underwater mountains in this area contributing significantly the biotopic structure include flat guyot-like peaks and relatively small distance from them to the water surface. Over the peaks and slopes of these underwater mountains (Atlantis, Playto, Yer, Meteor, Erving, etc.) 93 fish species of 46 families were found. According to our data more than 50 species were found for the first time (Maul, 1976; Erich, 1977; Scherbachev et al., 1985; Kukuev, 1990). In the water column over the mountains peaks (thalassoepipelagic zone) such species as horse mackerel (*Trachurus picturatus*), mackerel (*Scomber japonicus*) and *Centracanthus cirrus* were permanently caught. These species belong to subtropical and tropical faunas.

Thalassosublithoral zone. This biotop exists over the peaks and upper slopes of the mountains with the minimum depths of 150-350 m and includes epibenthonic and epibenthopelagic species. This ichthyofauna is represented by 28 species: *Raja clavata*, *R. maderensis*, *Glossodon leioglossus*, *Autopus filamentosus*, *Chlopsis bicolor*, *Gnatophippocampus cadoniphorus*, *Gymnatorax maderensis*, *Macrorhamphosus scolopax*, *Phycis phycis*, *Carpos aper*, *Antigonia capros*, *Zenopsis conchifer*, *Anthias anthias*, *Callanthias ruber*, *Acantholatirus palloni*, *Lapanella fasciata*, *Callionymus phaeon*, *C. sausi*, *Bellottia apoda*, *Echiodon dentatus*, *Draconetta acanthopoma*, *Scorpaena loppei*, *Ponthinus kuhli*, *Lepidorhombus boscii*, etc.

The number of bottom species (17) in thalassosublithoral zone exceeds the number of near-bottom-pelagic species (15). Most epibenthonic and epibenthopelagic species (above 80%) of the Azore Banks thalassosublithoral zone belong to the east-atlantic ichthyofauna. Among them the north-subtropical species (see Fig. 3, IV) predominate. About 20% of thalassobathyal species are of amphiatlantic distribution within subtropic zone of both Western and Eastern Atlantic Ocean. Three species are known from the island areas of subtropical North-Western Atlantic Ocean, including Azore Banks (insular species). Such species as *Draconetta acanthopoma* and *Polymixia nobilis* observed on the shelf of subtropic North America and off the North-Eastern Atlantic islands and only recently on the shelf of Morocco, can be ascribed to this group with certain reservations.

Thalassomesobenthonic zone. This biotop is occupied by the most diversified fish group of the underwater mountains (52 species) and associates with the depths levels from 400-500 m to 1000-1500 m. It is represented mainly by bathyal-pelagic species. The number of bottom species is low. The bathyal-pelagic fauna includes macroplankton and nektonic groups. The first group includes 13 species: *Astronesthes gemmifer*, *Melanostomias spilorrhynchus*, *Polymetme corythaeola*, *Yarellia blackfordi*, *Diplophos maderensis*, *Argyripnus atlanticus*, *Gonostoma dcnudatum*, *Maurolicus mueileri*, *Xenodermichthys copei*, *Lampadena urophaos*, *Neoscopelus macrolepidotus*, *Sudis hialina*, *Ceratoscopelus maderensis*.

The nektonic group includes: *Heptranchias perlo*, *Deania calceus*, *Scymnodon ringens*, *Apristurus sp.*, *Scymnorhynchus licha*, *Chtamydoselachus anguineus*, *Roulania maderensis*, *Alepocephalus bairdii*, *Chlorophthalmus agassi*, *Gadella maraldi*, *Laemonema jarrellii*, *Mora moro*, *Physiculus dalwigki*, *Coeiorhynchus coelorhynchus*, *C. occa*, *Hymenocephalus gracilis*, *H. italicus*, *Malacocephalus laevis*, *Bathygadus favosus*, *Hoplostethus nrediterraneus*, *H. atlanticus*, *Beryx splendens*, *B. decadactylus*, etc.

In the area considered 12 bottom species were observed: *Gnatophippocampus mystax*, *Conger conger*, *Bathytyphlops marionae*, *Aldrovandia olcosa*, *A. phalacra*, *Chaunax pictus*, *Lophius piscatorius*? *Helicolenus dactylopterus*, *Setarches guentheri*, *Chimaera monstrosa*.

The upper boundary of thalassomesobenthonic zone (400-500 m) on the underwater mountains is overlapped with the lower depths levels of thalassosublithoral zone and represents the intermediate zone occupied by fishes of the upperbathyal and thalassosublithoral complex.

Within the lower mesobenthonic zone (1000-1500 m) 10 species were observed, including 6 species inhabiting only the Atlantic Ocean *Bathypterois dubius*, *Normichthys operosus*, *Sphagemacrurus grenade*, *Coelorhynchus occa*, *Aphanopus carbo*, *A. intermedia* and 5 species distributing also in 2 or 3 oceans: *Rouleina maderensis*, *Bathytyphlops marione*, *Aldrovandia oleosa*, *A. phalacra*, *Bathigadus fuvosus*.

