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Zoogeography of the bottom Foraminifera of the West-African coast

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Abstract

The sediment samples from the continental shelf of West-Equatorial Africa (from the Strait of Gibraltar to the Niger estuary), depths ranging from 0 to 69 m were found to contain 176 bottom foraminiferal species. For the majority of them (126 species), their areas of occurrences were mapped and the peculiar features of the geographical range and distribution were studied. The species natural habitats were established based on the taxonomical revision of the species in study all over the World Ocean based on the collections of the Zoological Institute RAS and wide literary data. The method of perforated cards was used to mark the geographical locations of all of the species studied. In order to establish the species geographic zonal distribution (together with their depth habitat) the five characteristic groups of the species were separated: 1. pan-oceanic (cosmopolitan), 2. widely spread tropical-boreal, 3. tropical-law boreal, 4. tropical-subtropical, 5. tropical. The percent of the species of each group among the species composition was established for the fauna of each station and for the whole region.

1 Material and methods

The present study was based on the materials gathered in 1965–1967 years by the AtlantNIRO vessels (fish trawlers) of the West-Equatorial African coast from the Strait of Gibraltar (19°31′06″ N) to the Niger estuary (04°45′03″ N) (21 stations) and 7 stations near the Guinea Coast (Canary region) by the Prof. P.V. Ushakov in 1963 (samples of the vessel “Hilda” and hand samples). All the samples were situated at the littoral and continental shelf (depths 0–69 m), at the oozy and sandy grounds. The region is characterized with permanent high temperatures (21.1° to 26.6°C).

The separation of the shells from the sediment was made using the carbon tetrachloride. The quantity of the shells of each species per 1 g of the dried sediment was counted. The thorough taxonomical revision of 126 bottom species was made

(Mikhalevich, 1983) as the collections of d'Orbigny who was the first in the foraminiferal study of this region (d'Orbigny, 1839) were lost and the understanding of his species in the later literature was rather wide. Many forms of the different regions of the World Ocean were previously attributed to his forms. The comparison of these forms with the topotypes of the Canary Islands in our material permits us to make the taxonomical revision of the species studied in the World Ocean, to map the natural habitat of 126 species and to describe their geographical distribution which is much more restricted than it was considered according the literary data. The method of perforated cards was used to mark the geographical locations of all of the species studied when the fields of the cards were specially marked to put the exact occurrences of the definite geographical areas. A system of special coding of with the indication of list of the classes and descriptors was composed. Perforations of these card fields permit to generalize the investigated cases much quicker (see the detailed description of the method in Gorodkov and Trjapicin, 1970). After d'Orbigny (1839) the foraminifera of the region were not studied till the end of the 20th century (Mikhalevich, 1974, 1975, 1976, 1977, 1983; Haake, 1980; Lutze and Coulbourn, 1983; Licari and Mackensen, 2005; works of Jorissen group: Jorissen et al., 1998; Jorissen and Wittling, 1999; Martinez et al., 1999; Morogo et al., 2001; Ernst et al., 2006; Fontanier et al., 2006). The latter studies were concerned mostly with the ecological investigations and at the deeper depths.

2 Results

The character of the zonal and depth distribution was studied for the 126 bottom species. The boarders of the arctic and boreal zones were followed after Golikov (1963), of the tropical and subtropical zones after Ekman, 1953 and Gurianova, 1972. It was possible to arrange these 126 species into 5 different groups.

The first group of pan-oceanic species includes widely spread forms occurring from Arctic to tropical regions, some of them were met in Antarctic (*Proteonina atlantica, Glomospira charoides, Karreriella bradyi, Pyrgo globulus,P. depressa, Miliolinella subrotunda, Hoeglundina elegans, Hyalinea baltica, Eponides tenerus, Epistominella rugosa, Cibicides pseudoungerianus, Pullenia subcarinata, Bulimina aculeata, B. marginata, Uvigerina canariensis, Angulogerina angulosa, Cassidulina carinata, Patellina corrugata*). Eurybathic and deep-water species constitute 84% of the species of this group. These are species bearing more cold waters.

