| GEOL. CROAT. | 50/2 | 215 - 223 | 3 Figs. | 1 Tab. | 2 Pls. | ZAGREB 1997 |
|---|---|---|---|---|---|---|

# Alveolinas From the Bunić Section (Lika, Croatia)

Katica **DROBNE**[1] and Mladen **TRUTIN**[2]

**Key words:** *Alveolina*, *A. histrica*, *A. rakoveci*, Palaeobiogeography, Biostratigraphic correlation, Cuisian, Adriatic carbonate platform, Bunić, Croatia, Golež, Slovenia, Hrgud, Herzegovina.

**Abstract**

The Bunić section of Palaeogene carbonates is exposed in a tectonic window through the Dinaric tectonic units in the Kozjak valley in the central part of the Lika region (Croatia). The Lower Eocene limestones in this section yielded *Alveolina histrica septentrionalis* and *A. rakoveci*. These two species characterize a particular facies of shallow water deposits during Middle to Late Cuisian times, as observed at Golež and Voz on the north-western margin of the Adriatic and also at Lištica and Hrgud in Herzegovina. This is in contrast to Alveolina assemblages of the same age composed of *A. levantina*, *Periloculina dalmatina*, *Coskinolina liburnica*, which characterize the shallow transgressive deposits of the coastal and insular regions in particular at the Pićan and Benkovac sections.

The Bunić Alveolina assemblage indicates that the limestones in the tectonic window formed part of the sedimentary realm representing the north-eastern margin of the Adriatic platform. This also supports Herak's tectonic model by distinguishing two tectonically superimposed carbonate platforms, the *Dinaricum* and the *Adriaticum*, separated by an interplatform basin called the *Epiadriaticum*.

## 1. INTRODUCTION

In central Lika (Croatia) the Palaeogene strata crop out over a very restricted area (Fig. 1). The largest occurrence of Eocene limestone and flysch is located between Bunić and Čanak villages, 23 km south of the Plitvice Lakes. The rudist limestones of the Upper Cretaceous are surrounded by tectonic contacts. For a few metres only, the original transgressive contact between the rudist limestones and the overlying Palaeogene carbonates has been observed by M. Šparica (POLŠAK et al., 1978; ŠPARICA, 1978).

These outcrops of Palaeogene strata initiated two hypotheses to explain their origin, either as erosional remnants of a palaeostructural syncline, limited partly by faults (ŠPARICA, 1978, p. 292, Pl. 1) or Eocene windows belonging to the subjacent unit of the Adriatic carbonate platform (*Adriaticum*) covered by the Dinaric carbonate platform (*Dinaricum*) (HERAK, 1986).

The schematical cross-section given in Fig. 1 corresponds to the former interpretation. In between the *Adriaticum* and *Dinaricum* platforms, Herak recognize an interplatform sedimentary belt, named *Epiadriaticum*, extending from NW Slovenia to Montenegro (Fig. 3 and HERAK, 1985, 1987, 1989, 1991, 1993).

Untill 1985 investigations were carried out within the frame of the project entitled "Palaeogene Foraminifera of Carbonate Development", organized by INA-Naftaplin. Researchers from Zagreb and Ljubljana cooperated with this and the Bunić locality was included in these studies. Among the foraminifera the *Alveolina* species were studied in more detail than other species. Selected species of the genus *Alveolina* were used for biostratigraphic correlation of the contemporaneous sections along the Adriatic coast and for comparison with the Bunić fauna (DROBNE, 1977; DROBNE et al., in press).

The aim of this paper is to present the nature and the probable causes of the faunistic similarities in the Alveolina associations from Bunić and the Adriatic platform.

## 2. THE BUNIĆ SECTION

The Palaeogene strata crop out over a distance of 10 km along the very narrow Kozjan valley. The belt of limestone is not continuous. Flysch sediments are visible for less than 1 km along the road (Fig. 1). The Bunić-Kozjan section (I-9-J) with the collected samples Bu-Ko from 11 to 4 is located on the southwestern slope of the valley, approximately southeast of Čanak village. The samples Bu-Ko 64-67 were taken from the bottom of the valley below, in front of the main section (Fig. 2a).

The base of the logged section is marked by the rudist limestones of Senonian age at an altitude of 965 m. Probably, there is a tectonic contact between the Senonian and Eocene strata. The total length of the outcropping section amounts approximately to 400 m, and the thickness of the alveolina-nummulite limestone to 120

[1] I.Rakovec Institute of Palaeontology ZRC SAZU, Gosposka 13, SLO-1000 Ljubljana, Slovenia.

[2] INA-Consulting, Savska 88a, HR-10000 Zagreb, Croatia.

