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SMALLER FORAMINIFERS OF THE UPPER CARBONIFEROUS AUERNIG GROUP, CARNIC ALPS (AUSTRIA/ITALY)

DANIEL VACHARD* & KARL KRAINER**

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Riassunto. Viene descritta la componente micropaleontologica, in particolare i piccoli foraminiferi, dei calcari del Carbonifero Superiore del Gruppo di Auernig (Alpi Carniche, Austria/Italia). La maggior parte dei taxa sono stati descritti in precedenza dall'America Settentrionale, dall'Artico e dalla Russia (Urali, Donbass). Viene riconosciuto il valore biostratigrafico di *Pseudovidalina, Nodosinelloides, Tezaquina* e *Vervilleina* per il piano Orenburgiano. La parte sistematica è principalmente dedicata alle discussioni sui generi *Hemidiscus* e *Eolasiodiscus; Palaeobigenerina, Deckerella, Cribrogenerina* e *Climacammina; Ammovertella, Calcivertella* e *Calcitornella; Spireitlina* e *Pseudopaleospiroplectammina; Pseudovidalina* e *Raphconilia; Vervilleina* e *Tezaquina;* e *Nodosinelloides, Protonodosaria* e *Nodosaria.*

Abstract. The micropaleontological components, particularly smaller foraminifers, from limestones of the Upper Carboniferous Auernig Group (Carnic Alps; Austria/Italy) are described. Most of the taxa have been previously recorded from North America, Arctica and Russia (Urals, Donbass). The biostratigraphical value of *Pseudovidalina, Nodosinelloides, Tezaquina* and *Vervilleina* for the Orenburgian stage is recognized. The systematical part is principally devoted to generic discussions concerning *Hemidiscus* and *Eolasiodiscus; Palaeobigenerina, Deckerella, Cribrogenerina* and *Climacammina; Ammovertella, Calcivertella* and *Calcitornella; Spireitlina* and *Pseudopaleospiroplectammina; Pseudovidalina* and *Raphconilia; Vervilleina* and *Tezaquina;* and *Nodosinelloides, Protonodosaria* and *Nodosaria.*

Introduction

The Carnic Alps are one of the classic localities in Europe where upper Paleozoic shallow marine, fossiliferous sedimentary rocks are well exposed and well preserved. During the last decades major progress has been achieved on the sedimentology, paleontology and stratigraphy of this upper Paleozoic sequence, which is documented in a great number of publications (e.g. Boeckelmann, 1985; Sartorio & Venturini, 1988; Flügel & Krainer, 1992; Flügel et al., 1997; Forke, 1995; Forke et al., 1998; Fohrer, 1991; Fritz et al., 1990; Kahler, 1983, 1985, 1986, 1989; Krainer, 1991, 1992, 1995; Krainer & Davydov, 1998; Davydov & Krainer, 1999; Venturini, 1990 a-b, 1991).

Schellwien (1892, 1898) was the first who described foraminifers (fusulinids as well as smaller foraminifers) from upper Paleozoic limestones of the Carnic Alps. In the 1930's Kahler started with an extensive study of the fusulinid fauna. His work was continued by Forke (1995), Krainer & Davydov (1998), and Davydov & Krainer (1999), resulting in a detailed knowledge on the fusulinid assemblages of upper Paleozoic limestones.

Although many workers have pointed out that small foraminifers are a frequent constituent of the late Paleozoic limestones of the Carnic Alps (e.g. Flügel, 1971; Boeckelmann, 1985; Ebner, 1989; Kahler, 1989; Fohrer, 1991; Krainer, 1992, 1995), a systematic study of this fossil group is still missing.

The aim of this paper is to present a description of the smaller foraminifers of the upper Carboniferous Auernig Group and to discuss their distribution as well as their paleoecological and biostratigraphical significance.

Study area

The classic outcrops of the Auernig Group are located in the central Carnic Alps along the Austrian/Italian border, particularly east of Nassfeld Pass (Garnitzenberg = Monte Carnizza and Kronalpe = Monte Corona), near Straniger Alm (Rio Cordin, Cima Val di Puartis) and near Zollnersee.

This study is based on the investigation of 375

*Université des Sciences et Technologies de Lille, UFR Sciences de la Terre, UPRESA 8014 du CNRS, Bâtiment SN 5, F-59655 Villeneuve d'Ascq Cedex (France). Fax: 00.33.20.43.69.00. E mail: Daniel.Vachard@univ-lille1.fr

** Institut für Geologie und Paläontologie, Universität Innsbruck, Innrain 52, A-6020 Innsbruck (Austria). E mail: Karl.Krainer@uibk.ac.at

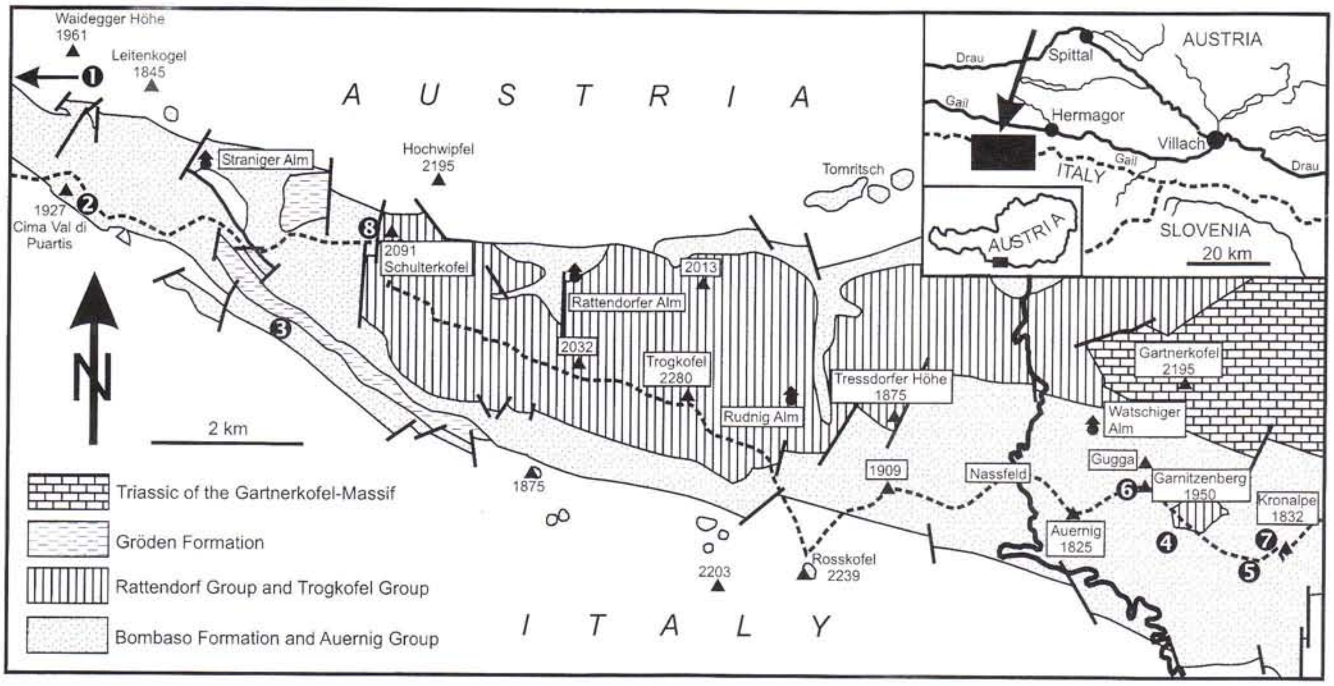

Fig. 1. - Simplified geologic map with distribution of the upper Paleozoic sedimentary rocks and location of the studied sections (1 Zollnersee, 2 Cima di Val di Puartis, 3 Rio Cordin, 4 Garnitzenberg S, 5 Ofenalm, 6 Garnitzenberg, 7 Kronalpe (= Monte Corona), 8 Schulterkofel).

thin sections from the following localities:

- Monte Auernig (localities A and B of Pasini, 1963) - basal Meledis Formation
- Zollnersee (sections Zollnersee W and Zollnersee SW of Davydov & Krainer, 1999, figs. 3 and 4) - basal Meledis Formation
- Cima Val di Puartis (Davydov & Krainer, 1999, fig. 5) - basal Meledis Formation
- Rio Cordin (Krainer, 1992, fig. 20) - Meledis Formation
- Garnitzenberg S (section Rio Tratte; Krainer, 1992, fig. 23) - Pizzul Formation
- Ofenalm (section Ofenalm/Casera For; Krainer, 1992, fig. 26) - uppermost Pizzul and Corona Formation
- Garnitzenberg (Krainer, 1992, figs. 32 and 33; Krainer, 1995, figs. 3, 4 and 5) - Auernig and Carnizza Formations
- Kronalpe (Krainer, 1992, fig. 27; Krainer, 1995, fig. 6) uppermost Corona and Auernig Formations
- Schulterkofel (Krainer, 1992, fig. 34) - uppermost Carnizza Formation.

The locations of these sections are shown in Fig. 1, sample numbers in this paper refer to the samples of the sections mentioned above.

Geological setting and stratigraphy

The late Paleozoic sedimentary sequence of the Carnic Alps rests unconformably upon the folded Variscan basement. The more than 2000 m thick sequence is divided into Bombaso Formation, Auernig Group, Rattendorf Group, Trogkofel Group, Tarvis Breccia, Gröden (= Val Gardena) Formation and Bellerophon Formation (Fig. 2) and consists of mixed carbonate-siliciclastic sediments which predominantly formed in a shallow marine environment.

Bombaso Formation

This basal unit is a clastic sequence with a maximum thickness of 200 m, composed of poorly sorted, immature breccias, conglomerates and sandstones derived from the folded Variscan basement. The deposits consist either predominantly of radiolarian chert and volcanic clasts (Pramollo Member) or predominantly of Silurian to Devonian limestone clasts (Malinfier Horizon). Fossils are rare, a few brachiopods, crinoids and fusulinids indicate a marine depositional environment. The deposits of the Bombaso Formation are interpreted as mass gravity flow deposits of fan deltas (Fenninger et al., 1976; Krainer, 1992; Venturini, 1990 a-b).

Auernig Group

The Auernig Group is a cyclic sequence of clastic and carbonate sedimentary deposits generated in a shallow marine environment. The sequence is up to 1200 m thick and according to Selli (1963) divided into Meledis, Pizzul, Corona, Auernig and Carnizza Formations. Meledis, Corona and Carnizza Formations are dominantly clastic with only a few thin limestone intercalations, Pizzul and Auernig Formations are composed of clastic sedimentary rocks interbedded with fossiliferous limestone-horizons.

Within the Auernig Group the following lithofa-

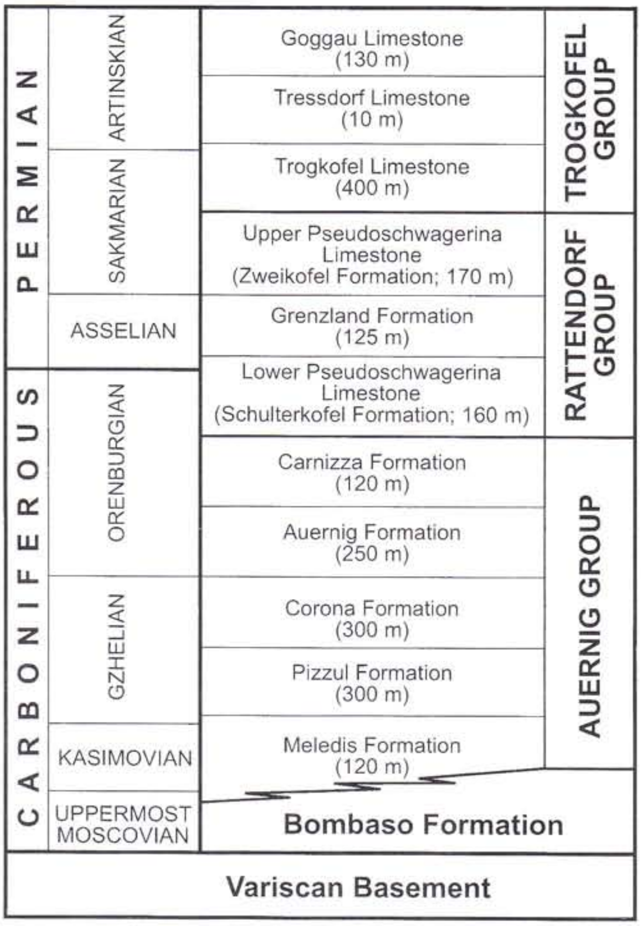

Fig. 2. - Generalized stratigraphic sequence of the late Carboniferous and early Permian sediments in the Carnic Alps, Austria/Italy (from Davydov & Krainer, 1999).

cies are recognized:
(a) quartz-rich conglomerates (nearshore environment),
(b) trough-crossbedded sandstones (upper shoreface),
(c) hummocky-crossbedded sandstones (lower shoreface),
(d) bioturbated and locally fossiliferous siltstones and shales (offshore),
(e) fossiliferous limestones (offshore),
(f) locally thin coal horizons and dark shales rich in plant fossils are present on top of conglomerate horizons (coastal swamp deposits).

