THE SYSTEMATICS OF JURASSIC AND EARLY CRETACEOUS GLOBIGERINACEA

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ABSTRACT: Eight species of Jurassic and Early Cretaceous Globigerinacea, including topotypes of the type species of the genera Globuligerina and Conoglobigerina of the family Favusellidae have been investigated by scanning electron microscope. The state of knowledge concerning the systematics of the Jurassic and Early Cretaceous Globigerinacea is discussed, and a modified and updated description is given of the family Favusellidae and its constituent genera. The time of the family's existence is more closely defined (from Middle Jurassic to Early Cenomanian). The evolution of the family is considered.

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Jurassic planktonic foraminifers are a very interesting, but as yet poorly studied group. Although individual records have been known since the end of the 19th century, adequate material for systematization was not available until recent years. The oldest Early Cretaceous (Berriasian-Valanginian-Hauterivian) members are also poorly known. However, whereas the generic composition of the Jurassic and Early Cretaceous plankton has now been more or less established, the suprageneric systematics remains to be worked out and this presents considerable difficulties. There are problems involved in studying the morphology, phylogeny, and systematics of Jurassic and Early Cretaceous planktonic foraminifers, which have become apparent as the result of study of material, collected by the authors, at high magnification using a scanning electron microscope (Moscow University). This group is also of interest from the point of view of its use for detailed stratigraphic studies and for stratigraphic correlation.

The present article is devoted to those Jurassic and Early Cretaceous Globigerinacea that are characterized, inter alia, by the umbilical location of the aperture and the distinctive ornament of the surface. Members of the families Globotruncanidae, Planomalinidae and Schackoinidae that occur widely in Lower Cretaceous deposits are not discussed, because their morphology and systematics are already much better understood (Moullade, 1966; Risch, 1971; Gorbachik and Krechmar, 1971; Gorbachik, 1975, 1977, 1978).

The material considered here comes from the Murassic of the southwestern part of Soviet territory in the Baltic region, the Pechora-Timan ridge (Pizhma River), Moldavia (coll. M.M. Danich), Poland (coll. O. Pazdrowa, the Lower Cretaceous of Azerbaidzhan (coll. L.A. Poroshina), Dagestan (coll. U.T. Temirbekova), the Crimea, and the eastern Atlantic (along the coast of Morocco, deep water drilling material from the research vessel Glomar Challenger sent by V.A. Basov).

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THE PRESENT LEVEL OF KNOWLEDGE

Jurassic planktonic foraminifers have been reviewed by Morozova and Moskalenko (1961), Pazdrowa (1969), Fuchs (1973, 1975), and Grigyalis (1974, 1975). Some of the species and genera

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of Lower Cretaceous foraminifers belonging to the group under consideration have been described by Subbotina (1953), Antonova et al. (1964), Bolli (1959), Michael (1972) and Longoria (1974). Developmental features of Early Cretaceous planktonic foraminifers have been studied by Gorbachik (1977, 1978).

Morozova and Moskalenko (1961) erected Conoglobigerina as a new subgenus of the genus Globigerina (table 1) for spirally coiled forms in which the base diameter D of the test is less than its height H, i.e., the ratio H:D > 1. The genus is characterized by subspherical, more or less tightly arranged chambers and an umbilical aperture. Four species from the Bajocian-Callovian of the Caucasus and the Crimea had been assigned to this subgenus. Eoglobigerina is another subgenus of the genus Globigerina established by Marozova (1959) from Paleocene deposits. G. (Eoglobigerina) balakhmatovae from the Bajocian-Bathonian in the south of the USSR and G. (E.) oxfordiana from the xfordian of Latvian have been placed in it. Loeblich and Tappan (1964) included the subgenus Eoglobigerina among the synonyms of the genus Globorotaloides Bolli, 1957. We place these species in the genus Globuligerina.

Interesting although somewhat controversial data are given by Fuchs (1973), who established the following generic composition for the Jurassic plankton on the basis of a study of Australian and Polish material; Conoglobigerina Morozova, 1961 (Bajocian-Tithonian), Polskanella Fuchs, 1973 (Callovian-Oxfordian), Tectoglobigerina Fuchs, 1973 (Callovian), Woletzina Fuchs, 1973 (Bajocian-Oxfordian), Eoheterohelix Fuchs, 1973 (xfordian), Globuligerina Bignot and Guyader, 1971 (Callovian-Oxfordian), Mariannenina Fuchs, 1973 (Callovian-Oxfordian), Jurassorotalia Fuchs, 1973 (Bajocian-Oxfordian). The last two genera are rotaloid forms and, in our opinion, do not belong to the Globigerinacea. From among the genera of Jurassic planktonic foraminifers accepted by Fuchs, we regard Globuligerina, Conoglobigerina and Tectoglobigerina as valid (the last provisionally). Globuligerina and Tectoglobigerina have a trochoid test with a moderately convex spiral (dorsal) side and a flattened umbilical (ventral) side (H:D ≤ 1) and an umbilically located aperture. Tectoglobigerina is distinguished mainly by the valvelike process of the final chamber, closing the aperture and the umbilicus. The independence of this genus needs confirmation on the basis of more extensive material.

The genus Globuligerina, originally separated as a subgenus of the genus Globigerina with the type species G. oxfordiana Grigelis (Bignot and Guyader, 1971), is considered to be of generic rank (Grigyalis, 1974). It should be noted that Fuchs (1973) changed the diagnosis of the genus Globuligerina and selected the new type species G. frequens Fuchs for it on the grounds that Globigerina oxfordiana in Bignot and Guyader (1971, Pl. 1, figs. 1-3) allegedly did not correspond to the description of the holotype in the paper by Grigyalis (1958, textual fig.). The type species Globigerina oxfordiana, which the authors of the genus used as a basis for the subgenus Globuligerina (Bignot and Guyader, 1971, v. 80), was used by Fuchs as the type species of his genus Polskanella. It is impossible to agree with this, firstly because Bignot and Guyader quite correctly equated the forms described by them with the holotype (the difference

TABLE 1. Systematic position of some Jurassic and Early Cretaceous genera of planktonic foraminifers according to different authors.