The bottom ichthyofauna of the underwater peaks and upper slopes in the eastern part of NAR (Azore system) is closely related to the fauna of subtropical Eastern Atlantic Ocean, weakening towards meso- and bathy-benthonic depths, where ichthyofauna acquires amphiatlantic pattern (see Fig. 3, IV). The majority of amphiatlantic species belongs to wide-tropical type of distribution.

DISCUSSION

In conclusion it is possible to do some generalizations. Peaks of high mountains located eastwards of NARE (the Rockall mountains and mountains southwards of Azores) are inhabited by thalassosublithoral ichthyofauna, faunistically related to the European and North-African shelves. In this areas the east-atlantic species predominate as compared to the amphiatlantic species. On the Rockall plateau these are boreal and low-boreal, boreal-subtropical European species, while on the underwater mountains southwards of Azores the north-subtropical, east-atlantic species were found common to the shelf of the Southern Europe and North-Western Africa. In thalassosublithoral zone of these areas the number of bottom species exceeds the number of near-bottom-pelagic species. Over the Rockall Mountains this ratio is 5:18, in Azore Banks area – 15:17 (see Table 1). At mesobenthonic depths (more than 500 m) the fauna pattern changes with the ichthyofauna composition shift. (over the high underwater mountains). It acquires bathyal pattern irrespective of the thalassobathyal zone location within NAR or to the west and to the east of these mountains. Everywhere at these depths levels, the amphiatlantic, wide-tropical and other widely distributed species predominate. The number of the east-atlantic species is low as compared to the above mentioned groups, though a relative increase of their number was observed over the slope of the Rockall Mountains and the underwater mountains southwards of Azores as compared to the Corner Mountains and NAR, as well as increase of the wide-tropical species proportion in the latter two areas. The west-atlantic component of fauna at sublithoral and mesobenthonic depths levels is extremely small: one species in NAR area, 3 species in the Corner Mountains area and 1 species in Azore Banks area. Even on the Corner Mountains, located westwards of NAR, the east atlantic species number more than twice exceed the number of west-atlantic species (3:11). At mesobenthonic depths at the mountains slopes of all areas the bathyal species begin to dominate both in the terms of species diversity and biomass.

In the thalassobathyal zone of the Northern Atlantic Ocean most mesobenthonic and mesobenthopelagic fish species are found on more than one mountain system.

Eight species including common species of potential commercial importance, such as *Maurolicus muelleri*, *Epigonus telescopus*, *Aphanopus carbo*, *Hoplostethus*, *Beryx* were observed in all four researched areas, 13 species (including *C. rupestris*, *H. atlanticus*) – in 3 areas and 25 species – in 2 areas. The highest similarity of mesobenthonic ichthyofauna is observed between NAR and European and North-African slopes (coefficient of similarity 0.47-0.51 reduces from the north to the south) and North-American slope (coefficient of similarity 0.27-0.42) also reduces from the north to the south); between the Rockall mountains and European and North-African slopes (coefficient of similarity 0.39-0.69). Less

pronounced similarity is observed between ichthyofaunas of the Rockall Mountains and North-Western Atlantic Ocean (0.12-0.20); Azore Banks and Northern American slope (0.15); the Corner Mountain and the northern American slope (0.14).

In general the mesobenthonic ichthyofauna of considered thalassobathyal areas constitutes a part of the north-atlantic bathyal faunas. It is less diversifies than the continental fauna and is characterized by significant predominance of bathyal-pelagic species as compared to bottom (this trend becomes stronger with the depth), more or less extent of the same species recurrence in different parts of the thalassobathyal zone.

CONCLUSIONS

1. On the researched underwater mountains located within boreal and subtropical zones of the Northern Atlantic ocean at the depths up to 1500 m about 200 species of near-bottom and bottom fishes of 609 families were found. About 70 species of the total number were caught on NAR, about 70 species in the Rockall Mountains area more than 90 species in Azore Banks area and 52 on the Corner Mountains.

2. Peaks of high underwater mountains located eastwards of NAR (Rockall and Azore Banks) approach the water surface to no more than 250 m and are inhabited by ichthyofauna found also on the shelf (sublithoral zone) of Europe and North Africa. On the Rockall plateau boreal and boreal-subtropical European species predominate, while at Azore Banks subtropical and wide-subtropical species common to the shelf of Southern Europe and North Africa prevail. The proportion of amphiatlantic species there is significantly less than of east-atlantic species. The endemic species are absent on the Rockall plateau, while at Azore Banks only few species can be found.

3. Peaks and slopes of the Corner mountains located far from adjacent continents at the minimum depths more than 700 m are inhabited mainly by the common bathyal species with amphiatlantic and wide-tropical distribution areas. The number of east-atlantic species is low as compared to the above mentioned groups and decreases with depth. The west-atlantic component is very small. The number of endemic species is also low.

4. Bathyal depths (more than 500 m) of all underwater mountains irrespective of their location westwards of eastwards of the Mid-Atlantic Ridge are inhabited by ichthyofauna typical to the continental slope, however represented mainly by common amphiatlantic and wide-tropical species. Though the east-atlantic component is available everywhere its proportion is higher at Azore Banks and the Rockall plateau than in NAR and the Corner mountains.

