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BENTHONIC FORAMINIFERAL RESPONSE TO THE CENOMANIAN-TURONIAN BOUNDARY EVENT IN THE GANUZA SECTION, NORTHERN SPAIN

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ABSTRACT

The studied interval comprises a 26.5 m thick section of the uppermost Cenomanian strata representing the uppermost *Rotalipora cushmani* and lowermost *Whiteinella archaeocretacea* Zones. Changes in the foraminiferal assemblages recorded in this interval may be summarized as follows:

1. P/B ratio fluctuates throughout the section; the highest values (78%) are recorded in the lowermost part of the *Whiteinella archaeocretacea* Zone.
2. Benthonic diversity in the Ganuza section varies from 9 to 27 with decreasing tendency up the section. Highest number of species (16-27) in the studied interval is observed in the *Rotalipora cushmani* Zone while 9 to 14 species are found in the *Whiteinella archaeocretacea* Zone.
3. Stepped extinctions of foraminiferal species were recorded - two planktonic *Rotalipora greenhornensis* and *R. cushmani* and several benthonic, e.g. *Gavelinella baltica, Conorbina* sp., rosalinids, *Gubkinella graysonensis* and *Textularia chapmani* went extinct during latest *Rotalipora cushmani* and earliest *Whiteinella archaeocretacea* chrons; several species disappeared temporarily, e.g. *Praebulimina elata;* they reappeared in the Lower Turonian; some others e.g. *Lingulogavelinella globosa, Gavelinella plummerae* appeared after the extinction of *Rotalipora greenhornensis* and become very abundant in the upper part of the studied interval; there is also a group of species present in the entire section which dominated assemblages in the middle and upper part of the studied section, e.g. *Gaudryinella pusilla, Lenticulina rotulata* or *Gavelinella berthelini.*

The benthonic foraminiferal assemblage changes reflect probably the decline of the oxygenation level of the bottom waters at the end of the *Rotalipora cushmani* Zone and the persistence of these unfavourable conditions in the early *Whiteinella archaeocretacea* Zone. We propose two new species: *Rosalina? iberica* n.sp., and *Lingulogavelinella ganuzensis* n.sp.

Keywords: N Spain, Oceanic Anoxic Event, benthonic foraminifera, faunal turnover.

RESUMEN

Se estudia una sección de edad Cenomaniense superior (parte terminal de la Zona de *Rotalipora cushmani* y parte inicial de la Zona de *Whiteinella archaeocretacea*) con 26,5 m de potencia. Los cambios en las asociaciones de foraminíferos pueden resumirse como sigue:

1. Los porcentajes de foraminíferos planctónicos son variables a lo largo de la sección, presentando sus máximos valores (78%) en la parte basal de la Zona de *W. archaeocretacea.*
2. La riqueza de especies bentónicas varía entre 9 y 27. Sus valores más altos (de 16 a 27 especies) se observan en la Zona de *R. cushmani,* mientras que en la de *W. archaeocretacea* varían entre 9 y 14.
3. El registro de las extinciones de los foraminíferos planctónicos sigue un modelo en etapas. Entre la parte terminal de la Zona de *R. cushmani* y la más basal de la de *W. archaeocretacea* se extinguieron dos especies de foraminíferos planctónicos: *Rotalipora greenhornensis* y *R. cushmani,* y varias de bentónicos, p. ej.: *Gavelinella baltica, Conorbina* sp. rosálinidos, *Gubkinella graysonensis* y *Textularia chapmani.* Otras especies desaparecen temporalmente en el registro y luego vuelven a aparecer en el Turoniense inferior, tal es el caso de *Praebulimina elata.* Otras tienen su primer registro antes del último de *R. greenhornensis* y se hacen muy abundantes en la parte superior de la sección estudiada. Otras especies, con un registro continuo en toda la sección, presentan incrementos en su abundancia en las partes media y alta de la misma, p. ej.: *Gaudryinella pusilla, Lenticulina rotulata* y *Gavelinella berthelini.*

Los cambios en las asociaciones, de los foraminíferos bentónicos, probablemente reflejen el declive de la oxigenación de las aguas del fondo del mar al final de la Zona de *R. cushmani*; condiciones desfavorables que se mantuvieron durante la parte inicial de la Zona de *W. archaeocretacea.* Se proponen dos nuevas especies: *Rosalina? iberica* n.sp., y *Lingulogavelinella ganuzensis* n.sp.

Palabras clave: N de España, Acontecimiento oceánico anóxico, foraminíferos bentónicos, renovación de faunas.

INTRODUCTION

A relatively short lived, but major paleoceanographic event often referred to as the Oceanic Anoxic Event II (OAE II) or the Cenomanian-Turonian Boundary Event (CTBE) took place in the latest Cenomanian-earliest Turonian (Schlanger and Jenkyns, 1976; Arthur *et al.,* 1987). CTBE involved a widespread deposition of sediments enriched in organic carbon (e.g. Pratt, 1985), a major positive $\delta^{13}C$ excursion (e.g. Scholle and Arthur, 1980) and a significant faunal turnover (Raup and Sepkoski, 1984).

The Ganuza section in N Spain (Fig. 1) paleogeographically belongs to the Navarro-Cantabrian line, which corresponded to a middle/outer shelf setting during the Late Cretaceous. During the Cenomanian and Turonian the platform subsided significantly so that more than 2000 m of sediment accumulated (Lamolda, 1978; Lamolda *et al.,* 1987).

LADs of planktonic foraminiferan *Rotalipora greenhornensis* (Morrow) and *Rotalipora cushmani* (Morrow) and FAD of coccolith species *Quadrum gartneri* Prins and Perch-Nielsen are events recognized worldwide and commonly used for correlation. Comparison of distances between those events in the Ganuza section with equivalent events in some selected sections which are considered as the most expanded and complete, revealed that the succession in the Ganuza section is about four times thicker than that at Eastbourne (S England), five times than that at Pueblo (Colorado, USA) and seven times than that at Dover (SE England) (Fig. 2) (cf. Gale *et al.,* 1993).

The section at Ganuza offers therefore a particularly complete representation of the highest Cenomanian and lowest Turonian succession. The aim of this study is to trace foraminiferal response to the late Cenomanian event from the shelf zone.

LITHOLOGY

The section at Ganuza represents an uninterrupted sequence across the Cenomanian-Turonian boundary in carbonate facies. The studied interval is composed generally of two marly/silty and two calcareous complexes (Fig. 3). At the bottom there is a 14.8-m-thick sequence of siltstones with limestone intercalations which form interbeds and lenticular bodies. The sequence is overlain by a 6.3 m thick calcareous series composed mainly of limestones and nodular limestones interbedded with thin marlstones and siltstones. Higher up in

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the section there is a 3.1-m-thick series of siltstones with irregular and scarce limestone interbeds. The top of the studied interval (4.3 m) is represented by calcareous complex comprising alternating limestones and marlstones (Fig. 3).

MATERIAL AND METHODS

Twenty five samples from a 26.5 m thick sequence in the Ganuza section were studied. 400-500 specimens from the >100 μm size fraction were picked up and all species in each sample were identified. P/B ratio (relative abundances of planktonic and benthonic foraminifers in the assemblages) and relative abundances of benthonic species within assemblages were calculated and H(S) - the Shannon-Weaver heterogeneity index of benthonic foraminiferal assemblages was computed. The results are presented on Figs. 3-5.

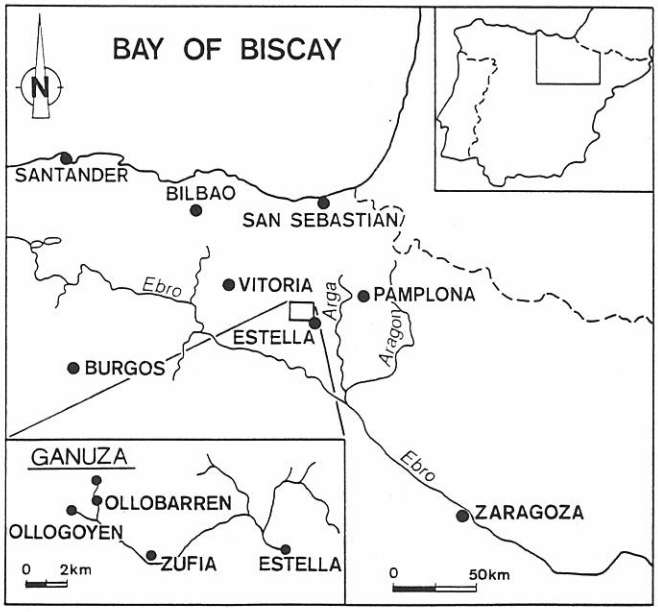

Figure 1. Location of the Ganuza section in northern Spain.

BIOSTRATIGRAPHY AND FORAMINIFERAL ANALYSES

Twenty three species of planktonic and fifty five species of benthonic foraminifers were recorded in the studied section (Fig. 3).

The studied interval represents the uppermost Cenomanian - the upper part of the *Rotalipora cushmani* and the lower part of the *Whiteinella archaeocretacea* Zones. The boundary between the Cenomanian and Turonian is placed at the first appearance of the coccolith species *Quadrum gartneri* Prins and Perch-Nielsen (Birkelund *et al.,* 1984; Gorostidi, 1993) within the *Whiteinella archaeocretacea* Zone.

BENTHONIC FORAMINIFERAL ASSEMBLAGE

Figure 3 lists all species identified, Fig. 4 shows relative percent abundances of dominant species, i.e. species which abundance at least in one sample exceeds 10 % and Fig. 5 documents a diversity of benthonic assemblages and relative abundances of planktonic and benthonic foraminifers. To characterize the faunal dynamics in time four faunules (similar associations of dominant species in adjacent samples - cf. Murray and Wright, 1974) - have been distinguished in the Ganuza section (Fig. 4).

Faunule I - interval comprising samples 33 to 25 (11 m thick): Benthonic diversity is the highest and varies between 18 and 27 species. H(S) values are comprised between 2.0 and 2.4. P/B ratio is between 28 and 73 %. Benthonic foraminiferal assemblages were relatively highly diversified and with low dominance. *Gubkinella graysonensis* (Tappan), *Textularia chapmani* Lalicker along with conorbinids (*Conorbina* cf. *brotzeni* Gandolfi, *Conorbina* sp., *Eurycheilostoma* sp., *Iuliusina grata* Fuchs) and rosalinids (*Gavelinopsis* sp., *Rosalina? iberica* n. sp., *Neoconorbina* sp.) were the main components of benthonic foraminiferal assemblages. *Gavelinella intermedia-cenomanica-baltica* group —common in shelf seas of the Boreal province— was a minor contributor here and was represented by *Gavelinella baltica* Brotzen and *G. intermedia* (Berthelin). Other species were present in all or only in some samples from this interval and their relative abundance was always lower than 10 %.

In the uppermost part of the interval a stepped extinction of foraminifers began. *Gavelinella intermedia* (Berthelin) and planktonic *Rotalipora greenhornensis* (Morrow) went extinct in

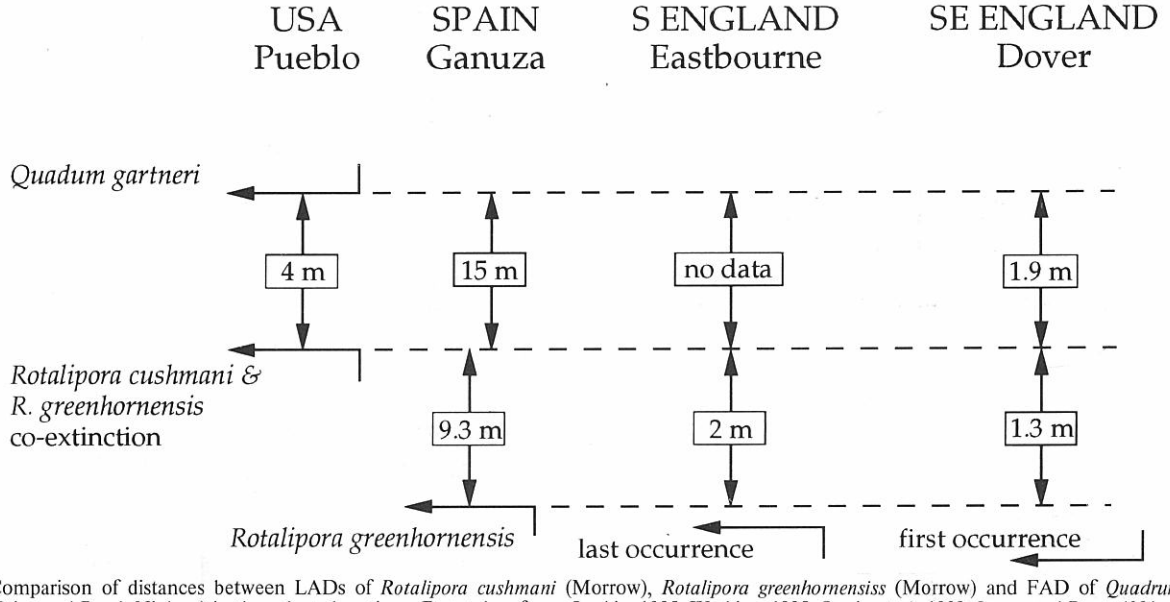

Figure 2. Comparison of distances between LADs of *Rotalipora cushmani* (Morrow), *Rotalipora greenhornensiss* (Morrow) and FAD of *Quadrum gartneri* (Prins and Perch-Nielsen) in the selected sections. Data taken from: Leckie, 1985; Watkins, 1985; Jarvis *et al.,* 1988; Leary and Peryt, 1991; Gorostidi, 1993; Lamolda *et al.,* 1994.

samples 28 and 26, respectively. *Gubkinella graysonensis* (Tappan) temporarily disappeared together with the extinction of *Rotalipora greenhornensis* (Morrow) while *Lingulogavelinella globosa* (Brotzen) newly appeared at the same level (Fig. 3).

