

MARIETA BONJAKO*, S. PRILLO**

* Universiteti Teknologjik "I. Qemali" Vlore, Albania

** Q.K.SH.H. Fier, Albania

e-mail: lbonjako@yahoo.it

THE STRATIGRAPHIC AND PALEOECOLOGICAL SIGNIFICANCE OF BOLIVINITIDAE IN THE PLIOCENE OF SOUTH ADRIATIC BASIN

SUMMARY

The present study, which is considered as a continuation of the previous one, is based on the stratigraphic and paleoecological significance of the middle to the late Miocene Bolivinitidae of the same basin. However, in the previous study the existing Bolivinitidae dominant biofacies in many cases has been associated with distinct planktic / benthic ratio fluctuations from the latest Serravallian to Messinian in numerous sections of the Ionian area; but these fluctuations are not present in Pliocene. Only those based on the transgressive and regressive sequences can be present on two sedimentary sub-basins during Pliocene in the Ionian area of Albania. In spite of this, based on the characteristics of *Brizalina*, *Bolivina* and *Ammonia* associations here are suggested on sedimentary environments during the Pliocene.

Brizalina dilatata could have been used in Pliocene only for paleoecological purposes in the studied area. Also individual species of Bolivinitidae are stratigraphically and paleoecologically less significant than those of the late Miocene ones. The presence in Rogozhina Pliocene Formation of *Ammonia inflata* frequent biofacies followed by *Ammonia beccarii* dominant in Lushnja and Rogozhina sections as in late Miocene indicate for (account for?) the replacement nearly the same paleoenvironments by the end of Pliocene particularly for the both above-mentioned sections. In the main part of Mediterranean basin the Miocene sediments, which in most of cases don't have marine faunas, terminate with "lagomare" biofacies. The Pliocene or entire Neogene sediments, which are found nearly everywhere in the Ionian area, terminate with coarse clastic material of Astian facies (now Rogozhina Formation), which in most of cases are devoid of fossils.

INTRODUCTION

PRILLO and HASANAJ (1994-95) based the study on the re-examination of foraminifers of sampled sections by DALIPI *et al.* (1974), and on the study of Pliocene foraminifers of the sampled sections. Also here are taken into consideration all the conclusions obtained from the previous work which has the same title for middle and late Miocene PRILLO and KUMATI (1996). In both works the benthic foraminifera especially occurred Bolivinitidae qualitatively and quantitatively have been studied in order to evaluate their stratigraphic and palaeoecological significance. Also based on these analyses the graphical representation of the Bolivinitidae, the stratigraphic distribution and their frequency in percentage are given in every studied section.

Pliocene sediments of the entire Ionian zone of Albania are characterized by few variations in their lithologic composition. Since 1974 Helmsi and Rrogzhina Formation respectively were used instead of Piancensian and Astian facies (DALIPI *et al.*, 1974).

Helmsi Formation: was named after the Helmsi village in Kavaja type section. This formation, which is found everywhere in the Ionian zone of Albania, is represented by the un-stratified blue-grey clays. Rare thin sandstone layers may be found only at its end.

Its maximum thickness is 1900m in Kavaja section and is about 1500m in Rrogzhina section. The only one available for the application of Mediterranean planktic foraminiferal zonation is Helmsi Pliocene Formation. Thus, in the studied region the lowest levels of Helmsi which frequently contain *Globorotalia puncticulata* (Deshayes) are exposed in Kavaja and in Durres. In Durres, where the erosion by shallow Quaternary transgression is well-documented, its youngest levels are studied in Qe-2. In Kavaja and in the other studied sections the Helmsi Fm passes gradually in the overlying Rrogzhina Formation, which is not available for plankton study.

Planktonic zones of Helmsi formation used in this study

Without and with *Sphaeroidinellopsis* Zone

Definition: Interval zone from first appearance of permanent open marine conditions after late Miocene salinity crisis to the entry level of *G. margaritae* Bolli & Bermudez. The interval contains relatively a large number of *Orbulina universa* and both of *O. universa*, and *Sphaeroidinellopsis*.

Remarks: Till now this interval zone has been considered as *Sphaeroidinellopsis* Acme zone in our studies on Pliocene biostratigraphy. In fact, frequent presence of *Sphaeroidinellopsis* which takes about 2 per cent of total plankton as in Lushnja, Rrogzhina and Durres is found in most of the surface Pliocene section carried

out in Ionian area. In Kavaja section this interval zone can be divided into two parts:

1. **An early part without *Sphaeroidinellopsis***, where *Orbulina*, *Globigerinoides*, *Globigerina* and *Globorotalia* (in smaller than 0.250 mm size fraction) frequently occur.