5. The basic distinguish feature of underwater mountains ichthyofauna is poor species diversity as compared to fauna of the adjacent shelf and continental slope areas and predominance of bathyal-pelagic species over the bottom both in the terms of biomass and species diversity.

REFERENCES

- Andriyashev A. P. 1979. On some problems of the bottom marine fauna vertical zoning // Biological resources of the World Ocean. – M.- p.117-138 (In Russian).
- Blacker R.W. 1962. Rare fishes from the Atlantic slope fishing grounds //Ann.Mad.Nat.Hist.-1962.-15.5.-P.61-271.
- CLOFNAM (Check-list of the North-eastern Atlantic and of the Mediterranean//UNESCO, Paris.-1973.-682.
- Dolganov V.N. Raja (Rajella) kukueyevi; sp.n. – a new species of ray in the North-Atlantic Ridge area // Zoological Journal, 1985. - Vol.24, issue 2. - P.304-307.
- Enrich S. 1977. Die Fischfauna der Grossen Meteorbank//”Meteor” Forschungsergebnisse. R.D.N.-1977.-25.-S.1-23.

FNAM (Fishes of the North-eastern Atlantic and of the Mediterranean//UNESCO, 1984-1986.-Vol.1-3.-1475 pp.

Gershanovich D.E., Muromtsev A.M. 1982. Oceanologic principles of the World Ocean biological productivity. - L., Hydrometizdat, - 318 p. (In Russian).

Golovan G.A. 1978. Ichthyofauna composition and distribution at the continental slope of the western Africa. // Trudy of IO AS USSR. - Vol.102. - p.195-258. (In Russian).

Guschin A.V., E.I.Kukuev. 1981. On composition of ichthyofauna of the northern part of the Middle-Atlantic Ridge. IN: Fishes of the open Ocean. Institute of Oceanology Academy of Sciences of the USSR. pp. 36-40 (In Russian).

Il'yn A.V. 1976. Geomorphology of the Atlantic Ocean bottom. - M.: Nauka, - 232p

Kukuev E.I. 1982. Fish fauna of the Corner Mountains and New England submarine ridge in the western North Atlantic. In: Poorly known fishes of the open ocean. Institute of Oceanology Academy of Sciences of the USSR. pp. 92-109 (In Russian).

Kukuev E.I. 1991. Ichthyofauna of submarine rises of boreal and subtropical areas of the North Atlantic// Biological resources of the thalassobathyal. Part I. The Atlantic and Indian Oceans: Collected papers.-Moscow:VNIRO.-P.15-39 (In Russian).

Kukuev E.I., Guschin A.V., Gomolotski V.D., Miloradov G.K., Miloradov G.K. 1980. Methodical materials for fish identification in the open Northern Atlantic Ocean. - Kaliningrad : AtlantNIRO, - 145 p. (In Russian).

Kukuev E.I., Konovalenko I.I. 1988. New species of sharks of Scymnodalatiidae (Dalatiidae) from the Northern Atlantic Ocean and South-Eastern Pacific Ocean // Problems of Ichthyology.- Vol.28, issue.2. - P.115-119 (In Russian).

Litvin V.I. 1980. Morphostructure of the Atlantic Ocean bottom and its development during Mesozoic and Cainozoic. - M.: Nauka, - 123 p. (In Russian).

Maul G.E. 1976. The fishes taken in bottom trawl by RV "Meteor" during the 1967 seamounts cruises in the Northeast Atlantic// "Meteor" Forschungsergebnisse. R.D.-22.S.1-69.

Nesis K.N. Zoogeography of the World Ocean: comparison of pelagic zoning and E regional segmentation of the shelf (Cephalopoda) // Marine biogeography. - M., 1982a.- P. 114-134. (In Russian).

Nesis K.N. Zoogeographic position of the Mediterranean Sea // Marine biogeography. - M.: 1982b. - P.270-299 (In Russian).

Parin N.V. 1982. Biotopic groups of the ocean fishes and some problems of their researches. // Thesis of reports II All-Union Conference of Oceanologists. - Issue 5. Biology of the Ocean. - P.3-4.

Parin N.V. 1987. Ocean ichthyocenoses system and its fishery potential // Biological resources of the open Ocean. - M.: Nauka, - P.138-163.

Parin N.V., Golovan G.A. 1976. Pelagic deep-water fishes of families common in the open ocean // Trudy IO AS USSR. - Vol.104. - P.237-276.

Preston P.W. 1962. The canonical distribution of commonness and rarity//Ecology.- Vol.43, N.2.-P.185-215; N. 3.-P.410-432.

Scherbatchev Yu.P., Kukuev E.I., Shlibanov V.I. 1985. Bottom and near-bottom ichthyocenoses species composition in the underwater mountains of the southern North-Atlantic Ridge // Problems of Ichthyology. - Vol.25, issue.1. - P.35-50.

Zeina O.N. Ecology and distribution of present-day brachiopods. - M.: Nauka, 1976. - 138p.