**This paper was presented at the scientific meeting dedicated to the 80th anniversary of the life of Professor Milan Herak, held on March 5th, 1997 in Zagreb**

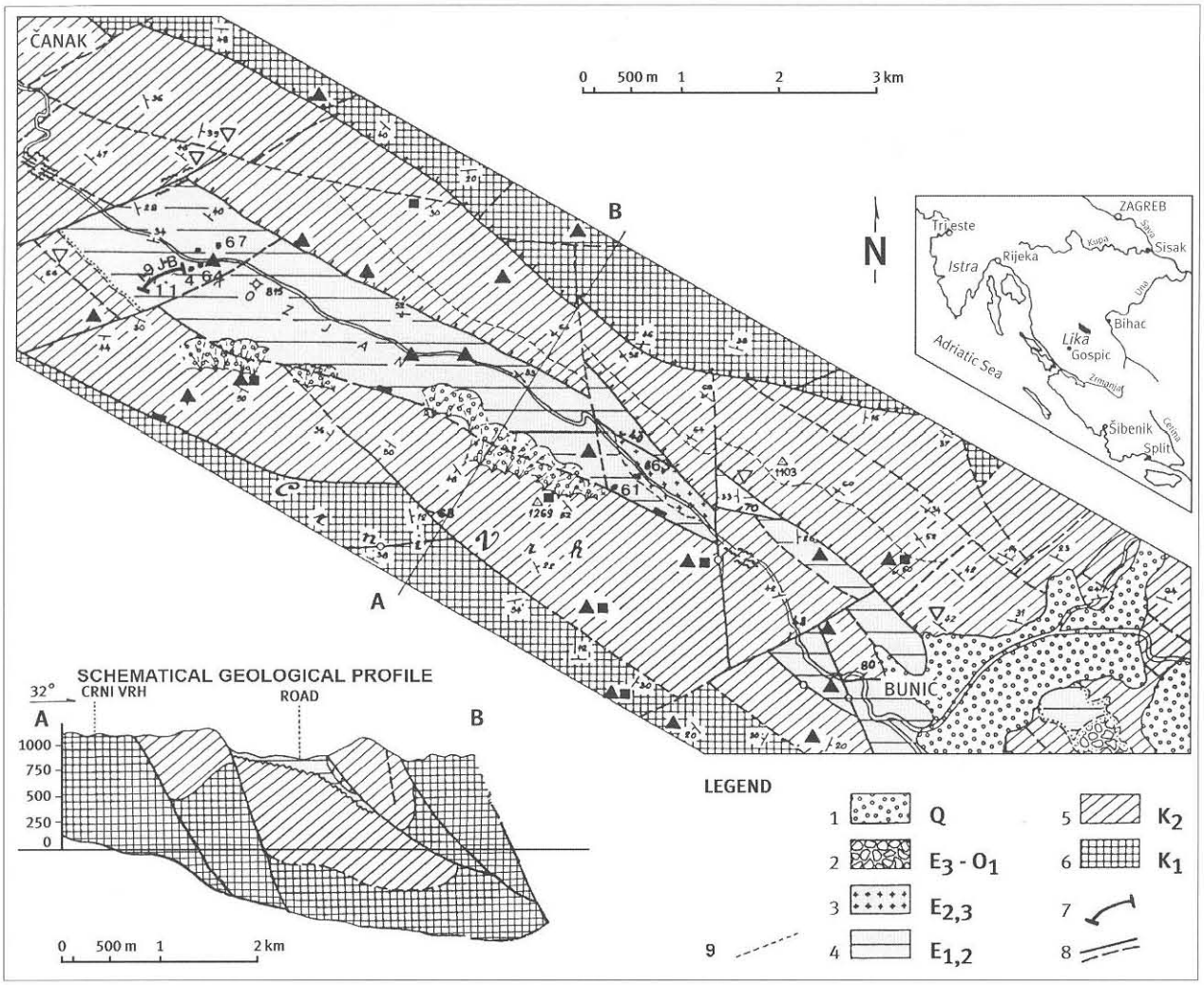



Fig. 1 Location and geological map of the study area (modified after ŠPARICA, 1978, tab. 1). Legend: 1) Quaternary; 2) Upper Eocene/Lower Oligocene - breccias; 3) Middle and Upper Eocene - marls, rarely sandstones; 4) Lower Eocene - limestone with larger foraminifera; 5) Upper Cretaceous - limestones, dolomites; 6) Lower Cretaceous and Upper Jurassic, on the map only Lower Cretaceous; 7) position of Bunić section (I-9-J); 8) tectonic lines; 9) transgressive contact Cretaceous/Palaeogene considered by ŠPARICA (1978).

m. The logged section ends at sample Bu-Ko 4 (Figs. 2a, 2b) where the section is interrupted by a fault (Fig. 2b). The inclination of strata varies from 30-45°, and their strike is in NNE direction. The beds are in inverse position, and are partially folded.

The limestone is tectonized and cut by calcitic veins. Due to the dense vegetation the succession of layers can not be easily observed. Beds of 30-70 cm thickness prevail, alternating with rare, thicker beds of 1.0-1.5 m.

In the sequence packstones to wackstones are dominant. The foraminifera are poorly preserved, their shells, regenerated during life, were broken by post-diagenetic microtectonic events (Plate I).