2. **A late part**, where in addition of above-mentioned genera also *Sphaeroidinellopsis* frequently occur.

Within this interval *Brizalina* and *Bolivina* are represented by the rare occurrence of *Bolivina antiqua* d'Orbigny, *B. praeplacentina* Prillo, *B. retiformis* Cushman and *Brizalina dilatata* (typical).

***Globorotalia margaritae* Zone**

Definition: Interval-zone from the first appearance of *G. margaritae* to first appearance of *G. puncticulata*.

Remarks: Only in Durres section there is an abundance of *G. margaritae* (sample 27) due to the entry level of it. Also bathyal species of Bolivinitidae as *Bolivina antiqua*, *B. retiformis* and *Brizalina dilatata* (typical) occur only in this zone of Durres. In Lushnja and in Rrogozhina sections the uppermost part of the zone seems to be non-documented thanks to its passage into shallow Rrogozhina Formation.

***Globorotalia puncticulata*-*G. margaritae* Zone**

Definition: Competitive range interval from first appearance of *G. puncticulata* to last appearance of *G. margaritae*.

Remarks: Rare *Globoquadrina altispira altispira* (Cushman and Jarvis) are present at the end of this zone in Durres. Also in the same area of this section benthonic forams (including here also Bolivinitidae) are continuous just the same as in the previous zone.

***Globorotalia puncticulata* Zone**

Definition: Interval-zone from last occurrence of *G. margaritae* to last occurrence of *G. puncticulata*.

Remarks: The upper boundary of this zone is not given after its authors Iaccarino and Salvatorini, (1982) because neither *G. aemiliana* Colalongo & Sartoni nor *G. bononiensis* Dondi occur in our Pliocene sections. Only *G. puncticulata* is sections continuously found in Durres and Divjaka where the zone is documented. The *G. puncticulata* Zone seems to be more complete in Divjaka section (Fig. 1) because the sporadically finding of *G. aemiliana* in its uppermost levels was reported by Prillo and Hasanaj 1998. Its gradual passage was reported into shallow Rrogozhina Fm.

Rrogozhina Formation: was named after Rrogozhina town in Rrogozhina type section. Everywhere the Helmesi Fm underlies Basin of Albania in the south of Adriatic. Lithology mainly consists of thick sandstone and conglomerates

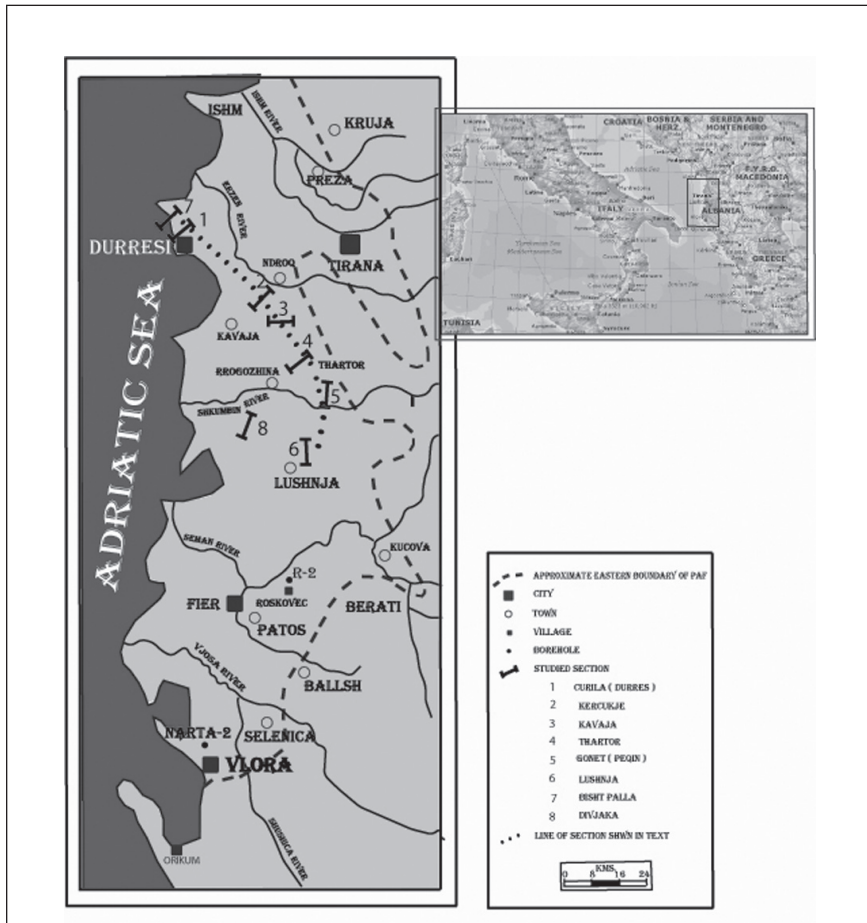


Fig. 1 - Location map.

alternated with rare unstratified blue-gray clays often containing brackish water fossils such as *Cyprideis* and representative of *Ammonia* genus. Locally sandstone and conglomerates wadge out rapidly. The upper-most part of formation is mainly composed of coarse clastic materials. Its total maximum thickness is in Rrogozhina type-section which reaches 950 m, whereas in Lushnja section reaches about 700 m.