Morozova and Moskalenko, 1961	Longoria, 1974	Fuchs, 1975	Gorbachik and Grigyalis, present work
Family Globigerinidae Genus Globigerina Subgenus G. (Eoglobigerina) Subgenus G. (Conoglobigerina)	Family Caucasellidae Genus Caucasella Family Heterohelicidae Subfamily Guembelitriinae Genus Gubkinella Family Favusellidae Genus Favusella	Family Hedbergellidae Subfamily Hedbergellinae Genus Mariannenina Genus Jurassorotalia etc. Family Guembelitriidae Subfamily Guembelitriinae Genus Conoglobigerina Genus Gubkinella etc. Family Ceratobuliminidae Genus Globuligerina etc.	Family Favusellidae Genus Globuligerina Genus Conoglobigerina Genus Favusella

in the height of the aperture was explained by the better preservation of the French material), and secondly because Polskanella oxfordiana in the paper by Fuchs (1973, pl. 1, illus. 7) does not correspond in the structure of the aperture (relict apertures are indicated) to the holotype of Globigerina oxfordiana Grigelis, and Globuligerina frequens is figures with a looplike aperture (Fuchs, 1973, Pl. 2, fig. 6), which is a feature of ceratobulimnids. Because the type of any taxon designated in conformity with the rules of the International Code of Zoological Nomenclature cannot be changed, the selection by Fuchs of a new types species for the genus Globuligerina is inadmissible, and the genus Polskanella based on the type species employed is a junior objective synonym of the genus Globuligerina (ICZN [Russian translation], 1966, p. 35, article 61c). The genus "Globuligerina" with the type species "G." frequens Fuchs should be given another generic name if it is in fact a discrete taxon.

Among the genera listed, Conoglobigerina is somewhat isolated morphologically, having a spirally coiled test (H:D > 1) and an umbilically located aperture. It was originally separated as a subgenus of the genus Globigerina (Morozova and Moskalenko, 1961). Fuchs (1973) established generic rank for it, and this should be accepted.

The genus Woletzina Fuchs, 1973, with the type species Globigerina jurassica Hofman, 1958 from the Bathonian - Lower Callovian of the Crimea does not differ appreciably in morphological characters from Conoglobigerina and is treated by us as a junion synonym of it.

The genus Eoheterohelix Fuchs, 1973 has been poorly studied. We regard its separation as having little foundation. It is possible that, under this name, Fuchs was describing certain aberrant forms typified by biserial arrangement of the chambers at the end of the final whorl.

One of the authors of the present article (Grigyalis, 1974, 1975) has distinguished two groups of species among Jurassic planktonic foraminifers, one of which he assigned to the genus Globigerina, and the other provisionally to the genus Gubkinella Suleymanov, 1955, following Loeblich and Tappan (1964) in regarding Conoglobigerina as a synonym of the latter. We now regard these two genera, Gubkinella and Conoglobigerina, as discrete genera of two different groups of planktonic foraminifers — Heterohelicida and Globigerinida.

Early Cretaceous members of the group under consideration that also have a trochoid test and an umbilical aperture have been described under the generic name Globigerina (Subbotina, 1953; Antonova et al., 1964; Bolli, 1959) from deposits ranging from the Hauterivian to the Albian. In 1972, Michael described the new genus Favusella with the type species Globigerina washitensis Carsey from the Cretaceous of the United States. This genus is characterized by a trochoid test; "aperture interiomarginal to spiral-umbilical, with all possible intermediate positions" (Michael, 1972, p. 213), test surface with cancellate ornament. In the terminology of Loeblich and Tappan (1964) an interiomarginal umbilical aperture is located on the inner margin of the final chamber and opens into the umbilicus, while an interiormarginal spiral-umbilical aperture opens on the umbilical side in the umbilicus and outside it and extends partly on to the spiral side. According to Michael, members of the genus Favusella occur in the Albian and Cenomanian deposits of Tethys and the south of the Boreal zone. They were originally placed in the genus Globigerina, from which they differ in having numerous small pores within each cell of the ornament, whereas in Globigerina each cell contains only one large pore.

A new systematic arrangement of Later Jurassic and Early Cretaceous Globigerinacea has been proposed by Longoria (1974). He erected four new families — Caucasellidae, Favusellidae, Globigerinelloididae, and Ticinellidae. The first two will be discussed (Table 1). According to Longoria the Caucasellidae consist of the one genus Caucasella erected by him with the type species Globigerina hauterivica Subbotina. In addition to the type species he included in the new genus: C. oxfordiana (Grigelis), C. helvetojurassica (Hauesler), C. balakhmatovae (Morozova), and C. kugleri (Bolli). According to Longiria, the Caucasellidae are characterized by a trochoid test with "umbilical or slightly extraumbilical" aperture surrounded by an imperforate lip, with a deep, narrow or broad umbilicus (Longoria, 1974, p. 48). Longoria suggests that the members of this family existed from the Middle Jurassic (Bathonian) to the middle of the Aptian. Caucasella is characterized by a globigerinacean test with a low or relatively high spiral, umbilical location of the aperture, and the smooth surface of the finely perforate wall (Longoria, 1974). The other new family, Favusellidae, also contains a single genus, Favusella Michael, with the type species Globigerina washitensis Carsey. It existed from the end of the Albian to the beginning of the Cenomanian. The typical characters of the family and the genus are the umbilical location of the aperture and the surface ornament of the test, which has the form of regular polygonal cells. There are twenty or more pores within each cell. The cancellate ornament is the main feature distinguishing members of the Favusellidae from the Caucasellidae. Longoria regards Albian members of Hedbergella as the direct ancestor of the genus Favusella, and the genus Hedbergella as having originated from the Neocomian Caucasellidae.