## 3. ALVEOLINA FROM THE BUNIĆ SECTION

The study of the *Alveolina* species is based on 8 samples from the main sequence of the Bunić - Kozjan (I-9-J) section and on 7 samples from isolated localities (Figs. 2a and 2b).

The oriented sections of *Alveolina* represent 14 species (Tab. 1). This indicates a Middle Cuisian age in the lower and middle part of the section, and Upper Cuisian age in the uppermost beds only (Fig. 2b; Pl. I, II). There are Tethyan species represented by *A. cremae* CHECCHIA-RISPOLI, *A. schwageri* CHECCHIA-RISPOLI, *A.* aff. *canavarii* CHECCHIA-RISPOLI, *A. ruetimeyeri* HOTTINGER, *A. rectiangula* DROBNE and others. They have a broad geographical distribution in the Mediterranean, in both carbonate and clastic deposits (CHECCHIA-RISPOLI, 1905; HOTTINGER, 1960; Di SCOTTO, 1966). The appearance of species belonging to the phylogenetic lineage of *Alveolina histrica* is of particular significance. They were first described in SW Slovenia in the Kozina, Slavec and Golež sections under the specific designation: *A. histrica histrica* DROBNE and *A. h. septentrionalis* DROBNE from the Middle Cuisian, as well as *A. rakoveci*

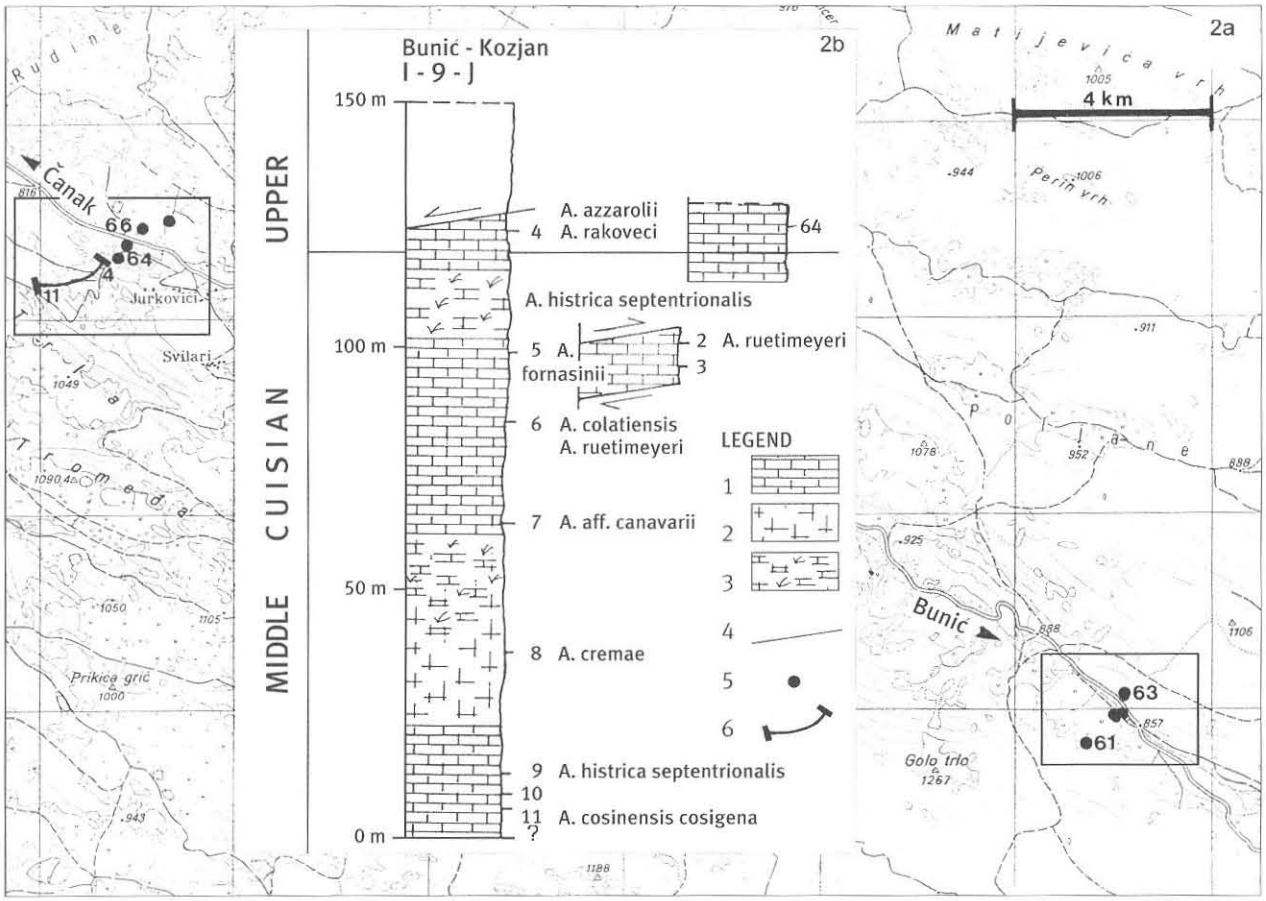



Fig. 2 a) Topographical map showing the position of the Bunić section and isolated points (Bu-Ko 61-67). b) Stratigraphic column of the Bunić logged section, lithology and main species of *Alveolina* (after DROBNE et al., in press). Legend: 1) limestone; 2) micritic limestone; 3) weakly bedded limestone; 4) tectonic line; 5) isolated point; 6) section line.