The second tropical-boreal group is composed of the widely spread species distributed in boreal and tropical zones but not entering Arctic and Antarctic areas:*Sigmoilopsis schlumbergeri, Eggerella scabra, Lenticulina thalmanni,Discorbis globularis, Discopulvinulina araucana, Neoconorbina williamsoni, Nonionella turgida, Gavelinonion barleanum, Euvigerina peregrina, Bolivina variabilis, Spirillina vivipara.*

The third widely spread tropical-law-boreal group includes species occurring in the law and middle latitudes but not spreading North to the Great Britain thus limited in their distribution by the northern boarder of the law-boreal province. It is possible to distinguish among them the species with predominantly low-boreal (*Quinqueloculina lata, Q. trigonula, Spirophhtalmidium acutimargo, Robulus orbicularis, Discorbis floridensis, D. bertheloti,D. subaraucana, Gavelinopsis praegeri, Siphonina tubulosa, Cribroelphidium depressulum, Robertina bradyi, Bulimina affinis, B. gibba, Uvigerina parvula, Ehrenbergina pupa, Bolivina inflata, B. spathula, B. spinescens, B. subspinescens*) and mainly subtropical distribution: *Textularia saggitula, Vulvulina pennatula, Spirophthalmidium acutimargo v. concava, Lenticulina peregrina, Planulina ariminensis, Astrononion tumidum, Elphidium poeyanum, Ammonia beccarii, Rotamorphina laevigata, Bulimina alazanensis.* In this third group the shallow water species predominate, the deep water and eurybathic ones constitute only 20% of its composition. Opposite to the first two groups the species of the third one prefer warmer waters.

The fourth group of the foraminiferal species of this region inhabits tropical and subtropical areas. This tropical-subtropical group is the most multiple one (Fig. 1)– *Placopsilina glabra, Reophax petrosum*, *Ammotium salsum, Sigmoilopsis flintii, S. procericollis, Bigenerina nodosaria, Clavulina crustata, Goesella obscura, Gaudryina siciliana, Spiroloculina canaliculata, S. grata, S. limbata, S. subcommunis, S. soldanii,*

Edentostomina disparilis, Tschokrakella carinata (=Edentostomina carinata Mikhalevich, 1977), Quinqueloculina bicostata, Q. boueana, Q. lamarckiana, Q. undosa, Ptychomiliola separans, Sigmoilina distorta, Pyrgo subsphaerica, Lagena guynensis, L. inepta, L. limbata, Parafissurina lateralis pontica, Sigmomorphina pauperata, Discorbis advenus, D. candeiana, D. concinna, Planodiscorbis rarescens, Gyroidina altiformis, G. umbonata, Pileolina pileolus, Cancris sagra, C. oblonga v. scabra, Cibicidina rhodiensis, Amphistegina gibbosa, Stomatorbina concentrica, Eponides repandus, Anomalina atlantis, Nonion asterizans, N. grateloupi, Astrononion stelligerum, Rotalia translucens, Elphidium crispum, E. advenum, Fursenkoina pontoni, Loxostomum limbatum, L. mayori, Reussella atlantica, Uvigerina auberiana, U. compressa, U. nodosa, Bolivina albatrossi, B. atlantica, B. simplex, Brizalina difformis minuta, B. amigdaleforme, B. tongi, Trifarina fornasini and some others. Most of these species are typical for the continental shelf, the role of deep water and eurybathic species in this group is much lesser than in the composition of the second and the third groups and is equal to 10%.

The species of the fifth group are restricted in their distribution to the tropical area (*Textularia conica, Norvanganina pseudorugosa fistulosa, Tetragonostomina rhombiformis, Miliammina horrida, Spiroloculina antillarum, Quinqueloculina crassa, Q. candeiana, Q. boueana, Q. compta, Q. polygona, Bolivina daggarius, B. robusta, B. tortuosa, Trifarina bradyi, Calcarina calcar – Pl. 1),* all of them (with the exclusion of *Trifarina bradyi)* belongs to the shallow water forms.

The percent of the species of each group described above among the species composition was established for the fauna of each station and for the whole region. The results of the zoogeographical analysis shows that the greater part of the fauna studied comprise the tropical-subtropical and tropical species. They comprise 60% among all the species occurred in our material. Widely spread tropical boreal (8.5%) and tropical-law-boreal species (14.5%) play lesser part. All the shallow-water species enter the groups with the restricted geographic zonal distribution. Cosmopolitan species compose 17%. Nearly all of them are eurybathic.