Age: This formation is devoid of any local marker species apart from the presence of *Ammonia inflata* (Seguenza), *A. beccarii pinuseptata* Myatlyuk (MYATUK, 1960) in its lower part, which can be used to distinguish this Pliocene formation from those of late Miocene contains only *A. inflata* (without *A. pinuseptata*). This last subspecies occurs since the preceding Pliocene Helmsi Fm. Also the age of the formation could be determined according to the age of the underlying Helms

Formation. Thus, in Lushnja and Rrogozhina sections its age is not older than *G. margaritae* Zone, while in Kavaja and Divjaka its age is not older than *G. puncticulata* underlying Zone. Thus, the age of the Rrogozhina Fm. in Albania varies from section to section due to its migration or its regressive cycle from south eastern part of the study area (Lushnja section) overlying *Margaritae* Zone towards north western part of the area (Durrresi section), overlying *G. puncticulata* Zone.

Such a gradual migration of Rrogozhina Fm, evolves in the *Ammonia beccarii* Acme Zone which represents the lower part of Rrogozhina Fm, not only within the studied area, but also in the S of Vlora region, or in the SE part of the studied area (BONJAKO, 2005) in Kucova region. The contrary of this migration is the migration of the *Ammonia beccarii* Acme Zone in the previous study on Miocene Bolivinitidae (PRILLO and KUMATI, 1996). In the latter the studied area is the same. In its southern part in south of the Lushnja section and SE and to E of this section, are studied here mainly Serravallian and Tortonian sediments, which seem to originate from Paratethys realm. Thus according to this study, the *Ammonia beccarii* Acme Zone named as *Ammonia beccarii* dominant biofacies overlying late Tortonian age, there is a sudden or a great vertical migration which becomes again a gradual migration within the studied area. Therefore this study is concluded with the presence of two different sedimentary basins, since the Serravallian age

Stratigraphic distribution of Bolivinitidae

In Pliocene sediments of the studied region have been found *Bolivina* and *Brizalina* species not so much and no more significant than late Miocene. Thus, species like *Bolivina placentina* Zanmatti, *Brizalina aenaeriensis* Costa, *B. alata* (Seguenza) are useful only in distinguishing the Pliocene age from the Miocene age. *Bolivina antiqua*, *B. placentina* and *B. praeplacentina* can be used to distinguish the early Pliocene from the middle Pliocene.

The palaeoecology of occurred Bolivinitidae during middle and late Miocene was discussed by PRILLO and KUMATI (1996) where also are included, *Bolivina antiqua*, *Bolivina praeplacentina*, *B. retiformis* and *Brizalina* like *B. dilatata*, *B. dilatata* (typical) and *B. spathulata* which continue to occur in Pliocene. In the previous study much attention has been paid to the nature of the Bolivinitidae assemblages, such as species frequency, species diversity and species dominances. These characteristics of benthic assemblages during late Miocene have been very significant for palaeoecological and stratigraphical interpretations. Their study in Pliocene displays other characteristics of their assemblage being so less significant than in late Miocene. Thus, in Pliocene it is impossible to establish the continuity of the frequency of Bolivinitidae species, while there seem to be lack of species dominance or a slight dominance. Based on the data given by Prillo and Kumati (1996); PRILLO and HASANAJ (1998) and on Bolivinitidae ecology in Mediterranean and Adriatic Sea which are covered by such works as those of

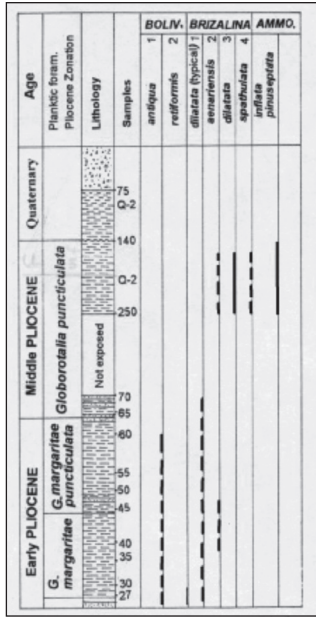


Fig. 2 - The stratigraphic distribution of Bolivina, Brizalina and Ammonia species in Durres section.

