

LOWER CARNIAN FORAMINIFERS FROM THE TYPE LOCALITY OF THE CALCARE DEL PREDIL (RAIBL GROUP, NORTHEASTERN ITALY)

ROBERTO RETTORI*, CARMELA LORIGA** & CLAUDIO NERI**

Received January 13, 1998; accepted June 6, 1998

Key-words: Foraminifera, Taxonomy, Paleoecology, Basinal facies, Early Carnian, Raibl Group, Northeastern Italy.

Riassunto. Nella località tipo del Calcare del Predil (Cordevolico Auct., Gruppo di Raibl) sono stati individuati 19 taxa di foraminiferi bentonici, prevalentemente riferibili ai sottordini Involutinina Hohenneger & Piller e Miliolina Delage & Hérouard. La parte superiore della sezione studiata comprende la base della Formazione di Rio. Il Calcare del Predil ("scisti ittiolitici", "calcarei bituminosi", "calcarei neri" Auct.) è costituito da dolomie, calcari dolomitici e calcari scuri, frequentemente bituminosi alternati ad argilliti, marne e calcari marnosi nerastri. Le litologie granulari formano depositi torbiditici o debris-flow. Tra gli Involutinina sono presenti specie appartenenti ai generi *Lamelliconus* Piller, *Aulotortus* Weynschenk, *Prorakusia* di Bari & Laghi mentre i Miliolina sono rappresentati da *Turriglobina* Zaninetti, *Gsolbergella* Zaninetti, *Ophthalmidium* Kübler & Zwingli ed *Agathammina* Neumayr. Subordinatamente sono presenti esemplari riferibili al genere *Piallina* Rettori & Zaninetti ed altri Textulariina Delage & Hérouard insieme a *Duostomina* Kristan-Tollmann, *Variostoma* Kristan-Tollmann e *Nodosaria* Lamarck. Nove taxa sono comuni ad entrambe le Formazioni.

Gsolbergella spiroloculiformis (Oravec-Scheffer) è la specie più comune e costante. Gli Involutinina si rinvencono nei litotipi calcarei finemente granulari costituiti da materiale proveniente dalla piattaforma adiacente. *Gsolbergella* e *Turriglobina* sono invece legate a sedimenti micritici spesso in associazione a radiolari e spicole. *Turriglobina carnica* (Dager), *T. conica* (He) e *Gsolbergella spiroloculiformis* sono qui considerate specie adattate all'ambiente bacinale. Dal punto di vista della distribuzione cronostratigrafica si segnala che *Lamelliconus artiskomorphos* di Bari & Laghi e *Prorakusia salaji* di Bari & Laghi, due specie fino ad oggi note nello Julico sup. (zona ad *Austriacum*), sono già presenti nello Julico inf. (zona ad *Aon*, Cordevolico Auct.). Si propone, inoltre, di attribuire il genere *Prorakusia* di Bari & Laghi alla famiglia Triadodiscidae (Triadodiscinae) Zaninetti piuttosto che alle Involutinidae Bütschli.

Abstract. Foraminiferal content from the type section of the Calcare del Predil, Early Carnian in age, is here firstly reported. Dolomites, dololimestones and blackish limestones alternate black shales, marls and marly limestones; in addition turbiditic deposits and debris flow consisting of calcirudites and thin to coarse calcarenites occur in the stratigraphical unit. The bottom of the Rio del Lago Formation overlying the Calcare del Predil, was also investigated from a micropaleontological point of view. Nineteen taxa were classified; they are mainly represented by Aulotortinae Zaninetti, Lamellininae Zaninetti et al., Triadodiscinae Zaninetti, Turriglobininae

Zaninetti and Ophthalmidiidae Wiesner. Furthermore, some Ammodiscidae Reuss, "Trochamminidae" Schwager, Piallinae Rettori & Zaninetti, Duostominidae Brotzen and rare Lagenina Delage & Hérouard have been recorded. Undetermined encrusting foraminifers also occur. Nine taxa are in common with the lowermost part of the Rio del Lago Formation. The specimens referable to the superfamily Involutinacea Bütschli are dominant and represent the 40% of the finely grained laminas inside the black limestones. The turriglobininae occurring in the muddy lithotypes pertain to the morphogroup which is considered as typical of basinal environment. The occurrence almost constant in the micritic limestones of the ophthalmidiid *Gsolbergella spiroloculiformis* (Oravec-Scheffer) (few specimens) lead to suggest this species as inhabitant basinal environment also. Two Julic species of the *Austriacum* zone are firstly reported from the *Aon* zone (Cordevolico Auct.). The suprageneric position of the genus *Prorakusia* di Bari & Laghi is also discussed.

Introduction.

Carnian foraminifers are known from several localities of the Tethyan domain: Western Dolomites, Southern Apennines, Northern Calcareous Alps, Hungary, West Carpathian and from Eastern Tethys, but not from Carnia (Northeastern Italy). The Calcare del Predil Formation belonging to the Raibl Group (Carnia) has been investigated from a micropaleontological point of view in its type locality. The formation is a basinal unit, referred to the Early Carnian (*Aon* zone) on the basis of ammonites since the second half of the 19th century; it looks very poor in other macrofossils and conodonts whilst benthic foraminifers are frequent in its middle-upper part. Taxonomy, chronostratigraphical range, life environment of these early Carnian foraminifers are the aim of the present paper.

Geological setting.

The Calcare del Predil outcrops in the northeastern Carnia from val Bruna westward to Cave del Predil-Raibl eastward. It is 240 meters in thickness and lies between Dolomia Metallifera (bottom) and Rio del

* Dipartimento di Scienze della Terra, Piazza Università, 4, 06100 Perugia, Italy; e-mail: simocir@unipg.it.

** Dipartimento di Scienze Geologiche e Paleontologiche, Corso Ercole I d'Este 32, 44100 Ferrara, Italy.

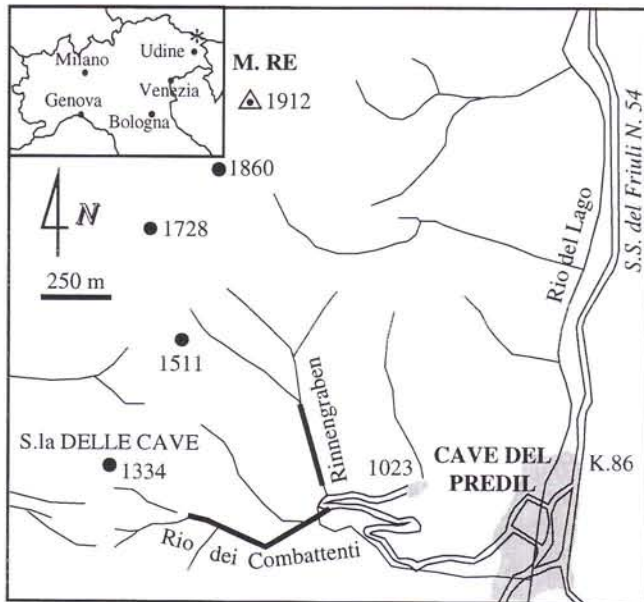


Fig. 1 - Geographic position of the Cave del Predil stratigraphic sections.