Table 1

Biotop structure of the North Atlantic underwater mountains

	Minimum depths over peaks (m)	Total number of species	Number of species in biotops			
			EB	EBP	MB	MBP
Rockall	160	64	18	5	13	28
Azore Banks	270	93	17	15	14	47
NAR	800	68	-	-	11	57
Corner Mountains	700	51	-	-	3	48

Legends: EB - epi-benthonic, EBP - epi-bentho-pelagic (< 300m), MB - meso-benthonic, MBP - meso-bentho-pelagic.

Table 2

Coefficient of similarity of bathyal ichthyofauna on various underwater mountains of the West and East Atlantic continental slope

Underwater mountains	Number of species	North-West Atlantic			Europe		Africa
		40-50°	40-30°	30-20°	60-50°	50-40°	38-30°
NAR	68	33/0.42	34/0.31	17/0.27	48/0.51	51/0.47	54/0.47
Rockall	41	8/0.12	17/0.20	10/0.13	41/0.69	39/0.55	32/0.39
Azore Banks	52	10/0.15	22/0.29	24/0.30	21/0.32	27/0.31	41/0.59
Corner	52	11/0.14	28/0.33	28/0.35	19/0.20	27/0.28	45/0.48

Note: The first number is the total number of species, after slash – coefficient of similarity Preston fauna (1-Z).

Table 3

Fish species on Submarine mounts in North Atlantic

SPECIES	SUBMARIN MOUNTANS			
	Corner Mountains	Azores Banks	NAR	Rockall Mountains
HEXANCHIDAE				
Hexanchus griseus (Bonnaterre)	X	X	-	-
Heptranchias perlo (Bonnaterre)	X	X	-	-
CHLAMYDOSELACHIDAE				
Chlamydoselachus anguineus Garman	-	X	X	-
MITSUKURINIDAE				
Mitsukurina owstoni Jordan	X	-	-	-
SCYLIORHINIDAE				
Apristurus laurussoni Saemundsson	-	-	X	X
A. manis Springer	X	-	X	-
A. profundorum Goode et Bean				
	X	-	X	-
Galeus melastomus Rafinesque	-	-	-	X
PSEUDOTRIAKIDAE				
Pseudotriakis microdon Capello	-	-	X	-
SQUAUDAE				
Dalatias licha (Bonnaterre)	-	X	-	X
Somniosus microcephalus (Schneider)	-	-	X	-
S. rostratus (Risso)	X	-	-	-
Scymnodalatias garricki				
Kukuev et Konovalenko	-	X	X	-
Centrophorus squamosus (Bonnaterre)	X	-	X	X
C. granulatus (Schneider)	-	-	X	X
Centroscyllium fabricii (Reinhardt)	-	-	X	X
Centroscymnus coelolepis Bocage et Capello	X	-	X	X
C. owstoni Garman	-	-	X	-
C. crepidator Bocage et Capello	-	-	-	X
Deania calceus Lowe	-	X	-	X
D. profundorum Smith et Radcliffe	-	-	X	-
Etmopterus princeps Collett	X	-	X	X
E. spinax (Linnaeus)	X	-	X	X
Scymnodon ringens Bocage et Capello	-	-	X	X
S. obscurus (Vaillant)	-	-	-	X
Squalus acanthias Linnaeus	-	-	-	X
RAJIDAE				
Raja oxyrinchus Linnaeus	-	-	-	X
R. clavata Linnaeus	-	X	-	X
R. circularis Couch	-	-	-	X
R. bathys Linnaeus	-	-	-	X

R. maderensis Lowc	-	X	-	-
Raja (Rajella) kukujevi Dolganov	-	-	X	-
TORPEDINIDAE				
Torpedo nobiliana Bonaparte	-	X	-	-
CHIMAERIDAE				
Chimaera monstrosa Linnaeus	-	X	-	X
Hydrolagus affinis Capello	-	-	-	X
H. pallidus Stehmann	-	-	X	-
H. mirabilis Collett	-	-	X	-
RI NYNOCHIMAERIDAE				
Harriotta raleighana Goode et Bean	-	-	-	X
ALEPOCEPHALIDAE				
Alepocephalus agassizi Goode et Bean	-	-	X	?
A. bairdii Goode et Bean	-	-	?	X
A. rostratus Risso	-	-	?	X
Bajacalifornia megalops (Lutken)	-	-	X	-
Einara macrolepis (Koefoed)	X	-	-	-
Rouleina maderensis Maul	-	X	-	-
Xenodermichthys copei (Gill)	X	X	X	X
PLATYTROCTIDAE				
Searsia koefoedi Parr	-	-	X	-
Barbanthus curvifrons				
(Roule et Angel)	-	-	X	-
Holtbyrnia anomala Krefft	X	-	X	-
H. macrops Maul	-	-	X	-
Normichthys operosus Parr	X	X	X	X
Sagamichthys schnakenbecki Krefft	X	X	X	X
Maulisia mauli Parr	-	-	X	-
M. microlepis Sazonov et Golovan	X	-	-	-
STERNOPTYCHIDAE				
Argyripnus atlanticus Maul	-	X	-	-
Maurolucus muelleri (Gmelin)	-	X	X	X
PHOTYCHTIIDAE				
Polymetme corythaeola (Alcock)	-	X	-	-
Jarrella blackfordi Goode et Bean	-	X	-	-
GONOSTOMATIDAE				
Gonostoma denudatum Rafinesque	X	X	X	-
ASTRONESTHIDAE				
Astronesthes gemmifer bGoode et Bean	X	X	X	-
A. macropogon Goodyear et Gibbs	X	?	-	-
Radonesthes decimus Zugmayer	-	-	X	-
MELANOSTOMIATIDAE				
Melanostomias spilorrhynchus Regan et Trewavas	X	X	X	X
ARGENTINIDAE				
Argentina sphyraena Linnaeus	-	-	-	X
Glossonodon leiglossus (Valenciennes)	-	X	-	-
Chlorophthalmus agassizi Bonaparte	-	X	-	-
Bathypterois dubius Vailant	-	X	-	-
B. phaeanax Parr	-	X	-	-