Limestones contain abundant fossils, particularly algae (*Anthracoporella spectabilis* Pia, 1920; *Archaeolithophyllum missouriense* Johnson, 1956; *Epimastopora* spp.; *Eugonophyllum* spp. and others; e. g. Boeckelmann, 1985; Sartorio & Venturini, 1988; Krainer, 1991, 1992, 1995; Flügel & Flügel-Kahler, 1998), fusulinids (e.g. Kahler, 1983, 1985, 1986, 1989), smaller foraminifers, echinoderms, bryozoans (Kodsi, 1967), sphinctozoans (Kügel, 1987), brachiopods (Gauri, 1965), ostracods (Fohrer, 1991), *Tubiphytes* and other fossil remains. In the Meledis Formation small mounds formed of auloporid corals are described by Flügel & Krainer (1992).

Within thicker limestone horizons of the Auernig Formation locally massive algal mounds are developed (Krainer, 1995).

In the Corona, Auernig and Carnizza Formations the above listed lithofacies are arranged to form prominent high-frequency cycles ("Auernig cyclothems"). The cycles are 10-40 m thick. Each cycle is composed of conglomerates at the base, overlain by trough crossbedded sandstone, hummocky-crossbedded sandstone, siltstone and shale, fossiliferous limestone, siltstone and shale and sandstone.

Conglomerates formed during relative sea-level lowstands, and the fossiliferous limestones were deposited during relative sea-level highstands. The formation of these cycles is related to glacioeustatic sea-level changes (Massari & Venturini, 1990; Massari et al., 1991; Krainer, 1992, 1995).

Biostratigraphy of the Bombaso Formation and Auernig Group is mainly based on fusulinids (for summary see Kahler, 1983, 1985, 1986, 1989; Krainer & Davydov, 1998; Davydov & Krainer, 1999; Forke & Samankassou, 2000). Breccias of the Bombaso Formation contain the oldest fusulinid fauna of the Carnic Alps, which belongs to the *Quasifusulinoides quasifusulinoides-Protriticites ovatus* zone, indicating latest Moscovian age (Krainer & Davydov, 1998; Davydov & Krainer, 1999). The basal Meledis Formation yielded fusulinids of the *Protriticites pseudomontiparus* zone and *Montiparus paramontiparus* zone, pointing to early-middle Kasimovian age (Davydov & Krainer, 1999). The uppermost part of the Meledis Formation is characterized by the occurrence of *Ferganites ferganensis*, *Rauserites* sp. and *Rauserites rossicus*, indicating early Gzhelian age. Pizzul and Corona Formations contain *Schagonella* and *Daixina* species and are therefore regarded to be of late Gzhelian age. Auernig and Carnizza Formations contain a rich fusulinid fauna of Orenburgian age (Krainer & Davydov, 1998) (Gzhelian E according to Kahler). The Carboniferous/Permian boundary lies in the uppermost part of the Lower Pseudoschwagerina Limestone (Rattendorf Group), which overlies the Auernig Group (Krainer & Davydov, 1998; Forke, 1995; Forke et al., 1998).

Fossil assemblage of the lower Meledis Formation (early Kasimovian)

At localities A and B of Pasini (1963) at Monte Auernig, near the Italian/Austrian border, the following assemblage has been determined:

Pseudo-algae: *Tubiphytes obscurus* Maslov, 1956; *Beresella* sp.; *Trinodella* sp.; *Uraloporella* sp.; *Eflugelia* sp.

Smaller foraminifers: *Pachysphaerina pachysphaerica*

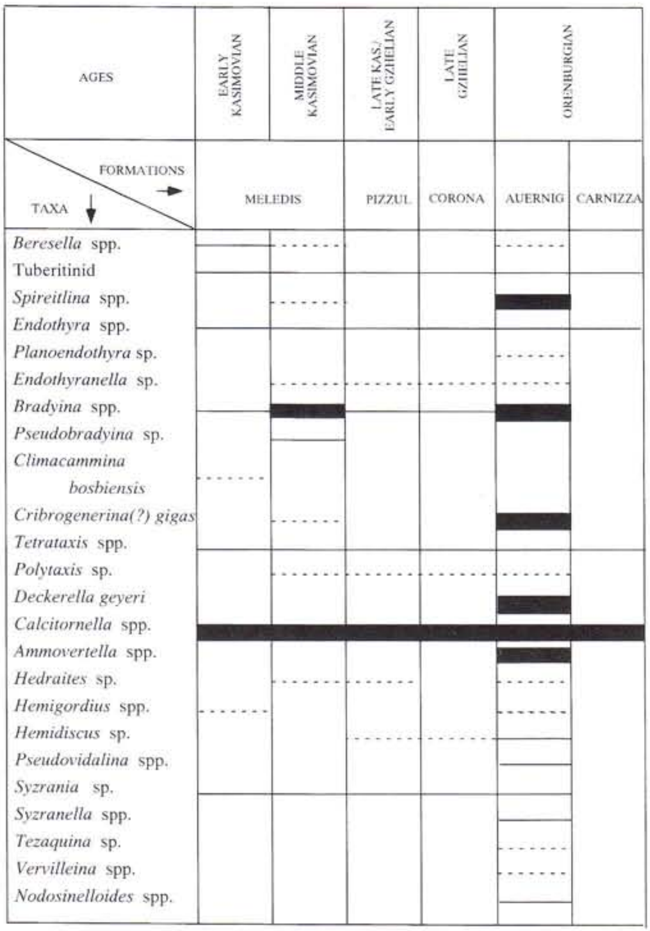

Fig. 3. - Main components of late Carboniferous microfacies of Carnic Alps.

(Pronina, 1963); *Diplosphaerina inaequalis* (Derville, 1931); *Tuberitina bulbacea* Galloway & Harlton, 1928; *Endothyra* sp.; *Bradyina samarica* Reitlinger, 1950; Tetrataxis sp.; *Climacammina bosbiensis* Bogush, 1963; *Globivalvulina* sp.; *Calcitornella* sp.; *Ammovertella* sp.; *Hemigordius harltoni* Cushman & Waters, 1928; «*Glomospira*» spp.; *Syzrania* sp.

Fusulinids: *Ozawainella* sp.; *Nankinella* sp.; *Eoschubertella* sp.; *Schubertella mjachkovensis* Rauser in Rauser et al., 1951; *Fusiella lancetiformis* Putrya, 1939; Wedekindellina sp.; *Praeobsoletes* ex gr. *tethydis* (Igo, 1972); *Protriticites pramollensis* (Pasini, 1963); P. ex gr. *ovatus* Putrya, 1948.

This assemblage was initially illustrated by Sartorio & Venturini (1988, p. 21, 22 middle, 23 above) thanks to a microfacies with *Protriticites, Wedekindellina, Ozawainella, Bradyina samarica* and *Bradyinelloides pseudonautiliformis.*

Except the acme of the genera *Protriticites* and *Praeobsoletes*, the characteristics of this association, compared to a late Moscovian one (Reitlinger, 1950), are: (1) the relative scarcity of Beresellids, (2) the small diversity of *Bradyina* and *Climacammina* (Fig. 3), (3) the abundance of *Calcitornella* sp., and (4) the disappearance of *Haplophragmina, Glomospiroides* and *Mediocris.*

Fossil assemblage of the upper Meledis Formation (middle Kasimovian)

The upper Meledis Formation, sampled in Rio Meledis, Rio Cordin, Cima Val di Puartis, Zollnersee SW (Geotrail stops 11 and 12; Schînlaub, 1991) contains:

Algae: *Anthracoporella spectabilis* Pia, 1920; *Epimastopora* sp.; *Pseudoepimastopora* sp.; *Gyroporella* spp.; *Herakella paradoxa* Kochansky, 1970a (Pl. 5, fig. 1; see also Forke & Samankassou, 2000: pl. 33, fig. 1-6); *Archaeolithophyllum missouriense* Johnson, 1956.

Pseudo-algae: *Tubiphytes* sp.; *Beresella translucea* Kulik, 1964 (Pl. 5, fig. 10).

Smaller foraminifers: *Diplosphaerina inaequalis* (Derville, 1931) (Pl. 1, fig. 2); *Tuberitina* sp.; *Insolentitheca horrida* (Brazhnikova in Brazhnikova et al., 1967 emend. Vachard in Bensaid et al., 1979); *Spireitlina bashkirica* (Rauser, 1949) (Pl. 1, fig. 7); *Endothyra* spp.; *Endothyranella* sp.; *Bradyina nautiliformis* von Moeller, 1878 (Pl. 1, fig. 20-21); *B. lucida* Morozova, 1949; *B.* cf. *arctica* Pinard & Mamet, 1998; *Bradyinelloides pseudonautiliformis* (Reitlinger, 1950); *Pseudobradyina pulchra* Reitlinger, 1950 (Pl. 1, fig. 22); *Hemidiscus carnicus* Schellwien, 1898 emend. herein (= *Lasiodiscus tenuis* Reichel, 1945); *Climacammina* sp.; *Deckerella* aff. *tenuissima* Reitlinger, 1950 (Pl. 2, fig. 9); *Cribrogenerina* (?) ex gr. *elegans* (von Moeller, 1879) sensu Schellwien, 1898 emend. herein [= *C.* (?) *gigas* (Suleimanov, 1949) = *C.* (?) *sphaerica* Potievskaya, 1962]; *Tetrataxis* spp.; *Polytaxis maxima* (Schellwien, 1898) (Pl. 2, fig. 12); *Globivalvulina ex gr. bulloides* (Brady, 1876); *Ammovertella* sp.; *Calcitornella* sp.; *Hedraites* sp. (Pl. 4, fig. 13); *Palaeonubecularia* (?) sp. (Pl. 4, fig. 16); *Hemigordius* sp.; *Syzrania* sp.

Fusulinids: *Ozawainella* sp.; *Staffella* sp.; *Nankinella* sp.; *Schubertella* sp.; *Protriticites* sp.; *Obsoletes* sp.; *Montiparus* sp.

The upper Meledis Formation is characterized by the scarcity of Beresellids, the diversity of *Bradyinidae*, the numerous *Spireitlina*, and the absence of *Pseudovidalina* and *Nodosinelloides*.

Fossil assemblage of the Pizzul Formation

The assemblage of the Pizzul Formation is similar to that of the upper Meledis Formation, with an apparent lack of *Beresella*. That is very episodic, since *Beresella* extends in the investigated samples up to the Auernig Formation. The observed fossil assemblage consists of:

Algae: *Anthracoporella* sp.; *Archaeolithophyllum* *missouriense* Johnson, 1956; «*A.*» *lamellosum* Wray, 1964 (already mentioned by Krainer, 1992: pl. 5, fig. 3); *Eugonophyllum* sp.; *Connexia slovenica* Kochansky, 1979 (= *C. carniapulchra* Flügel & Flügel -Kahler, 1980) (Pl. 5, fig. 2-3).

Pseudo-algae: *Asphaltina* (?) sp. (Pl. 5, fig. 11); *Claracrusta* sp.; *Tubiphytes* sp.; *Eflugelia* sp.

Smaller foraminifers: *Diplosphaerina* sp.; *Tuberitina* sp.; *Spireitlina bashkirica* (Rauser, 1949); *Endothyra bowmani* Phillips, 1846 emend. Brady, 1876 emend. China, 1965 (see Sartorio & Venturini, 1988, p. 20, center); *E.* sp.; *Endothyranella stormi* (Cushman & Waters, 1928); *Bradyina compressa* Morozova, 1949; *B. lucida* Morozova, 1949; *B.* sp.; *Tetrataxis* sp.; *Globivalvulina* sp.; *Climacammina* sp.; *Hemidiscus* (= *Eolasiodiscus*) sp.; *Calcitornella* sp.; *Palaeonubecularia* (?) sp.; (Pl. 4, fig. 16); *Hemigordius schlumbergeri* (Howchin, 1895) (Pl. 4, fig. 8); *Syzrania* sp.

Fusulinids: *Ozawainella* sp., *Quasifusulina* sp. (see Sartorio & Venturini, 1988, p. 23, below), *Rauserites* sp.