Lago Formation (top) (Assereto et al., 1968). The Calcare del Predil laterally onlaps the slope of the retrograding coeval carbonate platform. Dolomites, dololimestones and blackish limestones alternate black shales, marls and marly limestones; in addition turbiditic deposits and debris flow consisting of calcirudites and thin to coarse calcarenites occur.

The Early Carnian age has been inferred from the occurrence of the *Trachyceras aon* Münster and *Protrachyceras brasileus* Münster from the lower part of the formation (*Aon* zone, Cordevolian; Assereto et al., 1968). According to Assereto et al. (1968) the type section completely outcrops at west of the Raibl Mine. Its lower part is in the Rinnengraben; the middle-upper part to the overlying Rio del Lago Formation is exposed along the Combattenti River (Fig. 1). Three subunits are recognizable in the area surrounding Re Mountain from the Rio Freddo Valley to the subsurface of the Predil mine (Fig. 2). The subunits are the following:

bottom: Dolomia Metallifera

Calcare del Predil

Subunit 1; 30 meters (CR9)

Layers of blackish grey and bituminous dolomites, 2-20 cm. thick, intercalate mm-to cm black and bituminous claystones. Parallel lamination and graded beds occur, bioturbation is lacking, but the original textures of the calcirudites (with centimetric clasts) and of the coarse to fine calcarenites have been mostly obliterated by the dolomitization processes. Carbonate muds are poor; debris of echinoderms, pelecypodes, gastropodes etc. frequently occur.

Subunit 2; 170 meters (CR10-38)

Micritic to finely grained black limestones and blackish grey marls form a monotonous succession. The packstones-wackestones contain peloids, radiolarians, sponge spicules, pelagic bivalves, foraminifers etc. The grained lithotypes make laminas and mm-to cm graded thin layers with parallel laminations. The supply of the coarse clastic sediments from the platform is very poor despite of the frequency of the fine bioclastic turbidites which contain platform fossils.

Marls and marly limestones are dominant in the segment 2a and 2c (Fig. 2); the segment 2b is almost completely carbonate. At the top slumpings occur.

The relative greatest taxonomical diversity of the foraminiferal associations is in the segment 2a and 2b and in the middle-upper 2c where the occurrence of foraminifers reaches 40% in the finely grained laminas. Very rare specimens also occur in the limestones with radiolarians and sponge spicules of the upper 2c (Fig. 2, sample Cr 23).

Subunit 3; 35 meters (CR39,40,44-60)

Polygenic breccias (debris flow) in dm - layers including carbonatic clasts and fossils from the platform alternate to turbidites which consist of bioclastic calcarenite. Debris of the macrofossils are dominant in comparison to the microfossils. The deposition of this subunit looks to be connected with a tectonic phase testified by the slumpings at the top of the subunit 2 (Fig. 2). Foraminifers are very rare.

Top: lowermost Rio del Lago Fm. (CR41-43)

It consists of a sequence of grey marls, micritic limestones and graded packstones-wackestones, very similar to the facies belonging to the subunit 2 of the Calcare del Predil. The contact between the two formations is sharp; in fact the basal marls of Rio del Lago Fm overlie the large clast breccias bank pertaining to the topmost Calcare del Predil.

Foraminiferal association is very similar to that recorded in the subunit 2a,b and in the middle-upper part of the subunit 2c.

Foraminifer assemblages.

The foraminifers are always regularly distributed. The composition of the assemblage does not show any peculiar qualitative or quantitative variations along the succession (Fig. 2). The characterizing species, for their abundance and ecological or stratigraphic significance are almost always present in all the studied samples with just a few oscillations in frequency being recorded. Such variations seem to be due to the different amount of fine material deriving from the carbonate platform. Foraminiferal test dimensions are in agreement with the

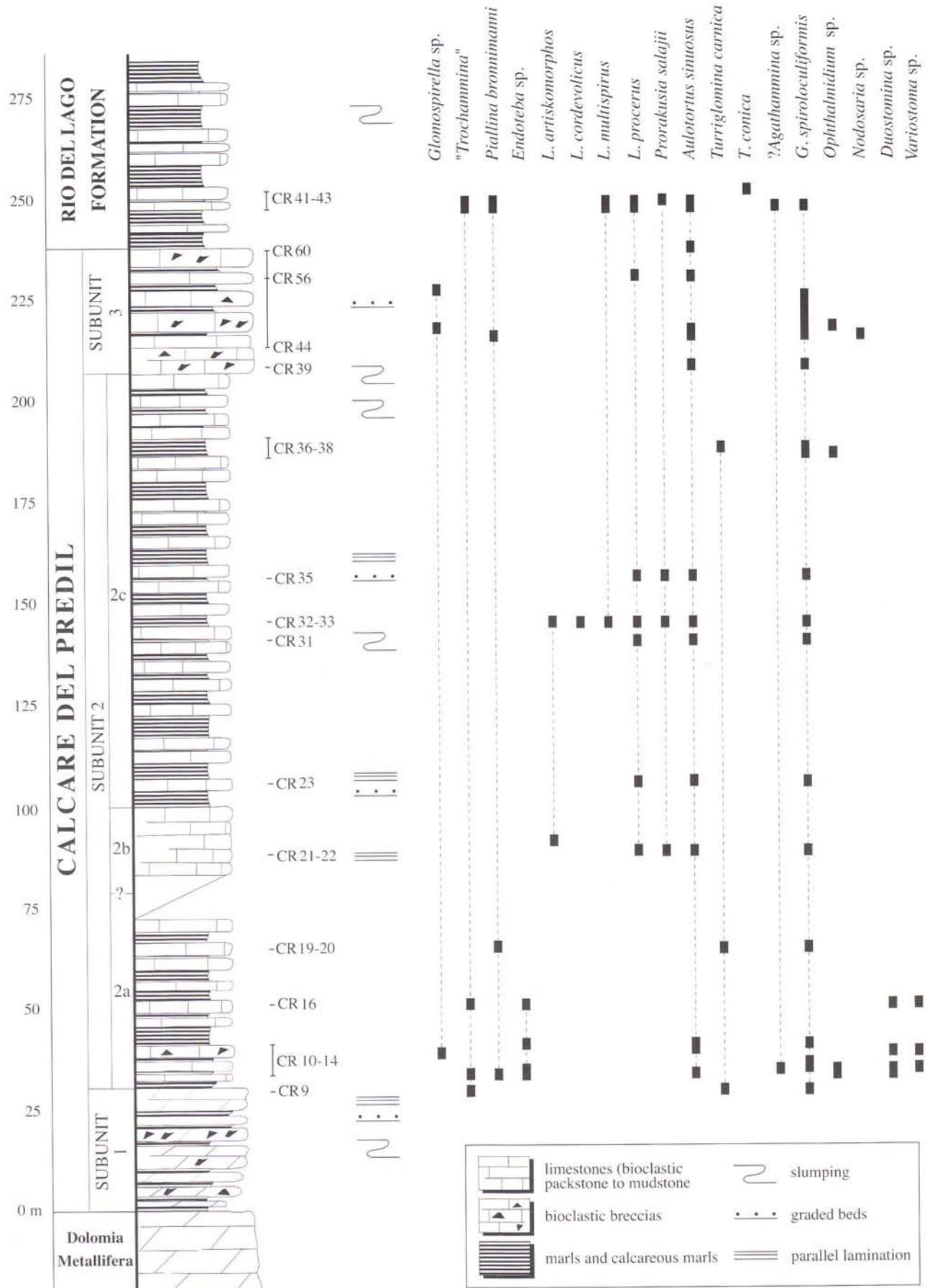


Fig. 2 - Stratigraphic column and foraminiferal distribution.