Faunule II - interval comprising samples 24 to 19 (5.5 m thick): Benthonic diversity is moderate and number of species varies between 16 and 23. H(S) index is between 1.8 and 2.0 and P/B ratio is between 19 and 68 % with the highest values in the lower part of the discussed interval. In the faunule II assemblages were dominated by conorbinids and rosalinids along with *Gyroidinoides praestans* Magniez-Jannin (in the lower part) and with *Praebulimina elata* Magniez-Jannin (in the upper part).

Faunule III - interval from sample 18 to 12 (5.8 m thick). Number of benthonic species and H(S) index are similar to those in the faunule II. P/B ratio raises from 39 % in sample 18 to 78 % in sample 12. In the faunule III agglutinated forms *Falsogaudryinella alta* (Magniez-Jannin) and *Gaudryinella pusilla* Magniez-Jannin were the most common species along with the other agglutinant *Textularia chapmani* Lalicker (in the lower part) and calcareous *Lenticulina rotulata* Lamarck (in the upper part).

In the faunules II and III the biggest changes in the structure of benthonic communities took place. A stepped extinction began in the uppermost part of faunule I was continued through the faunule II and III. Conorbinids and rosalinids which dominated assemblages for a long time (faunule I and II) disappeared suddenly in sample 19 together with *Praebulimina elata* Magniez-Jannin. Some time later (sample 14) another planktonic *Rotalipora cushmani* (Morrow) and agglutinated *Textularia chapmani* Lalicker (in sample 12) went extinct. Vacated ecospace was recolonized by species which

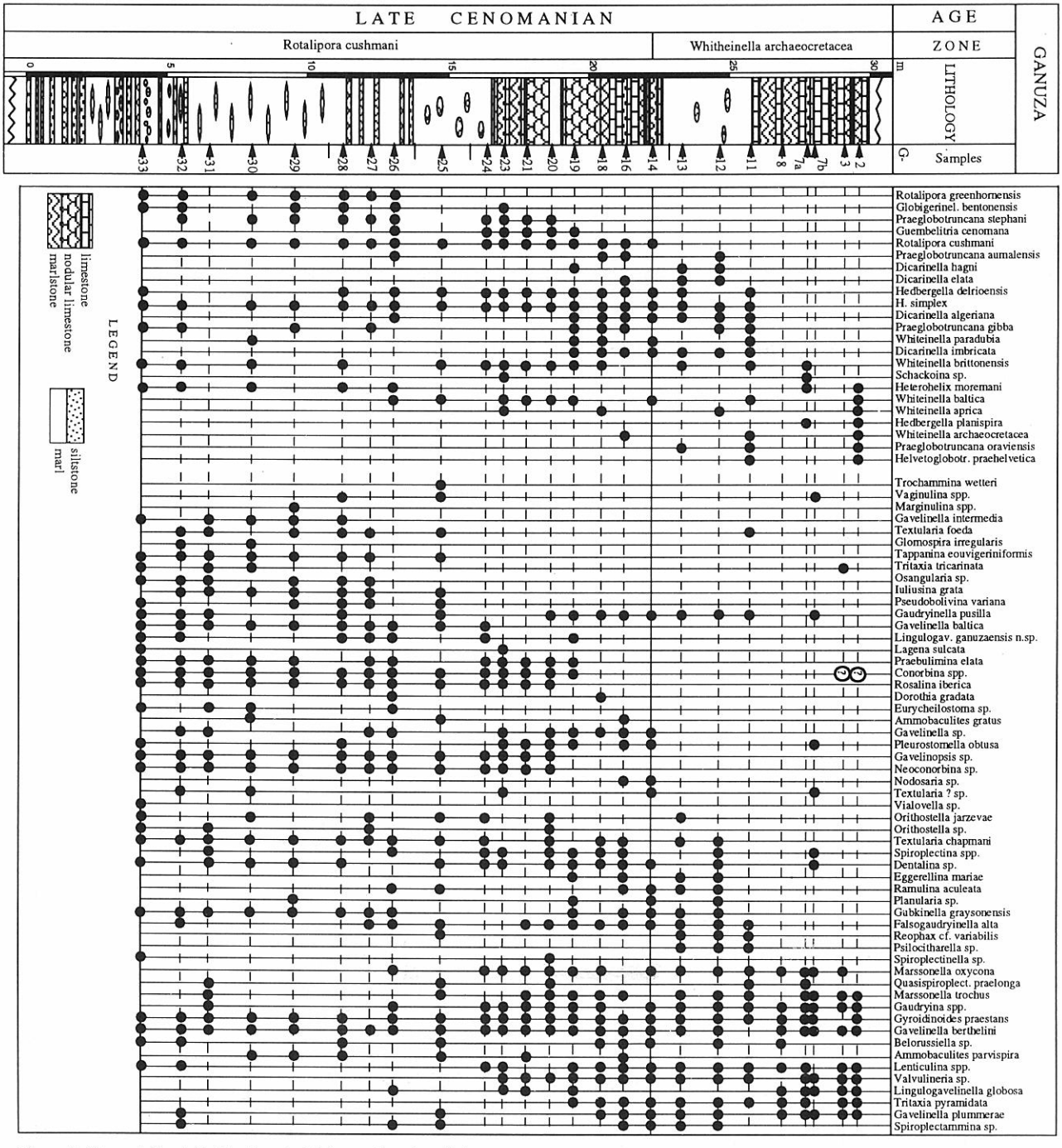

Figure 3. Foraminiferal distribution and lithostratigraphy of the uppermost Cenomanian in the Ganuza section.

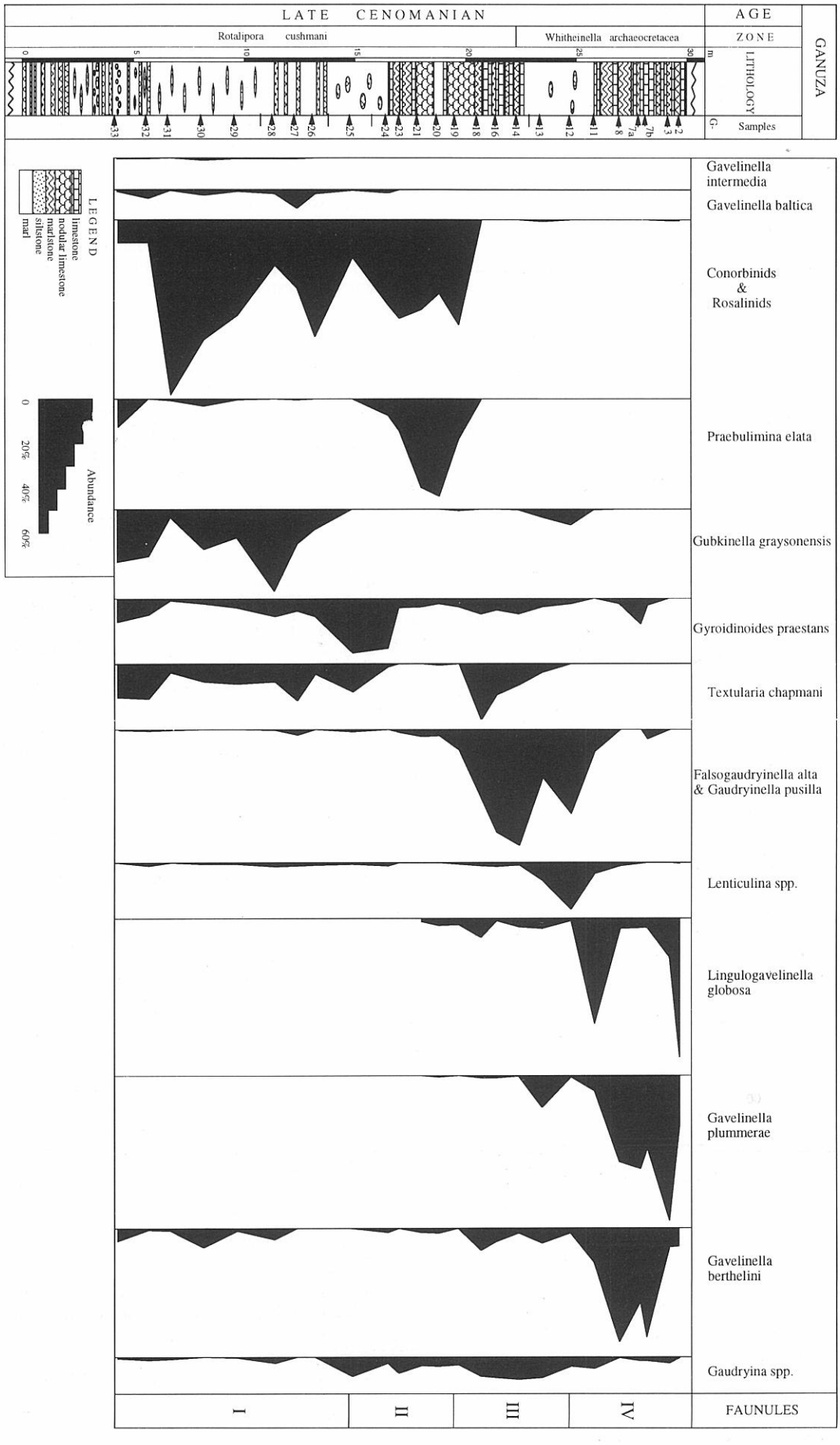

Figure 4. Relative abundances of dominant species in the uppermost Cenomanian in the Ganuza section.

emmigrated from the area after the extinction of *Rotalipora greenhornensis* (Morrow), e.g. *Gubkinella graysonensis* (Tappan) or *Textularia chapmani* Lalicker and species which were minor contributors to the assemblages in the faunule I and II, e.g. *Falsogaudryinella alta* (Magniez-Jannin), *Gaudryinella pusilla* Magniez-Jannin and *Lenticulina rotulata* Lamarck. There were also species which appeared for the first time in faunule II, e.g. *Gavelinella plummerae* (Tappan) in sample 25.

Faunule IV - interval from sample 11 to 2 (5.3 m thick): Benthonic diversity is low and varies between 9 and 14. H(S) index is comprised between 1.1 and 1.8 and P/B ratio is between 12 and 65 %. *Lingulogavelinella globosa* (Brotzen), *Gavelinella plummerae* (Tappan), *Gavelinella berthelini* (Keller) and *Gyroidinoides praestans* Magniez-Jannin dominated benthonic foraminiferal assemblages in this interval.

PALEOECOLOGY

In the studied section benthonic diversity varies from 9 to 27 species with decreasing tendency up the section. H(S) - the Shannon-Weaver heterogeneity index varies between 1.1 and 2.4. Highest values were computed in the lower part of the section, and they decrease continually up the section in its upper part (Fig. 5). Values of H(S) between 1.1 and 2.4, equivalent to those found in the studied section, are prominent on the Recent continental shelf off the eastern United States at depths of 20 to 120 meters and again on the continental slope at around 2000 meters (Buzas and Gibson, 1969).