In one of his most recent works (1975) Fuchs summarized the systematics and evolution of Mesozoic planktonic foraminifers and allied forms. We do not agree with certain aspects of the Fuchs's system (Table 1), first, on account of the very broad sense in which he understands the family Hedbergellidae and the fact that he places members of the Planomalinidae and Schackoinidae in the subfamily Hedbergellinae. According to Loeblich and Tappan (1964), Gorbachik (Gorbachik and Krechmar, 1971) and Subbotina (1973), the Planomalinidae and Schackoinidae are discrete taxa. Our second objection is to the placing of the Guembelitriidae in the superfamily Globigerinacea and the inclusion in it of the first Jurassic genera (Conoglobigerina, Tectoglobigerina, Eoheterohelix), which have nothing in common with heterohelicids. The present authors accept the Heterohelicida as a discrete order, as they are treated in Principles of Paleontology. This seems more justifiable than the inclusion of heterohelicids in the Globigerinacea (Loeblich and Tappan, 1964), because the former are distinguished by the planispiral initial portion of their ancient members, multiserial arrangement of the chambers and a basal or terminal aperture (Grigyalis, 1978). Thirdly, Fuchs shows the genus Globuligerina as a dead end in the family Ceratobuliminidae, but this is a result of mistaken interpretation of the morphology and content of this genus. Conversely, the presence of G. oxfordiana (Grigelis) in the Oxfordian, of G. stellapolaris Grigelis in the Kimmeridgian and Volgan (Grigyalis, 1974; Grigyalis et al., 1977), of G. caucasica Gorbatchik and Poroschina and G. gulekhensis Gorbatchik and Poroschina in the Berriasian and Valanginian (Gorbachik and Poroshina, 1979), of G. hauterivica (Subbotina) in the Hauterivian (Subbotina, 1953), of G. graysonensis (Tappan) in the Barremian, and of G. kugleri (Bolli) [= ? G. quadricamerata (Antonova)] in the Barremian and Aptian (Bolli, 1959; Antonova et al., 1964) demonstrates that this is an important branch in the evolution of Jurassic and Early Cretaceous planktonic foraminifers.

NEW DATA ON TEST MORPHOLOGY (ORNAMENT AND PERFORATION) AND ON SYSTEMATICS

Our material shows that the Globigerinacea with the umbilically located aperture, that occur from the Middle Jurassic to the Cenomanian, and that have been assigned by various authors to different genera and families, are characterized by well-expressed shell ornament, the development of which begins in the Middle Jurassic with the formation of separated tubercles in Conoglobigerina dagestanica Morozova (Pl. I, figs. 1-3) and C. bathoniana (Pazdro) (Pl. I, fig. 3). They are partly or wholely fused in Late Jurassic forms, constituting irregular, more or less tetragonal cells (Globuligerina oxfordiana Grigelis, Oxfordian, Pl. I, fig. 4 and G. stellapolaris Grigelis, Kimmeridgian and Volgan stages, Pl. II, fig. 1). The tubercles of C. dagestanica have irregular outlines, and randomly arranged pores measuring about 0.7 μm are seen Most of the tubercles on the surface of the test of C. bathoniana are rounded (Pl. I, fig. b); two to three merging tubercles are sometimes seen. Pores have been observed on tests of this species only between tubercles, frequently at their base; the pores measure up to 2 μm, the tubercles about 2.5 μm. Tests of G. oxfordiana and G. stellapolaris are covered by many smaller pores 0.4 to 0.5 μm in diameter, among which there are some larger ones. Most of the pores are located in depressions on the test, between tubercles and inside cells; far less frequently they are found on elevations (Pl. I, fig. 4b).

Further development of the ornament occurred in the Berriasian and Valanginian. The cells on the test surface became deeper and more regular in G. gulekhensis and G. caucasica; relatively frequent pores (some ten or more) measuring 0.3 to 0.5 μm are clearly seen on the floor of the cells. Slightly smaller and less numerous pores are located on the ridges forming the cells. A few pores reaching a size of 1 μm are apparent. The cells measure 2 to 4 μm (Gorbachik and Poroshina, 1979). Elements of ornament are also seen in the Hauterivian species G. hauterivica (Pl. II, fig. 3). Unfortunately, our specimen was poorly preserved, and it was difficult to establish whether the ornament consisted of separate tubercles or broken cancellate ornament (most probably the latter).

Ornament in the Globerigerinacea (Favusella) evidently reached its maximal development in the Barremian: a large proportion of the cells had closed, irregularly tetragonal, frequently elongated contours; the ridges forming the cells were high and perforated by sparse pore canals smaller than those on the floor of the cells. Some ten pores measuring 0.4 to 0.6 μm are seen on the floor of the cells; the pores on the ridges measure about 0.2 μm, and the largest cells about 12 μm.

No similar Late Aptian forms that could be an intermediate link between the Barremian-Aptian F. tardita (Antonova) and the Albian species have as yet been discovered. The cells on the test surface are appreciably larger in the latter, reaching a diameter of 47 μm (F. washitensis Michael, Pl. II, fig. 5), they are irregularly polygonal, and pores measuring around 1 μm are clearly apparent on the cell floor. In connection with the large size of the cells in Albian members of the genus Favusella, the number of pores in each cell is also greater than in Barremian-Aptian forms (20 or more).