granulometric size of the sediment. Preservation state is generally good, in particular the wall structure of the lenticular forms of involutinids (*Aulotortus*) still shows the lamellar structure and the original perforations. The wall of the conic high-spined forms of involutinids (*Lamelliconus*) are often micritized and partially dissolved. The studied microfauna are mainly represented by hyaline, lamellar, perforated wall referable to the families Aulotortidae (Aulotortinae) and Triadodiscidae (Lamelliconinae, Triadodiscinae) and porcelainous forms, both biloculine belonging to the family Meandrospiridae (Turri-glomininae) and pluriloculine mainly referable to the family Ophthalmidiidae. Agglutinated foraminifers belonging to the families Ammodiscidae (*Glomospirella* sp., Pl. 2, fig. 14, 15), "Trochamminidae" ("*Trochammina*") and Endotebidae (*Endoteba* sp., Pl. 2, fig. 10) are present to a lower degree. Further to the above, specimens referable to the families Piallinidae and Duostominae were recorded. Foraminifers belonging to the suborder Lagenina are rare and only present in the most micritic microfacies of the succession. There are also undetermined crusting foraminifers.

The taxa recorded in the Calcare di Predil are the following:

Ammodiscidae Reuss, 1862
Glomospirella Plummer, 1945
Glomospirella sp.

Trochamminidae Schwager, 1877
Trochammininae Schwager, 1877
"Trochammina" Parker & Jones, 1859
"Trochammina" sp.

Piallinidae Rettori & Zaninetti in Rettori et al., 1993
Piallina Rettori & Zaninetti in Rettori et al., 1993
Piallina bronnimanni Martini, Rettori, Urosevic & Zaninetti, 1995

Endotebidae Vachard, Martini, Rettori & Zaninetti, 1994
Endoteba Vachard & Razgallah, 1988
Endoteba sp.

Triadodiscidae Zaninetti, 1984
Lamelliconinae Zaninetti, Ciarapica, Decrouez & Martini, 1987
Lamelliconus Piller, 1978
Lamelliconus artiskomorphos di Bari & Laghi, 1994
L. cordevolicus (Oberhauser, 1964)
L. multispirus (Oberhauser, 1957)
L. procerus (Liebus, 1942)
Triadodiscinae Zaninetti, 1984
Prorakusia di Bari & Laghi, 1994
Prorakusia salajii di Bari & Laghi, 1994

Aulotortidae Zaninetti, 1984
Aulotortinae Zaninetti, 1984
Aulotortus Weynschenk, 1956
Aulotortus sinuosus Weynschenk, 1956

Mendrospiridae Saidova, 1981 emend. Zaninetti et al., 1987
Turri-glomininae Zaninetti in Limongi et al., 1987
Turri-glomina Zaninetti in Limongi et al., 1987
Turri-glomina carnica (Dager, 1978)
T. conica (He, 1984)

Hemigordiopsidae Nikitina, 1969
Hemigordiopsinae Nikitina, 1969
? *Agathammina* Neumayr, 1887
? *Agathammina* sp.
Ophthalmidiidae Wiesner, 1920
Gsollbergella Zaninetti, 1979
Gsollbergella spiroloculiformis (Oravec-Scheffer, 1968)
Ophthalmidium Kübler & Zwingli, 1870
Ophthalmidium sp.

Nodosariidae Ehrenberg, 1838
Nodosaria Lamarck, 1812
Nodosaria sp.

Duostominae Brotzen, 1963
Duostomina Kristan-Tollmann, 1960
Duostomina sp.
Variostoma Kristan-Tollmann, 1960
Variostoma sp.

From the top of the stratigraphic section including Rio del Lago Fm. the following taxa occur:

? *Agathammina* sp.
Aulotortus sinuosus Weynschenk
Gsollbergella spiroloculiformis (Oravec-Scheffer)
Lamelliconus multispirus (Oberhauser)
L. procerus (Liebus)
Piallina bronnimanni Martini, Rettori, Urosevic & Zaninetti
Prorakusia salajii di Bari & Laghi
"Trochammina" sp.
Turri-glomina conica (He)

Thus, any peculiar change in foraminiferal content was observed at the base of the Rio del Lago Fm.

The involutinids.

In the examined succession the specimens referable to the superfamily Involutinacea are dominant, particularly in the parts of the succession with the highest bioclastic content. They occur in the finely grained laminae inside the black limestones and they may represent the 40% of the grains. The elongated high-spined forms (Lamelliconinae) predominate over the lenticular ones (Aulotortinae). In the latter in some cases the lamellae and the perforations are both clearly visible, whilst the wall of the conic forms is often micritized and partially dissolved. These processes obliterate the original structure of the wall which looks dark and compact. This diagenesis is common in such foraminifers, making it sometimes difficult to define their systematic position. When phenomena involve the species of *Lamelliconus* having a maximum test diameter much inferior to the maximum height (*L. multispirus* and *L. procerus*) the taxa prove to be difficult to distinguish from others which are morphologically comparable, but which have a different wall structure (*Turri-glomina*). When the cross sections of *L. multispirus* and *L. procerus* are not perfectly centred these forms look morphologi-

cally very similar to species which are of large size and with thick walls, such as *Turriglomina magna* (Urosevic, 1977) and *T. scandonei* Zaninetti et al., 1987. This diagenetic process makes the wall of the Lamelliconinae dark and compact and fairly undistinguishable from the porcelaneous one of *Turriglomina*. The above mentioned genus is characterized by the presence of a meandrospiroid early stage, often reduced or impossible to observe in the cross sections that do not cross over the first part of the test. In the genus *Lamelliconus* the test is always trochospired, but the juvenile stage can be in eccentric position, as previously illustrated by Kohen-Zaninetti (1969) (fig. 43 E,L,M,U) and Zaninetti (1976) (pl. 10, fig. 5, 6, 10, 11) in some forms of *Lamelliconus* recorded in the Lower Carnian of Northern Calcareous Alps (Austria). When a tangential section crosses the eccentric initial portion of the test of these specimen (Pl. 2, fig. 1), what you see could be mistakenly interpreted as a highly tangential section of the meandrospiroid early stage of *Turriglomina*. Taking into consideration all of the above, the only real diagnostic criteria able to distinguish diagenised specimens of *Lamelliconus* from non-centred cross sections of *Turriglomina* proves to be the degree of involution of the whorls of the tubular chamber. In fact, in *Lamelliconus* the whorls are involute and not visible on outer surface, whilst the evolute coils of the high-spired *Turriglomina* are singly defined by deep sutures, regularly distributed and clearly marked at the beginning of each successive convolution.