B. longipes Gunther	-	X	-	-
Bathytylphlos marione Mead	-	X	-	-
Bathyrmirops regis				
AULOPIDAE	-	X	-	-
Aulopus filamentosus Cloguet	-	X	-	-
PARALEPIDIDAE				
Sudis hialina Rafinesque	X	X	X	-
S.atrox Rofen	X	-	-	
NEOSCOPELIDAE				
Neoscopelus macrolepidotus Johnson	X	X	-	-
CONGRIDAE				
Gnatophis mistax (Dclaroche)	-	X	-	-
Conger conger Linnaeus	-	X	-	-
MURAENIDAE				
Gymnatorax maderensis (Johnson)	-	X	-	-
XENOCONGRIDAE				
Chlopsis bicolor Rafinesque	-	X	-	-
SYNAPHOBRANCHIIDAE				
Synaphobranchus kaupi Johnson	-	?	X	X
HALOSAURIDAE				
Aldrovandia oleosa Sulak	-	X	-	-
A. phalacra (Vaillant)	-	X	-	-
NOTACANTHIDAE				
Notacanthus chcmnitzii Btoch	-	-	X	-
N. bonapartei Risso	-	-	X	X
MACRORHAMPHOSIDAE				
Macrorhamphosus scolopax Linnaeus	-	X	-	-
MORIDAE				
Aniimora rostrata Gunther	-	-	X	X
Gadella maraldi (Risso)	-	X	-	-
Halargyreus johnsoni Gunther	-	-	X	X
Lepidion eues (Gunther)	-	-	X	X
Physiculus dalwigki Kaup	X	X	X	-
Mora mora (Risso)	-	X	-	X
Laemonema jarrelli (Lowc)	-	X	-	-
GADIDAE				
Melanogrammus aeglefinus Linnaeus	-	-	-	X
Pollachas virens Linnaeus	-	-	-	X
Trisopterus minutus Linnaeus	-	-	-	X
Gagiculus argentheys thori Risso	-	-	-	X
Gaidropsaras macrophtalmus Gunther	-	X	-	X
G. mediterraneus (Linnaeus)	-	-	-	X
Phicis blenoides (Brunnich)	-	-	-	X
P. Phycis Linnaeus	-	X	-	-
Molva molva (Linnaeus)	-	-	-	X
M. dopterigia dipterigia (Pennat)	-	-	-	X
M. dipterigia macrophtalma(Rafinesque)	-	-	-	X
Brosme brosmes (Linnaeus)				
Micromesistius poutassou Schmidt	-	-	X	X
MACROURIDAE				
Trachirinchus trachirinchus (Risso)	-	X	-	X
T. murrayi Gunther	-	-	X	-
Bathygadus favosus Goode et bean	-	X	-	-
Hymenocephalus itelicus Giglioli	-	X	-	-

