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SMALLER FORAMINIFERS, CHARACTERISTIC ALGAE AND PSEUDO-ALGAE OF THE LATEST CARBONIFEROUS/ EARLY PERMIAN RATTENDORF GROUP, CARNIC ALPS (AUSTRIA/ITALY)

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Riassunto. I calcari del Gruppo di Rattendorf (Calcare a *Pseudoschwagerina* inferiore, Formazione Grenzland e Calcare a *Pseudoschwagerina* superiore delle Alpi Carniche (Austria Italia) contengono una ricca ed interessante associazione di piccoli foraminiferi, alghe e pseudo-alghe del Carbonifero terminale e del Permiano basale. L'associazione a foraminiferi del Calcare a *Pseudoschwagerina* inferiore è identica a quella della Formazione di Auernig. La Formazione Grenzland è caratterizzata dalla comparsa dei generi *Geinitzina* e *Pseudovermiporella*, e dalla scomparsa delle Bradyinidae. Il Calcare a *Pseudoschwagerina* superiore contiene le stesse specie della formazione sottostante, ma è caratterizzato dalla comparsa locale di *Neoendothyra* (?) e di diverse specie di Hemigordiidae e Nodosarioidea. Viene brevemente discusso il significato biostratigrafico di diverse specie di *Hemigordius*, *"Arenovidalina"* sensu Baryshnikov = *"Neohemigordius"* sensu Pinard & Mamet, *Nodosinelloides, Protonodosaria* and *Geinitzina*, per quanto concerne l'Asseliano e il Sakmariano inferiore. Il capitolo della sistematica contiene alcune note a proposito di generi delle Hemigordiidae e Nodosarioidea. Per la presenza di una parete porcellanacea, i microfossili *Ellesmerella permica* (Pia) (= *"Girvanella" subparallela* Flügel & Flügel-Kahler) e *Pseudovermiporella* spp., generalmente interpretati come alghe, sono invece qui considerati come foraminiferi miliolinidi sessili. Viene infine proposto un nuovo genere problematico di Chlorophyta, *Homannisiphon*.

Abstract. Limestones of the latest Carboniferous-early Permian Rattendorf Group (Lower *Pseudoschwagerina* Limestone, Grenzland Formation and Upper *Pseudoschwagerina* Limestone) of the Carnic Alps (Austria/Italy) contain a rich and interesting assemblage of smaller foraminifers, algae and pseudo-algae. The foraminiferal assemblage of the Lower *Pseudoschwagerina* Limestone is identical to that of the Auernig Formation. The Grenzland Formation is characterized by the appearance of the genus *Geinitzina* and *Pseudovermiporella*, and the disappearance of Bradyinidae. The Upper *Pseudoschwagerina* Limestone contains the same species as the Grenzland Formation, but is characterized by the local appearance of *Neoendothyra* (?) and diverse species of Hemigordiidae and Nodosarioidea. The biostratigraphical value of diverse species of *Hemigordius*, *"Arenovidalina"* sensu Baryshnikov = *"Neohemigordius"* sensu Pinard & Mamet, *Nodosinelloides, Protonodosaria* and *Geinitzina* for the Asselian and early Sakmarian stages is briefly discussed. The systematical part contains some generic remarks on the Hemigordiidae and Nodosarioidea. Due to the porcelaneous wall, the microfossils *Ellesmerella permica* (Pia) (= *"Girvanella" subparallela* Flügel & Flügel-Kahler) and *Pseudovermiporella* spp., which are generally interpreted as algae, are considered as attached miliolinid foraminifera. A new genus of problematical Chlorophyta, *Homannisiphon*, is established.

Introduction.

Limestones of the late Carboniferous/early Permian Auernig and Rattendorf Group in the Carnic Alps (Austria/Italy) are well preserved and contain abundant fossils. All major late Paleozoic biotic groups are represented, most of them with a great number of species, particularly calcareous algae (e.g. Homann 1972; Flügel 1966, 1980, 1987; Flügel & Flügel- Kahler 1980; Krainer 1995a) and fusulinids (e.g. Kahler 1983, 1985, 1986, 1989; Kahler & Kahler 1937, 1941; Kahler & Krainer 1993; Forke 1995; Forke et al. 1998), bryozoans (Kodsi 1967), sphinctozoans (Kügel 1987), ostracods (Fohrer 1991), brachiopods (Gauri 1965), trilobites (Gauri 1965; Hahn et al. 1989). Although smaller foraminifers are an abundant constituent of these limestones, this fossil group has been studied in detail only from the Upper *Pseudoschwagerina* Limestone by Flügel (1971) in terms of a paleoecological interpretation and recently from the Auernig Group by Vachard & Krainer (2001). Many authors have mentioned the occurrence of smaller foraminifers, although a systematic study is still missing.