The turriglominas.

The recorded specimens of *Turriglomina* are of small dimensions, thin wall and have a reduced meandrospiroid early stage. The morphological and biometric features allows it to be referred to the species *Turriglomina carnica* and *T. conica*. According to the data coming from the study of the Middle Triassic turriglominas recorded in the Southern Appenines, it has been demonstrated that the species *T. mesotriassica* (Koehn-Zaninetti) and *T. conica* (He) which occur in micritic limestone in association with pelagic bivalves and ammonite, are always of small dimensions and have an elongated silhouette, which implies a notably fragile test. On the contrary, in the carbonate platform paleoenvironment in association with Dasycladales and calcareous poriphers, the turriglominas characterized by large and solid tests are dominant (Zaninetti et al., 1990; Rettori, 1995). *Turriglomina carnica* can also be included in the morphogroup which is typical of the basinal paleoenvironment, and allows for the presumed autoctony of these specimens that are always present in the most micritic levels of the studied succession.

The gsollbergellas.

At present, the genus *Gsollbergella* is a monospecific genus and its species is rarely recorded and for the time being limited to the Carnian of some regions of the Western Tethys (Austria, Bulgaria, Hungary) and Israel. In contrast with the majority of species which more frequently, but irregularly, are found in the Calcare del Predil, *Gsollbergella spiroloculiformis* is the most constantly found taxon, even though it is represented by few specimens. From the bibliography there is very little information about the lithotypes in which this species has been found, but in the Calcare del Predil it is always present in micritic limestones suggesting that the species inhabited basinal environments.

Systematic Palaeontology

Order Foraminiferida Eichwald, 1830

Suborder Textulariina Delage & Hérouard, 1896

Superfamily *Verneuiliinae* Cushman, 1911

Family *Piallinidae* Rettori & Zaninetti in

Rettori et al., 1993

Genus *Piallina* Rettori & Zaninetti in

Rettori et al., 1993

Piallina bronnimanni Martini, Rettori,

Urosevic & Zaninetti, 1995

Pl. 1, fig. 1-3

1995 *Piallina bronnimanni* Martini, Rettori, Urosevic & Zaninetti, pl. 1, fig. 1, 2, 4, 5.

Remarks. The dimensions and morphology of the specimens recorded in the Calcare del Predil and in the lowermost part of the Rio del Lago Fm., are in agreement with those expressed for *P. bronnimanni* by Martini et al. (1995). The species can be distinguished from the other Carnian *P. tethydis* Rettori et al. (1993) by its reduced dimensions and by the different morphology of the chambers in the terminal part of the test, which are rounded and more voluminous in *P. bronnimanni*.

Stratigraphic and geographic distribution. Carnian of Lomnica (Eastern Serbia) as proposed by Urosevic & Sudar (1991) according to the conodont zonal scheme.

Suborder Involutinina Hohenegger & Piller, 1977

Family *Triadodiscidae* Zaninetti, 1984

Subfamily *Lamelliconinae* Zaninetti,

Ciarapica, Decrouez & Martini, 1987

Genus *Lamelliconus* Piller, 1978

Lamelliconus artiskomorphos di Bari & Laghi, 1994

Pl. 1, fig. 4-9

1994 *Lamelliconus artiskomorphos* di Bari & Laghi, pl. 7, fig. 8, 9.

Remarks. Compared with the other species belonging to the genus *Lamelliconus*, this species is characterised by a typical dome-shaped profile with a flat umbilical area. In the specimens recorded in the Calcare del Predil there are fewer whorls of the tubular chamber (5-8) in comparison with those (10) indicated by di Bari & Laghi (1994).

Stratigraphic and geographic distribution. Upper Julian (*Austriacum* Zone) of the Dolomites.

Lamelliconus cordevolicus (Oberhauser, 1964)

Pl. 1, fig. 10

1964 *Trocholina cordevolica* Oberhauser, pl. 1.1976 *Trocholina cordevolica* - Zaninetti, pl. 11, fig. 1-3.1978 *Trocholina cordevolica* - Trifonova, pl. 1, fig. 7-9.1983 *Lamelliconus cordevolicus* - Salaj, Borza & Samuel, pl. 124, fig. 8; pl. 128, fig. 2.1987 *Lamelliconus cordevolicus* - Oravec-Scheffer, pl. 44, fig. 4, 5, 7-9.1992 *Lamelliconus cordevolicus* - Trifonova, pl. 2, fig. 10, 15; pl. 3, fig. 4.1994 *Lamelliconus cordevolicus* - di Bari & Laghi, pl. 6, fig. 5.

Remarks. This species is characterised by a chonic-shaped dorsal profile and by a ratio of the maximum diameter of the test *vs.* the height of the test approximately equal to 1. The umbilical area is flat, as in the specimens of the group *biconvexus-ventroplanus*, which have though a maximum diameter greater than their height.

Stratigraphic and geographic distribution. Carnian of Austria, Slovakia, Hungary and Italy; Longobardian-Early Carnian in Bulgaria.

Lamelliconus multispirus (Oberhauser, 1957)

Pl. 1, fig. 11

1957 *Trocholina (Trocholina) multispira* Oberhauser, pl. 20, figs. 1-14; fig. 1(1).1995 *Lamelliconus multispirus* - Rettori, pl. 13, fig. 1, 3, 4, 9, 10 (*cum syn.*).

Remarks. The species is characterised by a reduced apical angle and by the maximum diameter of the test which is less than the height. The species can be distin-

guished from *L. procerus*, which it is often associated with, not only by the ratio of diameter *vs.* height, but also by the general shape of the cone, by the reduced length of the spire, and because in *L. procerus* the distance between the lumina is constant, whilst in *L. multispirus* it increases towards the umbilical area. Furthermore, the species can be distinguished from *L. cordevolicus* essentially by the biometric features of the apical angle, by the ratio between the maximum diameter and the height, and because in *L. cordevolicus* the umbilical area is characteristically flat.

Stratigraphic and geographic distribution. Anisian (Illyrian)-Carnian of Central and Southern Europa, Israel and China. The species is present both in the Calcare del Predil and in the lowermost part of the Rio del Lago Fm.