P/B ratio fluctuates significantly (12 % - 80 %) in the uppermost Cenomanian in the Ganuza section (Fig. 5). Highest values (50 % - 80 %) were recorded from short intervals following extinctions of planktonic species *Rotalipora greenhornensis* (Morrow) and *Rotalipora cushmani* (Morrow), respectively. Values of P/B ratio between 12 and 80 %, equivalent to those found in the Ganuza section, are prominent on the continental shelf of recent open-marine environments (Murray, 1976, 1991). Combined quantitative data on foraminiferal assemblages indicate a shelf water depth during latest Cenomanian time at the Ganuza section.

Benthonic foraminifera occupy many niches within the sediment profile. Although they may migrate within the sediment during ontogeny, broad classification of sediment type/depth morphotypic associations have been proposed (Corliss, 1985; Jones and Charnock, 1985; Jones, 1986; Corliss and Chen, 1988). Epifaunal mode of life is the most typical for rounded trochospiral, plano-convex trochospiral, milioline and biconvex trochospiral morphotypes. Infaunal mode of life prevails within rounded planispiral, flattened ovoid, tapered and cylindrical, spherical, flattened tapered morphotypes. However, this simple classification is often disordered by motile species which are living free on the muddy sediment and may migrate down to penetrate unconsolidated soft part of the mud in the search for food and/or may move within the sediment because the microhabitat preference of individual taxa may change as a function of the depth of the Redox Potential Discontinuity Layer, e.g. Recent *Astronion, Bolivina, Epistominoides, Elphidium, Pyrgo, Melonis, Ammotium, Sphaeroidina* (Jorissen, 1988; Corliss and Emersson, 1990; Murray, 1991; Barmavidjaja *et al.,* 1992). Thus a distribution of benthonic foraminifers should be regarded as a dynamic process. Motile species may be found in different microhabitats in response to changing environmental conditions and food supply. This group of species by changing habitats from epifaunal to infaunal is regarded as highly adaptable and tolerant (Linke and Lutze, 1993).

Latest Cenomanian low trochospiral inflated and laterally compressed *Lingulogavelinella globosa* Brotzen, lenticular planispiral biconvex *Lenticulina rotulata* Lamarck, plano-convex trochospiral *Gavelinella berthelini* (Keller) and *Gavelinella plummerae* (Tappan) which during the OAE II not only survived but also considerably increased in abundance are interpreted here as forms of inferred infaunal/semi-infaunal mode of life (cf. Koutsoukos *et al.,* 1990; Leary and Peryt, 1991). Fig. 5 shows relative abundances of infaunal/semi-infaunal and epifaunal morphogroups in the assemblages. In the faunule I within dominant species the foraminiferal epifauna is represented by rosalinids, conorbinids and *Gyroidinoides praestans* Magniez-Jannin, i.e., forms trochospiral and planoconvex while trochospiral and subspherical *Gubkinella graysonensis* (Tappan) and flattened tapered *Textularia chapmani* Lalicker represent infauna. Gavelinella berthelini (Keller) was included to semi-infauna. Epifaunal morphotypes are more abundant than infaunal ones and they contribute to the assemblages from 40 % to more than 80 %. Up the faunule II there is a gradual increase in abundance of infaunal morphotypes from 18 % in the lower part of the interval to more than 60 %. Tapered cylindrical infaunal *Praebulimina elata* Magniez-Jannin expanding through faunule II in the expense of epifaunal *Gyroidinoides praestans* Magniez-Jannin which diminished in abundance in the same time.

A rapid change in the community structure is observed in the uppermost part of the *Rotalipora cushmani* Zone (sample 18 - boundary between faunules II/III) where contribution of epifaunal morphogroups to the assemblages decreases to 10-15 % and such low values are continuing upward till the top of the studied section. Assemblages of the faunule III are dominated mainly by infaunal morphogroups - tapered cylindrical *Falsogaudryinella alta* (Magniez-Jannin) and *Gaudryinella pusilla* Magniez-Jannin and flattened tapered *Textularia chapmani* Lalicker. In turn in faunule IV dominate low trochospiral inflated *Lingulogavelinella globosa* Brotzen and trochospiral plano-convex *Gavelinella berthelini* (Keller) and *Gavelinella plummerae* (Tappan) - epifaunal/shallow infaunal morphogroups.

DISCUSSION

The late Cenomanian marine basins saw widespread dysaerobic conditions (Arthur *et al.,* 1987) embodied in the so-called Oceanic Anoxic Event of Schlanger and Jenkyns (OAE II) (1976) with catastrophic affects for the benthonic and planktonic biota (e.g. Eicher and Worstell, 1970; Kuhnt *et al.,* 1986; Elder, 1987; Jarvis *et al.,* 1988; Peryt and Wyrwicka, 1991, 1993). In the detailed sequencing of the biotic response the benthonic biota were affected first by an expanding oxygen minimum zone (Jarvis *et al.,* 1988; Leary and Peryt, 1991; Peryt and Wyrwicka, 1991, 1993).

Do the benthonic foraminiferal assemblages changes reflect presence of the oxygen-minimum zone in the Ganuza section? Recent studies documented that assemblages of modern benthonic foraminifers from anoxic sediments differ from those of oxic deposits. The differences are concerned both with the faunal composition and morphology.

The faunas from the oxygen minimum zone are characterized by high abundance, low diversity, small size and high dominance, typically with 2 or 3 calcareous species constituting up to 80 % of the total assemblage (Phleger and Soutar, 1973; Bernard, 1986; Perez-Cruz and Machain-Castillo, 1990; Sen Gupta and Machain-Castillo, 1993). Infaunal species dominate assemblages associated with relatively high organic-carbon values (Corliss and Chen, 1988).

Recently, it has been suggested that the microhabitat preference of individual taxa may change as a function of the depth of the redox front and/or the amount of food in the substrate (Jorissen, 1988; Corliss and Emerson, 1990; Koutsoukos *et al.,* 1990; Barmavidjaja *et al.,* 1992).

Infaunal or potentially infaunal taxa generally are more tolerant for low oxygen concentrations and are therefore the first to profit from the high food availability (Byers, 1977;

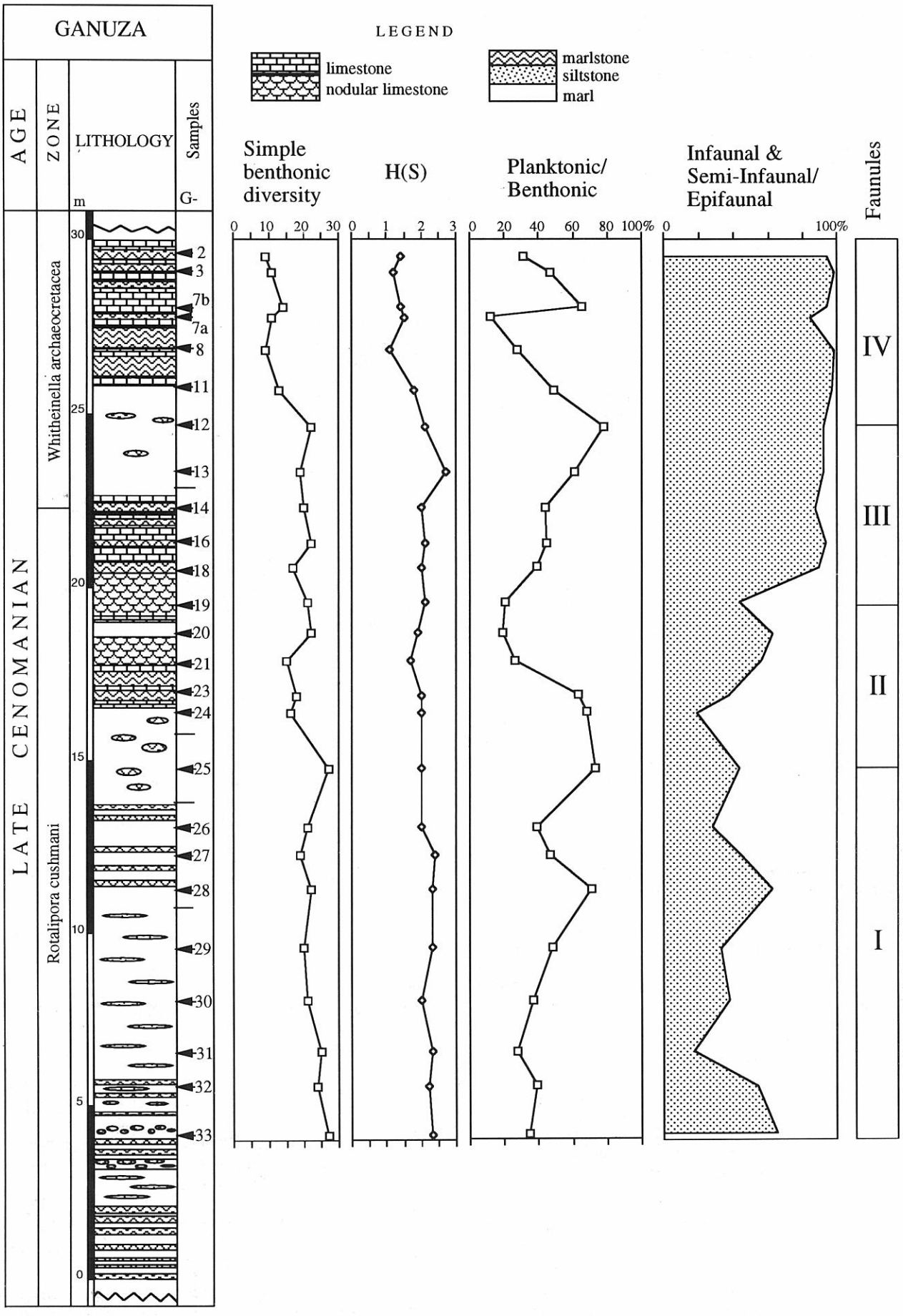

Figure 5. Results of quantitative analyses of benthonic foraminiferal assemblages in the uppermost Cenomanian in the Ganuza section.

Jarvis *et al.,* 1988; Koutsoukos *et al.,* 1990; Leary and Peryt, 1991; Jorissen *et al.,* 1992). The ultimate downward organic flux rate controls both the food availability and the oxygen concentrations at the sediment-water interface. Deposit feeders with the infaunal or semi-infaunal life position as living within the sediment are thought to be more tolerant for oxygen deficiency and these groups might survive and even grow in abundance under these environmentally stressed conditions (Koutsoukos *et al.,* 1990; Leary and Peryt, 1991). Bemard (1993) suggested that benthonic foraminifers survive anoxia by using altemative strategies - either metabolic depression (i.e., dormancy) or encystment; they can be also facultative anaerobes.

Late Cenomanian low oxygen tolerant faunas have been recorded from several regions (North America: Bemard, 1986; Leckie, 1985; NW Pacific: Kaiho *et al.,* 1993, 1994; South Atlantic: Koutsoukos *et al.,* 1990; Lincolnshire, UK: Hart and Bigg, 1981; Anglo-Paris Basin: Jarvis *et al.,* 1988; Danish-Polish Trough: Peryt *et al.,* 1994; Bohemian Basin: Ulicny *et al.,* 1993; Vocontian Basin: Tronchetti and Grosheny, 1990). These regions show very similar morphotypic associations; the faunal differences which nevertheless exist most probably reflect provincialism within benthonic foraminifers.

Recorded changes in composition of benthonic foraminiferal assemblages in the Ganuza section are characteristic for the environments with depleted oxygen concentration and/or increased food availability. Considerable changes in the structure of foraminiferal assemblages began in the uppemmost part of the *Rotalipora cushmani* Zone (faunule I) when the probable severe decreasing of oxygen concentration in bottom waters caused the temporary disappearance of species *Gubkinella graysonensis* (Tappan) and *Textularia chapmani* Lalicker and decreasing abundance of *Gyroidinoides praestans* Magniez-Jannin (Fig. 3, 4). The vacated niches were colonized by a minute, tapered, infaunal calcareous species *Praebulimina elata* Magniez-Jannin which along with epifaunal conorbinids and rosalinids –also very small calcareous forms– dominated assemblages for some time (faunule II) after the extinction of *Rotalipora greenhornensis* (Morrow). However, the group of these species disappeared suddenly prior to the extinction of *Rotalipora cushmani* (Morrow) at the boundary between faunule II and III (Fig. 3, 4). Probably, they could not stand increasing deficiency of oxygen in bottom waters. Now vacated niches were colonized by infaunal agglutinants - *Textularia chapmani* Lalicker, *Falsogaudryinella alta* (Magniez-Jannin) and *Gaudryinella pusilla* Magniez-Jannin. This group disappeared soon after the extinction of *Rotalipora cushmani* (Morrow) and was replaced in faunule IV by calcareous, semi-infaunal and infaunal species: *Lingulogavelinella globosa* (Brotzen), *Gavelinella berthelini* (Keller) and *G. plummerae* (Cushman) (Fig. 4).