DROBNE from the Upper Cuisian. Members of this lineage also occur on the Island of Krk, on the northern Voz promontory (DROBNE, 1977, 93-95, 78, 111). In the Eocene limestone extending from Ćićarija to Trieste, a perfectly preserved assemblage with *A. rakoveci,* was discovered at the Rosandra panorama viewpoint at the Slovenian-Italian border (personal data). North of the Karavanke Mts. in the Ivartnik section, the presence of a few *A. h. histrica* specimens was recorded by DROBNE et al. (1977, Tab.1, Pl. 1, Figs. 5-7). This locality belongs to a particular tectonic domain (Fig. 3), the so-called Dinaric-Alpidic complex of HERAK (1991).

In Herzegovina, the species from the *A. histrica* lineage were also found in the Lištica section (personal data), and on Mt. Hrgud above the historical city of Stone (DROBNE et al., in press).

## 4. PALAEOGEOGRAPHIC DISTRIBUTION OF SPECIES BELONGING TO THE *A. histrica* LINEAGE

All occurrences (except Ivartnik, Tab. 1) which yield representatives of the phylum *A. histrica* are located within a narrow restricted area extending in NW-SE Dinaric direction. This area represents a palaeogeographic domain interpreted as the north-eastern margin of the Adriatic platform. North-Eastwards, this margin is obscured by basinal terrigenous sediments along its extension, in NW Slovenia (PAVŠIČ et al., 1996) as well as in Herzegovina (SLIŠKOVIĆ et al., 1978). The Adriatic platform constituted an isolated shoaly zone in the Central Tethys during the Palaeogene (HOTTINGER, 1990). It was drowned at different times in different places according to the latter's relative position with respect to the platform margin, and subsequently covered by terrigenous sediments. Therefore, is the geographically restricted occurrence of the *A. histrica* phylum due to true endemism, or to environmental restrictions corresponding to a particular facies belt characterizing the platform margin?

The isolated position of the Palaeogene Adriatic platform in the Tethyan sea may be a good prerequisite for endemism. The occurrence of *A. histrica* in Ivartnik, outside of the Adriatic domain would suggest otherwise. However, the palaeogeographic position of this latter locality remains clear, as the position of the Palaeogene-Eurasian continental margin in the Alpine realm has not been accurately reconstructed. In particular the position of the Karinthian Krappfeld outcrops

| *Alveolina* | Golež | Voz | BUNIĆ | Lištica Dobrinj | Hrgud Stolac | Rosandra Ivartnik | |
|---|---|---|---|---|---|---|---|
| *A. azzarolii* | O | | O | O | | | Upper |
| *A. rakoveci* | <O> | <O> | <O> | <O> | | <O> | |
| *A. h. septentrionalis* | <O> | <O> | <O> | <O> | <O> | | |
| *A. histrica histrica* | <O> | | <O> | | <O> | <O> | C |
| *A. fornasinii* | | | O | | O | | U |
| *A.* aff. *canavarii* | O | O | O | O | O | | I |
| *A. cosinensis cosigena* | O | | O | O | O | O | S |
| *A. ruetimeyeri* | O | | O | O | O | O | I |
| *A. cremae* | O | O | O | O | O | | A |
| *A. distefanoi* | O | O | O | O | O | O | N |
| *A. schwageri* | O | | O | | | O | |
| *A. colatiensis* | | | O | O | | O | |
| *A. carantana* | | | O | O | | O | Middle |
| *A. rectiangula* | O | | O | | | | |

Table 1 Association of alveolinas, specially the species of the phylogenetic lineage *Alveolina histrica*, marked <O>; for location of sections see Fig. 3.

(where *A. histrica* is absent - Van HINTE, 1963), in relation to Ivartnik is unknown.

Alternatively, the Adriatic area corresponding to the distribution of *A. histrica* exhibits a common sedimentary history. Carbonate sedimentation is continuous from the Ilerdian to the Cuisian and the platform was drowned prior to the base of the Lutetian. This characterizes the platform margin in contrast to inner parts of the platform where the marine carbonate sedimentation began late, with the Cuisian transgression, and ended, during the Lutetian (DROBNE, 1977).

Platform margins doubtlessly have habitats other than restricted areas of the internal parts (HOTTINGER, 1980) and may therefore delimit narrow, belt-like areas of distribution for taxa of the larger foraminifera. The present state of knowledge does not permit a definite answer to these questions. However, the linear alignment of the *A. histrica* occurrences emphasizes the close facies relationship between the Lištica-Hrgud and the Rosandra-Voz areas (Fig. 3) and justifies adding the Bunić *A. histrica* occurrence into the linear realm. As a consequence, the Bunić occurrence must be interpreted as a tectonic window, where a piece of the Adriatic platform margin is expressed from beneath the overthrusted Dinaric tectonic unit.