Lamelliconus procerus (Liebus, 1942)

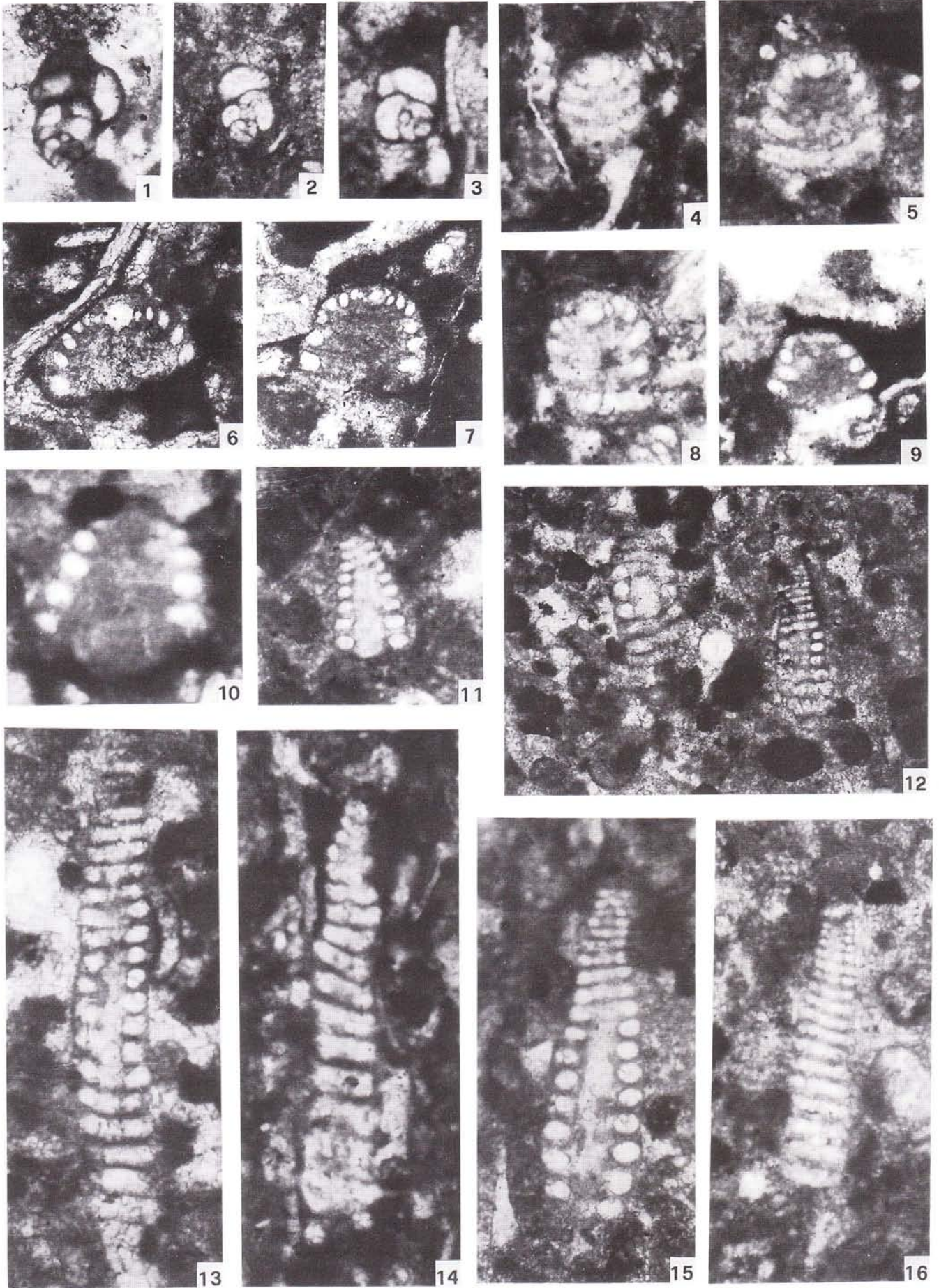
Pl. 1, fig. 12-16; Pl. 2, fig. 1, 3

1942 *Turritelletta procerus* Liebus, pl. 3, fig. 2a, b-d, *non* fig. 1(a, b) in the text.1995 *Lamelliconus procerus* - Rettori, pl. 13, fig. 2, 5, 6 (*cum syn.*).

Remarks. The species is abundant in the studied material from the Calcare del Predil and from the lowermost part of the Rio del Lago Fm. and it is often subject to micritisation processes of the wall, which sometimes make it difficult even to identify its generic attribution. The specimens have a high number of whorls (up to 20), often incomplete and sometimes with the juvenile stage eccentric in position (Pl. 2, fig. 1) The species, whose lectotype was designated by Rettori (1995), has a conic dorsal profile and can be distinguished from all the other species of the genus by the high number of whorls and by the values of the maximum diameter of the test, which are very reduced in comparison with those of the height. The whorls are quite distanced from each other and the dimension of the lumina is constant during the growth. The ratio between the height of the test and the diameter of its base is often greater than 1:3. This is a further diagnostic feature of the species which has a narrow, elongated test, allowing it to be distinguished from the other species belonging to the genus, which are generally characterised by a widening towards the base of the test.

PLATE 1

- Fig. 1-3 - *Piallina bronnimanni* Martini, Rettori, Urosevic & Zaninetti. Fig. 1) Sample CR 10, Calcare del Predil, Lower Carnian; Fig 2-3) Sample CR43/2, Rio del Lago Fm., Lower Carnian.
 Fig. 4-9 - *Lamelliconus artiskomorphos* di Bari & Laghi. Fig 4) Sample CR33, Calcare del Predil, Lower Carnian, Fig. 5, 6, 9) Sample CR56, Calcare del Predil, Lower Carnian, Fig. 7, 8) Sample CR21B, Calcare del Predil, Lower Carnian.
 Fig. 10 - *Lamelliconus cordevolicus* (Oberhauser). Sample CR41, Calcare del Predil, Lower Carnian.
 Fig. 11 - *Lamelliconus multispirus* (Oberhauser). Sample CR41, Calcare del Predil, Lower Carnian.
 Fig. 12-16 - *Lamelliconus procerus* (Liebus). Sample CR41, Calcare del Predil, Lower Carnian.
 Magnification: x 120.



Stratigraphic and geographic distribution. Ladinian-Carnian of Central and Southern Europe, Israel.

Subfamily *Triadodiscinae* Zaninetti, 1984

Genus *Prorakusia* di Bari e Laghi, 1994

Prorakusia salaji di Bari & Laghi, 1994

Pl. 2, fig. 4

1994 *Prorakusia salaji* di Bari & Laghi, pl. 8, fig. 1-3, 6, 8; pl. 9, fig. 1-3.

1988 *Gandinella* cf. *falsofriedli* (Salaj, Borza & Samuel) - Broglio Loriga, Marchesini & Neri, fig. 1.

Remarks. The involute test of *Prorakusia* (type-species: *P. salaji* di Bari & Laghi, 1994), is characterised by two coiling stages of the tubular chamber. The early stage is planispirally coiled, whilst the second part is trochospired. The latter stage of the tubular chamber has a subtriangular section whose lumen is much larger in comparison with that of the first part. Di Bari & Laghi (1994) refer this genus to the family Involutinidae Bütschli, but they consider *Prorakusia* to be linked to *Triadodiscus* Piller both from the microstructural point of view and from the phyletic one. On the basis of this it is here preferred to refer the genus to the family Triadodiscidae (Triadodiscinae) according to the taxonomic subdivision of the superfamily Involutinacea proposed by Zaninetti (1984). From the study of the features of the axial cross sections, the specimens of the Calcare del Predil and Rio del Lago Fm. are morphologically referable to *P. salaji* rather than to *P. primigenia* di Bari & Laghi which is characterised by a developed planispiral early stage and a reduced streptospiral final stage.