Our results indicate that, there are no grounds for placing globigerinacean foraminifers of the genera Globuligerina (Caucaselidae, the genus Caucasella according to Longoria) and Favusella (Favusellidae according to Longoria) in different families. Members of the two genera have many shared characters, including similar structure and identical locations of the aperture. We regard it as superfluous to erect the genus Caucasella, since "C." hauterivica (Subbotina) selected by Longoria as the type species has all the characters of the genus Globuligerina, including the ornament.

A phylogenetic series from the Middle Jurassic (or earlier) to the Cenomanian, that overall constitutes the family Favusellidae, is suggested by the study of Jurassic and Early Cretaceous Globigerinacea, including topotypes of the type species of Globuligerina and Conoglobigerina, and also of the type species of the genus Favusella. There are at present a number of difficulties as regards establishing the complete range of this family, because the Jurassic and Early Cretaceous Globigerinacea described in the literature (Subbotina, 1953; Bolli, 1959; Yovcheva and Trifonova, 1961; Antonova et al., 1964) were studied by means of optical microscopes, in which the ornament could not been seen. Use of the scanning electron microscope has enabled new and important characters to be described in the species that we have examined. An electron microscopic reexamination of holotypes or topotypes of previously established species is thus essential.

Below is given a description of the family Favusellidae and its constituent genera.

Superfamily GLOBIGERINACEA Carpenter, Parker and Jones, 1862

Family FAVUSELLIDAE Longoria, 1974

Caucasellidae: Longoria, 1974, p. 48.
Favusellidae: Longoria, 1974, p. 74.

Type genus. Favusella Michael, 1972.

Description. Test trochoid, irregularly trochoid (initial whorls displaced relative to the center of the final whorl and sequence of chamber formation indistinct) or cochlespiral. Chambers spherical, ellipsoidal or flattened. Peripheral margin rounded. Aperture interiomarginal, ranging from umbilical to spiral-umbilical, bordered by a narrow or broad lip that sometimes assumes the form of a basket covering the aperture. Umbilicus ranging from narrow to very broad. Test surface with ornament consisting of separate, well-expressed tubercles or cells of various shapes. The wall may possibly have been smooth in the earliest members of this family. The test wall was apparently calcitic, radiate, and perforate.

Composition. Three genera: Favusella Michael, 1972, Conoglobigerina Morozova, 1961, Globuligerina Bignot and Guyader, 1971.

Comparison. In the structural type of the test the family Favusellidae is closest to the families Globotrucanidae (genus Hedbergella) and Globigerinidae (genus Globigerina). It is distinguished from the first by the irregularly trochoid structure of the test in most members, the distinctive tuberculate or cancellate ornament and the umbilical or spiral-umbilical location of the aperture. It is also distinguished from the second by the predominance of forms with an irregularly trochoidal structure of the test and by features of the performation. Globigerinids with cancellate ornament have a single large pore in the middle of the cell, whereas favusellids have a considerable number of smaller pores.

KEY TO PLATE I

Conoglobigerina dagestanica Morozova;
1 - topotype 222/1: a) peripheral margin (x 300), b) the same, showing ornament in the form of tubercles on the penultimate chamber (x 600);
2 - spec. 222/2, aperture (x 300);
Dagestan, Chokh village; Middle Jurassic, Lower Bathonian.
Conoglobigerina bathoniana (Pazdro);
3 - topotype 222/3: a) peripheral margin (x 350), b) the same, showing ornament in the form of tubercles (x 600), c) the same, fragment of the wall of the first chamber of the final whorl showing tubercles (x 3000);
Poland, Ogradzienecs; Middle Jurassic, Middle Bathonian.
Globuligerina oxfordiana (Grigelis);
4 - topotype 222/4: a) spiral side, showing ornament (x 300), b) the same, fragment of the wall of the final chamber showing pores (x 3000);
Lithuania; Upper Jurassic, Lower Oxfordian.
Type specimens are in the Department of Paleontology in Moscow University.