The aim of our study is to describe the assemblages of smaller foraminifers with some characteristic algae and pseudo-algae, from the late Carboniferous/early Permian Rattendorf Group (Lower Pseudoschwagerina Limestone = LPL, Grenzland Formation and Upper Pseudoschwagerina Limestone = UPL). We have particularly studied the importance of the Bradyinidae,

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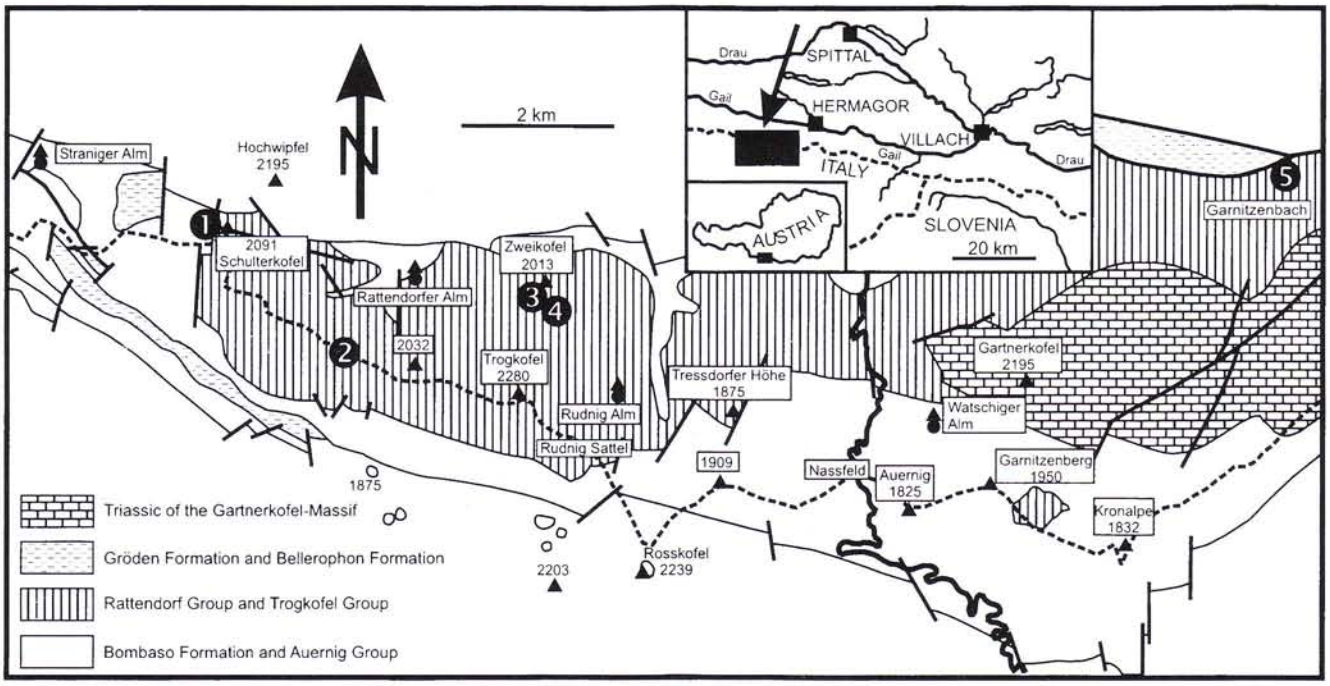


Fig. 1 - Simplified geologic map of the central Carnic Alps with distribution of late Paleozoic rocks and location of the studied sections: 1: Schulterkofel; 2: Rattendorfer Sattel; 3: Zweikofel West; 4: Zweikofel East; and 5: Garnitzenbach.

Lasiodiscoidea, Hemigordiidae and Nodosarioidea. The biostratigraphical value of several algae is also confirmed.

Geological setting

In the Carnic Alps, an East-West-trending mountain chain situated along the Austrian-Italian state boundary (Fig. 1), a thick pile of mostly shallow marine clastic and carbonate sedimentary rocks of Late Carboniferous and Permian age unconformably overlies the deformed Variscan basement. These sediments were deposited in discrete basins formed by block- and wrench-faulting during the Westphalian (Venturini 1982, 1990a, b, 1991; Krainer 1992, 1993a).