Fossil assemblage of the Corona Formation

This assemblage is very poor and consists of:

Algae: *Anthracoporella* sp.; *Archaeolithophyllum* sp.; *Epimastopora* sp.

Pseudo-algae: *Claracrusta* sp.; *Tubiphytes* sp.; *Eflugelia* sp.

Smaller foraminifers: *Diplosphaerina* sp.; *Endothyra* sp.; *Endothyranella* sp.; *Bradyina lucida* Morozova, 1949 (Pl. 2, fig. 1); *Hemidiscus* (= *Eolasiodiscus*) sp.; *Climacammina* sp.; *Tetrataxis* sp.; *Polytaxis* sp.; *Ammovertella* sp.

Fusulinids: *Quasifusulina* sp.; *Daixina* sp.

Fossil assemblage of the Auernig Formation

Limestones of the Auernig Formation contain a very rich fossil assemblage including:

Algae: *Anthracoporella spectabilis* Pia, 1920; *Epimastopora alpina* Kochansky & Herak, 1960; *Pseudoepimastopora* spp.; *Gyroporella nipponica* Endo & Hashimoto, 1955; *G. dissecta* Chuvashov, 1974 (Pl. 5, fig. 4); *Mizzia cornuta* Kochansky & Herak, 1960; *Anchicodium* sp., *Archaeolithophyllum missouriense* Johnson, 1956; *Aseelahella* (nomen nudum: Vachard et al. unpublished, in press in Géobios) n. sp. (Pl. 5, fig. 5; Kronalpe, Mount GI). Appearance of very rare *Neoanchicodium* (Kronalpe) and *Globuliferoporella*.

Pseudo-algae: very rare *Ungdarella* ex gr. *uralica* Maslov, 1956 (Pl. 5, fig. 7); episodic *Eflugelia johnsoni* (Flügel, 1966) emend. Vachard in Massa & Vachard, 1979; scarce *Beresella polyramosa* Kulik, 1964 (Pl. 1, fig. 1; Pl. 5, fig. 6, 9); *Nostocites* sp.; *Claracrusta* ex gr. *catenoides* (Homann, 1972) emend. Vachard, 1980 (Pl. 5, fig. 8); *Tubiphytes* sp.

Smaller foraminifers: *Diplosphaerina inaequalis* (Derville, 1931); *Mendipsia conili* (Tien, 1980) (Pl. 1, fig. 4-5); *Tuberitina bulbacea* Galloway & Harlton, 1928 (Pl. 1, fig. 3); *Insolentitheca horrida* (Brazhnikova in Brazhnikova et al., 1967) emend. Vachard in Bensaid et al., 1979 (Pl. 1, fig. 6); *Spireitlina bashkirica* (Rauser, 1949) (Pl. 1, fig. 10, 12); S. cf. *conspecta* (Reitlinger, 1950) (Pl. 1, fig. 9); *S. tokmovensis* (Reitlinger, 1961) (Pl. 1, fig. 8, 11) = ? *S. kerri* (Pinard & Mamet, 1998); *Endothyra* ex gr. *bowmani* Phillips, 1846 emend. Brady, 1876 emend. China, 1965 (Pl. 1, fig. 16, 18); *E. arctica* Ross, 1967 (Pl. 1, fig. 14-15); *Planoendothyra* sp. (Pl. 1, fig. 19); *Endothyranella stormi* (Cushman & Waters, 1928) (Pl. 1, fig. 13, 17); *Bradyina nautiliformis* von Moeller, 1878; *B. samarica* Reitlinger, 1950 (Pl. 2, fig. 2); *B. lucida* Morozova, 1949 (Pl. 1, fig. 23-25); *B. compressa* Morozova, 1949 (Pl. 1, fig. 26); *B. arctica* Pinard & Mamet, 1998 (Pl. 2, fig. 4); *Bradyinelloides pseudonautiliformis* (Reitlinger, 1950) (Pl. 2, fig. 3); *Pseudobradyina pulchra* Reitlinger, 1950; *Hemidiscus carnicus* Schellwien, 1898 (= *Lasiodiscus tenuis* Reichel, 1945) (Pl. 4, fig. 17-26); *Pseudovidalina modificata* (Potievskaya, 1962) (Pl. 4, fig. 27, 29); *P. multihelicis* Pinard & Mamet, 1998 (Pl. 4, fig. 28, 30); *P. media* (Wang, 1974) (Pl. 4, fig. 31-32); *Palaeotextularia* spp. (Pl. 3, fig. 5-6); *Climacammina* cf. *magna* Roth & Skinner, 1930 (Pl. 3, fig. 15); *Cribrogenerina* (?) *elegans* (von Moeller, 1879) sensu Schellwien, 1898 emend. (Pl. 2, fig. 5); *C.* (?) ex gr. *elegans* (Pl. 2, fig. 5, 8, 10, 15-16; Pl. 3, fig. 4, 9, 12-14 [including *C.* (?) *gigas* (Suleimanov, 1949); *C.* (?) *sphaerica* (Potievskaya, 1962); *C.* (?) *major* (Morozova 1949) and *C.* (?) *stiliformis* (Lee & Chen in Lee et al., 1930)]; *Deckerella geyeri* (Schellwien, 1898) emend. herein (= *Deckerella laheei* Cushman & Waters, 1928) (Pl. 2, fig. 14; Pl. 3, fig. 1-3, 7-8, 10-11); *D. tenuissima* Reitlinger, 1950 (Pl. 2, fig. 6?; Pl. 3, fig. 16-18); *Tetrataxis* ex gr. *paraconica* Reitlinger, 1950 (Pl. 2, fig. 7, 17); *T.* spp. (Pl. 2, fig. 19); *Polytaxis maxima* (Schellwien, 1898) (Pl. 2, fig. 11); *Globivalvulina* sp.; *Ammovertella* spp. (Pl. 4, fig. 1, 10-12, 14-15); *Calcitornella heathi* Cushman & Waters, 1928 (Pl. 2, fig. 13, 18?, 20); *C.* sp. 2 (Pl. 4, fig. 9); *Hedraites* sp.; *Palaeonubecularia* sp.; *Cornuspira* (?) sp. 1 (Pl. 4, fig. 2-7); *Syzrania confusa* Reitlinger, 1950 (Pl. 4, fig. 33); *S. bella* Reitlinger, 1950 (Pl. 4, fig. 34); *Syzranella* cf. *higginsi* Pinard & Mamet, 1998 (Pl. 4, fig. 35); indeterminate Syzraniidae (Pl. 4, fig. 37); *Tezaquina clivuli* Vachard in Vachard & Montenat, 1981 (Pl. 4, fig. 38); *Vervilleina bradyi* (Spandel, 1901) (Pl. 4, fig. 36); *Nodosinelloides potievskayae* Mamet & Pinard, 1996 (Pl. 4, fig. 39-40, 42-43, 45-46, 49); *N.* aff. *longa* (Lipina, 1949) (Pl. 4, fig. 47, 50-52); *N. netschajewi* (Cherdyntsev,

	GARNITZENBERG	GUGGA	KRONALPE	MOUND GI (MONTE CARNIZZA)
Diplosphaerina inaequalis	●	●	●	●
Mendipsia conili	●		●	
Tuberitina bulbacea	●	●	●	●
Insolentitheca horrida	●		●	
Spireitlina cf. *conspecta*	●		●	
Spireitlina bashkirica	●	●	●	●
Spireitlina tokmovensis		●	●	
Endothyra ex gr. *bowmani*		●	●	
Endothyra spp.	●	●	●	●
Planoendothyra sp.	●			
Endothyranella stormi	●	●	●	
Endothyranella sp.		●		
Bradyina samarica	●			
Bradyina lucida	●	●		
Bradyina (?) arctica	●	●		
Bradyinelloides pseudonautiliformis	●			
Bradyina nautiliformis	●	●		
Tetrataxis paraconica	●	●	●	
Tetrataxis spp.	●	●	●	●
Polytaxis maxima	●			●
Deckerella geyeri/laheei	●	●	●	●
Palaeotextularia sp.			●	
Cribrogenerina (?) elegans	●		●	●
Cribrogenerina (?) spp.	●	●	●	●
Globivalvulina ex gr. *bulloides*	●			●
Hemidiscus carnicus/Lasiodiscus tenuis	●	●	●	●
Pseudovidalina modificata	●	●	●	●
Pseudovidalina multihelicis			●	
Pseudovidalina media	●		●	
Calcitornella spp.	●	●	●	●
Ammovertella spp.	●	●	●	
Hedraites sp.	●			
Palaeonubecularia sp.	●			
Cornuspira (?) sp. 1	●			
Syzrania spp.	●	●	●	●
Syzranella cf. *higginsi*	●		●	
Vervilleina bradyi	●			
Tezaquina clivuli	●	●		
Nodosinelloides potievskayae	●	●	●	●
Nodosinelloides sp.	●			
Nodosinelloides netschajewi	●			
Nodosinelloides aff. *longa*	●			
Protonodosaria aff. *longissima*	●			

Fig. 4. - Small foraminifers of the Auernig Formation in Carnic Alps, in several outcrops.

1914) (Pl. 4, fig. 41, 44, 48); *Protonodosaria* (?) aff. *longissima* (Suleimanov, 1949) (Pl.4, fig. 53-54).

Fusulinids: *Eostaffella* sp.; *Staffella* sp.; *Nankinella* sp.; *Boultonia* sp.; *Quasifusulina* sp.; *Schellwienia* sp.

The foraminiferal assemblage of the Auernig Formation of the Carnic Alps belongs to the biozone of *Pseudovidalina multihelicis* and *Nodosinelloides potievskayae*, which exhibits also the last Beresellids (Fig. 3-4). *Spireitlina, Climacammina* and *Bradyina* are diversified. *Deckerella geyeri/laheei* seems to be restricted to this interval. *Tezaquina* appears in the Carnic Alps before the early Permian. *Geinitzina* is totally absent. The last local occurrence of *Eostaffella* contributes to a better knowledge of this genus; if its appearance in the early Viséan is well known, with the species of the group *E. nalivkini* Malakhova, 1957, its exact time of disappearance was poorly established.

Fossil assemblage of the Carnizza Formation

The limestones of the Carnizza Formation display a very poor fossil assemblage, which is composed of:

Algae: *Anchicodium* sp.; *Epimastopora* sp.

Pseudo-algae: *Eflugelia* sp.

Foraminifers: *Diplosphaerina* sp.; *Tetrataxis* sp.; *Globivalvulina* sp.; *Calcitornella* sp.; *Nodosinelloides*

potievskayae Mamet & Pinard, 1996.
Fusulinids: *Boultonia* sp.

Conclusions

Compared to the classical Moscovian assemblages (Reitlinger, 1950, 1961), the early Kasimovian of the lower Meledis Formation is characterized by the massive occurrence of Calcivertellidae (*Calcitornella* and *Ammovertella*). During this period, *Climacammina* is only represented by *C. bosbiensis* Bogush, 1963 (Fig. 3).

The middle Kasimovian is poorly characterized and corresponds only to the first local important diversity of Bradyinidae (Fig. 3).

The Pizzul Formation is not well defined, probably only by the appearance of *Hemigordius schlumbergeri*. No particularity can be signalized for the Corona Formation. In general, the middle Kasimovian to late Gzhelian interval is very poorly defined in the Carnic Alps. Inversely, Auernig Formation is very rich and diversified (Fig. 4), and corresponds to a new complete colonization, especially by *Pseudovidalina* and *Nodosinelloides*, whose appearance is in the Kasimovian of Canada and Russia (Pinard & Mamet, 1998). The appearance of *Vervilleina* seems to be coeval in North America and in the Carnic Alps, i. e. latest Carboniferous. The first diversity of *Nodosinelloides* is also a characteristic feature (Fig. 3-4).

The Carnizza Formation contains *Nodosinelloides potievskayae* without *Pseudovidalina modificata*; but this assemblage is too poor and not conclusive.

Selected systematical paleontology

For the systematics of smaller foraminifers we followed the recent classification of Pinard & Mamet (1998; with complete bibliography), with some precisions derived from the Russian references (Morozova, 1949; Lipina, 1949; Potievskaya, 1962; Brazhnikova et al., 1967) or from the North-American and North-European literature concerning the Barents Sea (Groves, 1997; Groves & Wahlman, 1997); Kansas (Groves & Boardman, 1999); and Sverdrup basin (Mamet & Pinard, 1992; Henderson et al., 1995; Pinard & Mamet, 1998).