## 5. CONCLUSION

The linear extension of the distribution of the Cuisian alveolinid species belonging to the *A. histrica* phylum, between NE Slovenia and SE Herzegovina corresponds to the NE margin of the Adriatic platform which constituted an isolated shoaly area in the Tethyan sea. The presence of *A. histrica* in this narrow belt may either reflect particular environmental conditions along the platform margin, or represent an area delimited by endemism, or result from a contribution of both factors. Thus, the facies relations between the Cuisian alveolina limestones are significant enough to justify an interpretation of the Bunić alveolina limestone as an intermediary part of the platform margin, hidden beneath the overthrusted Dinaric unit (Fig. 3) and emerging in isolated points from below in a tectonic window.

### Acknowledgement

The authors wish to thank the INA-Naftaplin institution, which, many years ago, provided the opportunity to study the Bunić section, colleagues Ljubo BABIĆ and Jožica ZUPANIČ for permission to use the data from the Lištica section, colleague Simon PIRC for translation of the text and not least Lukas HOTTINGER for critical remarks and for the enlargement of the palaeogeographic ideas. The authors also thank both our research Institutions ZRC SAZU and INA Consulting for support during the investigation and realisation of this study.

## 6. REFERENCES

CHECCHIA-RISPOLI, G. (1905): Sopra alcune Alveoline eoceniche della Sicilia.- Paleontographia Ital., 11, 147-167, pls. 12-13.

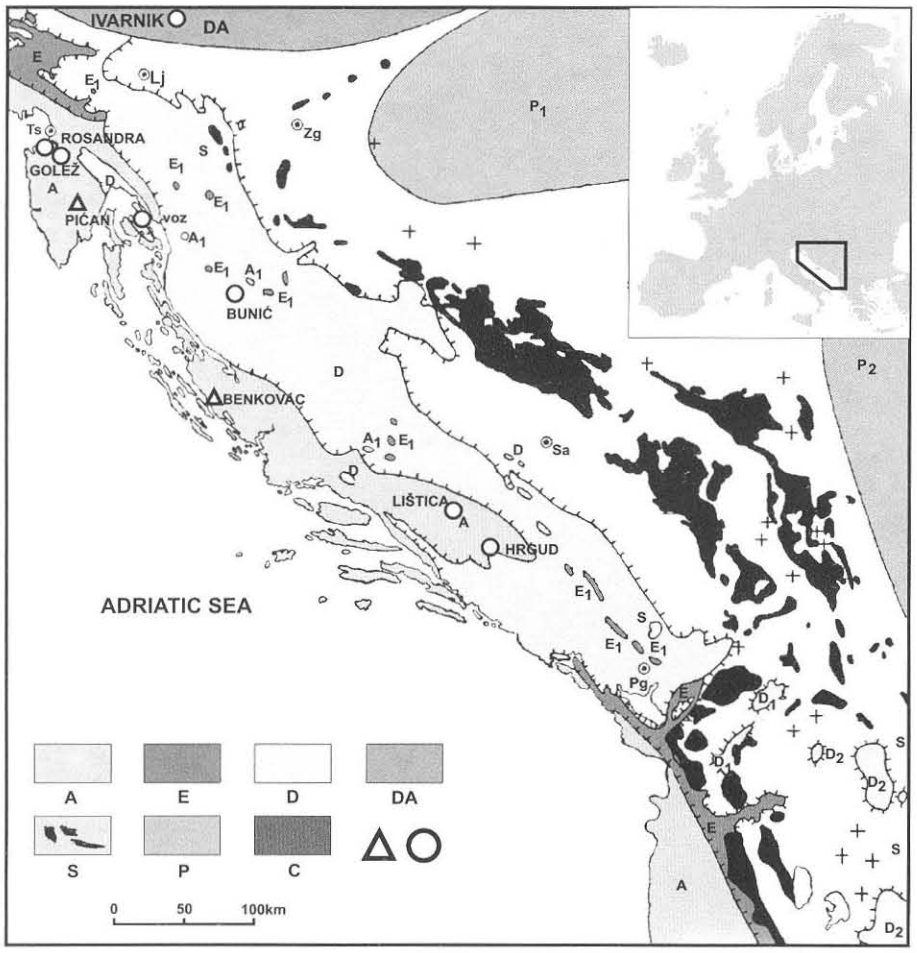



Fig. 3 Geotectonic belts, after HERAK (1986, 1991 - fig. 5) with the positions of the sections composed by alveolina-nummulite limestone. Legend: A) Structural complex of the Adriatic carbonate platform (*Adriaticum*); E) Deposits of pelagic provenance in connection with the Interplatform belt (*Epiadriaticum*); D) Structural complex of the Dinaric carbonate platform (*Dinaricum*); DA) The joint area of the Dinarides and Alpides; S) Structural complex of the Inner Dinarides (*Supradinaricum*) which originated in connection with the ocean belt of the Tethys; black: ultrabasic, basic and associated rocks; P) Pre-Alpine structural complexes ($P_1$ - Pannonian structure, $P_2$ - Serbo-Macedonian Massif); C) Carpatho-Balkanian Belt. $A_1$, $E_1$) tectonic windows within the *Dinaricum*; O Occurrence of *A. histrica*; Δ Coeval alveolinid assemblages without *A. histrica*, shown at the Pićan (Istria) and Benkovac - Ravni Kotari sections (DROBNE, 1977; DROBNE et al., 1991).