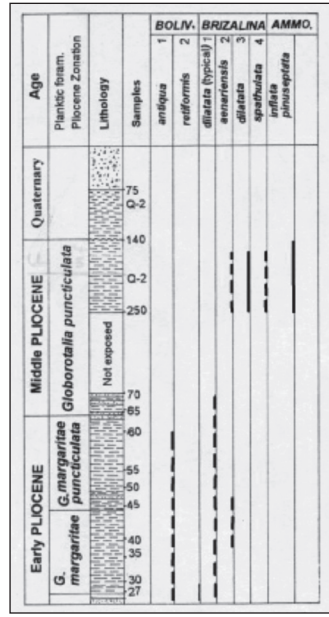


Fig. 3 - The stratigraphic distribution of Bolivina, Brizalina and Ammonia species in Durres section.

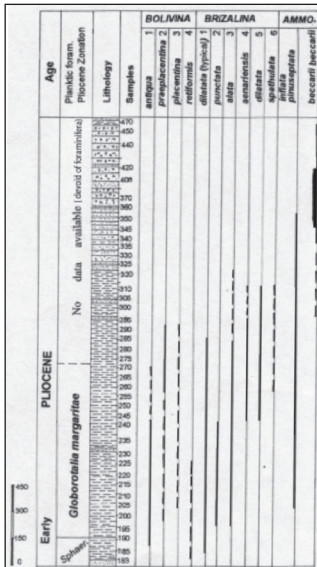


Fig. 4 - The stratigraphic distribution of Bolivina, Brizalina and Ammonia species in Rogozhina (Thartor) section.



Fig. 5 - The stratigraphic distribution of Bolivina, Brizalina and Ammonia species in Lushnje section.

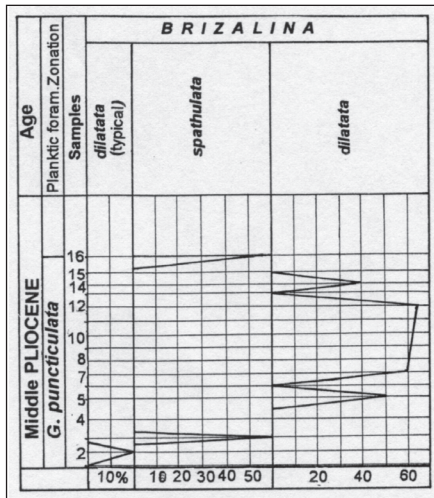


Fig. 6 - The percentages of Bolivinitidae specimens among the total benthic forams in samples of Divjaka section.

species among others *Ammonia inflata*, *Valvulineria bradyana*, *Brizalina dilatata* etc.). On the contrary, in Durres-Qeret section (on north of Kavaja) during entire early and lower-middle Pliocene only deep-water assemblages without any benthic neritic forams occur (fig. 2, 7). In addition to this, starting from location of the section towards the East as far as Preza region, Pliocene sediments are becoming younger and deeper contrary to all other southern Pliocene section. Thus, probably the Kavaja section represents a transition between two Pliocene sub-basins.

Pliocene individual species like *Brizalina aenariensis*, *B. alata* have been found in assemblages characterizing bathyal to outer neritic environments and more probably by prodeltaic facies BRUN *et al.* (1984). Only in Helmes Formation of Lushnja and Rogozhina section *Brizalina punctata* (d'Orbigny) occurs. This species has rarely been found since the middle Miocene. Its habitat may be bathyal and shallow near river estuary (refer-

CHERICI *et al.* (1962); JORISSEN (1988), CIMERMAN and LANGER (1991) and on the present study results, in Divjaka, Durres-Qeret and Lushnja sections (fig. 6, 7 and 10), it could distinctly be observed the occurrence replacement of *B. dilatata* (typical, stout-test) by *B. dilatata* (slender-test) reflecting in this way the replacement of a bathyal paleodepth by a neritic one respectively. Only in Kavaja section the both morphological variations of *B. dilatata* during nearly entire early Pliocene occur together. A detailed study of planktonic and benthic forams of Kavaja (PRILLO and HASANAJ, 1998). BONJAKO (2005) indicated for a periodic replacement of deep water assemblages by neritic ones (containing

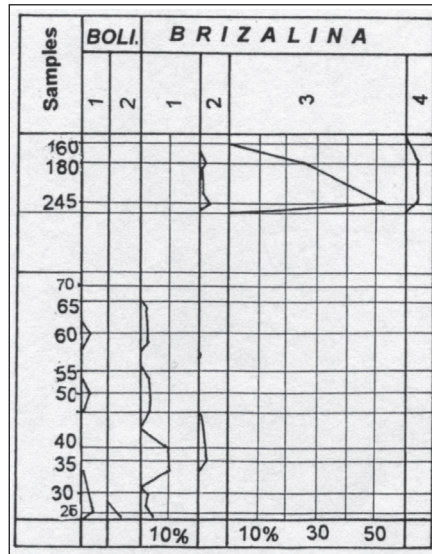


Fig. 7 - The percentages of Bolivinitidae specimens among the total benthic forams in samples of Durres.