1. Synonymy of *Spireitlina* and *Pseudopaleospiroplectammina*

Pl. 1, fig. 7-12

As indicated by Groves & Boardman (1999), *Spireitlina* Vachard in Vachard & Beckary, 1991 has priority on *Pseudopaleospiroplectammina* Mamet & Pinard, 1992 for designating these Haplophragmellidae (foraminifers with endothyrid-chambers and calcareous-agglutinated wall), firstly planispirally coiled and secondly uncoiled and biseriate. Many homeomorphs exist in the literature but differ essentially by the shape of the chambers in the early stage and each corresponds to a completely coiled genus, which give its name to the taxon (e. g. *Rectoseptaglomospiranella*, *Rectochernyshinella*, *Rectogranuliferella*). The exact nomenclature of these forms needs some precisions.

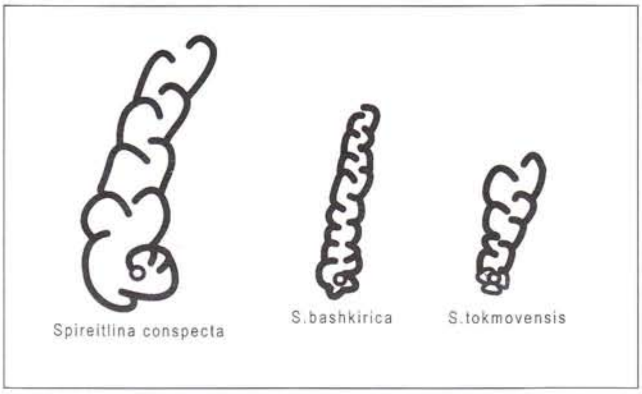

Fig. 5. - Sketches of different species of *Spireitlina* (approximative scale x100).

We have distinguished three species in the Auernig Group of the Carnic Alps (Fig. 5): *S. bashkirica* (Rauser, 1949) (Pl. 1, fig. 7, 12), *S.* cf. *conspecta* (Reitlinger, 1950) (Pl. 1, fig. 9) and *S. tokmovensis* (Reitlinger, 1961) (Pl. 1, fig. 8, 10). In contrast to Pinard and Mamet (1998, p. 62), we assume that *S. tokmovensis* is a valid species with the following reference: *Spiroplectammina tokmovensis* Reitlinger, 1961, p. 239, pl. 3, fig. 4, from the late Podolskian of the Russian Platform, sample number 3439/4. *Pseudospiroplectammina kerri* Pinard & Mamet, 1998, is probably synonym of *S. tokmovensis*.

In *Spireitlina conspecta* the initial part is prominent and relatively long (convergence with *Rectogranuliferella* Conil & Lys in Mansy et al., 1989 or *Malayspirina* Vachard in Fontaine et al., 1988), in *S. bashkirica*, this one is shorter but remains rather developed. In *S. tokmovensis* this part is very short (with convergence with *Globispiroplectammina* Vachard, 1977 emend. Vachard & Beckary, 1991).

2. Endothyrids and Bradyinids

Pl. 1, fig. 13-26, Pl. 2, fig. 1-4

Concerning these two families, we followed the nomenclature of Pinard & Mamet (1998), using the generic names *Endothyra, Planoendothyra* and *Endothyranella* for the former family, *Pseudobradyina, Bradyina* and *Bradyinelloides* for the second one.

SCHELLWIEN DESCRIBED TAXON	FIGURES	OUTCROPS	RECOMMENDED NAME
Endothyra aff. bowmani	pl. 23, fig. 3-4	Krone	*Bradyina compressa*
Endothyra cf. parva	pl. 23, fig. 5-6	Ibidem	*Endothyra* ex gr. *bowmani*
Hemidiscus carnicus	pl. 23, fig. 7-9	Ibidem	*Hemidiscus carnicus* = *Lasiodiscus tenuis* = *Eolasiodiscus spp.*
Psammophis inversus	pl. 23, fig. 10	Auernig Bed S	*Ammovertella inversa*
Textularia textulariformis	pl. 23, fig. 11	Auernig Bed S	*Palaeotextularia* sp.
Bigenerina geyeri	pl. 23, fig. 12-13	Auernig Bed S	*Deckerella geyeri* (= *D. laheei*)
Textularia cf. bradyi	pl. 23, fig. 14	Neumarktl in Oberkrain	*Palaeotextularia* sp.
Bigenerina sp.	pl. 23, fig. 15	Bombachs-graben	*Deckerella* ? sp.
Bigenerina elegans	pl. 24, fig. 1-4	Auernig Bed S	*Cribrogenerina* (?) *elegans*
Tetrataxis maxima	pl. 24, fig. 5-10	Auernig Bed S	*Polytaxis maxima*
Tetrataxis maxima var. depressa	pl. 24, fig. 11	Auernig Bed S	*Polytaxis* sp.

Fig. 6. - Reinterpretation of the taxa described by Schellwien, 1898 (see also Ebner, 1989).

3. The question of Paleotextulariid taxa: *Bigenerina geyeri* /*Deckerella laheei* and *Bigenerina elegans*/*Cribrogenerina gigas auctorum*

Pl. 2, fig. 5-6, 8-10, 14-16, Pl. 3, fig. 1-18

In the investigated samples we identified many *Deckerella laheei* Cushman & Waters, 1928, but no *Bigenerina geyeri* Schellwien, 1898 whose type locality is the bed «s» of Auernig (Fig. 6). In this case we suppose that *Bigenerina geyeri*, type species of *Palaeobigenerina* Galloway, 1933, is only a *Deckerella laheei* without the last chamber, while in the preceeding chamber the aperture seems to be not cribrate but single. Consequently the genus *Palaeobigenerina* is an immature *Deckerella* (Fig. 7). Therefore the differences of many *Climacammina*-like genera are very difficult to establish, but we admit the necessity of *Deckerella* or *Cribrogenerina* for subdividing the too much prolific genus *Climacammina*. Furthermore the species included into *Cribrogenerina* by Pinard and Mamet (1998) are very different to *Cribrogenerina* sensu stricto from the middle-late Permian, and more intermediate between *Climacammina* by the relatively long biseriate stage, and *Cribrogenerina* sensu stricto by the strongly cribrate apertural face. For this reason we attribute to *Cribrogenerina* (?) (Fig. 6-7), i. e. *C.* sensu lato, the species (or morphotypes) more or less identical to «*Bigenerina elegans*» (von Moeller, 1879) sensu Schellwien, 1898: *Cribrogenerina* (?) *elegans* (von Moeller, 1879), *C.* (?) *major* (Morozova, 1949), *C.* (?) *gigas* (Suleimanov, 1949), *C.* (?) *sphaerica* (Potievskaya, 1962), *C.* (?) *stiliformis* (Lee & Chen in Lee et al., 1930); that call for the following remarks: (a) all these species were discussed in Pinard & Mamet, 1998; (b) synoptical comparisons are given herein: Pl. 2, fig. 5, 8, 10, 15-16; Pl. 3, fig. 4, 9, 12-14; (c) among the two figures of *Climacammina elegans* (von Moeller), presented by Kochansky (1970: pl. 1, fig.12-13), the former corresponds exactly to *Cribrogenerina* (?) *elegans*, but the second one is typically a *C.* (?) *gigas*.

4. Precisions on *Tetrataxis* and *Polytaxis*

Pl. 2, fig. 7, 11-12, 17, 19

The genus *Tetrataxis* is well known, but its species are too numerous and generally impossible to distinguish. In the Auernig Group, *Tetrataxis paraconica*

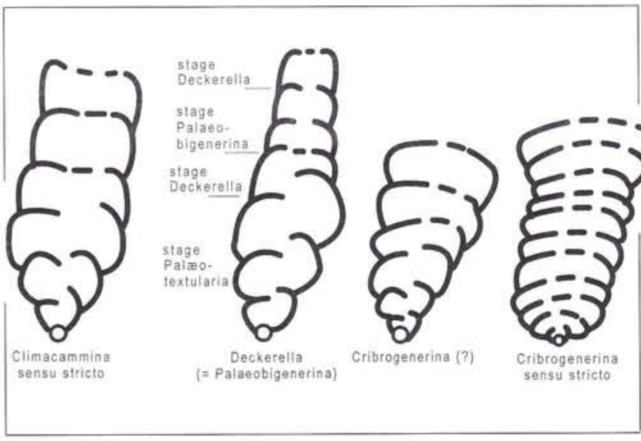

Fig. 7. - Sketches of different genera of Palaeotextulariidae (approximative scale x 25).

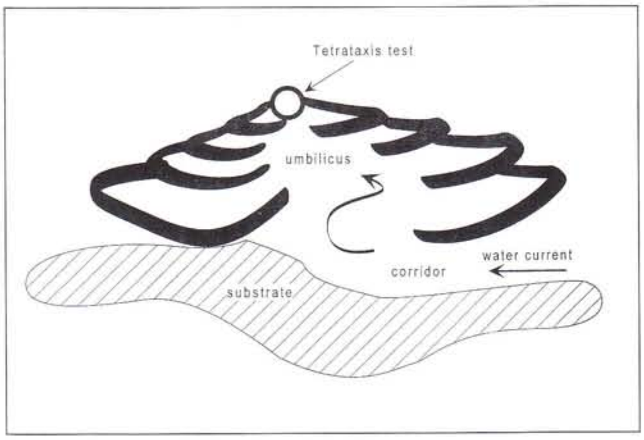

Fig. 8. - Sketch of Tetrataxidae (approximative scale x 50).

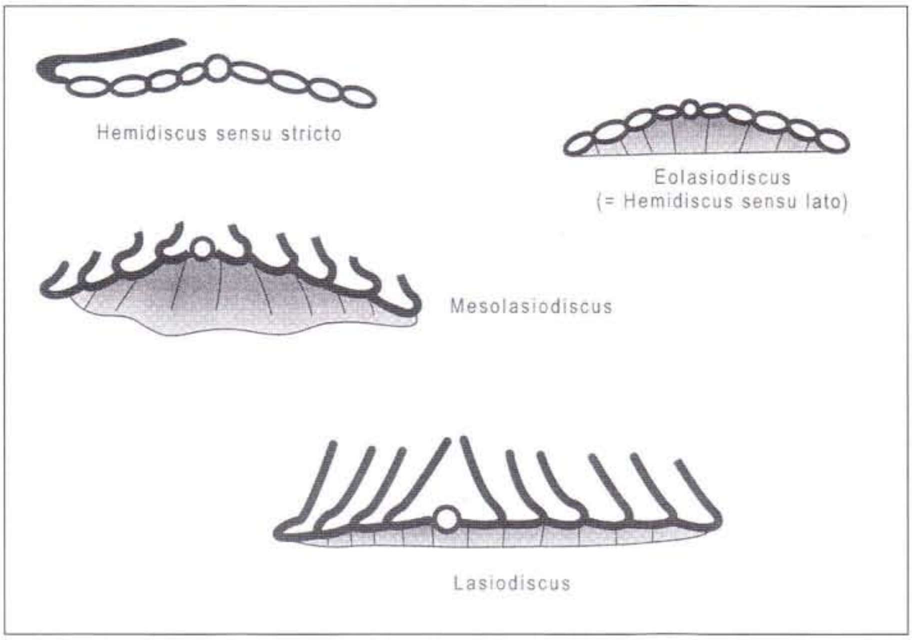

Fig. 9. - Sketches of different genera of Lasiodiscidae (approximative scale x 90).

Reitlinger, 1950 (Pl. 2, fig. 7 ?, 17) is frequently found. Three *Tetrataxis* were observed in life position (Pl. 2, fig. 19), i. e. incompletely attached to the substrate, the apex upwards, with an open space between the substrate and the umbilicus probably crossed over by water-currents leading the nutrients to the foraminifer (Fig. 8).

Polytaxis maxima (Schellwien, 1898) has been recognized throughout the Auernig Group (Pl. 2, fig. 11-12). This genus can be distinguished from *Tetrataxis* by the larger test and the shape of the umbilicus; the proloculus area of *Polytaxis* is probably more complex.

5. The problem of *Hemidiscus* and *Eolasiodiscus*

Pl. 4, fig. 17-26

Actually, *Hemidiscus* is generally considered as a genus more or less similar to an ammodiscid (planispiral, evolute non septate foraminifers with a siliceous-agglutinated wall). A such type is completely lacking in our investigated samples of the Carnic Alps, contrarily to the genus *Eolasiodiscus*, which is rather common. By the absence of hyaline filling in the umbilicus, Pinard & Mamet (1998) have interpreted *Hemidiscus* as a similar but distinct genus of *Eolasiodiscus* (Fig. 9). This proposed generic limit is not distinguishable in our samples. Therefore, we conclude that *Hemidiscus* and *Eolasiodiscus* are rigorously synonyms. By its shape and dimensions, *Hemidiscus carnicus* is probably also identical to the species described in the literature as «*Lasiodisus*» *tenuis* Reichel, 1945 (see: Kochansky, 1970b; Milanovic, 1982; Ebner, 1989), and more precisely to the morphotypes of this species illustrated herein Pl. 4, fig. 20-21, with a very weak or inexistent yellow axial filling and some irregularities of the coiling in the last whorl. However, *Lasiodiscus tenuis* likely belongs to *Eolasiodiscus*, by its absence of adventice chamberlets, and looks like *Eolasiodiscus* aff. *grandis* Ivanova, 1973 redescribed by Pinard and Mamet (1998).