Stratigraphic and geographic distribution. Upper Julian (*Austriacum* zone) of Dolomites.

Family *Aulotortidae* Zaninetti, 1984

Subfamily *Aulotortinae* Zaninetti, 1984

Genus *Aulotortus* Weynschenk, 1956

Aulotortus sinuosus Weynschenk, 1956

Pl. 2, fig. 2, 5

1956 *Aulotortus sinuosus* Weynschenk, p. 26.

1978 *Aulotortus sinuosus* - Piller, p. 45, *cum. syn.*

1983 *Aulotortus sinuosus* - Salaj, Samuel & Borza, pl. 102, fig. 1-5; pl. 103, fig. 1-3.

1987 *Aulotortus sinuosus* - Oravec-Scheffer, fig. 10; pl. 76, fig. 3; pl. 96, fig. 6-8.

1990 *Aulotortus sinuosus* - De Castro, pl. 1, 2; pl. 3, fig. 1, 2, 7; pl. 4, fig. 4-10.

1992 *Aulotortus sinuosus* - Trifonova, pl. 4, fig. 3.

1994 *Aulotortus sinuosus* - di Bari & Laghi, pl. 1, fig. 1-7; pl. 2, fig. 1, 2; fig. 8.

Remarks. In the studied succession the most abundant specimens recorded (Calcare del Predil and Rio del Lago Fm.) are completely planispirally coiled, but specimens slightly to strongly oscillating in the final stage are also present in the assemblage. The oscillation features of tubular chamber is herein considered as variations within the species *A. sinuosus* as already proposed by Piller (1978), De Castro (1990) and di Bari & Laghi (1994). The strong morphological affinity of the other characters allow to exclude the presence of different species of the genus *Aulotortus* in the assemblage.

Furthermore, di Bari & Laghi affirm that the oscillation degree is a feature not depending on paleoecological conditions because it is present in the specimens recorded in reefal complexes with different substratum and energy. According to Zaninetti (1976) and De Castro (1990) in low energy paleoenvironments the specimens of *A. sinuosus* are characterised by smaller size, thinner wall and they are laterally flatter than those recorded in high energy paleoenvironments.

Stratigraphic and geographic distribution. Ladinian-Rhaetian of Tethyan realm.

Suborder Miliolina Delage & Hérouard, 1896

Superfamily *Cornuspiracea* Schultze, 1854

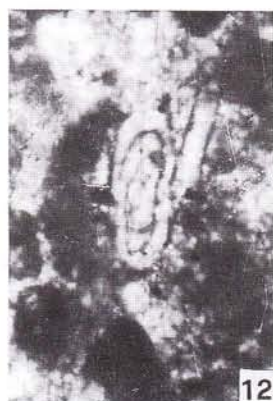
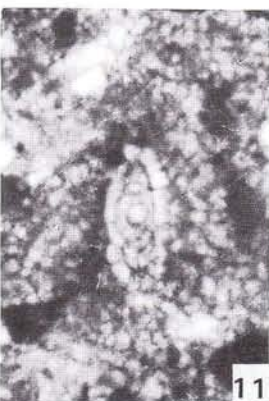
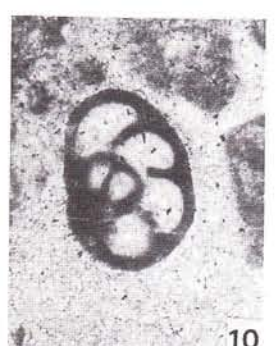
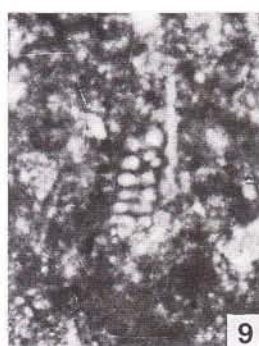
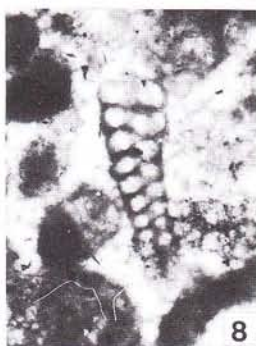
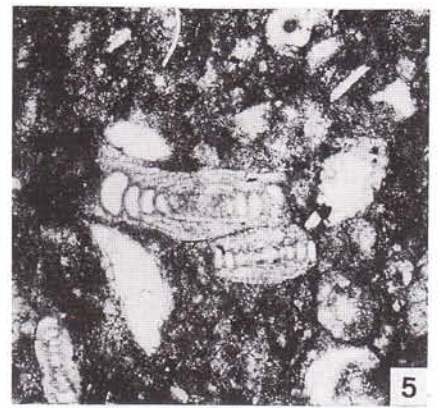
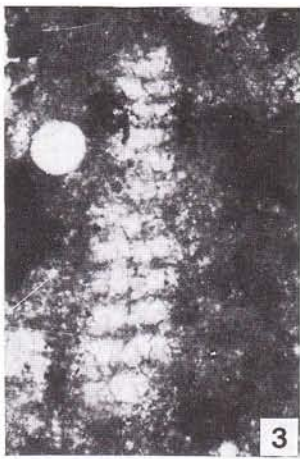
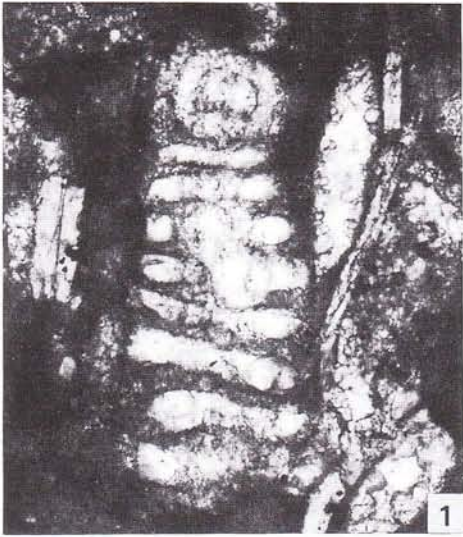
Family *Meandrospiridae* Saidova, 1981

emend. Zaninetti et al., 1987

PLATE 2

- Fig. 1, 3 - *Lamelliconus procerus* (Liebus). Fig. 1) Sample CR41, Calcare del Predil, Lower Carnian; Fig. 3) Sample CR21B, Calcare del Predil, Lower Carnian.
- Fig. 2, 5 - *Aulotortus sinuosus* Weynschenk. Fig. 2) Sample CR31, Calcare del Predil, Lower Carnian; Fig. 5) Sample CR21B, Calcare del Predil, Lower Carnian.
- Fig. 4 - *Prorakusia salaji* di Bari & Laghi. Sample CR33, Calcare del Predil, Lower Carnian.
- Fig. 6 - *Turriplomina conica* (He). Sample CR43/1, Rio del Lago Fm., Lower Carnian.
- Fig. 7-9 - *Turriplomina carnica* (Dager). Fig. 7) Sample CR37, Calcare del Predil, Lower Carnian; Fig. 8-9) Sample CR20, Calcare del Predil, Lower Carnian.
- Fig. 10 - *Endoteba* sp.. Sample CR16, Calcare del Predil, Lower Carnian.
- Fig. 11-13 - *Gsollbergella spiroculiformis* (Oravec-Scheffer). Fig. 11) Sample CR37, Calcare del Predil, Lower Carnian; Fig. 12) Sample CR9, Calcare del Predil, Lower Carnian; Fig. 13) Sample CR11, Calcare del Predil, Lower Carnian.
- Fig. 14, 15 - *Glomospirella* sp.. Sample CR11, Calcare del Predil, Lower Carnian.