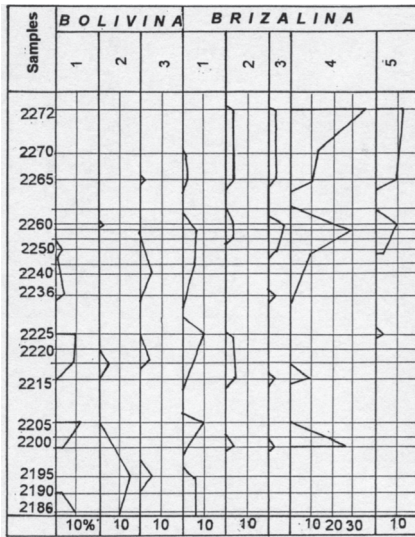


Fig. 8 - The percentages of Bolivinitidae specimens among the total benthic forams in samples of Kavaja section.

ring RAUZER CHERNOUSOVA *et al.*, 1959).

By the end of the Helmes Formation and during the lower part of Rogozhina one can establish almost the same *Ammonia inflata* frequent biofacies as in late Miocene PRILLO and KUMATI (1996). This analogy in replacement nearly the same palaeoecological conditions in late Miocene and Pliocene, which are very distinct in Lushnja and Rogozhina section. Moreover in the both sections as in younger levels of late Miocene and in younger levels of Pliocene

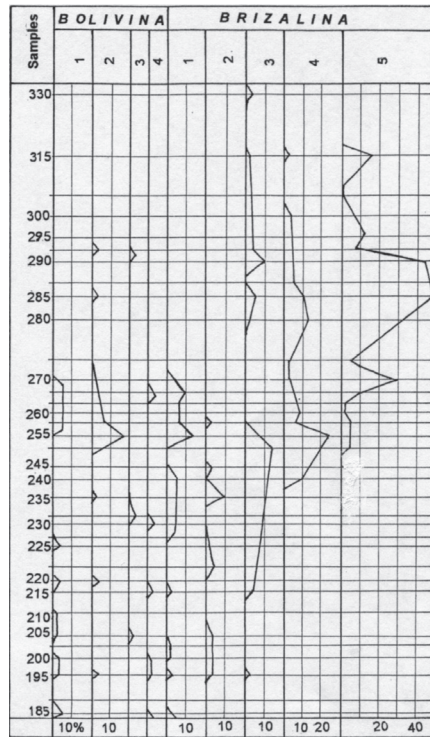


Fig. 9 - The percentages of Bolivinitidae specimens among the total benthic forams in samples of Rogozhina section.

(Rogozhina Fm.) was established *A. beccarii* dominant biofacies and indicating in this way similar shallow brackish water environment placed at different geological age.

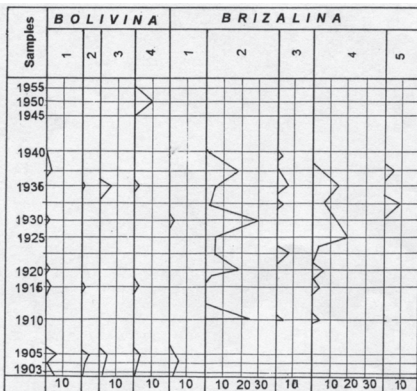


Fig. 10 - The percentages of Bolivinitidae specimens among the total benthic forams in samples of Lushnje section.

CONCLUSIONS

The basic Pliocene transgression made possible for the deeper parts of the sedimentary Pliocene basin to be filled up with fine coarse grained materials of an early part without Sphaeroidinellopsis, which is rich in planctonic foraminifers such as representatives of *Orbulina*, *Globigerinoides*, *Globigerina*, and *Globorotalia* genera. On the other hand, the gradual migration of the Rrogozhina formation its evolved *Ammonia beccarii* Acme Zone within the overall south Adriatic basin where this formation occurs, suggest the presence of the sole sedimentary basin during the Pliocene age. The main direction of Rrogozhina Pliocene Formation's regression is from S and SE towards NW part of the south Adriatic basin in Albania.