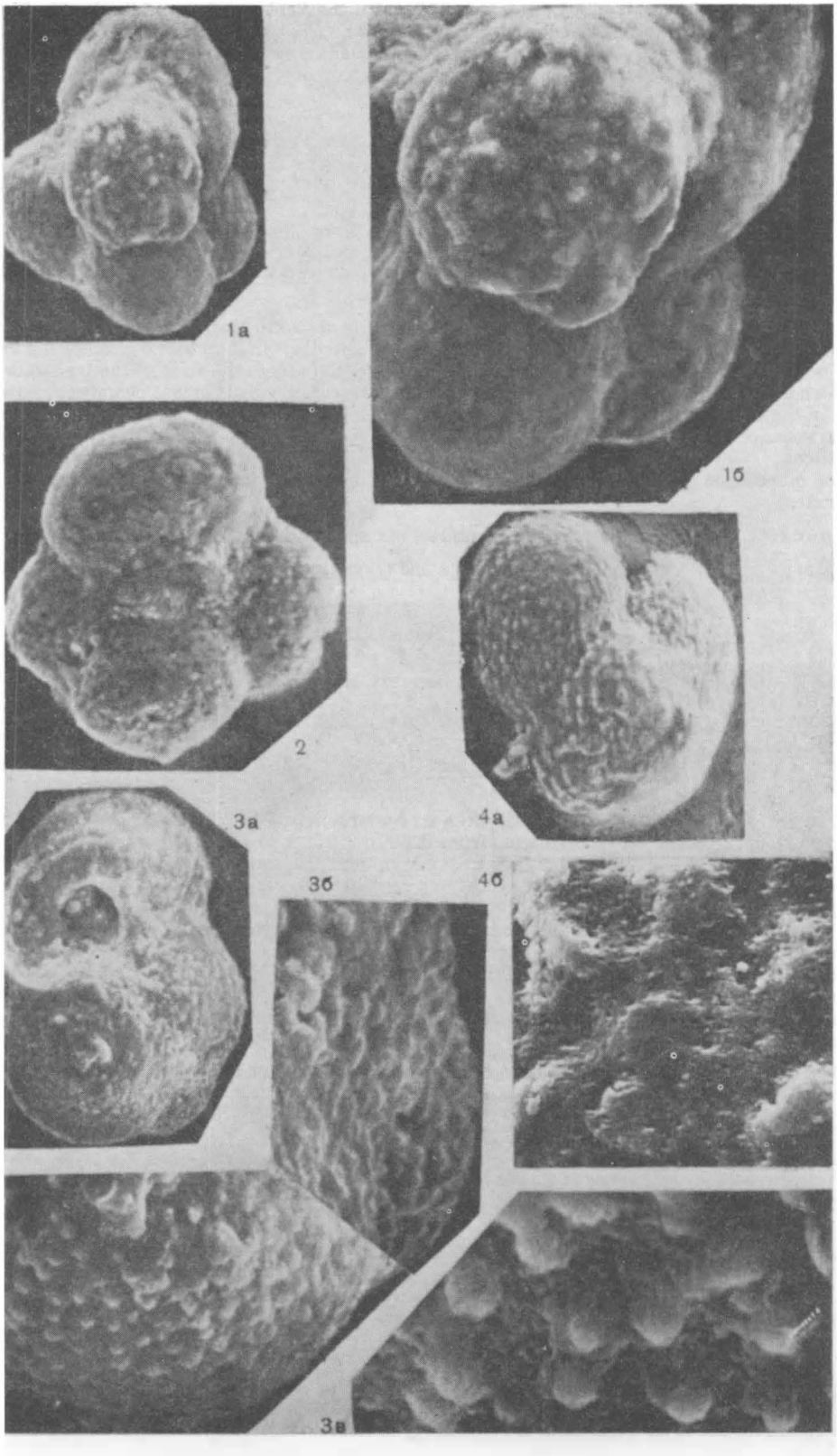

PLATE I

Remarks. We agree with Longoria (1974), that the first members of the family Globotruncanidae, species of the genus Hedbergella, may have originated from Early Cretaceous Favusellidae, while the Globigerinidae constitute another, genetically segregated and later branch, and their similarity to the Favusellidae is a result of homeomorphy.

Conoglobigerina Morozova, 1961

Globigerina (Conoglobigerina): Morozova and Moskalenko, 1961, p. 24-25.
Conoglobigerina: Fuchs, 1973, p. 454.
Woletzina: Fuchs, 1973, p. 460.

Type species. Globigerina (Conoglobigerina) dagestanica Morozova, 1961; Middle Jurassic, Lower Bathonian; S. Dagestan.

Diagnosis. Test cochlespiral, spiral consisting of two to four whorls; the number of chambers per whorl ranges from three to six in different species; in the course of ontogeny the number may be the same in all the whorls of a species or decrease from the first to the last whorl. The final whorl usually contains three to four, free, spherical or subspherical chambers. The chambers of the final whorl are usually appreciably larger than the preceding one, the peripheral margin is rounded and broad, the umbilicus is narrow and small. The arcuate aperture opens into the umbilicus. Test surface with ornament in the form of rounded or elongated tubercles, sometimes two or more tubercles fusing to form short ridges. Pores are located almost exclusively between tubercles.

Specific composition. The genus has six species (Table 2).

Comparison with the genera Favusella and Globuligerina is made when they are described.

Globuligerina Bignot and Guyader, 1971

Globigerina (Globuligerina): Bignot and Guyader, 1971, p. 80.
Polskanella: Fuchs, 1973, p. 456.
Globuligerina: Grigyalis, 1974, p. 56; Fuchs, 1973, p. 464.

Type species. Globigerina oxfordiana Grigelis, 1958; Upper Jurassic, Oxfordian; Lithuania.

Diagnosis. Test trochoid, most often irregularly trochoid, clearly conical or flattened, ratio of height to diameter H:D ranging from 0.50 to 0.75; test consisting of two to three whorls of a spiral, each of which contains four to six chambers that range from spherical to greatly flattened, especially in the initial whorls, and are compactly arranged. Peripheral margin rounded, ranging from broad to narrow. Umbilicus narrow and small. Aperture opening partly or wholly into umbilicus, arcuate or slit-like, bordered by a lip. Test surface with ornament in the form of tubercles and cells; some species have both types of ornament, others only one. The cells are irregularly square, open in some instances, and the ridges that form them are thick and often indistinctly separated from the floor of the cell. Pores are located mainly within the cells and between the tubercles; a few smaller pores are also seen on the ridges. Each cell has less than 20 pores.

Specific composition. The genus comprises some ten species (table 2).

KEY TO PLATE II

Globuligerina stellapolaris Grigelis;
1 - topotype 222/5, spiral side (x 300); Komi ASSR, Pechora River; Upper Jurassic, Lower Volgan substage.
Globuligerina gulekhensis, Gorbatchik and Poroschina;
2 - holotype 207/11: a) spiral side (x 300), b) the same, wall fragment of fourth chamber (from the end) on peripheral margin (x 3000); Azerbaidzhan; Lower Cretaceous, Berriasian.
Globuligerina hauterivica (Subbotina);
3 - spec. 222/6; a) spiral side (x 350), b) the same, showing ornament of penultimate and other chambers (x 1000); N. Caucasus, Urukh River; Lower Cretaceous, Hauterivian.
Favusella tardita (Antonova);
4 - spec. 222/7: a) dorsal side (x 300), b) the same, wall fragment of chamber in final whorl showing typical cells and pores (x 3000); Atlantic, Moroccan coast, 47th cruise of the Glomar Challenger, bore 397, sample 47/4; Lower Cretaceous, Barremian (?).
Favusella washitensis (Carsey);
5 - spec. 222/8, peripheral margin (x 150); Algeria, Hodna; Lower Cretaceous, Upper Albian.
Type specimens are in the Department of Paleontology in Moscow University.