<i>H. gracilis</i> Gilbert et Rubbs	-	X	-	-
<i>Sphagemacrurus grenade</i> Parr	-	X	-	-
<i>S.hirundo</i> (Collett)	-	-	X	-
<i>Nezumia sclerorhynchus</i> (Valenciennes)	X	-	-	-
<i>N. longibarbata</i> (Roule et Angel)	X	-	-	-
<i>Malacocephalus laevis</i> (Lowe)	X	X	-	X
<i>Coelirhynchus coelirhynchus</i> (Risso)	-	X	-	X
<i>Coryphaenoides rupestris</i> Gunther	X	-	X	X
<i>C. guentheri</i> (Vaillant)	-	-	X	?
<i>Macrourus berglax</i> Lacepede	-	-	X	X
MERLUCCIDAE				
<i>Lyconus brachycolis</i> Holt et byrne	-	-	X	-
POLYMIXIIDAE				
<i>Polymixia nobilis</i> Lowe	-	X	-	-
BERYCIDAE				
<i>Beryx splendens</i> Lowe	X	X	X	X
<i>B. decadactylus</i>	X	X	X	X
DIRETMIDAE				
<i>Diretmoides parini</i> Post et Quero	X	X	-	-
TRACHICHTHYIDAE				
<i>Gephyroberyx darwini</i> Johnson	-	X	-	X
<i>Hoplosthetus mediterraneus</i> Cuvier	X	X	X	X
<i>H. atlanticus</i> Collett	-	X	X	X
MELAMPHAIDAE				
<i>Melamphaes suborbitales</i> (Gill)	X	?	-	-
ZEIDAE				
<i>Zeus faber</i> Linnaeus	-	X	-	-
<i>Zenopsis conchifer</i> (Lowe)	-	X	-	-
<i>Cyttopsis roseus</i> (Lowe)	-	X	-	-
GRAMMICOLEPIDIDAE				
<i>Grammicolepis brachiusculus</i> Poey	-	X	-	-
OREOSOMATIDAE				
<i>Neocyttus helgae</i> Gilchris	X	?	-	X
CAPROIDAE				
<i>Capros aper</i> Linnaeus	-	X	-	-
<i>Antigonia capros</i> Linnaeus	-	X	-	-
ANTIIDAE				
<i>Anthias antias</i> Linnaeus	-	X	-	-
<i>Callanthias ruber</i> Rafinesque	-	X	-	-
POLYPRIONIDAE				
<i>Poliprion americanus</i> Schneider	X	X	X	-
CARANGIDAE				
<i>Trachurus picturatus</i>	-	X	-	-
CENTRACANTHIDAE				
<i>Centracanthus cirrus</i> Rafinesque	-	X	-	-
APOGONIDAE				
<i>Epigonus telescopus</i> (Risso)	X	X	X	X
LABRIDAE				
<i>Acantholabrax palloni</i>	-	X	-	-
<i>Lapanella fasciata</i>	-	X	-	-
<i>Echiodon dantatus</i>	-	X	-	-
CALLIONYMIDAE				
<i>Callionymus phaeton</i> Gunther	-	X	-	--

<i>C. maculatus</i> Rafinesque-Schmallz	-	-	-	X
<i>C. sausi</i> Maul	-	X	-	-
SCOMBEROLABRACIDAE				
<i>Scombrolabrax heterolepis</i>	X	X	-	-
TRICHIURIDAE				
<i>Aphanopus carbo</i> Lowe	X	X	X	X
<i>A. intermedia</i> Parin	X	X	-	-
<i>Lepidopus caudatus</i> Euphrasen	-	X	-	-
<i>Benthodesmus elongatus</i>	X	-	-	-
GEMPYLIDAE				
<i>Nesiarchus nasutus</i> Johnson	-	-	X	X
<i>Prometichthys prometeus</i> Cuvier	-	X	X	-
<i>Ruvetus proteosus</i> Cocco	X	X	-	-
<i>Lepidocibium flavobrunneus</i> (Smith)	X	-	-	-
DRACONNETTIDAE				
<i>Draconella acanthopoma</i> Kroyer	-	X	-	-
ANARHICHADIDAE				
<i>Anarhichas denticulatus</i> Kroyer	-	-	X	X
ZOARCIDAE				
<i>Lycodes esmarki</i> Collett	-	-	X	-
<i>Melanostigma atlantica</i> Kocfoed				
OPHIDIIDAE				
<i>Belottia apoda</i> Giglioli	-	X	-	-
<i>Brotulotaenia crassa</i> Parr	X	X	X	-
<i>Talassobathia pelagica</i> Cohen	-	-	X	-
CENTROLOPHIDAE				
<i>Centrolophus niger</i> Gmelin	X	X	X	X
<i>Hyperoglyphe perciformis</i> Michell	X	?	-	-
<i>Schedophilus ovalis</i> (Cuvier)	X	X	-	-
<i>S. medusophagus</i> Cocco	X	X	X	X
SCORPAENIDAE				
<i>Scorpaena loppei</i> Cadetnat	-	X	-	-
<i>Helicolenus dactylopterus</i> Delaroche	-	X	-	X
<i>Pontinus kuhli</i> (Bowdich)	-	X	-	-
<i>Scorpaenopsis menthella</i> Travin	-	-	X	X
<i>Setarchus guncithri</i> Johnson	-	X	-	-
<i>Ectreposebastes imus</i> Garman	-	X	-	-
TRIGLIDAE				
<i>Aspilrigia cuculus</i> Linnaeus	-	-	-	X
<i>Eutrigia gurnardus</i> Linnaeus				X
PLEURONECTIDAE	-	-	-	X
<i>Hypoglossoides platessoides</i> (Fabricius)				X
<i>Hypoglossus hypoglossus</i> Linnaeus				X
<i>Glyptocephalus cynoglossus</i>	-	-	-	X
<i>Microstomus kilt</i> (Walbaum)	-	-	-	X
BOTHIDAE				
<i>Arnoglossus imperialis</i> Rafinesque	-	X	-	X
<i>A. rueppelli</i> (Cocco)	-	X	-	-
SCOPHTALMIDAE				
<i>Lepidorhombus whiffiagonus</i> (Walbaum)		-	-	X
LOPHIIDAE				
<i>Lophiui piscatorius</i> Linnaeus	-	-	-	

<i>Lophioides kcmpti</i> (Norman)?	-	X	-	-
<i>Sladenia shafaresii</i> Caruso et Bulis	X	-	-	-
CHAUNACIDAE				
<i>Cnaunas pictus</i> Lowe	X	X	-	-
<i>Ch. nuttingi</i> Garman	X	-	-	-

LEGENDS

Fig. 1. Location of considered thalassobathyal areas.