REFERENCES

- BONJAKO M., 2005 - Paleogeografia, Paleoekologjia dhe Paleoklimatologjia e Ultësirës Pranë Adriatike dhe në veçanti e Rajonit Vlorë-Panaja. Universiteti Politeknik i Tiranës.
- BRUN L., CHERICI M. & MAJER M., 1984 - Evolution and morphological variations of the principal species of Bolivinitidae in the Tertiary of the Gulf of Guinea. *Geologie Mediterranee*, v.11, no.-1, pp.13-57.
- CHERICI M. A., BUSI M.T. & CITA M. B., 1962 - Contributin a une etude ecologique des foraminiferes dans la mer Adriatique. *Revue de micropaléontologie*. 5 no.-2, pp.123-142.
- CIMERMAN F. & LANGER M.R., 1991 - Mediterranean Foraminifera. Razred za naravoslovne vede, classis IV: historia naturalis, opera 30, pp.1-118, pls.1-93. Slovenska Akademia, Ljubljana.
- DALIPI H., NASTO TH., DALIPI V., PRILLO S., 1974 -Stratigrafia e paleogeografia e depozitimeve te Miocenit mesem, Miocenit te siperm e Pliocenit ne U.P.A. Fondi i Institutit te Naftes Fier.
- IACCARINO S., SALVATORINI G., 1982 - A frame work of planctonic foraminiferal biostratigraphy for Early Miocene to late Pliocene Mediterranean area. *Paleontol. Stratigr. Evol.*, 2, 115-125.
- IACCARINO S., 1985 -Mediterranean Miocene and Pliocene planktic foraminifera Plankton Stratigraphy. *Cambridge University Press*. pp. 283-314.
- JORISSEN P. J., 1988 - Benthic foraminifera from the Adriatic Sea; Principles of phenotypic variation. *Utrecht Microp. Bull.* no.37, pp. 5-174.
- MYATLYUK E. V., 1960 - Microfauna njeftyanh miestorozhdorozhdeniyu in Albania. Fondi ING. Tirane.
- PRILLO S. & HASANAJ L., 1994 - Projekti i temes se Pliocenit. Fondi i Institutit Naftes Fier.
- PRILLO S. & KUMATI LL., 1996 - The stratigraphic and paleoecological significance of the Bolivinitidae from the Serravallian to Pliocene sediments of Durres-Lushnja area. (*unpublished*).
- PRILLO S., HASANAJ L., 1998 - Interpretime paleoekologjike te foraminifereve te Pliocenit ne UPA. ING. Fier.
- RAUZER CHERNOUSOVA D. M. & FURSENKO A. V., 1959 - Osnovy paleontologii. Obshchaya chast prosteyshie: Akad. Nauk SSSR, 1-363, pl. 1-13, text-fig. 1-894. (Principles of Paleontology, Part I, Protozoa).