The boundary between faunule II and III divides studied section in two parts: lower - with bottom waters well-oxygenated - where mixed epifaunal and infaunal forms are present, and upper -with bottom waters oxygen-restricted - where infaunal and/or semi-infaunal groups dominate assemblages (Fig. 5).

CONCLUSIONS

The recorded changes in benthonic foraminiferal assemblages include stepped extinction of several foraminiferal species both benthonic and planktonic, sudden extinction of a large group of epifaunal rosalinids and conorbinids and recolonization of vacant niches by 2-4 infaunal and/or semi-infaunal species as well as temporary disappearance of several other species from the area. These changes most likely reflect the decline of the oxygenation level of the bottom waters at the end of the *Rotalipora cushmani* Zone and the persistence of these unfavourable conditions in the early *Whiteinella archaeocretacea* Zone. In the Ganuza section, however, complete anoxia is unlikely; in this site in the latest Cenomanian-earliest Turonian bottom waters were only dysaerobic.

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APPENDIX

SYSTEMATIC PALEONTOLOGY

Fifty five species of benthonic foraminifera recorded in the studied interval are described. Most of them are illustrated on plates I-V. Only a few species, rarely occurring in the studied section and badly preserved were not suitable for illustration.

Loeblich and Tappan's (1987) systematics has been adopted in the present paper. When original descriptions of species were not available, references are made to the Cataloque of Foraminifera compiled by Ellis and Messina (1940 et seq.). All the specimens described herein are deposited in the M.A. Lamolda's collection, Faculty of Sciences, Universidad del Pais Vasco.

Order FORAMINIFERIDA Eichwald, 1830
Suborder TEXTULARIINA Delage and Herouard, 1896
Superfamily **AMMODISCACEA** Reuss, 1862
Family **Ammodiscidae** Reuss, 1862
Subfamily **Ammovertellinae** Saidova, 1981
Genus *Glomospira* Rzehak, 1885

Glomospira irregularis (Grzybowski, 1898)

1898 *Ammodiscus irregularis* Grzybowski, 285, Pl. XI, Figs. 2-3 (fide Ellis and Messina).
1992 *Glomospira irregularis* (Grzybowski); Kuhnt, Pl. V, Figs. 1-4.

Superfamily **HORMOSINACEA** Haeckel, 1894
Family **Hormosinidae** Haeckel, 1894
Subfamily **Reophacinae** Cushman, 1910
Genus *Reophax* de Montfort, 1808

Reophax cf. *variabilis* Haeusler, 1885
Pl. I, Fig. 11

1885 *Reophax variabilis* Haeusler, 10, Pl. I, Fig. 8 (fide Ellis and Messina).

Remarks: Test medium-sized (length 0.56 mm), rough, composed of two chambers; first chamber globular, the second one - slightly horizontally compressed. Apertural neck thick, tapering and slightly out of center. This specimen resembles *R. variabilis* Haeusler by its shape of test and roughness of the wall surface. Since the size of *R. variabilis* Haeusler in the original description is not given specimens from the Ganuza section are not included to this species.

Superfamily **LITUOLACEA** de Blainville, 1827
Family **Lituolidae** de Blainville, 1827
Subfamily **Ammomarginulininae** Podobina, 1978
Genus *Ammobaculites* Cushman, 1910

Ammobaculites gratus Cushman and Applin, 1947
Pl. I, Fig. 20

1947 *Ammobaculites gratus* Cushman and Applin, 54, Pl. XIII, Fig. 4a-b (fide Ellis and Messina).

Remarks: This specimen differs from *A. parvispira* Ten Dam in smaller size, lesser number of chambers in the uniserial part, proportionally larger planispiral part and more globular chambers in the uniserial part and the apertural end with a definite lip.

Ammobaculites parvispira Ten Dam, 1950
Pl. I, Figs. 18, 22

1950 *Ammobaculites parvispira* Ten Dam, 10, Pl. I, Fig. 8a-b (fide Ellis and Messina).
1965 *Ammobaculites parvispira* Ten Dam; Neagu, 4, Pl. I, Figs. 1-3.
1975 *Ammobaculites parvispira* Ten Dam; Magniez-Jannin, 40-42, Pl. I, Figs. 19-26.

Remarks: Specific variability is expressed mainly in the number of chambers in the uncoiled part of test and in the roughness of test.

Superfamily **SPIROPLECTAMMINACEA** Cushman, 1927
Subfamily **Spiroplectammininae** Cushman, 1927
Genus *Quasispiroplectammina* Loeblich and Tappan, 1982

Quasispiroplectammina praelonga (Reuss, 1845)
Pl. I, Fig. 14

1845 *Textularia praelonga* Reuss, 39, Pl. XII, Fig. 14a-b (fide Ellis and Messina).
1972 *Spiroplectammina praelonga* (Reuss); Gawor-Biedowa, 18-19, Pl. I, Fig. 1.

Remarks: Specimens found in the Ganuza section differ from the type specimens in having less thickened sutures between chambers and the suture running along the test.

Quasispiroplectammina sp.
Pl. I, Fig. 5

Remarks: Test large, elongated, planispirally coiled in early portion, later biserial, periphery incised. Biserial part enlarging gradually in size as added. Sutures oblique, slightly depressed. Aperture at the base of last chamber. This species differs from *Quasispiroplectammina praelonga* by having larger dimensions, incised periphery and depressed sutures.

Genus *Spiroplectinella* Kisel'man, 1972

Spiroplectinella? sp.
Pl. I, Fig. 8

Remarks: Test large, early chambers planispirally coiled, than biserially arranged. The coil is as large as first pair of chambers in biserial part. Biserial part enlarging gradually in width. Aperture at the base of last chamber. This species has been tentatively included to *Spiroplectinella* because its test in horizontal section is rather oval than lozenge shaped.

Genus *Spiroplectammina* Cushman, 1927

Spiroplectammina sp.

Remarks: Test medium-sized, elongate, planispiral in early part, than biserial, oval in section. Chambers increasing gradually in size, aperture at the inner margin of last chamber.

Family **Pseudobolivinidae** Wiesner, 1931
Genus Pseudobolivina Wiesner, 1931

Pseudobolivina variana (Eicher, 1960)
Pl. I, Figs. 9, 10

1964 *Pseudobolivina variana* (Eicher); Loeblich and Tappan, 255, Pl. CLXVII, Figs. 5a-c, 6.
1975 *Pseudobolivina variana* (Eicher); Magniez-Jannin, 56-57, Pl. III, Figs. 25-34.

Remarks: Test tiny, biserial, slightly twisted, composed of 7-8 pairs of chambers, periphery incised. Chambers oval, increasing rapidly in size as added, arranged obliquely in relation to the vertical axis of test. Sutures oblique, depressed. Aperture subterminal. Specific variability expressed mainly in number and shape of chambers.

Superfamily **TROCHAMMINACEA** Schwager, 1877
Family **Trochamminidae** Schwager, 1877
Subfamily **Trochammininae** Schwager, 1877
Genus *Trochammina* Parker and Jones, 1859

Trochammina wetteri Stelck and Wall, 1955

1955 *Trochammina wetteri* Stelck and Wall, 59, Pl. II, Figs. 1-3, 6 (fide Ellis and Messina).
1967 *Trochammina wetteri* Stelck and Wall; Eicher, 184, Pl. XVIII, Figs. 7a-b, 9a-c.

Superfamily **VERNEUILINACEA** Cushman, 1911
Family **Verneuilinidae** Cushman, 1911
Subfamily **Verneuilinoidinae** Suleymanov, 1973
Genus *Eggerellina* Marie, 1941

Eggerellina mariae Ten Dam, 1950
Pl. II, Fig. 16

1950 *Eggerellina mariae* Ten Dam, 15-16, Pl. I, Fig. 17 (fide Ellis and Messina).
1977 *Eggerellina mariae* Ten Dam; Carter and Hart, 17, Pl. II, Fig. 7.
1983 *Eggerellina mariae* Ten Dam; Peryt, 433, Pl. XXI, Fig. 10.

Remarks: Test triserial, small, ovoid to almost globular in shape, surface smoothly finished. Chambers inflated, subglobular, increasing rapidly in size as added. Sutures depressed. Aperture a narrow hooklike slit extending up the apertural face for a short distance from its base. Specific variability is expressed mainly in the shape and size of test, in the height of last whorl and the width of the initial part of test.

Genus *Falsogaudryinella* Bartenstein, 1977

Falsogaudryinella alta (Magniez-Jannin, 1975)
Pl. I, Fig. 30

1975 *Uvigerinammina alta* Magniez-Jannin, 77-78, Pl. VI, Figs. 1-11.
1977 *Falsogaudryinella alta* (Magniez-Jannin); Bartenstein, 398, Pl. II, Fig. 8; Pl. IV, Figs. 3-6; Pl. V, Figs. 3-6.

Genus *Vialovella* Voloshina, 1972

Vialovella sp.
Pl. II, Fig. 18

Remarks: Test very small (length 0.18 mm), triserial, in section triangular with rounded angles; chambers enlarging rapidly in breadth; sutures straight, not depressed; aperture a high loop-shaped opening perpendicular to the base of the chamber. This species differs from *V. oblonga* (Reuss) in having smaller dimensions, less inflated chambers and more squat shape.

Subfamily **Spiroplectinatinae** Cushman, 1928
Genus *Belorussiella* Akimets, 1958

Belorussiella sp.
Pl. I, Fig. 27

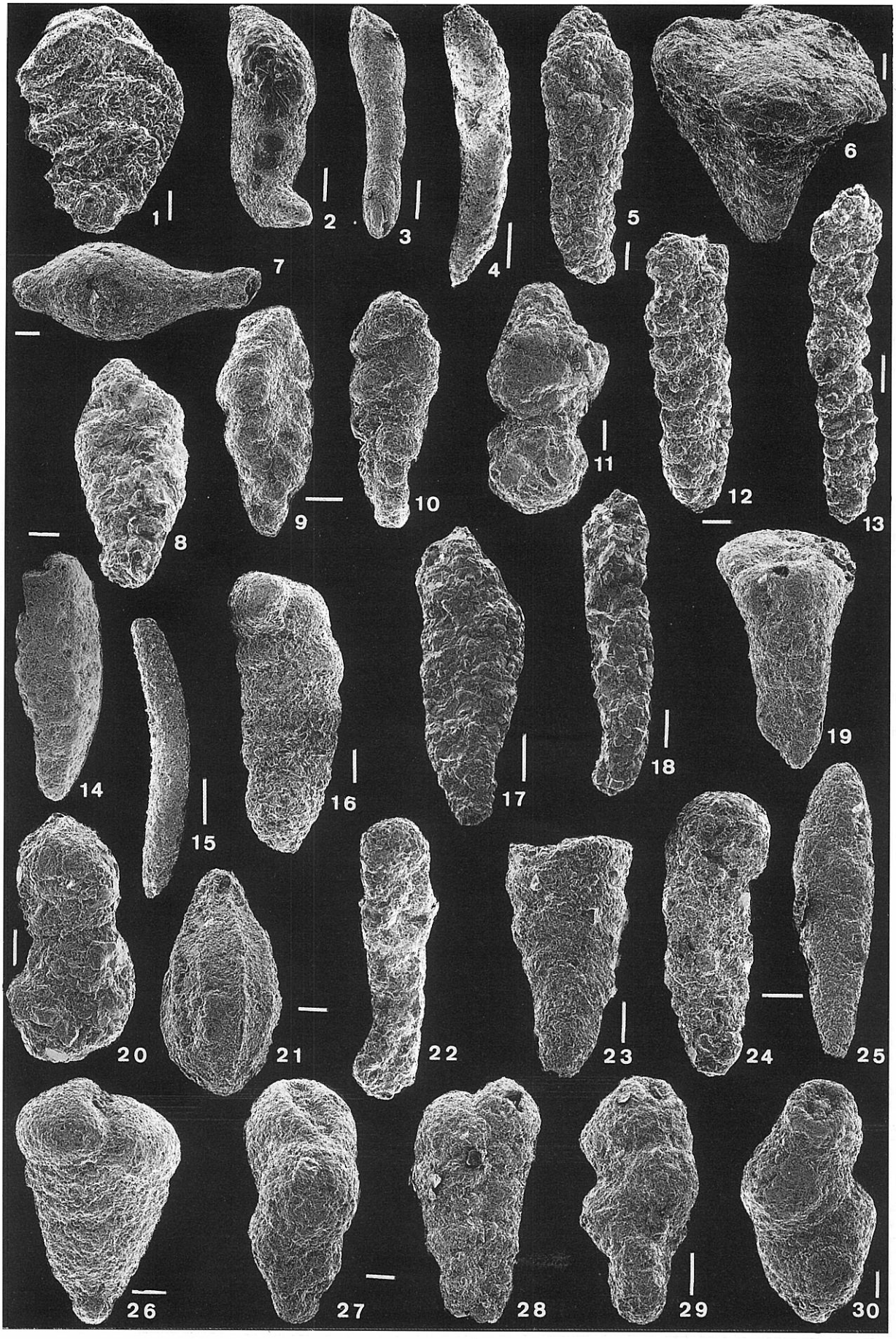
Remarks: Test composed of short triangular stage followed by a biserial stage; chambers nearly globular increasing rapidly in size; periphery rounded; sutures depressed; aperture an elongate slit extending from the base of the last chamber to the apex. This species differs from all other species of *Belorussiella* in having globular chambers, subcircular rather than ovate section of the biserial part and distinctly depressed sutures.