Magnification: x 120.



Subfamily *Turrioglobimininae* Zaninetti in
Limongi et al., 1987

Genus *Turrioglobina* Zaninetti in Limongi et al., 1987

Turrioglobina carnica (Dager, 1978)

Pl. 2, fig. 7-9

1978 *Turritellella carnica* Dager, pl. 1, fig. 6-8.

Remarks. The species is rare and it occurs in finely micritic limestones of the Calcare del Predil and Rio del Lago Fm., where the material deriving from carbonate platform is scarce. The specimens recorded have an elongated silhouette (max. 0.230 mm) and thin wall (0.008 mm). The species can be distinguished from the Middle Triassic *Turrioglobina mesotriasica* (Koehn-Zaninetti, 1968) by dimensions, by the direction of the coiling axis, by the height of the tubular chamber and by the number of convolutions which is superior in comparison with that of *T. mesotriasica* under the same height of the test. Berczi-Makk (1993) suggests the possible synonymy between *T. carnica* and *T. mesotriasica* affirming that the different position of the whorls to the coiling axis of the helicoidal stage is the result of the orientation of cross sections. According to us, on the contrary, some of the specimens from Carnian of Hungary, figured by Berczi-Makk (1993) as *Turrioglobina mesotriasica* do not seem to belong to this species.

Stratigraphic and geographic distribution. Carnian of the Koçaeli Peninsula (Turkey); the species has been also reported from the Carnian of Hungary and Bulgaria.

Turrioglobina conica (He, 1984)

Pl. 2, fig. 6

1984 *Turritellella conica* He, pl. 1, fig. 14-15.

1987 *Turrioglobina conica* - Zaninetti, Ciarapica, Martini, Salvini-Bonnard & Rettori, pl. 1, fig. 5, 6.

1990 *Turrioglobina conica* - Zaninetti, Ciarapica, Martini & Rettori, pl. 1, fig. 13; fig. 1.

1993 *Turrioglobina conica* - Berczi-Makk, pl. 1, fig. 11.

1995 *Turrioglobina conica* - Rettori, pl. 22, fig. 3-6.

Remarks. The species is very rare in the studied succession and it has been only recorded in the sample CR43/1 (lowermost part of the Rio del Lago Fm.) in association with pelagic bivalves. The reduced test dimensions (height: 0.130 mm) and the wide columellar axis allow to include the specimen in the species *T. conica* originally described by He (1984) from the Anisian of China (Anshun Limestone Group). The species can be distinguished from *T. mesotriasica*, by the scarcely developed meandrospiroid early stage, by the small dimensions of the test and of the diameter of the tubular chamber and by its very thin wall.

Stratigraphic and geographic distribution. Middle Triassic (Anisian) of Southern China; Anisian?-Ladinian of Southern Apennines (Italy); Ladinian-Late Carnian of Hungary.

Family *Ophthalmidiidae* Wiesner, 1920

Genus *Gsolbergella* Zaninetti, 1979

Gsolbergella spiroloculiformis (Oravec-Scheffer, 1968)

Pl. 2, fig. 11-13

1968 *Agathammina spiroloculiformis* Oravec-Scheffer, pl. 2, fig. 1-5.

1969 *Agathamminoides gsolbergellensis* Zaninetti, fig. 1.

1979 *Gsolbergella spiroloculiformis* - Zaninetti, not figured.

1983 *Agathamminoides spiroloculiformis* - Salaj, Borza & Samuel, pl. 8, fig. 5a; pl. 72, fig. 7-8.

non 1983 *Agathamminoides spiroloculiformis* - Salaj, Borza & Samuel, pl. 72, fig. 9-10.

1987 *Gsolbergella spiroloculiformis* - Oravec-Scheffer, pl. 32, fig. 1-4, 10; pl. 39, fig. 1-10; pl. 45, fig. 6; pl. 51, fig. 4; pl. 52, fig. 1-4.

1988 *Gsolbergella spiroloculiformis* - Benjamini, pl. 2, fig. 20.

non 1993 *Gsolbergella spiroloculiformis* - Trifonova, pl. 8, fig. 25.

? 1993 *Gsolbergella spiroloculiformis* - Trifonova, pl. 8, fig. 23-24.

Remarks. The species, which is the only existing in the genus *Gsolbergella*, is common both in the Calcare del Predil and Rio del Lago Fm. It is a porcelaneous foraminifer, small in dimensions and characterised by a test with quinqueloculinoid arrangement of the chamber which are separated by thickenings of the wall rather than true septa.

Stratigraphic and geographic distribution. Carnian of Hungary, Austria, Italy and Israel.

Salaj et al. (1983) and Trifonova (1993) cited the species also in the Norian to Rhaetian of Western Carpathians and Bulgaria, but the figured specimens do not seem to belong to this species.

Acknowledgements.

This research was supported by MURST (ex 40% C. Loriga) and CNR (N.96.00339, 97.00241, Ladinian-Carnian boundary, C. Loriga, IGCP 343, 359).

We are grateful to R. Brandoli and A. Fugagnoli (University of Ferrara) for photos and drawings respectively. Thanks are due to M. Gaetani (University of Milan) and A. Gazdzicki (University of Warszawa) for their useful suggestions to improve the manuscript.

REFERENCES

- Assereto R., Desio A., Di Colbertaldo D. & Passeri L. (1968) - Note illustrative della carta geologica d'Italia 1:100.000, F.14a, Tarvisio. *Servizio Geologico Ital.*, Roma.
- Benjamini C. (1988) - Triassic Foraminifera from Makhtesh, central Negev, Southern Israel. *Rev. Paléob.*, Vol. Spec. 2, Benthos '86, pp. 129-144, Genève.