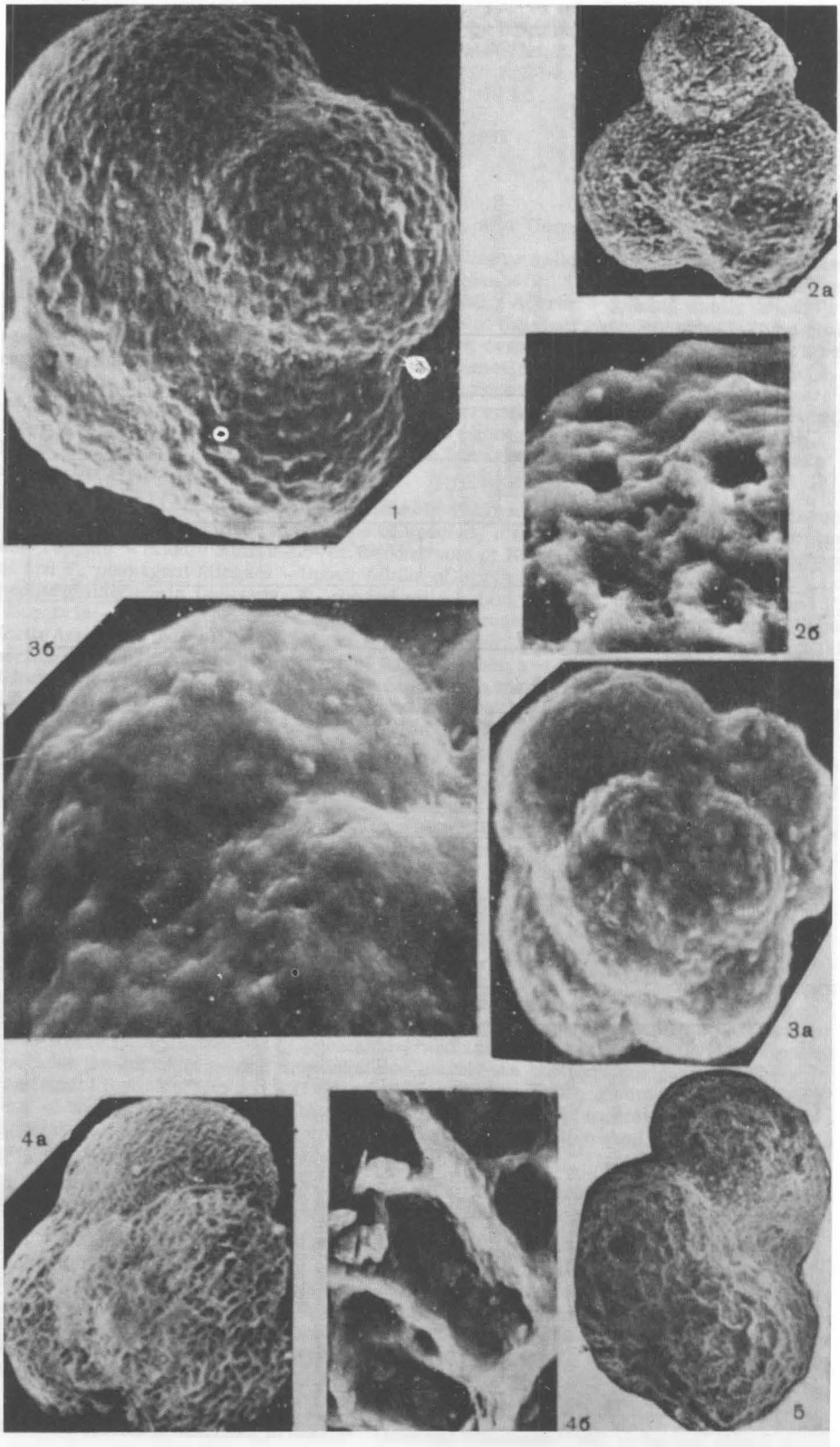

PLATE II

TABLE 2. Stratigraphic range of some Jurassic and Early Cretaceous members of the family Favusellidae.

Species	J_3bj	J_3bt	J_3cl	J_3ox	J_3km	$J_3^t(v)$	K_1br	K_1v	K_1h	K_1b	K_1ap	Site
Globuligerina balakhmatovae (Morozova, 1961)		—	—									Turkmenia, North Caucasus (Dagestan)
Globuligerina oxfordiana (Grigelis, 1958) (Pl. I, fig. 4)*				—								Baltic region, Paris basin, Sweden
Globuligerina helvetojurassica (Haeusler, 1881)				—								The south of the FRG
Globuligerina stellapolaris Grigelis, 1977 (Pl. II, fig. 1)*					—	—						Komi ASSR, Pechora River
Globuligerina terquemi (Jovceva et Trifonova, 1961)						—						Bulgaria
Globuligerina hauterivica (Subbotina, 1953) (Pl. II, fig. 3)									—			North Caucasus
Globuligerina gulekhensis Gorbatchik et Poroschina, 1979 (Pl. II, fig. 2)*							—	—				Southeastern Caucasus (Azerbaidzhan), Crimea
Globuligerina caucasica Corbatchik et Poroschina, 1979*							—	—				Southeastern Caucasus (Azerbaidzhan), Crimea
Globuligerina graysonensis (Tappan, 1940)										—		North America, United States; Trinidad
Globuligerina kugleri (Bolli, 1959)										—	—	Trinidad
Conoglobigerina gaurdakensis (Balakhmatova et Morozova, 1961)	—											Turkmenia
Conoglobigerina avarica Morozova, 1961		—										North Caucasus (Dagestan)
Conoglobigerina dagestanica Morozova, 1961 (Pl. I, fig. 1, 2)*		—										North Caucasus (Dagestan)
Conoglobigerina jurassica (Hofman), 1958		—	—									Crimea
Conoglobigerina bathoniana (Pazdro, 1969) (Pl. I, fig. 3)*		—										Poland
Conoglobigerina conica (Jovceva et Trifonova, 1961)						—						Bulgaria
Favusella tardita (Antonova, 1964)*										—	—	Northwestern Caucasus; Atlantic Ocean (Moroccan coast)
Favusella sp.*										—		Southeastern Caucasus (Azerbaidzhan)

*Test surface examined by the authors in the scanning electron microscope.