The Late Carboniferous-Permian sequence is divided into Bombaso Formation, Auernig Group, Rattendorf Group, Trogkofel Group, Tarvis Breccia, Gröden Formation and Bellerophon Formation (summary in Krainer 1993a).

Auernig and Rattendorf Groups are composed of cyclic, clastic-carbonate shallow marine sedimentary rocks. Classical outcrops of the Rattendorf Group are situated near the Rattendorf Alm in the central Carnic Alps (Felser & Kahler 1963).

The Rattendorf Group is up to 450 m thick and divided into three formations (Fig. 2):

a) Lower *Pseudoschwagerina* Limestone (LPL) = Schulterkofel Formation according to Krainer 1995b.

b) Grenzland Formation.

c) Upper *Pseudoschwagerina* Limestone (UPL) = Zweikofel Formation according to Krainer, 1995b.

The Lower *Pseudoschwagerina* Limestone is up to 160 m thick and consists of three depositional cycles which are dominantly composed of carbonate rocks with thin clastic intervals. These clastic intervals occur at the base of the cycles and were deposited during relative sea-level lowstands. During the transgression, thin bedded, fossiliferous limestones and massive algal mounds were accumulated. Relative sea-level highstands with maximum water depths of a few tens of meters are represented by bedded cherty limestones with thin marl intercalation (Flügel 1968, 1974, 1977; Homann 1969, 1972; Buggisch et al. 1976; Kahler & Krainer 1993; Flügel et al. 1997; Forke et al. 1998).

According to fusulinids, the lower and middle parts (sequence 1 and most part of sequence 2) of the LPL are correlated with the uppermost part of the *Daixina sokensis* zone and the lower part of the *Schwagerina robusta-Ultradaixina bosbytauensis* zone, or *Ultradaixina postsokensis* zone of the Southern Urals and Darvas. The uppermost part of sequence 2 and most part of sequence 3 correspond to the upper portion of the *Schwagerina robusta-Ultradaixina bosbytauensis* zone or with the *Ultradaixina postgallowayi* zone of the Southern Urals and Darvas. The uppermost part of sequence 3, characterized by the occurrence of *Schellwienia bornemani, Zigarella panjiensis* and *Likharevites inglorius*, is assumed to be of Asselian age (Krainer & Davydov 1998; see also Kahler 1983, 1985, 1986, 1989; Kahler & Krainer 1993; Forke et al. 1998).

The Grenzland Formation (maximum thickness of 125 m) is a cyclic sequence predominantly composed

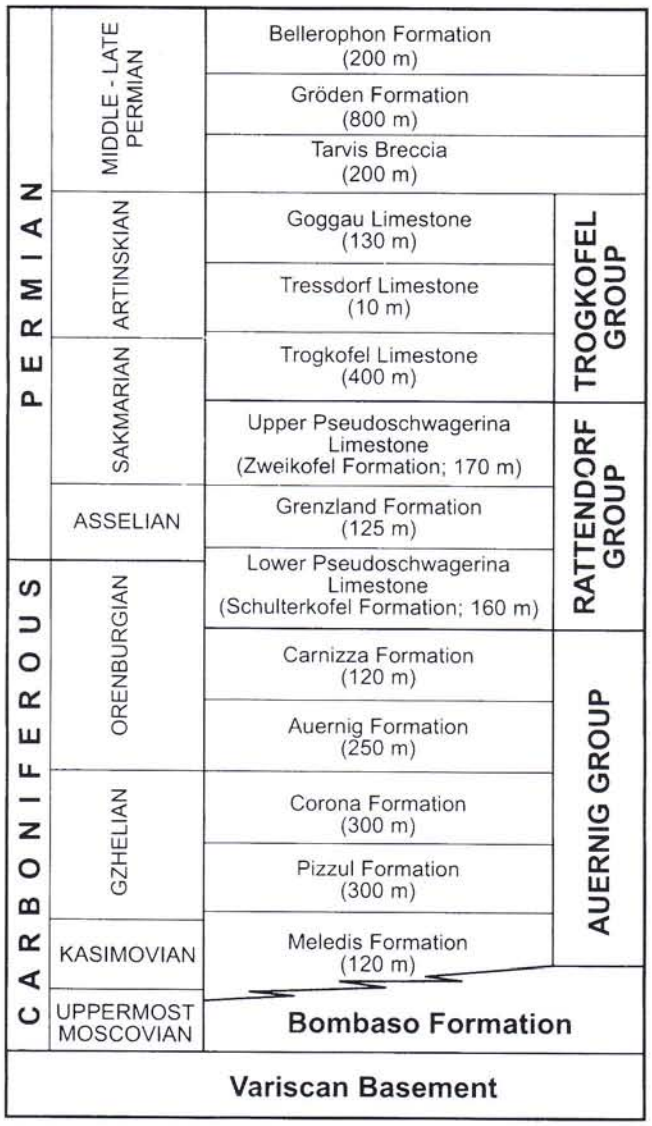


Fig. 2 - Late Carboniferous-Permian stratigraphy of the Carnic Alps.