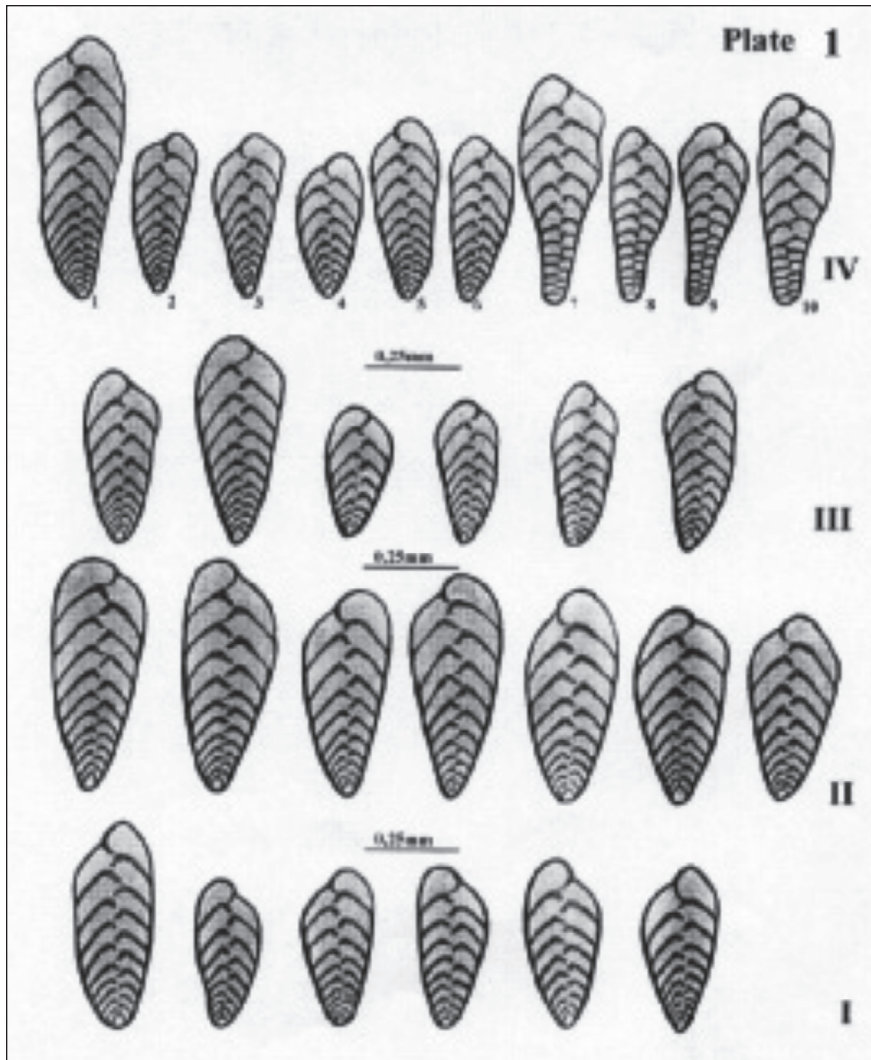


PLATE 1

Variation scales of *Bolivina praeplacentina* to *B. placentina* in different open marine environments of PAF (Peri-Adriatic Foredeep):

- I** - *B. praeplacentina* of the bathyal depth of the Late Serravallian. Ballshi- 2, 7m.
- II** - *B. praeplacentina* of the neritic depth of the Messinian, *G. conomiozea* Zone, Kavaja section 1974, sample 2053.
- III** - *B. praeplacentina* of the bathyal depth of the Early Pliocene Kavaja section 1974, sample 2194.
- IV** - From fig. 1 to fig. 6. *B. praeplacentina*, from 7 to 10. *B. placentina* of the bathyal depth of Early Pliocene Radhima section, sample 50.

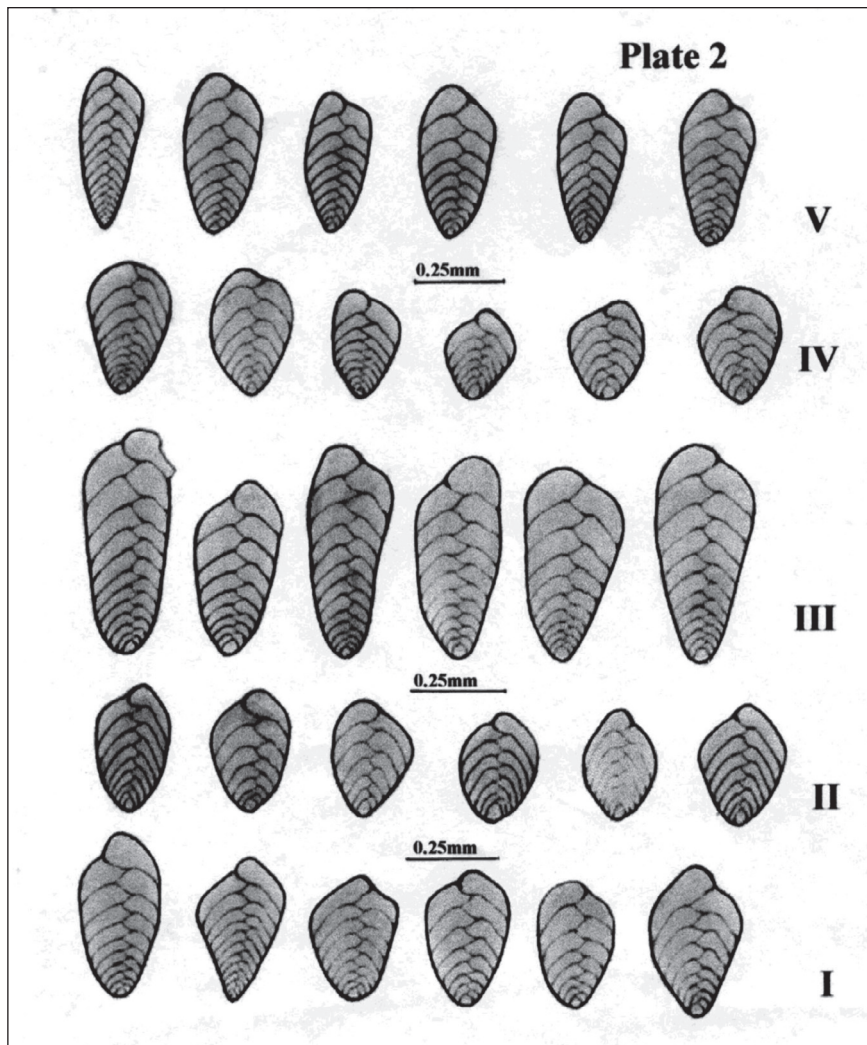


PLATE 2

Morphological variations of *Brizalina dilatata* group during different closed and open marine environments from the Late Serravallian to Middle Pliocene:

I - *Brizalina dilatata* (typical) of the closed basin of bathyal depth, Ros-2/s, 455. Late Serravallian.