Di SCOTTO, C.B. (1966): Le Alveoline del Gargano nord-orientale.- Palaeont. Ital., 6, 65-73, Pisa.

DROBNE, K. (1977): Alvéolines paléogenes de la Slovénie et de l'Istrie.- Mém. Suiss. Paléont., 99, 132p., 21 pls.

DROBNE, K., PAVLOVEC, R. & DROBNE, F. (1977): Paleogene larger Foraminifera from the area between Mežica and Slovenj Gradec (NW Yugoslavia).- Razprave SAZU 4. razr., 20, 88p., 23 pls., Ljubljana.

DROBNE, K., TRUTIN, M. & PAVLOVEC, R. (in press): Paleogene stratigraphy of the Adriatic carbonate platform.- Dela - Opera SAZU 4. razr., 34/3, Ljubljana.

DROBNE, K., VLAHOVIĆ, I., TRUTIN, M., PAVLOVEC, R., ĆOSOVIĆ, V., BABAC, D., CIMERMAN, F., LUČIĆ, D. & PAVŠIČ, J. (1991): Excursion B - Ravni Kotari, Paleogene.- In: VLAHOVIĆ, I. & VELIĆ, I. (eds.): Some aspects of the shallow water sedimentation on the Adriatic Carbonate Platform (Permian to Eocene), Excursion guide-book, 2nd Intern. Symposium on the Adriatic Carbonate Platform, Zadar, 53-90, 7 pls., Zagreb.

HERAK, M. (1985): On the relation of Adriatic and Dinaric structures.- Razprave SAZU 4. razr., 26, 401-414, Ljubljana.

HERAK, M. (1986): A new concept of geotectonics of the Dinarides.- Acta geol., 16, 1-42, Zagreb.

HERAK, M. (1987): The Mohorovičić discontinuity in Yugoslavia.- Acta geol., 17, 5-45, Zagreb.

HERAK, M. (1989): Relationship between Adriatic and Dinaric carbonate platforms.- Mem. Soc. Geol. It., 40 (1987), 289-293.

HERAK, M. (1991): Dinarides. Mobilistic view of the genesis and structure.- Acta geol., 21, 35-117, Zagreb.

HERAK, M. (1993): Additional consideration on the Epiadriaticum, Outer Dinarides.- Geol. Croatica, 46, 165-168.

HOTTINGER, L. (1960): Recherches sur les Alvéolines du Paléocène et de l'Eocène.- Mémoires Suisses de Paléontologie, 75-76, 243 p.

HOTTINGER, L. (1980): Répartition comparée des grands Foraminiféres de la Mer Rouge et de l'Océan

Indien.- Ann. Univ. Ferrara (Nuova Serie), Ser. IX, vol. suppl. 6, 1-13.

HOTTINGER, L. (1990): Significance of diversity in shallow benthic foraminifera.- Atti del Quarto Simposio di Ecologia e Paleoecologia delle Comunita Bentoniche, 35-51, Torino.

PAVŠIČ, J., DOLENEC, T. & HORVAT, A. (1996): Kanal-Lig Cretaceous/Tertiary boundary in flysch.- In: DROBNE, K., GORIČAN, Š. & KOTNIK, B. (eds.): Int.workshop "The role of impact processes in the geological and biological evolution of planet Earth", 203-209, Ljubljana.

POLŠAK, A., CRNKO, J., ŠIMUNIĆ, An., ŠIMUNIĆ, Al., ŠPARICA, M. & JURIŠA, M. (1978): Osnovna geološka karta SFRJ 1:100.000. Tumač za list Bihać L33-116.- Inst za geol. istraž. Zagreb (1967), Savezni geol. Zavod Beograd, 51 p.

SLIŠKOVIĆ, T., PAVLOVEC, R. & DROBNE, K. (1978): Older Paleogene in Hercegovina.- Zbornik radova 9. kongr. geol. Jugoslavije, 125-128, Sarajevo.

ŠPARICA, M. (1978): Stratigrafija, tektonika i paleogeografija područja Bunić-Čanak u Lici (Hrvatska) (Stratigraphy, tectonics and paleogeography of Bunić-Čanak area in Lika (Croatia)).- Geol. vjesnik, 30, 281-295.

Van HINTE, J.E. (1963): Zur Stratigraphie und Mikropaläontologie der Oberkreide und des Eozäns des Krappfeldes.- Kärnten Jahr. Geol. Bundesanstalt, Sonderband 8, 147 p., 22 pls., Wien.