Hemidiscus carnicus Schellwien, 1898 emend. herein

Pl. 4, fig. 17-26

1898 *Hemidiscus carnicus* Schellwien, p. 266-267, pl. 23, fig. 7-9.
1945 *Lasiodiscus tenuis* Reichel, p. 530, fig. 3; pl. 19, fig. 3.
1949 *Ammodiscus semiconstrictus* var. *regularis* Waters - Lipina, p. 199-200, pl. 1, fig. 1-2, 11.
1949 *Ammodiscus semiconstrictus* var. *minima* Lipina, p. 200, pl. 1, fig. 14.
1949 *Ammodiscus semiconstrictus* var. *lucida* Lipina, p. 200, pl. 1, fig. 3.
1949 *Hemidiscus carnicus* var. *spiralis* Lipina, p. 203-204, pl 2, fig. 1-2.
1949 *Hemidiscus carnicus* - Suleimanov, p. 237, pl. 1, fig. 2.
1954 *Lasiodiscus tenuis* - K.V. Miklukho-Maclay, p. 15, pl. 1,fig. 3.
1970b *Lasiodiscus tenuis* - Kochansky, p. 187, p. 227, pl. 16, fig. 7-8.
1971 *Hemidiscus carnicus* - Flügel, pl. 2, fig. 6.
1980 *Hemidiscus carnicus* - Flügel, pl. 1, fig. 3 (questionable, perhaps *Mesolasiodiscus*).
1981 *Hemidiscus carnicus* var. *spiralis* - Zhao et al., pl. 1, fig. 5.
1982 *Lasiodiscus tenuis artiensis* Baryshnikov in Baryshnikov et al., p. 38, pl. 9, fig. 21.
1982 *Eolasiodiscus donbassicus* - Milanovic, p. 12-13, pl. 1, fig. 9.
1982 *Lasiodiscus tenuis* - Milanovic, p. 12, pl. 1, fig. 10-11.
1989 *Hemidiscus carnicus* - Ebner, p. 39, pl. 6, fig. 1-3 (cum syn.).
1990 *Lasiodiscus tenuis* - Lin et al., p. 208, pl. 23, fig. 20.
1993 *Hemidiscus carnicus* - Vdovenko et al., p. 50, pl. 9, fig. 5a-b.
1993 *Lasiodiscus minor* - Vachard et al., pl. 3, fig. 4.
1995 *Eolasiodiscus* sp. - Forke, p. 241, pl. 16, fig. 4.
1997 *Lasiodiscus minor* - Sremac & Aljinovic, pl. 1, fig. 2.
1998 *Eolasiodiscus* sp. - Forke et al., pl. 4, fig. 8.
1998 *Hemidiscus minimus* - Pinard & Mamet, p. 100, pl. 25, fig. 3-4.
1998 *Eolasiodiscus lucidus* - Pinard & Mamet, p. 102, pl. 25, fig. 14-15, 17-20, 25.
1998 *Eolasiodiscus* sp. aff. *E. grandis* - Pinard & Mamet, p. 102-103, pl. 25, fig. 23, 26-29, pl. 26, fig. 1, 3-8, 10-13, 16-17.

	Diameter	Width	W/d	Whorls	Proloculus	Height of last whorl	Wall thickness
Hemidiscus carnicus Schellwien, 1898	0.45-0.50	-	-	6-7	-	0,05	-
Lasiodiscus tenuis Reichel, 1945	0.44	-	-	11-12	0.02	0.03	-
Lasiodiscus tenuis - K.V. Mikhlukho-Maclay, 1954	0.39-0.41	-	-	11-12	0.02	0.03-0.04	0.004
Lasiodiscus tenuis - Kochansky, 1970b	0.32-0.42	-	-	12	0.01-0.02	0.03-0.05	0.004
Ammodiscus semiconstrictus regularis - Lipina, 1949	0.27-0.48	0.03-0.06	-	7-10	0.02-0.04	-	0.010-0.012
Ammodiscus semiconstrictus var. minima Lipina, 1949	0.20-0.25	-	-	7-10	-	-	-
Ammodiscus semiconstrictus var. lucidus Lipina, 1949	0.25-0.38	0.05-0.08	-	> 7	0.03	0.02-0.04	0.007
Hemidiscus lucida - Pinard & Mamet, 1998	0.15-0.26	0.03-0.04	-	5-7 (9)	0.03-0.05	-	0.003-0.010
Eolasiodiscus aff. grandis Pinard & Mamet, 1998	0.41-0.50 (→0.58)	0.06-0.10	-	8-10	0.03-0.05	-	0.008-0.015
This study	0.43-0.54	0.15-0.30	0.32-0.53	9-10	0.02-0.03	0.01	0.003

Fig. 10. - Comparison of the measurements of various species attributed here to *Hemidiscus carnicus* emend.

Dimensions (Fig. 10). Diameter = 0.43-0.54 mm; width = 0.15-0.30 mm; width/diameter = 0.32-0.53 for 9-10 whorls. These measurements correspond to those of Schellwien (1898), and the size of our material is remarkably homogenous.

Occurrence. Kasimovian-Artinskian, Tethyan and Boreal.

6. Synonymy of *Pseudovidalina* and *Raphconilia*

Pl. 4, fig. 27-32

We agree with the synonymy proposed by Pinard & Mamet (1998) between *Pseudovidalina* and *Raphconilia* Brenckle & Wahlman, 1996 (= *Conilia* Brenckle & Wahlman, 1994; preoccupied). The general shape as well as the omega-shaped section of the tubular chamber are rigorously identical (see here: Pl. 4, fig. 28). We attempted to find more discrete differences, like that existing among the genera of Archae discids (see summary in Vachard, 1988 and Pinard & Mamet, 1998), but any is convincing. *Pseudovidalina* is represented by three species in the investigated material: *P. modificata* (Potievskaya, 1962) (Pl. 4, fig. 27, 29), *P. multihelicis* Pinard & Mamet, 1998 (Pl. 4, fig. 28, 30), and *P. media* (Wang, 1974) (Pl. 4, fig. 31-33).

P. modificata (Potievskaya, 1962) sensu Brenckle & Wahlman (1994) or Groves & Boardman (1999) for us is synonym of *P. pararecta* Pinard & Mamet, 1998, *Eolasiodiscus* (?) *facetus* Han in Zhao et al., 1984 and *Kasachstanodiscus* spp. of Davydov (1988), with a diameter between 0.26 and 0. 39 mm for 5 to 7 whorls, initially low and involute, becoming higher and evolute (Fig. 11). *P. multihelicis* Pinard & Mamet, 1998, displays identical parameters, but differs by its «*angulatus*» stage, according to the nomenclature of Archaeodiscids (revision in Vachard, 1988).

7. Discussion on Calcivertella, Ammovertella and Calcitornella

Pl. 2, fig. 13, 18, 20, Pl. 4, fig. 1, 9-16

The future type species of *Ammovertella* was described by Schellwien (1898) in the Carnic Alps under the name *Psammophis inversus*. According to our new

	Diameter	Width	Whorls	Proloculus	Height	Wall
Eolasiodiscus modificatus Potievskaya, 1962	0.26 - 0.39	-	5 - 7	22 (----> 33)	19 - 33	0.002 - 0.003
Conilia modificata Brenckle & Wahlman, 1994	0.19 - 0.26	0.035 - 0.060	5 - 7	30	17- 29	0.005 - 0.009
Raphconilia modificata Groves & Boardman, 1999	0.195 - 0.345	0.045 - 0.060	5 1/2 - 7	20 - 30	25 - 45	0.005 - 0.010
Pseudovidalina pararecta Pinard & Mamet, 1998	0.250 - 0.400	0.060 - 0.080	4 1/2 - 6	20 - 25	20 - 30	-
Pseudovidalina multihelicis Pinard & Mamet, 1998	0.245 - 0.355	---> 0.065	(6 1/2) 7 1/2 - 9 1/2	15 - 30	-	-
Eoladiodiscus? facetus Han in Zhao *et al.*, 1984	0.26 - 0.30	0.60 - 0.70	7	-	-	-

Fig. 11. - Table of dimensions of *Pseudovidalina* ex gr. *modificata* (Potievskaya, 1962).

discoveries of *Ammovertella inversa* (Schellwien, 1898) in the Carnic Alps, we consider the wall of *Ammovertella* to be porcelaneous and not siliceous-agglutinated. Therefore, *Ammovertella* Cushman, 1928 and *Calcivertella* Cushman & Waters, 1928 are synonyms. *Ammovertella* has priority according to Galloway & Ryniker (1930, p. 9), or not (Vdovenko et al., 1993, p. 56). We agree with the former opinion. The nomenclature of Calcivertellidae and/or other attached porcelaneous forms is complicate and questionable (Fig. 12).

The most common taxon in the Carnic Alps is *Calcitornella heathi* Cushman & Waters, 1928, strongly attached to the substrate (Pl. 2, fig. 13, 18, 20). Hypothetically, we determined: *Ammovertella* aff. *elegantissima* with closely serpentiform last whorls (Pl. 4, fig. 1, 10); *Calcitornella* sp. 2 short and relatively thick-walled (Pl. 4, fig. 9) and *Ammovertella* (?) with a thin-walled, zigzag-shaped last chamber (Pl. 4, fig. 11, 15).

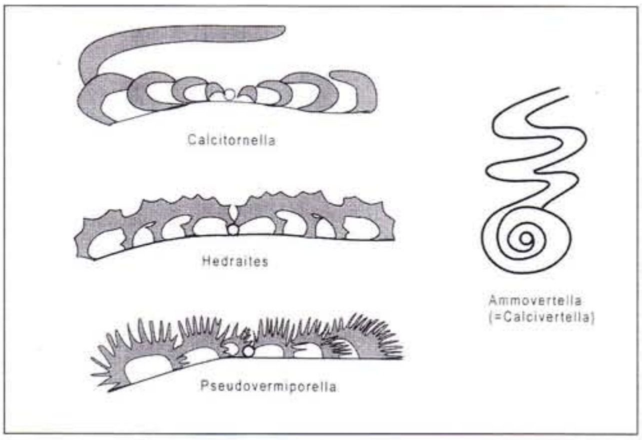

Fig. 12. - Sketches of different genera of Calcivertellidae (not to scale).

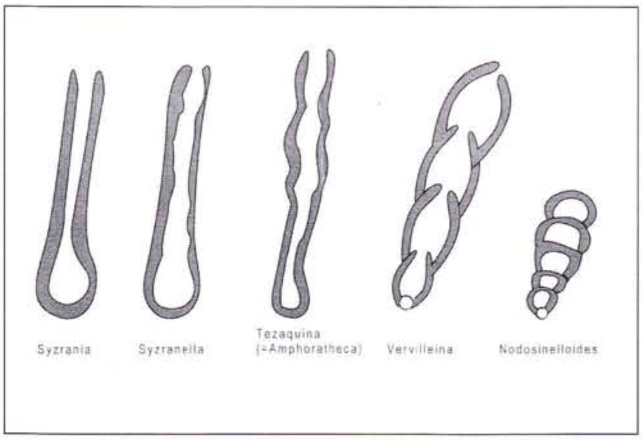

Fig. 13. - Sketches of different genera of Syzraniidae (approximative scale x90).

8. Composition of Syzraniidae: *Syzrania, Syzranella, Amphoratheca, Tezaquina* and *Vervilleina*

Pl. 4, fig. 33-38

As supposed by Vachard (1980) and confirmed by Groves & Wahlman (1997), the Syzraniidae are the missing link between the Earlandiidae and the Nodosariidae. The progressive appearance of the septation remains the familial characteristic with the evolution *Syzrania-Syzranella-Tezaquina (=Amphoratheca)-Vervilleina* (Fig. 13).