The data of the similar analysis of the geographical distribution of the species made

for each separate station shows the similar results. Thus, tropical-subtropical species have the most weight in all the stations varying from 41 to 50%. Their quantity falls only at the most northern station No. 166 (19°31′6″ N, 16°57′ W, depth 45 m) and at the station No. 7 (04°45′3″ N, 01°47′ W, depth 37 m) comprising 35% and 32.4% correspondingly. Vise versa, the quantity of the pan-oceanic and widely spread species increases at these two stations to 25.6 and 35%. Some cold water species occurring at these two stations at many other stations do not occur at all. Decrease of the number of specimens of the warm water species per 1 g of the sample comparing the rest stations could also be marked. Such differences could be explained by the special hydrological character at these stations distinctive from the rest ones of the region. All these peculiarities are the most apparent at the most Northern station No. 166. At the same time the whole species number of the warm water species at this station is rather big and the whole number of all the species increases significantly comparing the other stations. The whole enrichment of the fauna of this station and its mixed character could be explained with its position in the zone of convergence of the Canary Current and the Equatorial Countercurrent at the turn of the tropical and subtropical waters. As to the station No. 7 situated at the very South of the investigated area, the number of not only of pan-oceanic and widely spread species but also of the deep water and eurybathic species increases significantly composing up to 2/3 of the species number. Such faunal composition of the station could be explained by the up-welling of the South-Equatorial Current at this point which is congruent with the hydrologic data and data of Ganssen (1983). Thus the zoogeographical analysis of the fauna permits to elucidate the peculiar hydrologic conditions of the separate stations.

3 Conclusions

The detailed zoogeographical analysis with the thorough revision of their distribution in the World Ocean and of the taxonomic identity of each of the foraminiferal species of the area investigated was done for the first time (the similar analysis for the other

geographical areas was not done yet concerning the foraminifera). The results of this analysis are congruent with the data received on the oceanic Metazoan groups (Golikov, 1963, Gurjanova, 1972). Above the theoretical zoogeographical meaning the results obtained permit to elucidate the peculiar hydrologic conditions of the separate stations and to use definite foraminiferal species as the indicators of the character of the water masses serving as additional proxies in the cases when the hydrological data are not available. The latter data indicating the upwelling conditions could be utilized in the search of the highly productive water masses.

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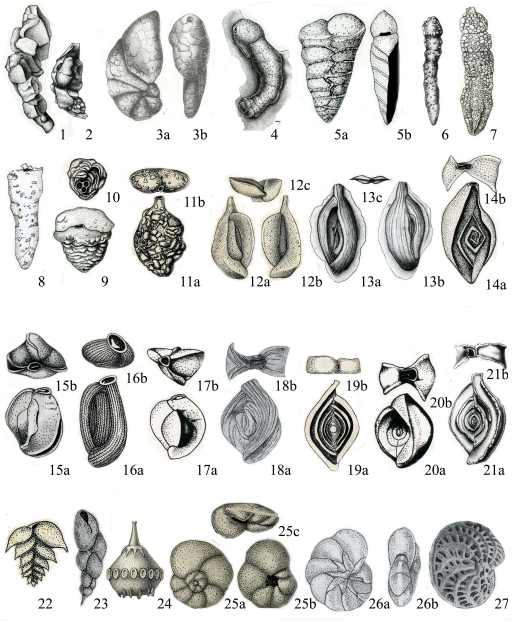

Fig. 1. Tropical-subtropical species off the North-West African Coast (not to the scale, for diagnoses and dimensions, see Mikhalevich, 1983): 1, 2 – Reophax petrosum, 3a, b – Ammotium salsum, 4 – Placopsilina glabra, 5a, b – Textularia. saggitula, 6 – Bigenerina nodosaria, 7 – Clavulina crustata, 8 – Goesella obscura, 9, 10 – Gaudryina siciliana, 11a, b – Sigmoilopsis flintii, 12a, b – S. procericollis, 13a, b, c – Tschokrakella carinata, 14a, b – Edentostomina disparilis, 15a, b – Quinqueloculina bicostata, 16a, b - Q. boueana, 17a, b – Q. lamarckiana, 18a, b - Q. undosa, 19a, b Spiroloculina canaliculata, 20a, b – S. limbata, 21 a, b – S. subcommunis, 22 – Brizalina difformis minuta, 23 - Fursenkoina pontoni, 24 - Lagena guynensis, 25a, b, c - Discorbis advenus, 26a, b – Nonion asterizans, 27 – Elphidium crispum.