II - *Br. dilatata* of the closed basin of bathyal depth, Thartor section 1984, sample 32. Tortonian.

III - *Br. dilatata* (*sensu* CIMERMAN and LANGE, 1991) of neritic depth, Thartor section 1974, sample 287. Pliocene.

IV - *Brizalina dilatata* (typical) of the open marine of bathyal depth. Divjaka section 1994, sample 2. Middle Pliocene.

V - *Brizalina catanensis* of the outer neritic depth. Divjaka section 1994, sample 5, Middle Pliocene.

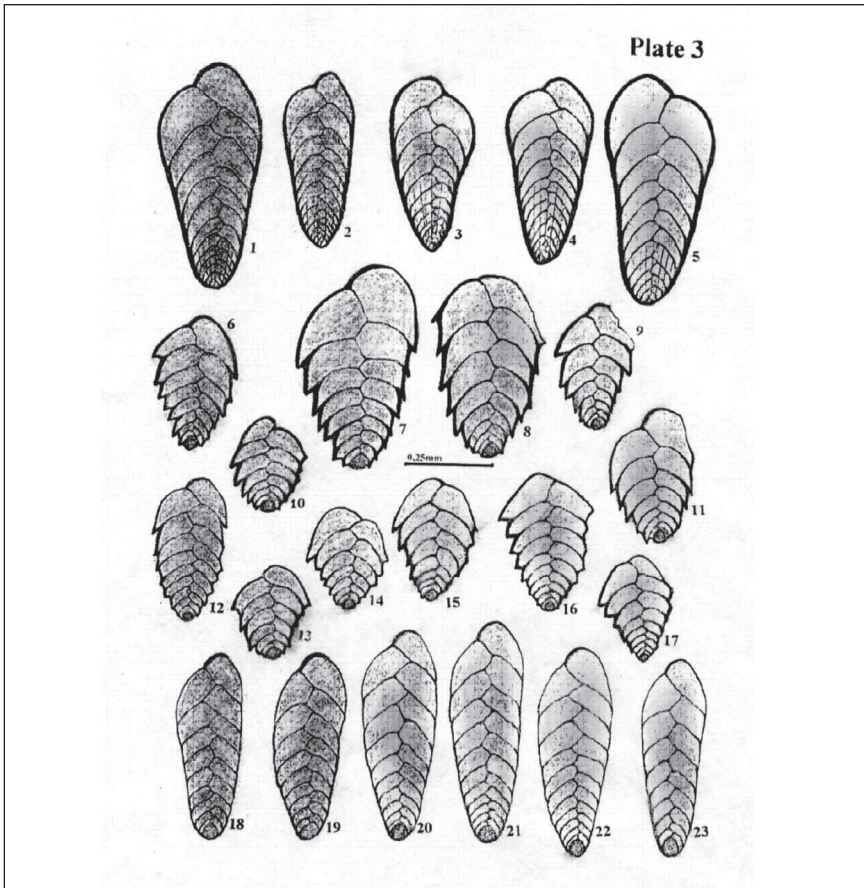


PLATE 3

Morphological variations of *Brizalina* genus in Pliocene sediments of PAF (Peri-Adriatic Foredeep).

Fig. 1, 3-5. *Brizalina aenariensis* Costa,- Middle Pliocene, Kavaja section 1974, sample 2272. Bathyal or delta slope environment.

Fig. 2. *B. aenariensis*, Early Pliocene. Rrogozhina section 1974, sample 244. Delta slope to prodeltaic environment.

Fig. 6 to 17. Morphological variations of *Brizalina alata* (Seguenza) which could be related with biotope bathymetry.

Fig. 6, 10, 15, 16, 17. *Brizalina alata* - Early Pliocene, Ros-4/s borehole 50m, Deltaic slope.

Fig. 7-8. *Br. alata*.- Early Pliocene, Rrogozhia section 1974, sample 269. Prodeltatic environment to shallow.

Fig. 9-11. *Br. alata* - Early Pliocene., Fier- Shegan- 2, 100 m, Prodeltatic environment.

Fig. 12, 14. *Br. alata*.- Early Pliocene, Penkova outcrop, Prodeltatic environment.

Fig. 18, 20, 23. *Brizalina punctata* (d'Orb.) - Early Pliocene, Fier-Shegan 2, 100m and Roms- 2, 70m. Prodeltatic environment.

Fig. 19, 21-22. *Brizalina punctata*, Early Pliocene, Lushnja section 1974, sample 1936. Prodeltatic environment. P