In contrast to the opinion of Groves & Boardman (1999) «*Tezaquina clivuli* Vachard, 1980» is invalid, because the holotype is not designated; the only valid species is *Tezaquina clivuli* Vachard in Vachard & Montenat, 1981: p. 74, pl 14, fig. 4-11. As indicated by Vdovenko et al. (1993, p. 97), and questionably admitted by Groves & Boardman (1999). *Tezaquina* seems to be a prioritary synonym of *Amphoratheca* Mamet & Pinard, 1992, both having in common the slightly depressed sutures of the irregular pseudochambers but we can also admit three stages of evolution = *Tezaquina-Amphoratheca-Vervilleina* (B. Mamet, personal communication). Several species with true chambers attributed to *Tezaquina* in the literature in fact belong to *Vervilleina* Groves & Boardman, 1999. In the Carnic Alps we recognized only a *Tezaquina clivuli* Vachard in Vachard & Montenat, 1981 non Vachard, 1980 (Pl. 4, fig. 38) and a *Vervilleina bradyi* (Spandel, 1901) emend. Groves & Boardman, 1999 (Pl. 4, fig. 36).

9. Exact limits of *Nodosaria, Nodosinelloides* and *Protonodosaria*

Pl. 4, fig. 39-54.

The differences of the wall indicated for these three genera are not convincing and not always conspicuous. The only true difference is the type of aperture: indistinct or inconstant in *Nodosinelloides*, terminal round in *Protonodosaria*, stellate in *Nodosaria* (Fig. 14). The exact period of appearance of the true *Nodosaria*, which is not clearly established, is probably earliest Jurassic or Triassic. *Nodosinelloides* and *Protonodosaria* are mentioned in the Kasimovian of Canada (Henderson et al., 1995; Pinard & Mamet, 1998) or only in the late

PLATE 1

Fig. 1 - *Beresella polyramosa* Kulik, 1964. Joint longitudinal and transverse sections, Kronalpe, Auernig Formation, Orenburgian, sample KR 28a; x 90.

Fig. 2 - *Diplosphaerina inaequalis* (Derville, 1931). Longitudinal section; tuberitinid stage with two spheres, Zollnersee, upper Meledis Formation, middle Kasimovian, sample ZO 3; x 90.

Fig. 3 - *Tuberitina bulbacea* Galloway & Harlton, 1928. Longitudinal section, Kronalpe, Auernig Formation, Orenburgian, sample KR 20a; x 36.

Fig. 4-5 - *Mendipsia conili* (Tien, 1980) Auernig Formation, Orenburgian; x 90. Fig. 4 - Tuberitinid stage (compare also with *Tuberitina* sp. of Kochansky, 1970b: pl. 1, fig. 3-5 or *Tuberitina collosa* of Sremac & Aljinovic, 1997: pl. 1, fig. 3), Garnitzenberg, sample G 35;

Fig. 5 - Diplospherid stage encrusted by a *Diplosphaerina inaequalis* at the tuberitinid stage (i. e. *Eotuberitina* auctoris), Kronalpe, sample KR 45.

Fig. 6 - *Insolentitheca horrida* (Brazhnikova in Brazhnikova et al., 1967) emend. Vachard in Bensaid et al., 1979 (not «syzygial kyst» auct.). Garnitzenberg, Auernig Formation, Orenburgian, sample G 31;x 90.

Fig. 7, 10, 12 - *Spireitlina baschkirica* (Rauser, 1949); x 90. Fig. 7 - Axial section. Zollnersee, upper Meledis Formation, middle Kasimovian, sample ZO 14; Fig. 10 - Kronalpe, Auernig Formation, Orenburgian, sample KR 27/2; Fig. 12 - Mature axial section. Mount GI, Auernig Formation, Orenburgian, sample GI 15.

Fig. 8, 11 - *Spireitlina tokmovensis* (Reitlinger, 1961). Two axial sections Auernig Formation, Orenburgian; x 90. Fig. 8 - Gugga, sample GL 15; Fig. 11 - Kronalpe, sample KR 38a.

Fig. 9 - *Spireitlina* cf. *conspecta* (Reitlinger, 1950). Axial section, Garnitzenberg, Auernig Formation, Orenburgian, sample GP 9 (D); x 84.

Fig. 13, 17 - *Endothyranella stormi* (Cushman & Waters, 1928). Auernig Formation, Orenburgian; x 90. Fig. 13 - Axial section, Kronalpe, sample KR 53; Fig. 17 - Transverse section, Garnitzenberg, sample G 40.

Fig. 14, 15 - *Endothyra arctica* Ross, 1967. Garnitzenberg, Auernig Formation, Orenburgian; x 85. Fig. 14 - Subaxial section, sample GP 30 (E); Fig. 15 - Subtransverse section, sample GP 25 (D); x 86.

Fig. 16 - *Endothyra bowmani* Phillips, 1846 emend. Brady, 1876 emend. China, 1965. Transverse section, Garnitzenberg, Auernig Formation, Orenburgian, sample GP b/3; x 86.

Fig. 18 - *Endothyra* ex gr. *bowmani* Phillips, 1846 emend. Brady, 1876 emend. China, 1965. Transverse section, Garnitzenberg, Auernig Formation, Orenburgian, sample G 45; x 90.

Fig. 19 - *Planoendothyra* sp. Subaxial section, Garnitzenberg, Auernig Formation, Orenburgian, sample GP 6 (E); x 85.

Fig. 20, 21 - *Bradyina nautiliformis* von Moeller, 1878. Fig. 20 - Subaxial section, Zollnersee, upper Meledis, middle Kasimovian, sample ZO 25; x 17; Fig. 21 - Subtransverse section, Zollnersee, upper Meledis, middle Kasimovian, sample ZO 25; x 19.

Fig. 22 - *Pseudobradyina pulchra* Reitlinger, 1950. Transverse section, Zollnersee, upper Meledis, middle Kasimovian, sample ZO 26; x 90

Fig. 23-25 - *Bradyina lucida* Morozova, 1949. Garnitzenberg, Auernig Formation, Orenburgian. Fig. 23 - sample G 31; x 36; Fig. 24 - sample GP 24 (D); x 36; Fig. 25 - sample GP 11/2(D); x 30.

Fig. 26 - *Bradyina compressa* Morozova, 1949. Axial section, Auernig E, Auernig Formation, Orenburgian, cf. sample GP 24; x 86.


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PLATE 2

Fig. 1 - *Bradyina lucida* Morozova, 1949. Transverse section, Casera For, Corona Formation, late Gzhelian, sample CF 1h; x 36.

Fig. 2 - *Bradyina samarica* Reitlinger, 1950. Axial section, Garnitzenberg, Auernig Formation, Orenburgian, sample GP 35a (B); x 83.

Fig. 3 - *Bradyinelloides pseudonautiliformis* (Reitlinger, 1950). Transverse section, Garnitzenberg, Auernig Formation, Orenburgian, sample GP e/1; x 36.

Fig. 4 - *Bradyina arctica* Pinard & Mamet, 1998. Subaxial section, Auernig E, Auernig Formation, Orenburgian, cf. sample GP 24; x 37.

Fig. 5 - *Cribrogenerina* (?) *elegans* (von Moeller, 1879) sensu Schellwien, 1898. Axial section, Garnitzenberg, Auernig Formation, Orenburgian, sample GP 33/2; x 37.

Fig. 6?, 9 - *Deckerella* aff. *tenuissima* Reitlinger, 1950. Fig. 6 - Subaxial section of an immature specimen, Garnitzenberg, Auernig Formation, Orenburgian, sample G 45; x 90; Fig. 9 - Axial section, Zollnersee, upper Meledis Formation, middle Kasimovian, sample ZO 26; x 36.

Fig. 7 - *Tetrataxis* ex gr. *paraconica* (Reitlinger, 1950). Axial section, Garnitzenberg, Auernig Formation, Orenburgian, sample GP y; x 37.

Fig. 8 - *Cribrogenerina* (?) *gigas* (Suleimanov, 1949). Subaxial section, Garnitzenberg, Auernig Formation, Orenburgian, sample GP 38; x 35.

Fig. 10 - *Cribrogenerina* (?) *sphaerica* Potievskaya, 1962. Oblique section, Garnitzenberg, Auernig Formation, Orenburgian, sample GP C/1; x 36.

Fig. 11, 12 - *Polytaxis maxima* (Schellwien, 1898). Fig. 11 - Subaxial section, Garnitzenberg, Auernig Formation, Orenburgian, sample G 43; x 36; Fig. 12 - Subaxial section, Zollnersee, upper Meledis Formation, middle Kasimovian, sample ZO 15/2; x 36.

Fig. 13, 20 - *Calcitornella heathi* Cushman & Waters, 1928. Two attached sections, Garnitzenberg, Auernig Formation, Orenburgian, sample GP 15 (D); x 86.

Fig. 14 - *Deckerella geyeri* (Schellwien, 1898). Sublongitudinal section, Garnitzenberg, Auernig Formation, Orenburgian, sample GP 27 (D); x 38.

Fig. 15, 16 - *Cribrogenerina* (?) *gigas* (Suleimanov, 1949). Garnitzenberg, Auernig Formation, Orenburgian; x 36. Fig. 15 - Axial section passing by the proloculus, sample GP b/2; Fig. 16 - Subaxial section, sample GP 33/2.

Fig. 17 - *Tetrataxis paraconica* Reitlinger, 1950. Axial section, Garnitzenberg, Auernig Formation, Orenburgian, sample GP 7a (B); x 36.

Fig. 18 - *Calcitornella* cf. *heathi* Cushman & Waters, 1928. Subaxial section, Garnitzenberg, Auernig Formation, Orenburgian, sample GP 14 (D); x 84.

Fig. 19 - *Tetrataxis* sp. Attached axial section, Garnitzenberg, Auernig Formation, Orenburgian, sample G 20; x 36.

PLATE 3

Fig. 1-3, 7-8, 10-11 - *Deckerella geyeri* (Schellwien, 1898) emend. hic (= *Deckerella laheei* Cushman & Waters, 1928; et auctorum), Garnitzenberg, Auernig Formation, Orenburgian. Fig. 1 - Subaxial section with characteristic apertures of the uniseriate stage, sample G 40; x 36; Fig. 2 - Oblique section with large initial biseriate stage, sample GP C/2j; x 35; Fig. 3 - Oblique section, sample GP e/1; x 37; Fig. 7 - Oblique section, sample GP C/2; x 37; Fig. 8 - Subaxial section with characteristic apertures, and curved axis of growth, sample GP 29 (D); x 38; Fig. 10 - Large oblique section, sample GP 9 (D); x 37; Fig. 11 - Subaxial section, sample GP c/x; x 37.

Fig. 4, 12-13 - *Cribrogenerina* (?) *major* (Morozova, 1949). Garnitzenberg, Auernig Formation, Orenburgian. Fig. 4 - Axial section, sample GP 4 (D); x 36; Fig. 12 - Axial section, sample GP 17 (D); x 38; Fig. 13 - Subaxial section, sample GP 27 (D); x 36.