- Berczi-Makk A. (1993) - *Turriplomina* Zaninetti in Limongi et al. (Foraminifera) species in Triassic formations, Aggtelek-Rudabanya Mts (Northern Hungary). *Acta Geol. Hungarica*, v. 36, pp. 297-314, Budapest.
- Broglio Loriga C., Marchesin F. & Neri C. (1988) - Foraminiferi del Calcare del Predil, Gruppo di Raibl (Carnico inferiore; Alpi Meridionali, Carnia). *Annali Univ. Ferrara*, N.S., Sez. Sci. Terra, v. 1, n. 5, pp. 63-70, Ferrara.
- Dager Z. (1978) - Sur quelques Foraminifères nouveaux du Trias de Koçaeli, Turquie. *Notes du Lab. de Paléont.*, v. 2 n. 1-13, pp. 21-25, Genève.
- De Castro P. (1990) - Studies on the Triassic carbonates of the Salerno Province (Southern Italy): the Croci d'Acerno sequence. *Boll. Soc. Geol. It.*, v. 109, n. 1, pp. 187-217, Roma.
- di Bari D. & Laghi G.F. (1994) - Involutinidae Bütschli (Foraminiferida) in the Carnian of the Northeastern Dolomites (Italy). *Mem. Sc. Geol. Padova*, v. 46, pp. 93-118, Padova.
- He Y. (1984) - Middle Triassic Foraminifera from central and southern Guizhou, China. *Acta Palaeont. Sinica*, v. 23, n. 4, pp. 420-431, Beijing.
- Koehn-Zaninetti L. (1968) - Les Foraminifères du Trias de la région de l'Almtal (Haute-Autriche). Texte condensé de la thèse n° 1467, Ed. Medicine et Hygiène, 14 pp., Genève.
- Koehn-Zaninetti L. (1969) - Les Foraminifères du Trias de la région de l'Almtal (Haute-Autriche). *Jb. Geol. Bundesanst.*, Sonderbd.14, pp. 1-155, Wien.
- Liebus A. (1942) - Zur Foraminiferenfauna der Triasablagerungen von Eberstein. *Palaeont. Z.*, v. 23, pp. 51-73.
- Limongi P., Panzanelli-Frattoni R., Ciarapica G., Cirilli S., Martini R., Salvini-Bonnard G. & Zaninetti L. (1987) - *Turriplomina* Zaninetti, n. gen., un nouveau nom pour "*Turritellella*" mesotriassica Koehn-Zaninetti, 1968 (Foraminifère, Trias Moyen). *Archs. Sc. Genève*, v. 40, n. 1, pp. 13-22, Genève.
- Martini R., Rettori R., Urosevic D. & Zaninetti L. (1995) - Le genre *Piallina* Rettori & Zaninetti (Foraminifère) dans des calcaires à Turriplomines du Trias (Carnien) de Serbie orientale (Domaine Carpatho-Balkanique). *Rev. Paléob.*, v. 14, n. 2, pp. 411-415, Genève.
- Oberhauser R. (1957) - Ein Vorkommen von *Trocholina* und *Paratrocholina* in der ostalpinen Trias. *Jb. Geol. Bundesanst.*, v. 100, pp. 257-267, Wien.
- Oberhauser R. (1964) - Zur Kenntnis der Foraminiferengattungen *Permodiscus*, *Trocholina* und *Triasina* in der alpinen Trias und ihre Einordnung zu den Archaeidisciden. *Verh. Geol. Bundesanst.*, v. 2, pp. 196-209, Wien.
- Oravecz-Scheffer A. (1968) - A Miliolacea Föcsalád (Foraminifera) Képviselei a Bakonyzúcs-1 Sz. Furas Karni Képződményeiben: *M. All. Földt. Int. Evi. Jel.*, pp. 89-105, Budapest.
- Oravecz-Scheffer A. (1987) - Triassic foraminifers of the Transdanubian Central Range. *Geol. Hung., Series palaeont.*, v. 50, pp. 1-331, Budapest.
- Piller W. (1978) - Involutinacea (Foraminifera) der Trias und des Lias. *Beitr. Paläont. Österreich*, v. 5, pp. 1-164, Wien.
- Rettori R. (1995) - Foraminiferi del Trias inferiore e medio della Tetide: revisione tassonomica, biostratigrafia ed interpretazione filogenetica. *Publ. Dep. Geol. Paleont. de Genève*, v. 18, pp. 1-147, Genève.
- Rettori R., Zaninetti L., Martini R. & Vachard D. (1993) - *Piallina tethydis* gen. et sp. nov. (Foraminiferida) from the Triassic (Carnian) of the Koçaeli Peninsula, Turkey. *Journ. Micropal.*, v. 12, n. 2, pp. 170-174, London.
- Salaj J., Borza K. & Samuel O. (1983) - Triassic Foraminifers of the West Carpathians. *Geolog. Ustav Dionyza Stura*, pp. 1-213, Bratislava.
- Trifonova E. (1978) - The Foraminifera Zones and Subzones of the Triassic in Bulgaria. II Ladinian and Carnian. *Geol. Balc.*, v. 8, n. 4, pp. 49-64, Sofia.
- Trifonova E. (1992) - Taxonomy of Bulgarian Triassic foraminifera. I. Families Psammospaeridae to Nodosinellidae. *Geol. Balc.*, v. 22, n. 1, pp. 3-50, Sofia.
- Trifonova E. (1993) - Taxonomy of Bulgarian Triassic Foraminifera. II. Families Endothyridae to Ophthalmidiidae. *Geol. Balc.*, v. 24, n. 2, pp. 21-70, Sofia.
- Urosevic D. (1977) - Stratigraphic position of some foraminifers in the Triassic sediments of the Carpatho-Balkanides. *Ann. Géol. Pénin. Balk.*, v. 41, pp. 227-231, Beograd.
- Urosevic D. & Sudar M. (1991) - Triassic conodont fauna of the Yugoslavian Carpatho-balkanides. *Ann. Géol. Pénin. Balk.*, v. 55, pp. 147-159, Beograd.
- Weynschenk R. (1956) - *Aulotortus*, a new genus of Foraminifera from the Jurassic of Tyrol, Austria. *Contr. Cushman Fdn. Foramin. Res.*, v. 7, n. 1, pp. 205-207, Washington.
- Zaninetti L. (1969) - *Agathamminoides* gen. n., un nouveau genre de Foraminifères du Trias alpin. *Riv. It. Paleont. Strat.*, v. 75, n. 4, pp. 697-704, Milano.
- Zaninetti L. (1976) - Les Foraminifères du Trias. *Riv. It. Paleont. Strat.*, v. 82, n. 1, pp. 1-258, Milano.
- Zaninetti L. (1979) - *Gsollbergella*, new name for the foraminiferal genus *Agathamminoides* Zaninetti, 1969. *Notes du Laborat. de Paléont. Univ. Genève*, v. 5, p. 73, Genève.
- Zaninetti L. (1984) - Les Involutinidae (Foraminifères). Proposition pour un subdivision. *Rev. Paléobiol.*, v. 3, pp. 205-207, Genève.
- Zaninetti L., Ciarapica G., Martini R. & Rettori R. (1990) - Paléoécologie des Turriplomines (Foraminifères) dans le Trias de l'Apennin méridional (Bassin de Lagonegro). *Archs. Sc. Genève*, v. 43 (2), pp. 295-305, Genève.
- Zaninetti L., Ciarapica G., Martini R., Salvini-Bonnard G. & Rettori R. (1987) - *Turriplomina scandonei*, n. sp., dans les calcaires récifaux du Trias Moyen (Ladinien) en Apennin méridional. *Rev. Paléobiol.*, v. 6 (2), pp. 177-182, Genève.