of shallow marine, quartz-rich conglomerates, sandstones, siltstones and shales, and intercalated thin fossiliferous bedded limestones (Tietz 1974; Buggisch et al. 1976; Buttersack & Boeckelmann 1984; Boeckelmann 1985; Krainer 1993b). A caliche horizon and an thin red shale intercalation with scattered angular quartz grains occur in the upper part. From thin shale horizons, plant fossils have been reported by Fritz & Boersma (1984) and Boersma & Fritz (1990). The fusulinid assemblage (see Kahler & Kahler 1937; Kahler 1985, 1986; Forke 1995) indicates middle/late Asselian age (Krainer & Davydov 1998).

The Upper *Pseudoschwagerina* Limestone is an up to 170 m, cyclic succession of dark-grey, thin bedded, fossiliferous limestones and thin intercalations of clastic sediments (siltstone, sandstone, well rounded and well sorted quartz-rich conglomerates). Locally, massive limestones (*Tubiphytes-Archaeolithoporella*-mounds) are exposed in the upper part. The well developed cycles indicate repeated shifting from nearshore to offshore environments in an open marine shelf lagoon (Flügel 1977, 1981). Limestones contain abundant fossils, particularly calcareous algae (Homann 1972), smaller foraminifers (Flügel 1971), fusulinids (Kahler 1983, 1985, 1986, 1989), corals, bryozoans, brachiopods, gastropods, pelecypods and echinoderm fragments. A description of the microfacies is presented by Flügel (1968) and Buttersack & Boeckelmann (1984). According to Flügel (1971, 1981) and Flügel et al. (1971) limestones of the UPL contain more diverse biota and microfacies types than limestones of the Grenzland Formation and LPL.

Based on the occurrence of the fusulinid *Zellia heritschi*, Kahler (1985) dated the UPL as late Asselian. According to Forke (1995) the UPL is considered as Sakmarian in age (*Robustoschwagerina geyeri and Zellia heritschi* zone).

Material and location.

Sedimentary rocks of the Rattendorf Group are well exposed in the central Carnic Alps, along the Austrian/Italian border, particularly in the Schulterkofel area, near the Rattendorf Alm (Rattendorfer Sattel, Zweikofel), at Tressdorfer Höhe, Rudnig Sattel and along the Garnitzenbach.

Smaller foraminifers were studied from the following sections (Fig. 1):

a) Schulterkofel (type section of the Lower Pseudoschwagerina Limestone, samples SK) (Forke et al. 1998, figs. 5-8),

b) Rattendorfer Sattel (type locality for the Grenzland Formation),

c) Zweikofel-West (upper part of the Grenzland Formation, type section of the Upper Pseudoschwagerina Limestone; samples ZK),

d) Zweikofel-East (upper part of the Upper Pseudoschwagerina Limestone; samples ZKO)

e) Garnitzenbach (uppermost part of the Grenzland Formation and Upper Pseudoschwagerina Limestone; samples GB; section in Flügel et al. 1997, fig. 10).

The study is based on the investigation of 490 thin sections of limestones collected in the above mentioned localities.

Previous identifications of smaller foraminifers and algae in the Rattendorf Group are numerous (Flügel 1966, 1971, 1980; Homann 1972; Brenckle & Wahlman 1994; Forke 1995; Forke et al. 1998). They are summarized and actualized in Fig. 3.

Fossil assemblage from Lower *Pseudoschwagerina* Limestone (LPL) Formation.