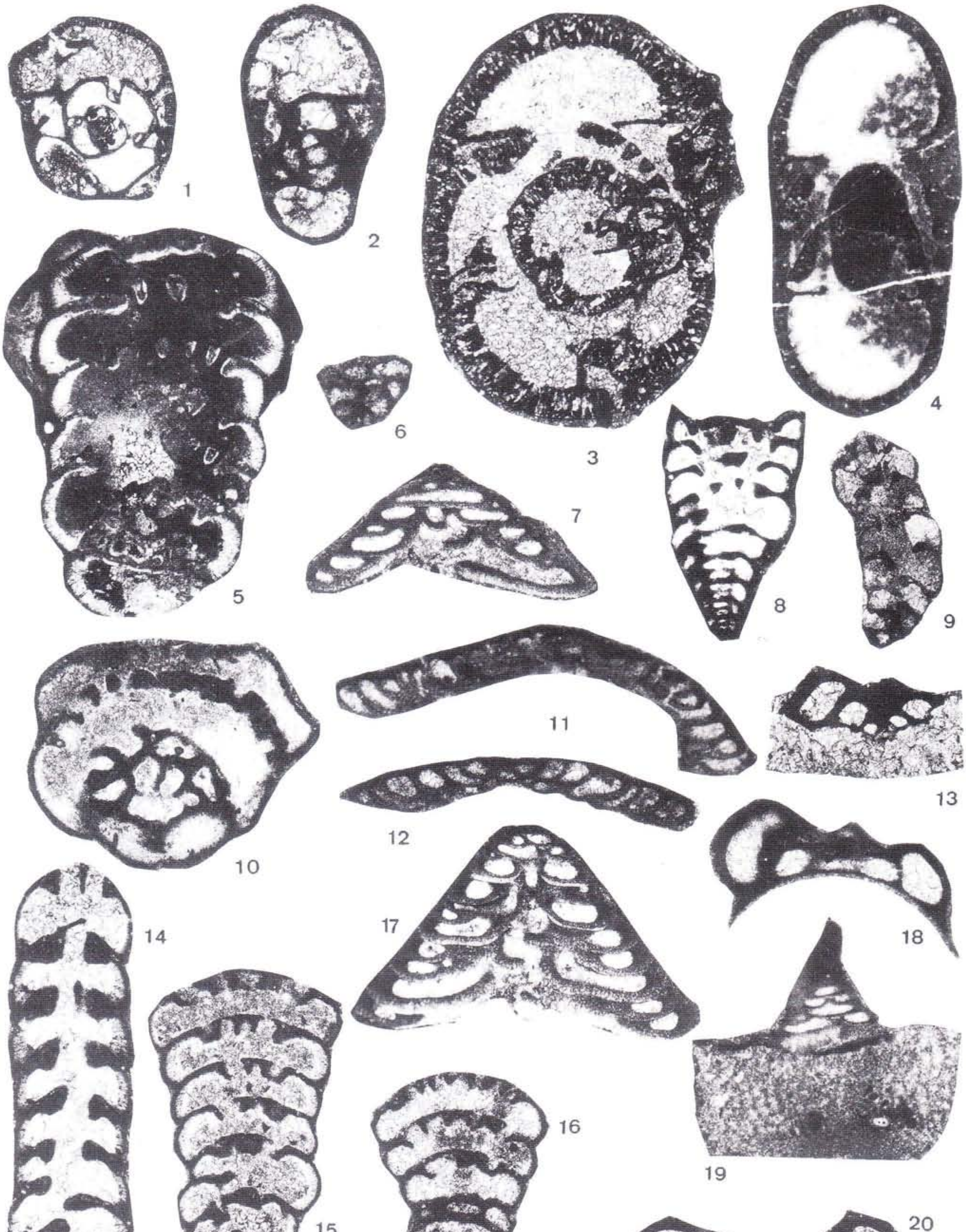
Fig. 5-6 - *Palaeotextularia* spp. or young Climacamminids. Auernig Formation, Orenburgian; x 36. Fig. 5 - Axial section, probably of a young *Deckerella geyeri*. Garnitzenberg, sample GP 35a (13); Fig. 6 - Subaxial section, Kronalpe, sample KR 42a.

Fig. 9 - *Cribrogenerina* (?) *stiliformis* (Lee & Chen in Lee et al., 1930). Axial section, Garnitzenberg, Auernig Formation, Orenburgian, sample GP 41 (B); x 37.

Fig. 14 - *Cribrogenerina* (?) *sphaerica* (Potievskaya, 1962). Subaxial section, Garnitzenberg, Auernig Formation, Orenburgian, sample GP 17 (D); x 38.

Fig. 15 - *Climacammina* cf. *magna* Roth & Skinner, 1930. Oblique section, Garnitzenberg, Auernig Formation, Orenburgian, sample KR 42a; x 36.

Fig. 16-18 - *Deckerella tenuissima* Reitlinger, 1950. Garnitzenberg Auernig Formation, Orenburgian. Fig. 16 - Axial section, sample GP 5 (D); x 37; Fig. 17 - Subaxial section, sample GP 17 (D); x 38; Fig. 18 - Subaxial section, sample GP 41 (B); x 36.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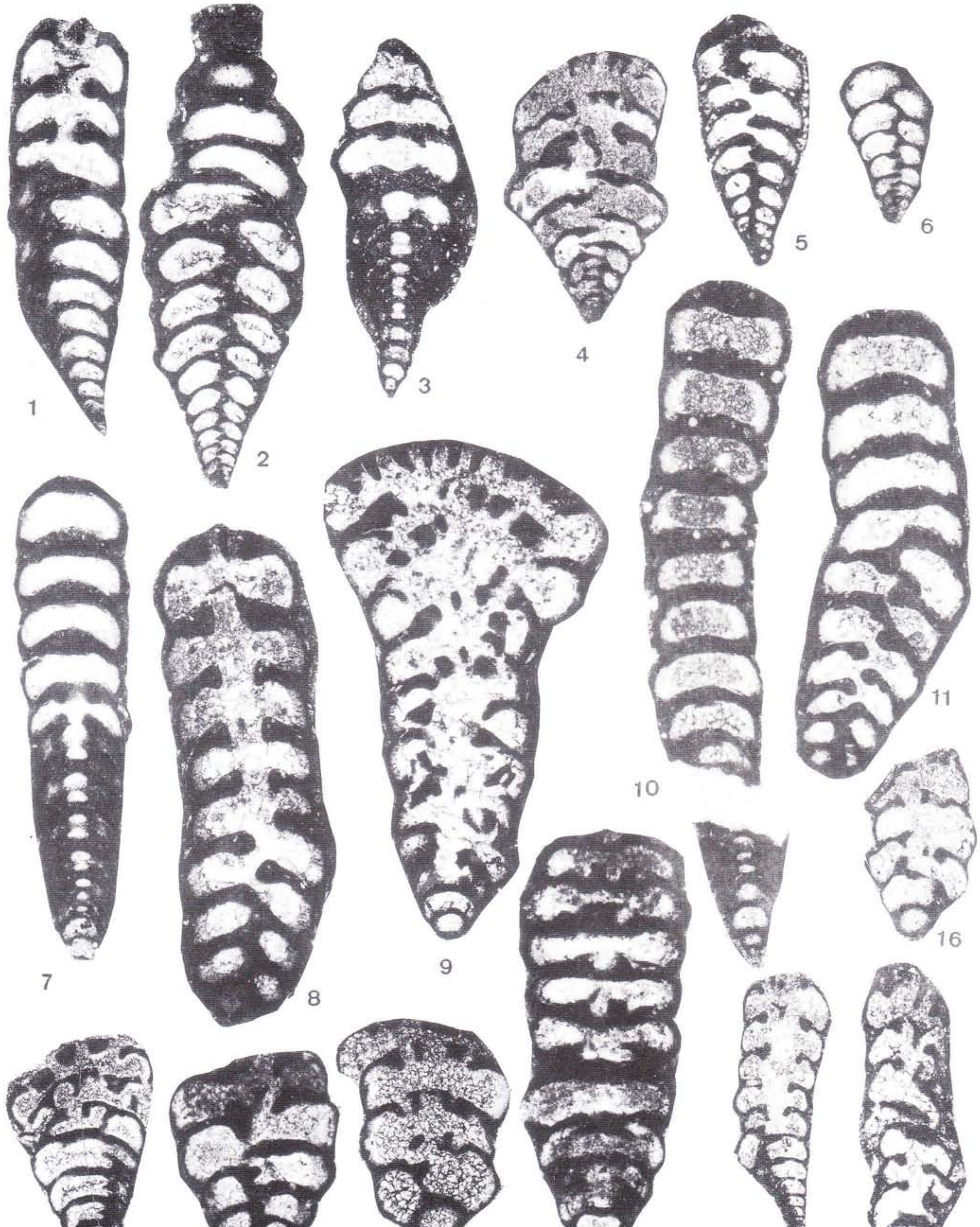
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PLATE 4

Fig. 1, 10 - *Ammovertella* cf. *elegantissima* Reitlinger, 1950. Garnitzenberg, Auernig Formation, Orenburgian. Fig. 1 - Longitudinal section, sample G 34; x 90; Fig. 10 - Oblique section, sample GP 11/1 (D); x 86.

Fig. 2-7 - *Cornuspira* (?) sp. 1. Garnitzenberg, Auernig Formation, Orenburgian, sample GP 36 (B); x 84. Fig. 2-5 - Axial sections; Fig. 6-7 - Transverse sections.

Fig. 8 - *Hemigordius schlumbergeri* (Howchin, 1895). Axial section, Cima Val di Puartis, Pizzul Formation, Kasimovian/Gzhelian, sample P 3; x 90.

Fig. 9 - *Calcitornella* sp. 2. Transverse section. Garnitzenberg, Auernig Formation, Orenburgian, sample GP 22 (E); x 83.

Fig. 11, 15 - *Ammovertella* (?) sp. Longitudinal sections, Garnitzenberg, Auernig Formation, Orenburgian. Fig. 11 - sample GP 33 (D)37; x 37; Fig. 15 - sample GP 6 (E); x 38.

Fig. 12, 14 - *Ammovertella inversa* (Schellwien, 1898). Transverse sections. Garnitzenberg, Auernig Formation, Orenburgian; x 84. Fig. 12 - GP 6 (E); Fig. 14 - GP 33 (D).

Fig. 13 - *Hedraites* sp. Transverse section. Zollnersee, upper Meledis, middle Kasimovian, sample Z0 3; x 36.

Fig. 16 - *Palaeonubecularia* (?) sp. Axial section, Zollnersee, upper Meledis, middle Kasimovian, sample Z0 3; x 36.

Fig. 17-26 - *Hemidiscus carnicus* Schellwien, 1898 emend. herein = *Lasiodiscus tenuis* Reichel, 1945; = *Eolasiodiscus* aff. *grandis* Ivanova, 1973 sensu Pinard & Mamet, 1998. Garnitzenberg (excepted Fig. 25), Auernig Formation, Orenburgian. Fig. 17 - Transverse section, sample GP 24 (D); x 83; Fig. 18 - Axial section with rather developed umbilical pillars, sample GP 33 (D); x 85; Fig. 19 - Axial section of an «*Eolasiodiscus*» auct., sample GP 14 (D); x 86; Fig. 20 - A «typical» *Hemidiscus carnicus* without umbilical filling and irregular last whorl; sample GP 22 (E); x 83; Fig. 21 - Other *Hemidiscus*, axial section, sample GP 11/2 (D); x 85; Fig. 22 - Axial section of a typical *Eolasiodiscus*, compare with the preceeding ones; sample GP 23 (B); x 90; Fig. 23 - Axial section, sample GP 22a (E); x 95; Fig. 24 - Axial section, sample GP b/2; x 100; Fig. 25 - Subaxial section (compare with *Lasiodiscus tenuis* sensu Kochansky, 1970b: pl. 16, fig. 8) Gugga, sample GG 5/2; x 90; Fig. 26 - Axial section, sample GP 46a (E); x 92.

Fig. 27, 29 - *Pseudovidalina modificata* (Potievskaya, 1962). Auernig Formation, Orenburgian. Fig. 27 - Axial section, Garnitzenberg, sample GP 5; x 86; Fig. 29 - Axial section, Gugga, sample GG 4; x 90.

Fig. 28, 30 - *Pseudovidalina multihelicis* Pinard & Mamet, 1998. Fig. 28 - Axial section of a typical *Raphconilia*, Auernig (E), cf. sample GP 24; x 86; Fig. 30 - Typical axial section, Kronalpe, sample KR 34; x 90.

Fig. 31-32 - *Pseudovidalina media* (Wang, 1974). Fig. 31 - Subaxial section, Garnitzenberg, Auernig Formation, Orenburgian, sample GP 35 (B); x 86; Fig. 32 - Axial section homeomorph of *Conilidiscus* Vachard, 1988, Kronalpe, Auernig Formation, Orenburgian, sample KR 17; x 90.

Fig. 33 - *Syzrania confusa* Reitlinger, 1950. Axial section, Auernig Formation, Orenburgian, Gugga, sample GG 8; x 90.

Fig. 34 - *Syzrania bella* Reitlinger, 1950. Axial section, Auernig Formation, Orenburgian, Kronalpe, sample KR 45; x 90.

Fig. 35 - *Syzranella* cf. *higginsi* Pinard & Mamet, 1998. Subaxial section, Kronalpe, Auernig Formation, Orenburgian, sample KR 36; x 90.

Fig. 36 - *Vervilleina bradyi* (Spandel, 1901). Axial section, Garnitzenberg, Auernig Formation, Orenburgian, sample G 25; x 90.

Fig. 37 - Indeterminate Syzraniidae. Longitudinal section, Garnitzenberg, Auernig Formation, Orenburgian, sample G 10; x 90.

Fig. 38 - *Tezaquina clivuli* Vachard in Vachard & Montenat, 1981 non Vachard, 1980. Axial section, Garnitzenberg, Auernig Formation, Orenburgian, sample G 55; x 90.

Fig. 39-40, 42-43, 45-46, 49 - *Nodosinelloides potievskayae* Mamet & Pinard, 1996. Auernig Formation, Orenburgian. Fig. 39 - Axial section with the curved axis and the badly conspicuous apertures, Kronalpe, sample KR 38 a; x 90; Fig. 40 - Axial section, Kronalpe, sample KR 27/2; x 90; Fig. 42 - Axial section, Garnitzenberg, sample GP a/3; x 84; Fig. 43 - Axial section, Garnitzenberg, sample GP 40a (A); x 86; Fig. 45 - Axial section, Garnitzenberg, sample GP c/1; x 84; Fig. 46 - Subaxial section, Garnitzenberg, sample GP 22 (E); x 84; Fig. 49 - Subaxial section, Garnitzenberg, sample GP e/1; x 84.