1 – North-Atlantic Ridge (NAR); 2 – Rockall Mountains; 3- Corner Mountains; 4, 5 – Azore Banks.

Fig. 2. Simplified pattern of some latitudinal distributions of epi-meso-benthonic fishes in thalassobathyal zone of the North Atlantic Ocean (see Fig. 3).

1- boreal; 2- low-boreal; 3- boreal-subtropical; 4- boreal-nothal-subtropical; 5- subtropical; 6- wide-tropical; 7- tropical, etc.

Fig. 3. Zoogeographic structure of thalassobathyal ichthyofauna:

I - of the NAR northern part (A-amphiatlantic species; B- east-atlantic species; C- endemic and other species, see Fig. 2);

II - of Rockall mountains (TC-thalassosubthoral zone; TM-thalassomesobenthonic zone; A,B – amphiatlantic and east-atlantic species, respectively);

III - of the Corner mountains (A,B,C – amphiatlantic, east-atlantic and west-atlantic species, respectively);

IV- of underwater mountains southwards of Azores (TC-thalassosubthoral zone; TM – thalassomesobenthonic zone; A, B – amphiatlantic and east-atlantic species; C –other species: endemics and insular).

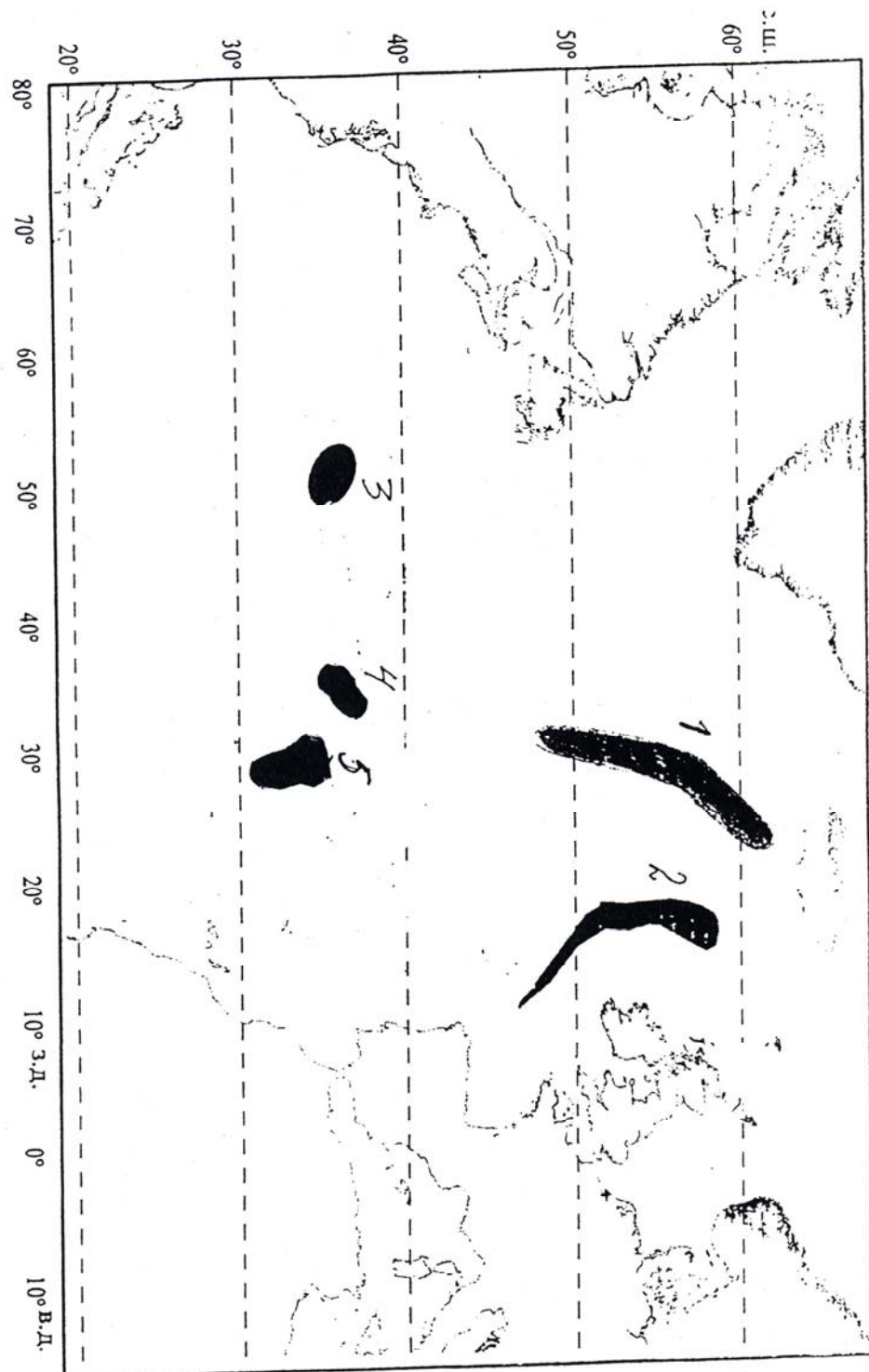


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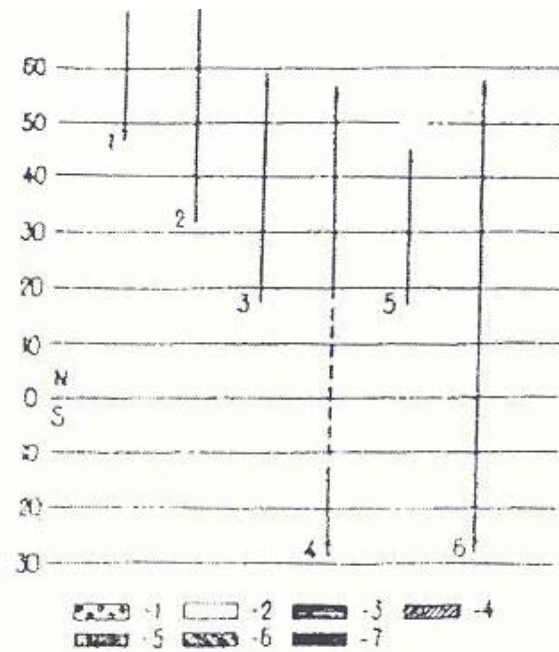


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-c o m p o n e n t s o f f a u n a-

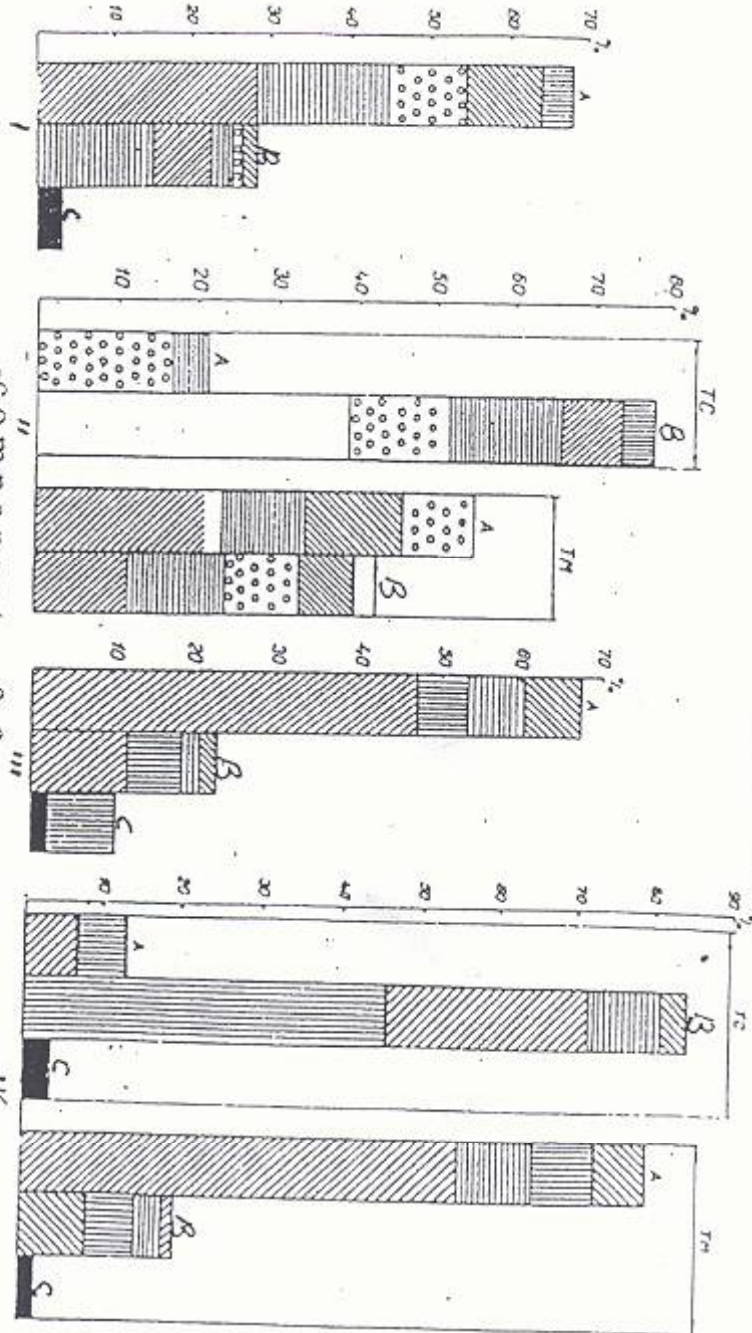


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