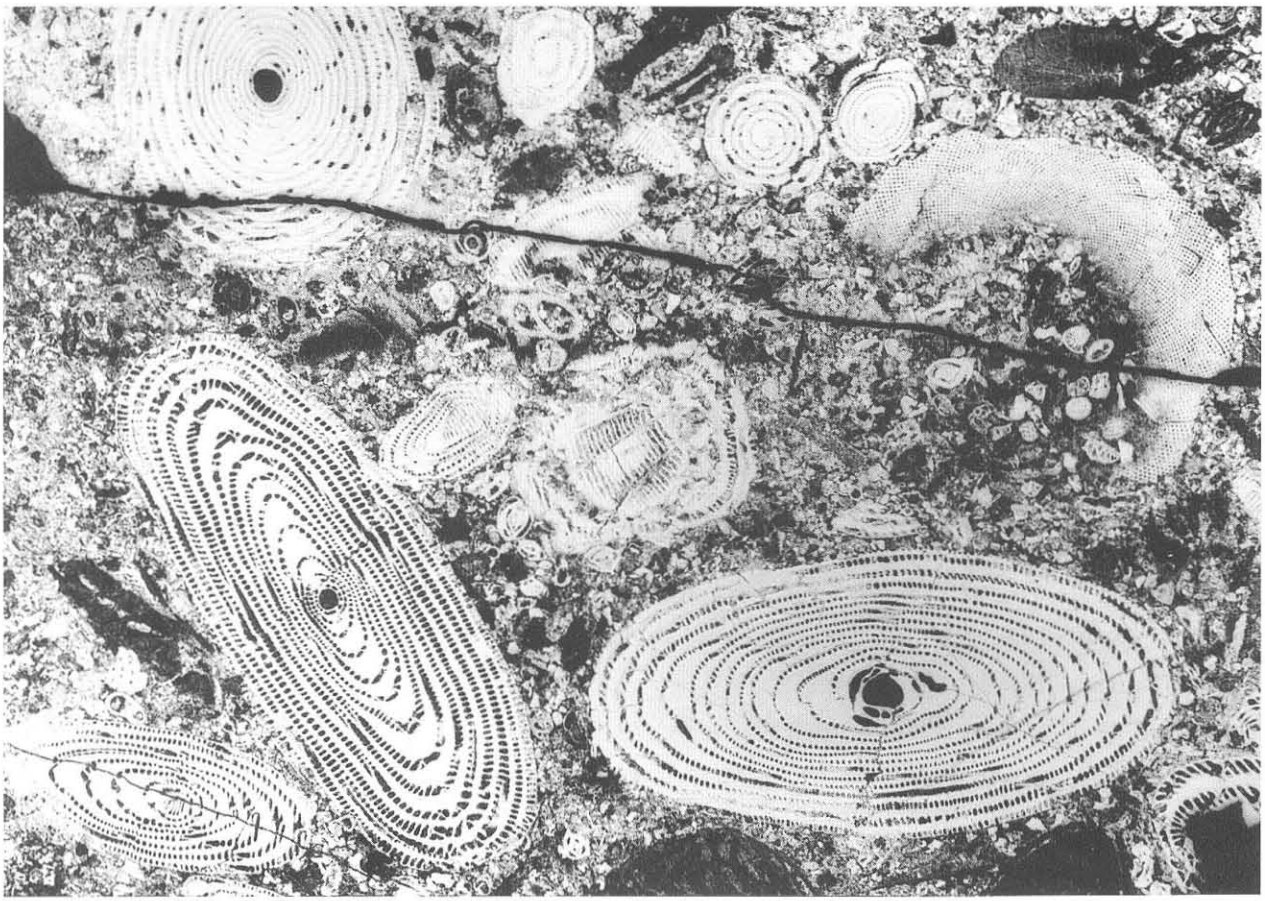
Manuscript received April 14, 1997.
Revised manuscript accepted November 10, 1997.

## PLATE I

1 Alveolina-nummulite limestone, *A. rectiangula* DROBNE, *A. rakoveci* DROBNE, *Glomalveolina* sp., *Orbitolites* sp., *Nummulites* sp., packstone, Bu-Ko 64/5413.

2 Packstone, badly preserved foraminifera, Bu-Ko 4/5258.

All enlarged x10, incident light



1

2

PLATE II

1 *Alveolina rakoveci* DROBNE, f A, axial section, Bu-Ko 64/5417, Upper Cuisian

2 *A. rakoveci* DROBNE, f A, equatorial section, Bu-Ko 64/5413, Upper Cuisian

3 *A. histrica septentrionalis* DROBNE, f A, axial section, Bu-Ko 65/5435, Upper Cuisian.