Plate I

1 *Tappanina eouvigeriniformis* (Keller); sample G-32; x 225.
2 *Marginulina* sp.; sample G-29; x 120.
3 *Dentalina* sp.; sample G-29; x 70.
4 *Dentalina sororia* Reuss; sample G-28; x 80.
5 *Quasispiroplectammina* sp.; sample G-25; x 50.
6 *Marssonella trochus* (d'Orbigny); sample G-18; x 100.
7 *Ramulina aculeata* (d'Orbigny); sample G-13; x 90.
8 *Spiroplectinella* sp.; sample G-33; x 30.
9 *Pseudobolivina variana* (Eicher); sample G-29; x 140.
10 *Pseudobolivina variana* (Eicher); sample G-29; x 130.
11 *Reophax* cf. *variabilis* Haeusler; sample G-25; x 55.
12 *Spiroplectina* sp.; sample G-25; x 100.
13 *Spiroplectina* sp.; sample G-20; x 70.
14 *Quasispiroplectammina praelonga* (Reuss); sample G-20; x 110.
15 *Ramulina aculeata* (d'Orbigny); sample G-25; x 40.
16 *Dorothia gradata* (Berthelin); sample G-25; x 120.
17 *Textularia foeda* Reuss; sample G-11; x 80.
18 *Ammobaculites parvispira* Ten Dam; sample G-11; x 70.
19 *Gaudryina* sp.; sample G-33; x 100.
20 *Ammobaculites gratus* Cushman and Applin; sample G-30; x 130.
21 *Lagena sulcata* (Walker and Jacob); sample G-23; x 200.
22 *Ammobaculites parvispira* Ten Dam; sample G-28; x 50.
23 *Marssonella oxycona* Reuss; sample G-21; x 140.
24 *Dorothia gradata* (Berthelin); sample G-26; x 80.
25 *Pleurostomella obtusa* Berthelin; sample G-33; x 150.
26 *Textularia chapmani* Lalicker; sample G-29; x 120.
27 *Belorussiella* sp.; sample G-32; x 90.
28 *Textularia?* sp.; sample G-23; x 100.
29 *Gaudryinella pusilla* Magniez-Jannin; sample G-21; x 150.
30 *Falsogaudryinella alta* (Magniez-Jannin); sample G-21; x 95.

Scale bar = 50 μm (except 1, 21 = 25 μm; 3-5, 11, 17, 18, 22, 24 = 100 μm; 8, 15 = 200 μm).

Plate I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Genus *Spiroplectina* Schubert, 1902

Spiroplectina sp.
Pl. I, Figs. 12, 13

Remarks: Test very finely agglutinated, elongated (0.85 mm length), laterally compressed, composed of a short trochospiral stage, a long biserial part (5-6 pairs of chambers) and again a short uniserial part (3-4 chambers); outline incised; chambers globular in the trochospiral part, oval in younger stages; sutures oblique, depressed; aperture in the uniserial part terminal, on a neck.

Subfamily **Verneuilininae** Cushman, 1911
Genus *Gaudryina* d'Orbigny, 1839

Gaudryina sp.
Pl. I, Fig. 19

Remarks: Test medium-sized (0.44 mm length), finely agglutinated, triserial and triangular in section in the older part with concave lateral walls, followed by low and rounded 3-4 pairs of chambers in the biserial part; wall surface smooth, sutures very slightly depressed; aperture a low arch at the base of the final chamber. This species differs from *G. angustata* Akimets by having circular rather than oval section in the biserial part, by straight not inflated walls of chambers and almost flush sutures.

Genus *Gaudryinella* Plummer, 1931

Gaudryinella pusilla Magniez-Jannin
Pl. I, Fig. 29

1975 *Gaudryinella pusilla* Magniez-Jannin, 68-69, Pl. V, Figs. 15-22.

Remarks: This species is characterized by great individual variability expressed mainly in size of specimens, shape of chambers and depresion of sutures.

Subfamily **Barbourinellinae** Saidova, 1981
Genus *Tritaxia* Reuss, 1860

Tritaxia tricarinata (Reuss)
Pl. II, Fig. 21

1965 *Tritaxia tricarinata* (Reuss); Neagu, 6, Pl. I, Figs. 7, 8, 17, 18.

Remarks: This species differs from *T. pyramidata* in having more concave lateral faces of test and more acute edges.

Tritaxia pyramidata Reuss, 1863
Pl. II, Fig. 22

1863 *Tritaxia pyramidata* Reuss, 32, Pl. I, Fig. 9a-c (fide Ellis and Messina).
1975 *Tritaxia pyramidata* Reuss; Magniez-Jannin, 71-75, Pl. V, Figs. 25-38.

Superfamily **TEXTULARIACEA** Ehrenberg, 1838
Familia **Eggerellidae** Cushman, 1937
Subfamily **Dorothiinae** Balakhmatova, 1972
Genus *Dorothia* Plummer, 1931

Dorothia gradata (Berthelin, 1880)
Pl. I, Figs. 16, 24

1880 *Gaudryina gradata* Berthelin, 24, Pl. I, Fig. 6 (fide Ellis and Messina).
1965 *Dorothia gradata* (Berthelin); Neagu, 8-9, Pl. II, Fig. 23.
1972 *Dorothia gradata* (Berthelin); Gawor-Biedowa, 29-30, Pl. II, Fig. 7a-b.

Remarks: Specimens from the Ganuza section differ from the type specimens in having more compressed chambers and less indented periphery.

Genus *Marssonella* Cushman, 1933

Marssonella oxycona (Reuss, 1860)
Pl. I, Fig. 23

1860 *Gaudryina oxycona* Reuss, 229, Pl. XII, Fig. 3 (fide Ellis and Messina).
1965 *Marssonella oxycona* (Reuss); Neagu, 8, Pl. I, Fig. 13.

Marssonella trochus (d'Orbigny, 1840)
Pl. I, Fig. 6

1840 *Textularia trochus* d'Orbigny, 45, Pl. IV, Figs. 25-26 (fide Ellis and Messina).
1965 *Marssonella trochus* (d'Orbigny); Neagu, 8, Pl. I, Figs. 14-16.

Family **Textulariidae** Ehrenberg, 1838
Subfamily **Textulariinae** Ehrenberg, 1838
Genus *Textularia* Defrance, 1824

Textularia chapmani Lalicker, 1935
Pl. I, Fig. 26

1935 *Textularia chapmani* Lalicker, 13, Pl. II, Figs. 8a-c, 9 (fide Ellis and Messina).
1972 *Textularia chapmani* Lalicker; Gawor-Biedowa, 19-20, Pl. I, Figs. 2a-b.

Remarks: Test medium-sized, biserial, composed of 5 to 7 pairs of chambers, tapering and stout, oval in section. Surface smooth to considerably roughly agglutinated. In macrospheric forms proloculus large, globular, distinctly separated from the following biserial part. Chambers in the biserial part oval, arranged a little obliquely in relation to the vertical axis of test, increasing moderately in size as added. Last pair of chambers more inflated than older ones. Sutures flush with the surface, except of the ones from the last pair of chambers which are distinctly depressed. Aperture a low arch at the base of the apertural face. An individual variability mostly concerning dimensions and shape of test related with microspheric or macrospheric forms and degree of convexity and number of chambers.

Textularia foeda Reuss, 1845
Pl. I, Fig. 17

1845 *Textularia foeda* Reuss, 109-110, Pl. XLIII, Fig. 12a-b, 13 (fide Ellis and Messina).
1972 *Textularia foeda* Reuss; Gawor-Biedowa, 20-21, Pl. I, Figs. 3a-b.

Remarks: This species differs from T. chapmani Lalicker in being slender in shape, having test more roughly agglutinated, larger and composed of 8 to 10 pais of chambers.

Textularia sp.
Pl. I, Fig. 28

Remarks: Illustrated specimen has been left in open nomenclature due to its bad preservation (older part broken).

Suborder LAGENINA Delage and Herouard, 1896
Superfamily **NODOSARIACEA** Ehrenberg, 1838
Family **Nodosariidae** Ehrenberg, 1838
Subfamily **Nodosariinae** Ehrenberg, 1838
Genus *Dentalina* Risso, 1826

Dentalina sp.
Pl. I, Fig. 3

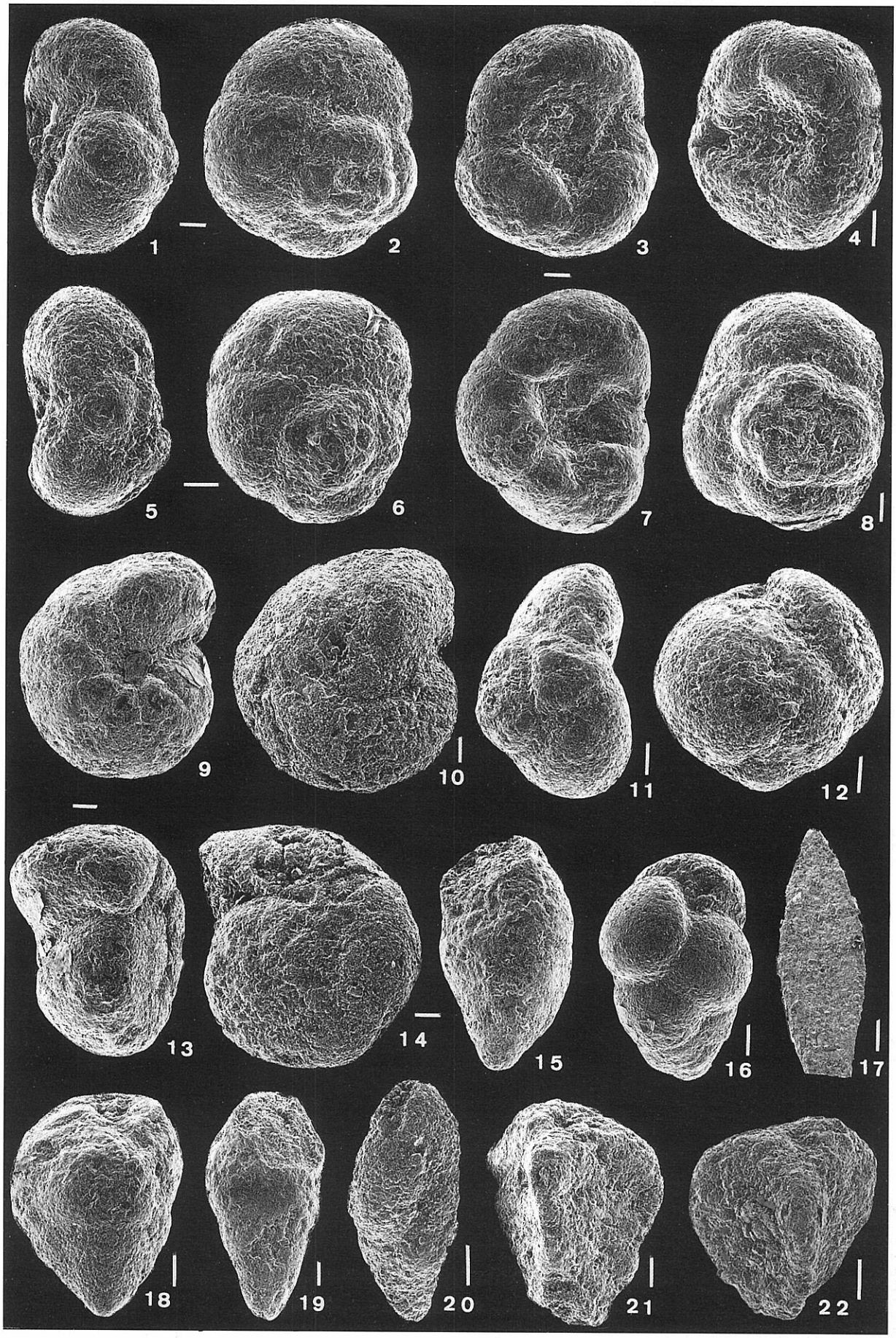
Remarks: Test gently curved, composed of three elongated, slightly inflated chambers, outline not incised, sutures oblique, flush. This species differs from *D. distincta* Reuss in having less inflated chambers and not incised outline.