Comparison. Distinguished from Conoglobigerina by the trochoid or irregularly trochoid test, and the presence of cancellate ornament in a number of forms. The genus Globuligerina is a connecting link between Conoglobigerina and Favusella.

Favusella Michael, 1972

Favusella: Michael, 1972, p. 212.

Type species. Globigerina washitensis Carsey; Lower Cenomanian; North America, Texas.

Diagnosis. Test trochoid or irregularly trochoid, low or relatively high, consisting of two to three whorls of a spiral, each containing four to five chambers; the final whorl has three chambers in some forms. Peripheral margin rounded and broad. Aperture opening wholly or partly into the umbilicus; in the latter case it extends along the base of the final chamber outside the umbilicus, not reaching the peripheral margin or partly carrying over on to the spiral side. Aperture usually arcuate, bordered by a broad or narrow lip that sometimes forms a basket. Umbilicus small, very narrow in ancient forms and broader in more recent forms (Albian, Cenomanian). Test surface with ornament in the form of cells that are irregular, frequently elongated rectangles in Barremian-Aptian species and regular polygonal cells (honeycomb) in Albian-Cenomanian species. Pores ranging from a few to 20 or more have been observed in each cell. There are smaller pores on the ridges bounding the cells.

Specific composition. According to Michael (1972) and Longoria (Longoria and Gamper, 1977) this genus includes, in addition to the type of species, a further ten species: F. hiltermanni (Loeblich and Tappan) - Middle Albian-Lower Cenomanian of North America (Texas), F. orbiculata Michael and F. pessagnoi Michael - Upper Albian of North America (Texas), F. confusa Longoria, F. hedbergellaeformis Longoria, F. papagoycensis Longoria, F. planata Longoria and F. voloshinae Longoria - Albian of North Mexico, F. nitida Michael, and F. scitula Michael - Upper Albian of North America (Texas) and Albian of North Mexico. We supplement the genus Favusella with two species - F. sp. from the Barremian of Azerbaidzhan and F. tardita (Antonova) [1], first established from Upper Barremian-Lower Aptian deposits in the northwestern Caucasus (Antonova, 1964) and identified by us from Barremian (?) deposits from the Atlantic Ocean along the Moroccan coast (Pl. II, fig. 4) (Material from cruise 47A of the Glomar Challenger, bore 397, sample 47/4).

Comparison. Distinguished from the genus Conoglobigerina by the trochoid or irregularly trochoid test, the more variable location of the aperture and the cancellate surface ornament. Differs from the genus Globuligerina in the greater width of the umbilicus and in the nature of the ornament, in the development exclusively of cancellate ornament; the ridges forming the cells are sharply delineated from the cell floor, the cells are closed, large and more regularly shaped.

SUMMARY

Thus, we have combined all the Jurassic and Early Cretaceous foraminifers that were previously of undetermined systematic position in the family Favusellidae and have ascribed them to three genera and more than thirty species. Members of this family are now quite well known from the Middle Jurassic to the Late Cretaceous (Cenomanian) and are characterized by a wide geographic range. Throughout the Jurassic period they inhabited mainly the northern periphery of Tethys and the epicontinental basins of Europe. Gordon (1970) stipulates that, given the fairly uniform normal salinity of basins in the Jurassic, the distribution of planktonic foraminifers was determined by temperature. It is probable that their spread from Tethys into the shelf seas took place only when favorable temperature conditions obtained.

The Early Cretaceous and Cenomanian Favusellidae also inhabited shallow neritic areas of basins; their remains have not been found in bathyal and abyssal deposits (Michael, 1972; Longoria, 1974; Longoria and Gamper, 1977).

In the south of the USSR favusellids have been found in comparatively shallow water Berriasian and Valanginian deposits (Crimea, Azerbaidzhan) and only as isolated specimens in deeper water Upper Albian and Cenomanian deposits (Crimea). Throughout the Middle Jurassic and Cretaceous the development of the Favusellidae was toward reduction in the height of the test, the acquisition of greater regularity in the coiling of the spiral, increasing complexity of the ornament and an increase in the size of the test, which is demonstrated well in the phylogenetic series Conoglobi-

[1] In our view, the same species is described in Roesler, Lutze and Pflaumann (1978) as the new species F. stiftia.

gerina - Globuligerina - Favusella. The Barremian members of this family may be regarded as possible ancestors of the genus Hedbergella.

The small size of the test and the relative paucity of the material explain appreciable gaps in the study of the family Favusellidae. The initial tasks of further research are to use the scanning electron microscope to study and redescribe holotypes and topotypes of known species, to study the structure of the test wall, and to seek the missing links of this family.

REFERENCES

Antonova, Z.A., Shmigina, T.A., Gnedina, A.G., and Kalugina, O.M., 1964, NEOCOMIAN AND APTIAN FORAMINIFERS OF THE PSHEKHA-UBIN INTERFLUVE (NORTHWESTERN CAUCASUS): Vses. Neftegaz. Naucyno-Issled. Inst. Krasnodarsk. Fil. Trudy, no. 12, p. 3-72, Nedra Press.