4 *A. h. septentrionalis* DROBNE, f A, axial section, Bu-Ko 5/5283, Middle Cuisian

5 *A. histrica histrica* DROBNE, f A, axial section, Bu-Ko 8/5333, Middle Cuisian

6 *A. rectiangula* DROBNE, f B, axial section, Bu-Ko 64/5411, Upper Cuisian

7 *A. distefanoi* CHECCHIA-RISPOLI, f A, axial section, Bu-Ko 5/5363, Middle Cuisian

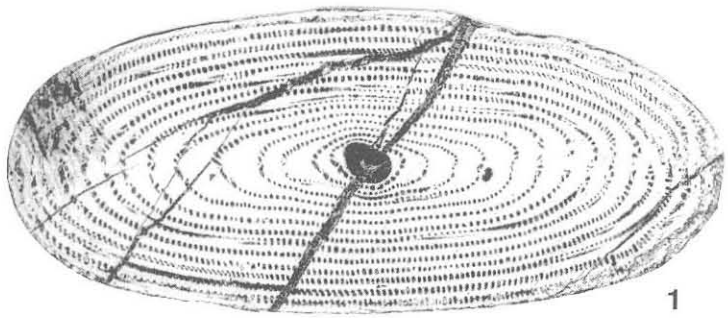
8 *A. schwageri* CHECCHIA-RISPOLI, f A, axial section, Bu-Ko 6/5297, Middle Cuisian

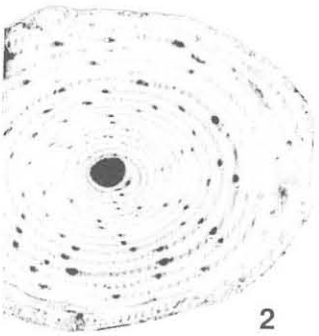
9 *A. ruetimeyeri* HOTTINGER, f A, axial section, Bu-Ko 6/5297, Middle Cuisian

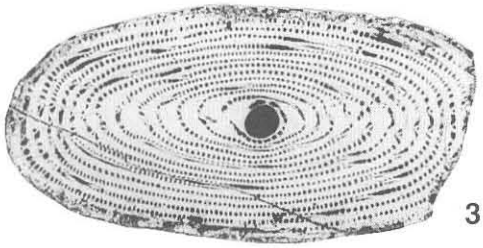
10 *A.* aff. *canavarii* CHECCHIA-RISPOLI, f A, axial section, Bu-Ko7/5316, Middle Cuisian

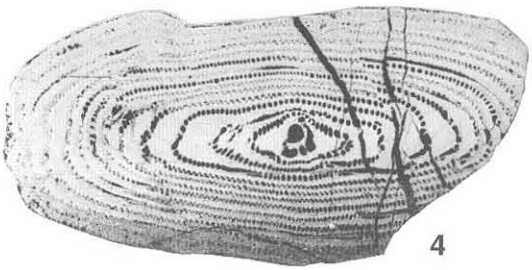
11 *A. cremae* CHECCHIA-RISPOLI, f A, axial section, Bu-Ko 10/5375, Middle Cuisian

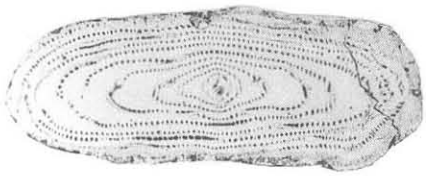
All enlarged x10, incident light

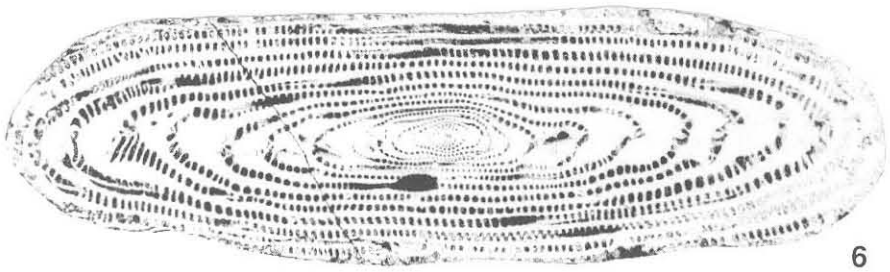

1

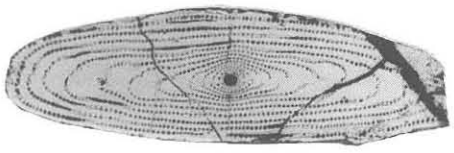

2


3

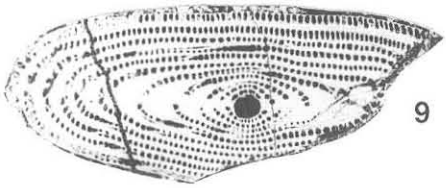

4

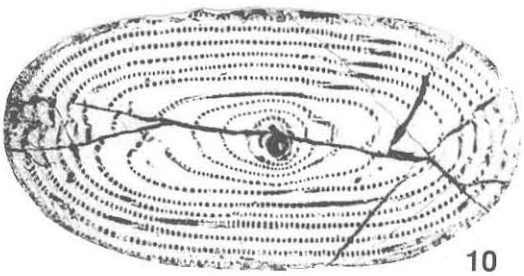

5

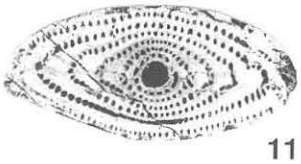

6


7


8


9


10


11