Plate II

1 *Iuliusina grata* Fuchs; sample G-29; x 195.
2 *Iuliusina grata* Fuchs; sample G-29; x 195.
3 *Iuliusina grata* Fuchs; sample G-29; x 180.
4, 5 *Iuliusina grata* Fuchs; sample G-30; the same specimen - x 250.
6 *Iuliusina grata* Fuchs; sample G-32; x 245.
7 *Iuliusina grata* Fuchs; sample G-29; x 175.
8 *Iuliusina grata* Fuchs; sample G-32; x 210.
9, 13 *Gyroidinoides praestans* Magniez-Jannin; sample G-32; x 190.
10 *Valvulineria* sp.; sample G-13; x 185.
11 *Iuliusina grata* Fuchs; sample G-29; x 220.
12 *Gubkinella graysonensis* (Tappan); sample G-33; x 260.
14 *Valvulineria* sp.; sample G-13; x 195.
15 *Praebulimina elata* Magniez-Jannin; sample G-33; x 190.
16 *Eggerellina mariae* Ten Dam; sample G-13; x 105.
17 *Frondicularia* sp.; sample G-11; x 30.
18 *Vialovella* sp.; sample G-33; x 220.
19 *Praebulimina elata* Magniez-Jannin; sample G-30; x 180.
20 *Praebulimina elata* Magniez-Jannin; sample G-29; x 150.
21 *Tritaxia tricarinata* (Reuss); sample G-33; x 200.
22 *Tritaxia pyramidata* (Reuss); sample G-14; x 140.

Scale bar = 25 μm (except 16, 20, 22 = 50 μm; 17 = 200 μm).

Plate II



Dentalina sororia Reuss, 1863
Pl. I, Fig. 4

1863 *Dentalina sororia* m. Reuss, 42 (fide Ellis and Messina).
1975 *Lenticulina (Dentalina) sororia* (Reuss); Magniez-Jannin, 145, Pl. XI, Figs. 52-53, Text-Fig. 73.

Genus *Nodosaria* Lamarck, 1812

Nodosaria sp.

Remarks: This species occurs sporadically in the studied material. A few broken specimens made us to classify it in open nomenclature.

Subfamily **Frondicularinae** Reuss, 1860
Genus *Frondicularia* Defrance, 1826

Frondicularia sp.
Pl. II, Fig. 17

Remarks: This form resembles *F. inversa* Reuss in the size and shape of test and shape of chambers but only one specimen found in the studied material, broken in the initial part and obscured by detritic material made us to leave it in open nomenclature.

Family **Vaginulinidae** Reuss, 1860
Subfamily **Lenticulininae** Chapman, Parr and Collins, 1934
Genus *Lenticulina* Lamarck, 1804

Lenticulina rotulata Lamarck, 1804
Pl. IV, Figs. 19, 20; Pl. V, Fig. 15

1804 *Lenticulina rotulata* Lamarck, 188 (fide Ellis and Messina).
1975 *Lenticulina rotulata* Lamarck; Magniez-Jannin, 100-101, Pl. IX, Figs. 3a-b.
1988 *Lenticulina rotulata* Lamarck; Hart and Leary *in* Jarvis *et al.*, Pl. X, Figs. j, k; Pl. XI, Figs. i, j.

Subfamily **Marginulininae** Wedekind, 1937
Genus *Marginulina* d'Orbigny, 1826.

Marginulina sp.
Pl. I, Fig. 2

Remarks: This species resembles *M. inaequalis* Reuss from which it differs, however, in having initial part of test longer and enrolled.

Genus *Psilocitharella* Loeblich and Tappan, 1986

Psilocitharella sp.

Remarks: Species very rare in the studied material. A few specimens found were broken and obscured by detritic material so they are classified in open nomenclature.

Family **Lagenidae** Reuss, 1862
Genus *Lagena* Walker and Jacob, 1798

Lagena sulcata (Walker and Jacob, 1798)
Pl. I, Fig. 21

1970 *Lagena sulcata* (Walker and Jacob); Eicher and Worstell, 286, Pl. II, Figs. 8, 9.

Remarks: This distinctive little species occurs rarely in the Ganuza section.

Family **Polymorphinidae** d'Orbigny, 1839
Subfamily **Edithaellinae** Fuchs, 1867
Genus *Ramulina* T. R. Jones, 1875

Ramulina aculeata (d'Orbigny, 1840)
Pl. I, Fig. 7, 15

1840 *Dentalina aculeata* d'Orbigny, 13, Pl. I, Figs. 2-3 (fide Ellis and Messina).
1975 *Ramulina aculeata* (d'Orbigny); Magniez-Jannin, 232-234, Text-fig. 124.

Suborder ROTALIINA Delage and Herouard, 1896
Superfamily **BOLIVINACEA** Glaessner, 1937
Family **Bolivinidae** Glaessner, 1937
Genus *Tappanina* Montanaro Gallitelli, 1955

Tappanina eouvigeriniformis (Keller, 1935)
Pl. I, Fig. 1

1935 *Bolivinita eouvigeriniformis* Keller, 548-549, Pl. III Figs. 20-21 (fide Ellis and Messina).
1972 *Tappanina eouvigeriniformis* (Keller); Gawor-Biedowa, 56-57, Pl. V, Figs. 5a-b.

Superfamily **TURRILINACEA** Cushman, 1927
Family **Turrilinidae** Cushman, 1927
Genus *Praebulimina* Hofker, 1953

Praebulimina elata Magniez-Jannin, 1975
Pl. II, Figs. 15, 19, 20

1975 *Praebulimina elata* Magniez-Jannin, 235-237, Pl. XV, Figs. 39-43.
1991 *Praebulimina elata* Magniez-Jannin; Tronchetti and Grosheny, Pl. IV, Figs. 7, 8.

Remarks: Test very small, fusiform, highly trochospiral, composed of 3 to 4 whorls. 3 chambers in each whorl increasing gradually in size. Sutures flush with the surface. Aperture a loop at the base of the final chamber. A small individual variability concerning shape and dimensions of test.

Superfamily **PLEUROSTOMELLACEA** Reuss, 1860
Family **Pleurostomellidae** Reuss, 1860
Subfamily **Pleurostomellinae** Reuss, 1860
Genus *Pleurostomella* Reuss, 1860

Pleurostomella obtusa Berthelin, 1880
Pl. I, Fig. 25

1880 *Pleurostomella obtusa* Berthelin, 29, Pl. I, Figs. 9a-b (fide Ellis and Messina).
1975 *Pleurostomella obtusa* Berthelin; Magniez-Jannin, 270-272, Pl. XV, Figs. 14-20.

Superfamily **DISCORBACEA** Ehrenberg, 1838
Family **Conorbinidae** Reiss, 1963
Genus *Conorbina* Brotzen, 1936

Conorbina cf. *brotzeni* Gandolfi, 1942
Pl. III, Figs. 16, 17

1942 *Conorbina brotzeni* Gandolfi, 91-92, Text-fig. 27a-c, Text-fig. 28-la-b, 2a-b (fide Ellis and Messina).
1972 *Conorbina brotzeni* Gandolfi; Gawor-Biedowa, 58-59, Pl. VI, Fig. 4a-c.

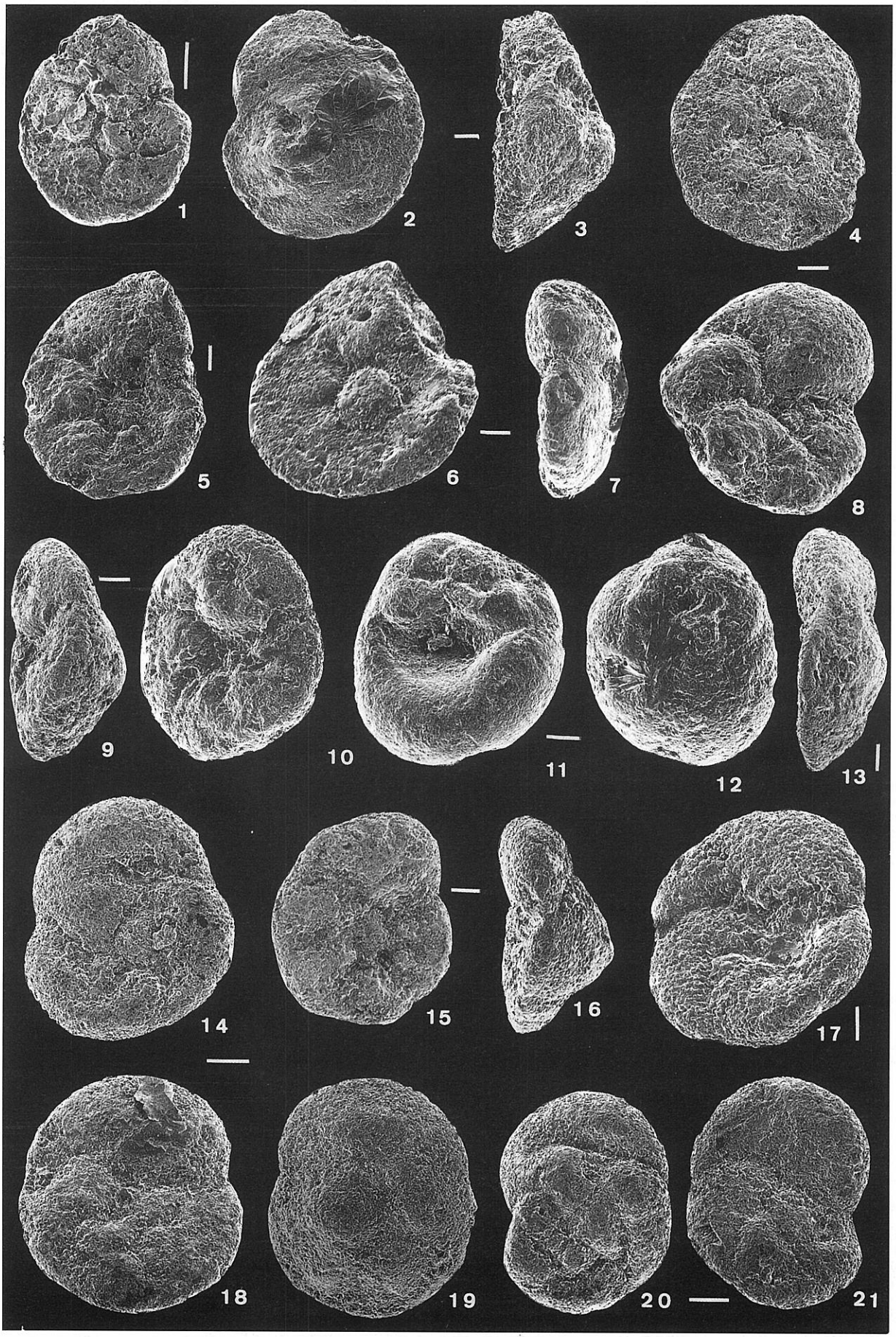
Remarks: Test very small (0.18-0.23 mm in diameter), trochospiral, spiral side domelike, outline subcircular, periphery acutely angled, composed of 2 to 2.5 whorls, 4-5 chambers in the last whorl. Chambers crescentic with curved, poorly visible, sutures on the spiral side; wedgelike to kidney shaped with radial to slightly curved and depressed sutures on the umbilical side; last chamber occupying about one-third of the periphery. Aperture a low extraumbilical and interiomarginal slit. This species differs from *C. brotzeni* Gandolfi in having two times smaller dimensions.