Fig. 41, 44, 48 - *Nodosinelloides netschajewi* (Cherdyntsev, 1914). Fig. 41 - Axial section, Kronalpe, Auernig Formation, Orenburgian, sample KR 27; x 90; Fig. 44 - Axial section, Garnitzenberg, Auernig Formation, Orenburgian, sample GP e/1; x 83; Fig. 48 - Subaxial section, Garnitzenberg, Auernig Formation, Orenburgian, sample GP 5 (1); x 84.

Fig. 47, 50-52 - *Nodosinelloides* aff. *longa* (Lipina, 1949). Garnitzenberg, Auernig Formation, Orenburgian, sample GP 5. Fig. 47 - Oblique section; x 83; Fig. 50 - Subaxial section (compare with *Pachyphloia* sp. illustrated by Kochansky, 1970b: pl. 1, fig. 10 mentioned in Rattendorf Group of Karavanken); x 84; Fig. 51 - Subaxial section; x 86; Fig. 52- Subaxial section; x 86.

Fig. 53-54 - *Protonodosaria* aff. *longissima* (Suleimanov, 1949). Two subaxial sections, Garnitzenberg, Auernig Formation, Orenburgian, sample GP 5; x 84.

PLATE 5

Fig. 1 - *Herakella paradoxa* Kochansky, 1970a. Oblique section showing the wall, the inner cavity and the furrows between the articles, Zollnersee, upper Meledis Formation, middle Kasimovian, sample ZO 20; x 36.

Fig. 2, 3 - *Connexia slovenica* Kochansky, 1979. Monte Pizzul, Pizzul Formation, Kasimovian/Gzhelian; x 36. Fig. 2 - Oblique section showing several verticilles; sample P 5; Fig. 3 - Axial section trough a verticille, sample P 8.

Fig. 4 - *Gyroporella dissecta* Chuvashov, 1974. Oblique section, Kronalpe, Auernig Formation, Orenburgian, sample KR 25/2; x 36.

Fig. 5 - *Aseelahella* n. sp. Longitudinal section, Kronalpe, Auernig Formation, Orenburgian, sample KR 25/2; x 36.

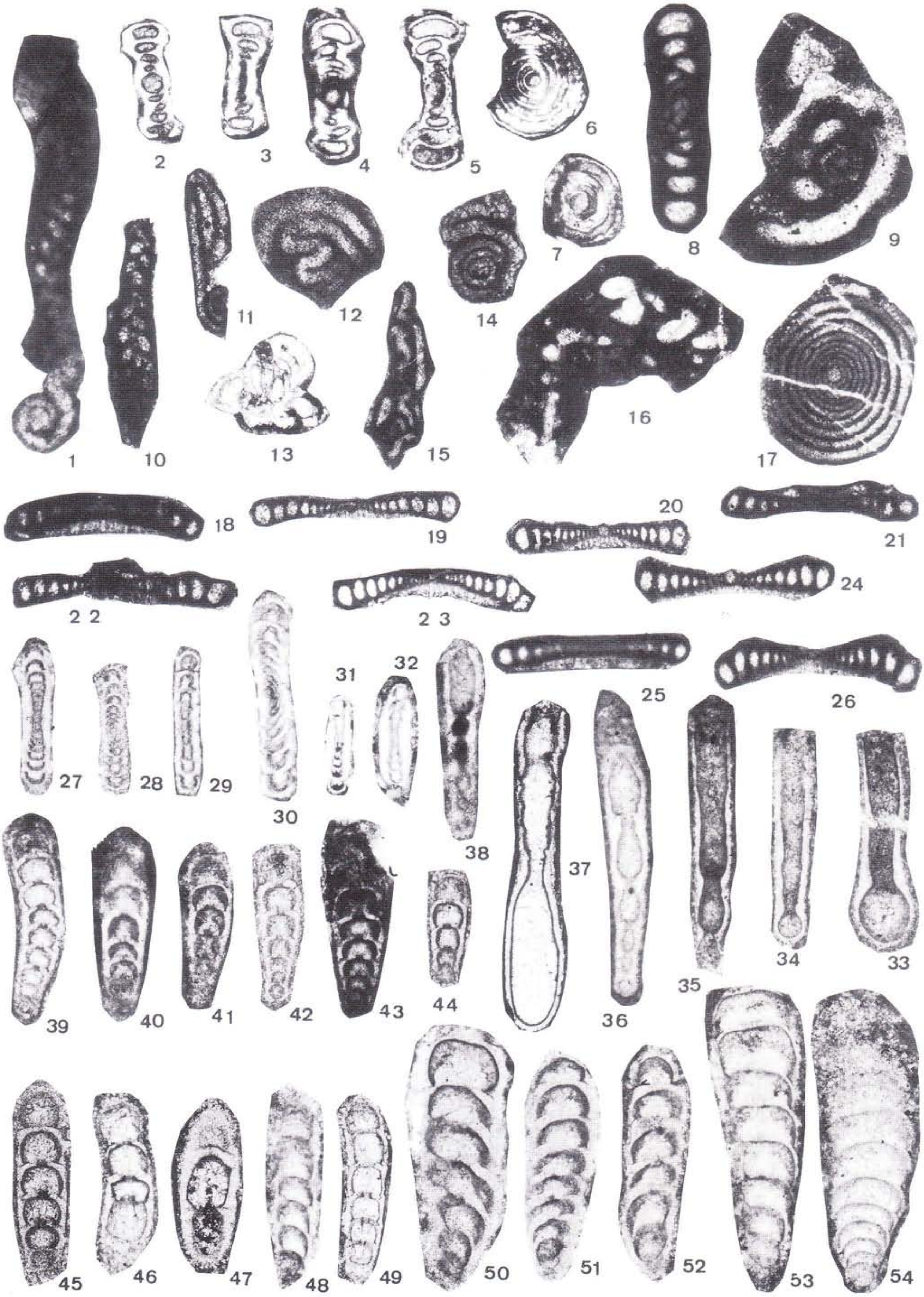
Fig. 6, 9 - *Beresella polyramosa* Kulik, 1964; x 90. Fig. 6 - Axial section, Mount GI, Auernig Formation, Orenburgian, sample GI/7; Fig. 9 - Axial section, Kronalpe, Auernig Formation, Orenburgian, sample KR 38/1.

Fig. 7 - *Ungdarella* ex gr. *uralica* Maslov, 1956. Attached axial section, Kronalpe, Auernig Formation, Orenburgian, sample KR 17; x 36.

Fig. 8 - *Claracrusta* ex gr. *catenoides* (Homann, 1972) Vachard, 1980. Transverse section, Kronalpe, Auernig Formation, Orenburgian, sample KR 37; x 36.

Fig. 10 - *Beresella translucea* Kulik, 1964. Oblique section, Rio Meledis, upper Meledis Formation, middle Kasimovian, sample RM 6; x 90.

Fig. 11 - *Asphaltina* (?) sp. Longitudinal section. Ofenalm, Pizzul Formation, Kasimovian/Gzhelian, sample OF 3; x 36.



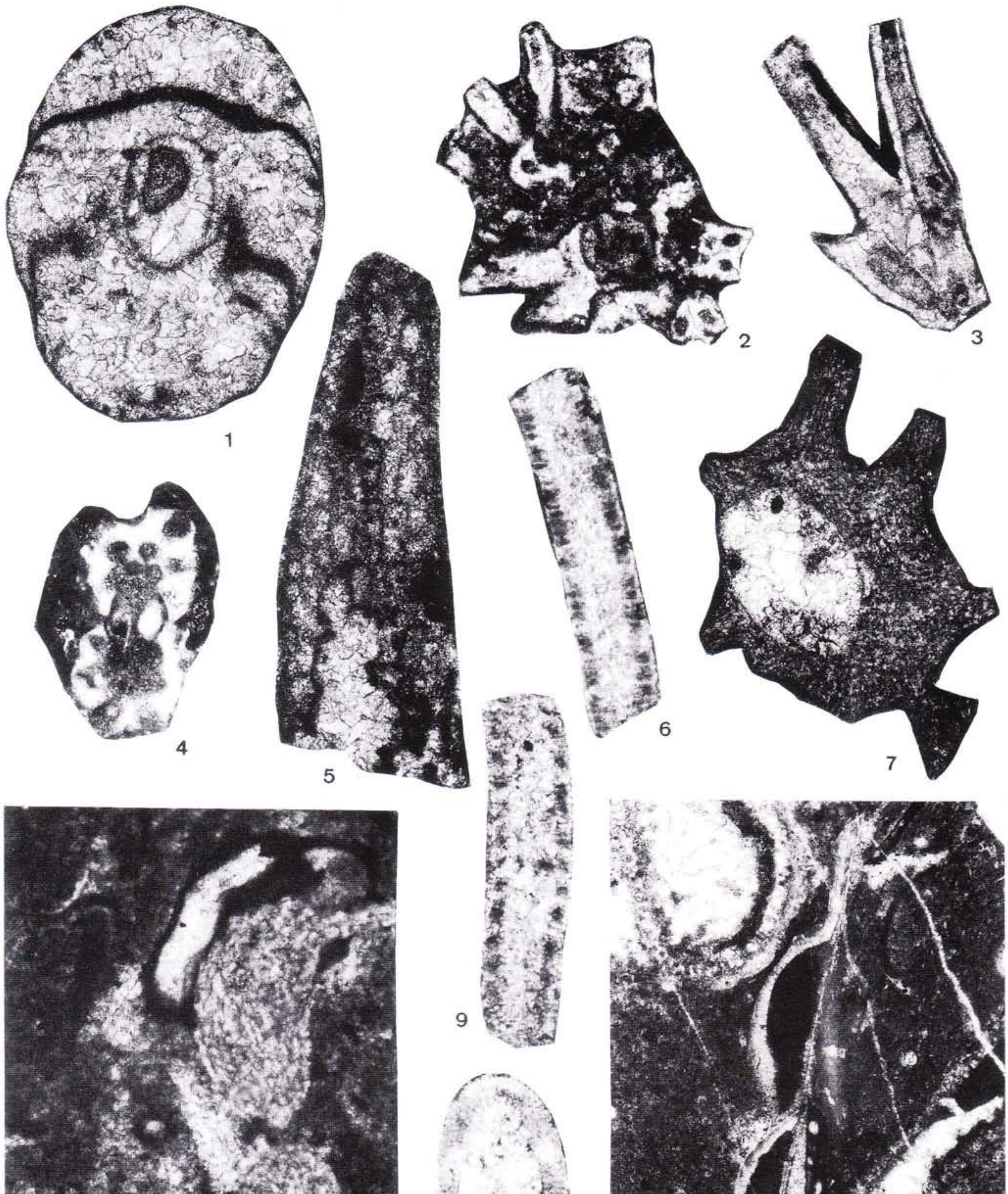

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Fig. 14. - Sketches of different nodosariiform genera (not to scale).

Gzhelian in Russia (Davydov, 1986).

The stellate typical aperture of *Nodosaria* was represented on many isolated Permian specimens (Crespin, 1958; Gerke, 1961); therefore a comparative study of Nodosariacea on isolated individuals and in thin-section is necessary until a complete revision of this group.

As indicated by Pinard & Mamet (1998), the species created by Lipina (1949) and Potievskaya (1962), and used by Davydov (1986) are too numerous and frequently homonyms. We follow here the nomenclature of Pinard & Mamet (1998).

In the Orenburgian (i. e. latest Gzhelian), the genus *Nodosinelloides* is yet well differenciated in the Carnic Alps, with three species. One is common, *N. potievskayae* Mamet & Pinard, 1996 (Pl. 4, fig. 39-40, 42-43, 45-46, 49), the two other are rare: *N. netschajewi* (Cherdyntsev, 1914) (Pl. 4, fig. 41, 44, 48) and *N.* aff. *longa* (Lipina, 1949) (Pl. 4, fig. 47, 50-52). A very rare taxon, more difficult to attribute generically, is *Protonodosaria* aff. *longissima* (Suleimanov, 1949) (Pl. 4, fig. 53-54), which possesses the wall of *P. longissima*, but displays chambers like that of *Geinitzina*, and therefore may belong to a new genus. Paradoxically these specimens have more similarities with the late Permian forms called *Nodosaria aceraeformis* Lin et al., 1990 or *Geinitzina reperta* sensu Bozorgnia, 1973 non Bykova, 1952.

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