Bignot, G., and Guyader, J., 1971, OBSERVATIONS NOUVELLES SUR Globigerina oxfordiana GRIGELIS: II Intern. Plankt. Conf. Microfossils. Proc., Rome, p. 79-83.

Bolli, H.M., 1959, Bull. Amer. Paleontol., v. 20, p. 257-277.

Fuchs, W., 1973, Verhandl. Geol. Bundesanst., no. 3, p. 445-487.

_____1975, Jahrb. Geol. Bundesanst., v. 118, p. 193-246.

Gordon, W.A., 1970, Geol. Soc. America Bull., v. 81, p. 1689-1704.

Gorbachik, T.N., 1975, SOME EARLY CRETACEOUS PLANKTONIC FORAMINIFERS (ASPECTS OF MORPHOLOGY, SYSTEMATICS AND GEOGRAPHIC RANGE): Akad. Nauk SSSR Sib. Otdel. Inst. Geol. i ie Geofiz. Trudy, no. 333, p. 48-52.

_____1977, Moskov. Obshch. Ispyt. Prirody Byull., otd. geol., v. 52, no. 1, p. 156-157.

_____1978, Symposium GEOLOGY AND MINERALS OF THE COUNTRIES OF ASIA, AFRICA AND LATIN AMERICA, no. 3: Published by the University of the Freindship of the Peoples, p. 102-114.

_____and Krechmar, V., 1971, WALL STRUCTURE IN SOME EARLY CRETACEOUS PLANKTONIC FORAMINIFERS: Vopr. Mikropaleontol., no. 14, p. 17-24.

_____and Poroshina, L.A., 1979, Paleont. Zhur., no. 3, p. 22-28.

Grigyalis, A.A., 1958, Globigerina oxfordiana sp. n., A DISCOVERY OF A GLOBIGERINID IN THE UPPER JURASSIC OF LITHUANIA: Nauchn. Dokl. vyssh. shkoly. Ser. geol.-geogr. nauk. no. 3, p. 109-111.

_____1974, Akad. Nauk SSSR Dokl., v. 219, no. 5, p. 1203-1205.

_____1975, THE JURASSIC DEVELOPMENT STAGE OF PLANKTONIC FORAMINIFERS. In THE MODE OF LIFE OF THE PRESENT DAY AND FOSSIL MICROFAUNA AND THE PATTERN OF ITS DISSEMINATION: Nauka Press, p. 56-62.

_____Mesezhnikov, M.S., Yakovleva, S.P., and Kozlova, G.E., 1977, Akad. Nauk SSSR Dokl., v. 233, no. 5, p. 926-927.

INTERNATIONAL CODE OF ZOOLOGICAL NOMENCLATURE ADOPTED BY THE XV INTERNATIONAL ZOOLOGICAL CONGRESS, 1966: Nauka Press, p. 1-100.

Loeblich, A.Ya., Jr., and Tappan, H., 1964, TREATISE ON INVERTEBRATE PALEONTOLOGY. Pt. C. PROTISTA, 2, SARCODINA CHIEFLY "THECAMOEBIANS" AND FORAMINIFERIDA. Geol. Soc. America - Univ. Kansas Press, p. 1-900.

Longoria, J.F., 1974, STRATIGRAPHIC, MORPHOLOGIC AND TAXONOMIC STUDIES OF APTIAN PLANKTONIC FORAMINIFERA: Rev. Esp. Micropaleontol. Numb. extraord, p. 1-107.

_____and Gamper, M.A., 1977, Jour. For. Res., vol. 7, no. 3, p. 196-215.

Michael, F.Y., 1972, Jour. For. Res., v. 2, no. 4, p. 200-220.

Morozova, V.G., 1959, Akad. Nauk SSSR Dokl, v. 124, no. 5, p. 1113-1116.

_____and Moskalenko, T.A., 1961, PLANKTONIC FORAMINIFERS OF THE BAJOCIAN AND BATHONIAN BOUNDARY LAYERS OF CENTRAL DAGESTAN (NORTHEASTERN CAUCASUS): Vopr. Mikropaleontol., no. 5, p. 3-30.

Moullade, M., 1966, ETUDE STRATIGRAPHIQUE ET MICROPALEONTOLOGIQUE DU CRETACE INFERIEUR DE LA "FOSSE VOCONTIENNE": Fac. Sci. Lyon Labor. Geol. Docum., no. 15, p. 1-369.

Pazdrowa, O., 1969, Polsk. Tow. Geol. Roczn., v. 39, no. 1-3, Krakow, p. 41-56.

Rauzer-Chernousova, D.M., and Fursenko, A.V. (Editors), 1959, PRINCIPLES OF PALEONTOLOGY. GENERAL SECTION. PROTOZOA: Acad. Sci. USSR Press, p. 1-482.

Risch, H., 1971, PALAEONTOGRAPHICA, Ser. A, v. 138, pt. 1-4, p. 1-80.

Rosler, W., Lutze, G., and Pflaumann, U., 1978, SOME CRETACEOUS PLANKTONIC FORAMINIFERA (Favusella) OF D.S.D.P. SITE 397 (EASTERN NORTH ATLANTIC): Deep Sea Drilling Project Init. Rep., v. 47.

Subbotina, N.N., 1953, GLOBIGERINIDAE, HANTKENINIDAE AND GLOBOROTALIIDAE: Vses. Neft. Nauchno-Issled. Geologorazv. Inst. Trudy, new ser., no. 76, p. 1-296.

Ťovcheva, P., and Trifonova, Ye., 1961, TITHONIAN Globigerina FROM NORTH WESTERN BULGERIA: Vŭrkhu Geol. Na Bălgariya Trudy, Ser. Paleontol., bk. 3, p. 343-351.