Plate III

1, 2 *Gavelinopsis* sp.; sample G-33; the same specimen - 1, x 165; 2, x 180.
3 *Gavelinopsis* sp.; sample G-33; x 180.
4 *Gavelinopsis* sp.; sample G-33; x 220.
5 *Gavelinopsis* sp.; sample G-29; x 180.
6 *Gavelinopsis* sp.; sample G-33; x 220.
7, 8 *Rosalina? iberica* n. sp. *Holotypus;* sample G-33; x 225.
9, 10 *Rosalina? iberica* n. sp.; sample G-33; the same specimen - x 225.
11, 12 *Eurycheilostoma* sp.; sample G-27; the same specimen - x 240.
13 *Rosalina? iberica* n. sp.; sample G-29; x 190.
14 *Neoconorbina* sp.; sample G-30; x 155.
15 *Gavelinopsis* sp.; sample G-19; x 195.
16, 17 *Conorbina* cf. *brotzeni* Gandolfi; sample G-33; the same specimen - 16, x 210; 17, x 240.
18, 19 *Neoconorbina* sp.; sample G-33; x 150.
20, 21 *Conorbina* sp. 1; sample G-33; x 140.

Scale bar = 25 μm (except 1, 14, 18-21 = 50 μm).

Plate III



Conorbina sp. 1
Pl. III, Figs. 20-21

Remarks: Test small (0.28 mm maximum diameter), low trochospiral, subcircular to oval in outline, with acutely angled periphery, composed of 2.5 whorls. All chambers visible on the spiral side; early chambers globular, later becoming crescentic separated by depressed and slightly curved sutures; on the umbilical side chambers crescentic, sutures curved and depressed. Four chambers in the last whorl; last chamber occupying more than one-third of the periphery. Aperture a low extraumbilical and interiomarginal slit. This species differs from *C.* cf. *brotzeni* Gandolfi in having almost flat spiral side of the test.

Genus *Eurycheilostoma* Loeblich and Tappan, 1957

Eurycheilostoma sp.
Pl. III, Figs. 11, 12

Remarks: Test very small (0.18 mm in diameter), highly trochospiral; periphery rounded; chambers semilunar, inflated, with sutures only very slightly depressed and poorly visible; 3-4 chambers in last whorl; aperture interiomarginal. This species differs from *E. altispira* Loeblich and Tappan in having smaller dimensions, less conical shape of test and less depressed sutures.

Genus *Iuliusina* Fuchs, 1971.

Iuliusina grata Fuchs, 1971
Pl. II, Figs. 1-8, 11

1971 *Iuliusina grata* Fuchs; *fide* Loeblich and Tappan, 1987, 541-542, Pl. 588, Figs. 6-8.

Remarks: Test very small (0.16-0.23 mm in diameter), trochospiral, composed from 2.5-3 whorls; periphery rounded; early chambers increase in size slowly to moderately in the first whorls, rapidly - in the last whorl; early chambers subglobular; oval to crescentic in the last whorl; sutures depressed, slightly curved on the spiral side, depressed and radial on the umbilical side. Aperture interiomarginal, sometimes with umbilical flap. Specimens from the Ganuza section differ from the holotype in having less lobulate periphery and more rapidly increasing in size chambers in the last whorl.

Family **Bagginidae** Cushman, 1927
Subfamily **Serovaininae** Sliter, 1968
Genus *Valvulineria* Cushman, 1926

Valvulineria sp.
Pl. II, Figs. 10, 14

Remarks: Test very small (0.22-0.24 mm in diameter), trochospiral, plano-convex, with rounded periphery, composed of 2 whorls; spiral suture depressed, intercameral sutures flush with the surface. Aperture an interiomarginal, extraumbilical-umbilical arch, with an imperforate flap projecting over the umbilicus. This species differs from *V. parva* Khan in having not depressed sutures.

Family **Rosalinidae** Reiss, 1963
Genus *Gavelinopsis* Hofker, 1951

Gavelinopsis sp.
Pl. III, Figs. 1-6, 15

Remarks: Test very small (0.18-0.23 mm in diameter), trochospiral, plano-convex, periphery carinate, subcircular in outline, composed of 2.5-3 whorls; chambers crescentic with curved sutures on the spiral side and subtriangular with depressed, radial to slightly curved, sutures around the umbilical plug on the umbilical side. Aperture an interiomarginal slit.

Genus *Neoconorbina* Hofker, 1954

Neoconorbina sp.
Pl. III, Figs. 14, 18, 19

Remarks: Test small (0.28 mm in diameter), low conical trochospiral, circular in outline, periphery carinate; composed of 3 whorls; chambers crescentic on the spiral side, increasing rapidly in size as added; 4-5 chambers in the last whorl; the final chamber occupying more than one-third of the circumference; sutures flush on the spiral side; curved, slightly depressed on the umbilical side; aperture at the umbilical margin of the chamber.

Genus *Rosalina* d'Orbigny, 1826

Rosalina? iberica n. sp.
Pl. III, Figs. 7-10, 13

Holotypus: The specimen figured in Pl. III, Figs. 7-8, from the uppermost Cenomanian in the Ganuza section. Figured paratypes in Pl. III, Figs. 9-10, 13.
Derivatio nominis: Rosalina? iberica n. sp. is named after the penninsula's name, where village Ganuza, a locality in which the specimens of this species were first found, is located.
Description: Test very small (0.13-0.23 mm in diameter), trochospiral, with low to medium spire, planocovex, periphery acute; chambers crescentic with curved sutures on the spiral side, wedgelike with arcuate, depressed sutures on the umbilical side; 4-5 chambers in the last whorl; aperture a low interiomarginal arch near the periphery on the umbilical side. Specimens of this species are tentatively included to *Rosalina* because characteristic for the genus umbilical folium is not observed probably due to the bad preservation of tests.

Superfamily **CHILOSTOMELLACEA** Brady, 1881
Family **Chilostomellidae** Brady, 1881
Subfamily **Pallaimorphininae** Loeblich and Tappan, 1988
Genus *Gubkinella* Suleymanov, 1955

Gubkinella graysonensis (Tappan, 1940)
Pl. II, Fig. 12

1940 *Globigerina graysonensis* Tappan, 122, Pl. XIX, Figs. 15-17 (fide Ellis and Messina).
1972 *Globigerina graysonensis* Tappan; Gawor-Biedowa, 87-89, Pl. V, Figs. 12a-c.
1975 *Gubkinella graysonensis* (Tappan); Magniez-Jannin, 249, Pl. XIX, Figs. 23-26.

Remarks: Test very small (0.13-0.18 mm), almost globular, very low trochospiral, composed of two to three whorls. Chambers inflated and subglobular, increasing rapidly in size as added and strongly overlapping. The last whorl makes more than three fourth of the test. Sutures depressed. Aperture a low arch at the base of the final chamber, bordered with a narrow lip. Specific variability expressed mainly in the height of the spire and the shape of the test.

Family **Osangulariidae** Loeblich and Tappan, 1964
Genus *Osangularia* Brotzen, 1940

Osangularia? sp.

Remarks: Specimens with trochospiral, lenticular and biumbonate test and periphery carinate were tentatively included to *Osangularia*. Aperture obscured.

Family **Gavelinellidae** Hofker, 1956
Subfamily **Gyroidinoidinae** Saidova, 1981
Genus *Gyroidinoides* Brotzen, 1942

Gyroidinoides praestans Magniez-Jannin, 1975
Pl. II, Figs. 9, 13

1975 *Valvulineria (Gyroidinoides) praestans* Magniez-Jannin, 244-246, Pl. XVI, Figs. 32-44.

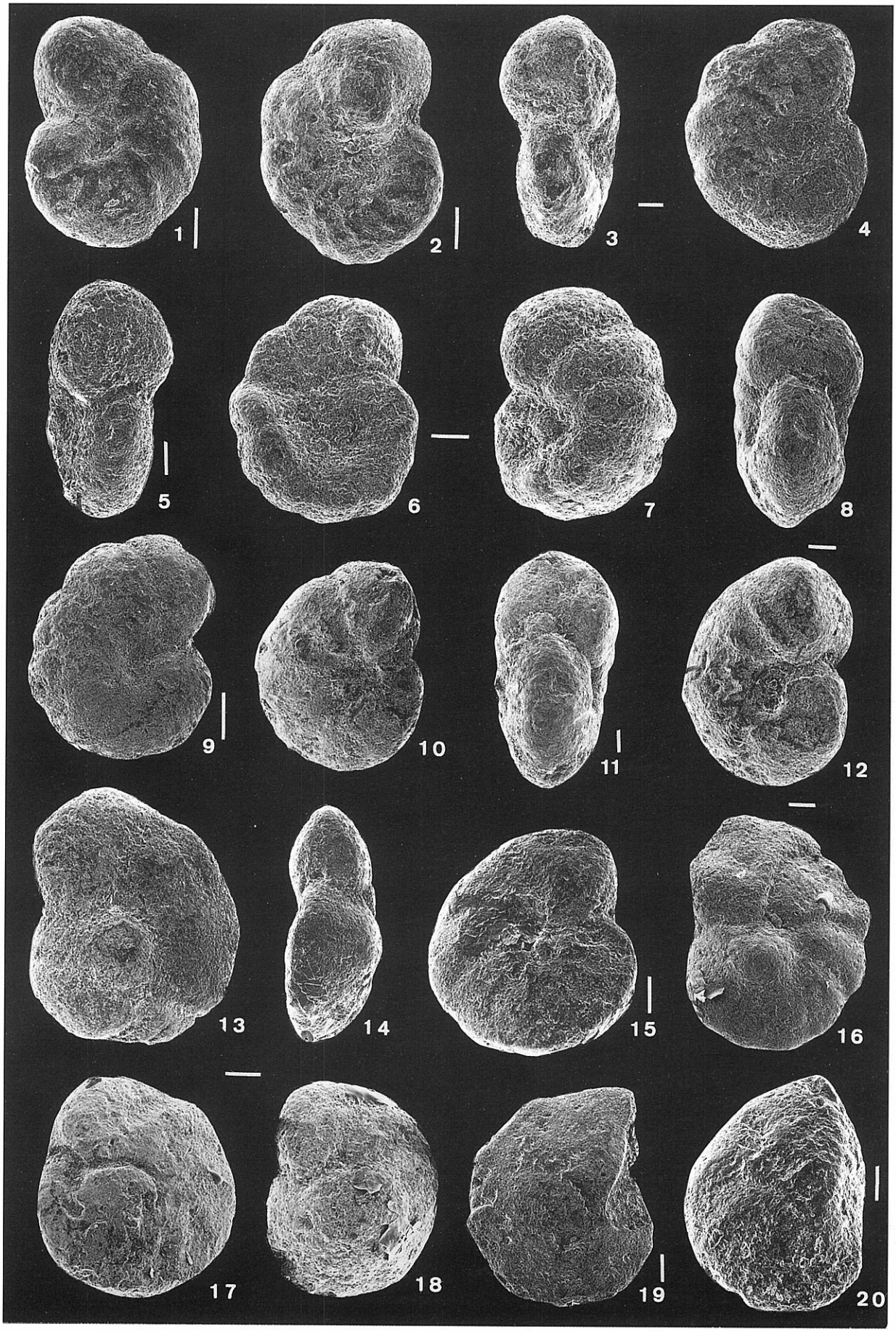
Subfamily **Gavelinellinae** Hofker, 1956
Genus *Gavelinella* Brotzen, 1942

Plate IV

1, 2 *Gavelinella baltica* Brotzen; sample G-30; the same specimen 1 x 76, 2 x 80.
3, 4 *Gavelinella baltica* Brotzen; sample G-30; the same specimen - x 90.
5 *Gavelinella baltica* Brotzen; sample G-28; x 120.
6, 7 *Gavelinella* sp., sample G-32; x 140.
8, 12 *Gavelinella intermedia* (Berthelin); sample G-30; x 100.
9 *Gavelinella intermedia* (Berthelin); sample G-33; x 85.
10, 11 *Gavelinella intermedia* (Berthelin); sample G-33; 10, x 165; 11, x 185.
13 *Gavelinella berthelini* (Keller); sample G-30; x 130.
14, 15 *Gavelinella berthelini* (Keller); sample G-30; x 130.
16 *Gavelinella berthelini* (Keller); sample G-21; x 100.
17 *Gavelinella plummerae* (Cushman); sample G-11; x 130.
18 *Gavelinella plummerae* (Cushman); sample G-11; x 130.
19 *Lenticulina rotulata* Lamarck; sample G-32; x 100.
20 *Lenticulina rotulata* Lamarck; sample G-30; x 130.

Scale bar = 50 μm (except 11 = 25 μm; 1, 2, 9 = 100 μm).

Plate IV



Gavelinella baltica Brotzen, 1942
Pl. IV, Figs. 1-5

1942 *Gavelinella baltica* Brotzen, 50-51, Pl. I, Fig. 7 (fide Ellis and Messina).
1972 *Gavelinella baltica* Brotzen; Gawor-Biedowa, 1972, 125-126, Pl. XVII, Figs. 5a-c.
1977 *Gavelinella baltica* Brotzen; Carter and Hart, 46, Pl. I, Figs. 36-38.

Remarks: This species differs from *G. intermedia* (Berthelin) in having narrower margin, less inflated chambers, more incised outline and less squat but more slender shape in the umbilical view.

Gavelinella berthelini (Keller, 1935)
Pl. IV, Figs. 13-16

1935 *Anomalina berthelini* Keller, 552-553, Pl. II, Figs. 25-26 (fide Ellis and Messina).
1991 *Gavelinella berthelini* (Keller); Tronchetti and Grosheny, Pl. V, Figs. 8-10.

Gavelinella intermedia (Berthelin, 1880)
Pl. IV, Figs. 8-12

1880 *Anomalina intermedia* Berthelin, 67-68, Pl. IV, Figs. 14a-c (fide Ellis and Messina).
1972 *Gavelinella intermedia* (Berthelin); Gawor-Biedowa, 120-122, Pl. XV, Figs. 7a-c, 8a-c, 9a-c; Text-fig. 12.
1977 *Gavelinella intermedia* (Berthelin); Carter and Hart, 48, Pl. I, Figs. 33-35.

Gavelinella plummerae (Tappan, 1944)
Pl. IV, Figs. 17, 18

1944 *Anomalina plummerae* Tappan, 124, Pl. XVIII, Figs. 15-16 (fide Ellis and Messina).
1970 *Gavelinella plummerae* (Tappan); Eicher and Worstell, 293, Pl. VI, Figs. 4a-b, 5a-c.

Remarks: Test trochospiral, semi-involute, asymmetrically biconvex, with a spiral side more convex, circular in outline; a prominent raised central boss on the spiral side obscures early whorls and early chambers of the last whorl, umbilical side flat to slightly convex, with a distinct umbilical knob; aperture interiomarginal-aequatorial, low, extending onto the ventral side. This species differs from *G. berthelini* (Keller) in having conical shape of the spiral side. It resembles *G. lodziensis* Gawor-Biedowa by its shape of test; however, a large node on the spiral side is not built from many tubercles as in *G. lodziensis* Gawor-Biedowa but is homogeneous and massive.

Gavelinella sp.
Pl. IV, Figs. 6, 7

Remarks: Test trochospiral, planoconvex to concavo-convex, with strongly convex umbilical side, periphery acutely angled from the spiral side and rounded from the umbilical side, deeply incised outline, composed of 2.5 to 3 whorls; chambers trapezoidal and almost flat on the spiral side, oval and elongated umbilically (increasing rapidly in height over the umbilicus). Sutures radial, slightly depressed on the spiral side, straight, depressed in the aboral view, radial and depressed on the umbilical side. Umbilicus narrow, empty. Aperture a low interiomarginal slit extending from near the periphery to the umbilicus. This species differs from all other species of *Gavelinella* in having umbilicoconvex not biconvex test.

Genus *Lingulogavelinella* Malapris, 1965

Lingulogavelinella ganuzensis n. sp.
Pl. V, Figs. 9-14

Holotypus: The specimen figured in Pl. V, Figs. 11-12, from the uppermost Cenomanian in the Ganuza section. Figured paratypes in Pl. V, Figs. 9-10, 13-14.
Derivatio nominis: Lingulogavelinella ganuzensis n. sp. is named after the village Ganuza, a locality in which the specimens of this species were first found.

Description and remarks: Test small, involute, only last whorl visible, asymmetrically biconvex, with dorsal side more elevated, circular in outline, periphery rounded, not incised; last whorl composed of 6-7 chambers flat and triangular on the ventral side, subconical on the dorsal side, with the most elevated part of chambers pointed and grouped closely around the axis of test in the middle of the dorsal side. Sutures slightly curved and deeply depressed on the dorsal side; on the ventral side lamellate flaps grow from the periumbilical parts of chambers and overlap, forming a characteristic starlike ornamentation in the middle of test. Aperture interiomarginal, semilunar, surrounded by a narrow lip, extending onto the ventral side and reaching under the flaps of chambers. This species differs from *L. ornatissima* (Lipnik) in having conical, elevated chambers on the dorsal side.

Lingulogavelinella globosa (Brotzen, 1945)
Pl. V, Figs. 16-20

1945 *Anomalinoides globosa* Brotzen, 58, Pl. II, Figs. 6a-c (fide Ellis and Messina).
1977 *Lingulogavelinella globosa* (Brotzen); Carter and Hart, 49, Pl. I, Figs. 12-14.

Genus *Orithostella* Eicher and Worstell, 1970

Orithostella jarzevae (Vasilenko, 1964)
Pl. V, Figs. 1-4, 6

1954 *Cibicides (Cibicides) jarzevae* Vasilenko, 121-122, Pl. XVII, Figs. 3a-c.
1961 *Anomalina (Pseudovalvulineria) jarzevae* (Vasilenko); Vasilenko, 114-115, Pl. XX, Figs. 3a-c, 4.
1977 *Lingulogavelinella jarzevae* (Vasilenko); Carter and Hart, 49-50, Pl. I, Figs. 29-30.

Orithostella sp.
Pl. V, Figs. 5, 7-8

Remarks: Test trochospiral, planoconvex, dorsal side flat, semievolute, umbilical side convex subconical; outline subcircular, periphery slightly incised, acutely angled; composed of 1.5-2 whorls, 6 chambers in the last whorl; chambers flat, triangular with curved, depressed sutures on the dorsal side; triangular and elevated separated by radial to slightly curved, depressed sutures on the umbilical side; the most elevated parts of chambers grouped around a narrow umbilicus. Aperture an interiomarginal, equatorial arch extending onto the flat side around the umbilical flap and along the preceding suture. This species differs from *O. viriola* Eicher and Worstell in having last three chambers elevated but not overhung over the umbilicus and wider umbilicus; from *O. jarzevae* (Vasilenko) in having flat but not concave spiral side, less acute periphery and less convex umbilical side.

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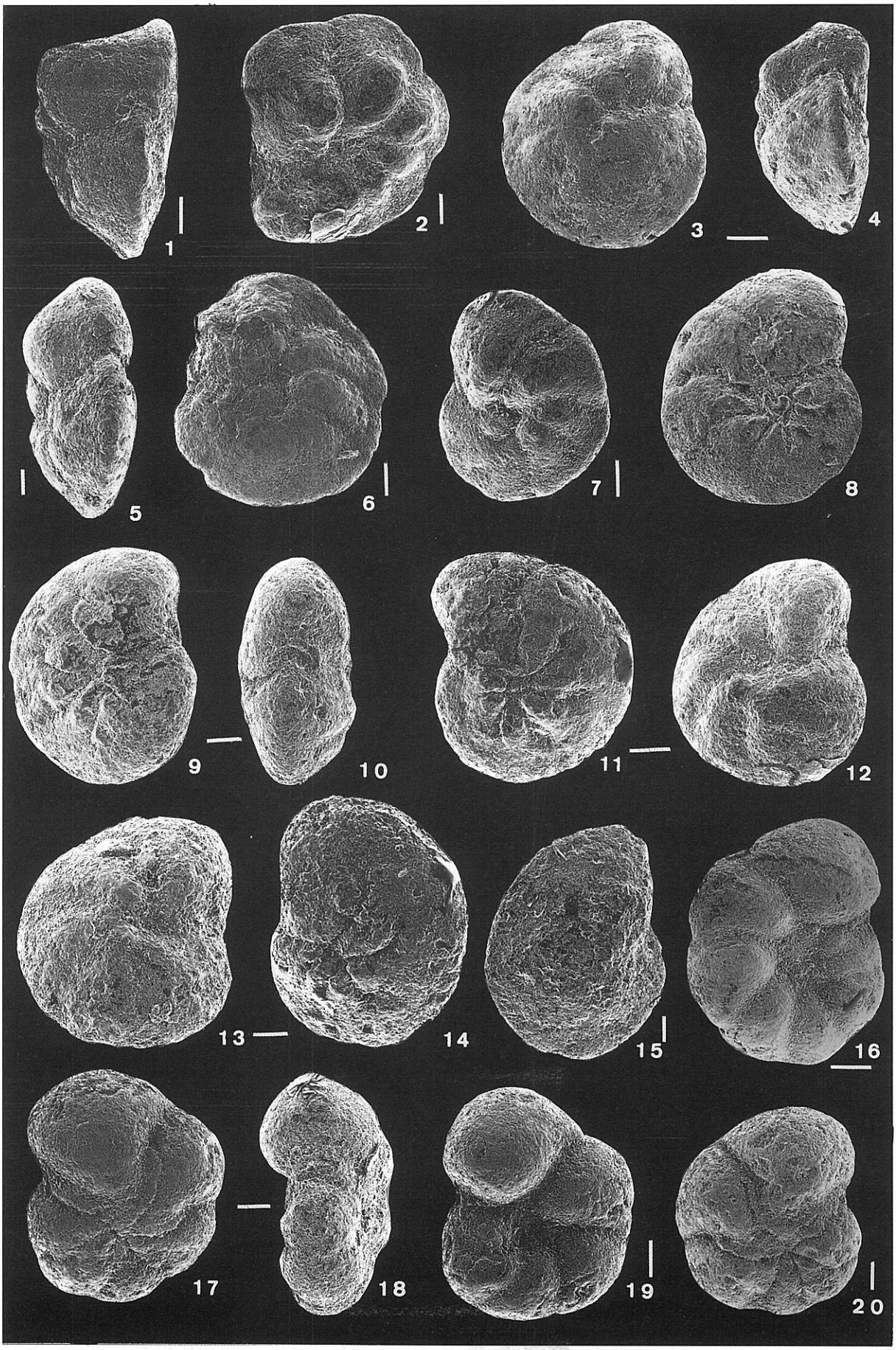
Plate V

1 *Orithostella jarzevae* (Vassilenko); sample G-25; x 135.
2 *Orithostella jarzevae* (Vassilenko); sample G-25; x 110.
3, 4 *Orithostella jarzevae* (Vassilenko); sample G-33; the same specimen - x 150.
5 *Orithostella* sp.; sample G-33; x 90.
6 *Orithostella jarzevae* (Vassilenko); sample G-33; x 115.
7, 8 *Orithostella* sp.; sample G-33; the same specimen - 7 x 126, 8 x 145.
9, 10 *Lingulogavelinella ganuzaensis* n. sp.; sample G-32; the same specimen - 5 x 133, 6 x 140.
11, 12 *Lingulogavelinella ganuzaensis* n. sp. *Holotypus;* sample G-33; the same specimen - x 155.
13, 14 *Lingulogavelinella ganuzaensis* n. sp.; sample G-33; the same specimen - x 260.
15 *Lenticulina rotulata* Lamarck; sample G-28; x 90.
16 *Lingulogavelinella globosa* (Brotzen); sample G-20; x 145.
17 *Lingulogavelinella globosa* (Brotzen); sample G-21; x 135.
18 *Lingulogavelinella globosa* (Brotzen); sample G-26; x 135.
19 *Lingulogavelinella globosa* (Brotzen); sample G-23; x 130.
20 *Lingulogavelinella globosa* (Brotzen); sample G-20; x 100.

Scale bar = 50 μm (except 13, 14 = 25 μm).

Plate V



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