The fossil assemblage of the LPL at Schulterkofel

Fig. 3	1 - FLUGEL 1966 (UPL and TK)	
DESCRIBED TAXA	ILLUSTRATIONS	RECOMMENDED NAME
Ungdarella uralica	pl. 1, fig. 1-2	*Ungdarella* ex gr. *uralica*
Permocalculus cf. *tenellus*	pl. 1, fig. 3	*Succodium* (?) n. sp.
Solenopora cf. *texana*	pl. 1, fig. 4	Recrystallized *Pseudochaetetes* ?
Cuneiphycus johnsoni	pl. 2, fig. 1-5	*Eflugelia johnsoni*
Archaeolithophyllum (?) sp.	pl. 2, fig. 6	*Archaeolithophyllum* cf. *missouriense*
Neoanchicodium catenoides	pl. 3, fig. 1-2	*Neoanchicodium catenoides*
Eugonophyllum johnsoni	pl. 3, fig. 3-4	*Eugonophyllum johnsoni*
Atractyliopsis carnica	pl. 4, fig. 1-3 pl. 5, fig. 1-4	*"Atractyliopsis" carnica* = *Gyroporella igoi*
Anthracoporella spectabilis	pl. 6, fig. 1	*Anthracoporella spectabilis*
Epimastopora hunzaensis	pl. 6, fig. 2	*Pseudoepimastopora* sp.
Epimastopora piae	pl. 6, fig. 3	*Pseudoepimastopora* sp.
Epimastopora alpina	pl. 6, fig. 4-5	*Epimastopora alpina*
Gyroporella symmetrica	pl. 7, fig. 1-2	*Globuliferoporella piai*
Pseudoepimastopora likana	pl. 7, fig. 3-4	*Pseudoepimastopora likana*
Gyroporella sp.	pl. 7, fig 5	*Gyroporella dissecta*
Vermiporella nipponica (pars)	pl. 8, fig. 1-2	*Pseudovermiporella nipponica*
Vermiporella nipponica (pars)	pl. 8, fig. 3	*Ps.* (?) *graiferi*
Girvanella permica	pl. 8, fig. 4-5	*Ellesmerella permica*
Stromatolithen	pl. 9, fig. 1-3	*Archaeolithoporella hidensis*
Hikorocodium carinthiacum	pl. 10, fig. 1-5	*Tubiphytes* ex gr. *obscurus*
Tubiphytes obscurus	pl. 11, fig. 1-3	*Tubiphytes obscurus*

2 - FLUGEL 1971 (Grenzland Fm and UPL)		
DESCRIBED TAXA	ILLUSTRATIONS	RECOMMENDED NAME
Ammovertella cf. *inversa*	pl. 1, fig. 1-2	*Ammovertella* cf. *inversa*
Ammovertella sp.	pl. 1, fig. 3	*Ammovertella* sp.
Tuberitina cf. *bulbacea*	pl. 1, fig. 4	*Tuberitina bulbacea*
Apterrinella sp.	pl. 1, fig. 5	*Calcitornella* sp.
Tetrataxis aff. *maxima*	pl. 2, fig. 1	*Tetrataxis* ex gr. *paraconica*
Tetrataxis sp.	pl. 2, fig. 2	*Tetrataxis* sp.
Problematikum	pl. 2, fig. 3	Indeterminate
Problematikum	pl. 3, fig. 4	*Palaeonubecularia* sp.
Tuberitininen	pl. 3, fig. 5	*Diplosphaerina* sp.
Hemidiscus carnicus	pl. 3, fig 6	*Hemidiscus carnicus*
cf. *Minammodytes bzw. Serpulinopsis*	pl. 3, fig. 7	*Palaeonubecularia* sp.
Textularia sp.	pl. 3, fig. 1-2	*Palaeotextularia* sp.
Palaeotextularia sp.	pl. 3, fig. 3	
Climacammina sp.	pl. 3, fig. 4-5	*Cribrogenerina* (?) ex gr. *elegans*
Cribrogenerina sp.	pl. 3, fig. 6	
Pachyphloia sp.	pl. 4, fig. 1-2	*Geinitzina postcarbonica*
Langella sp.	pl. 4, fig. 3	*Nodosinelloides longa*
Geinitzina sp.	pl. 4, fig. 4	*Ns. mirabilis*
Geinitzina sp.	pl. 4, fig. 5	*Protonodosaria longissima*
Ammobaculites sp.	pl. 4, fig. 6	*Ammovertella* sp.

Fig. 3 - Summary of the previous determinations of microfauna and microflora of the Rattendorf Group (Abbreviations: Gr. B: Grenzland Formation; LPL: Lower *Pseudoschwagerina* Limestone; TK: Trogkofel Limestone; UPL: Upper *Pseudoschwagerina* Limestone).

type section is remarkably similar to that of Auernig Formation (Vachard & Krainer, 2001); it contains:

Algae: *Neoanchicodium* sp., *Gyroporella nipponica* Endo & Hashimoto, 1955 (Pl. 1, fig. 1), *Epimastopora alpina* Kochanky & Herak, 1960, E. spp. (Pl. 1, fig. 4), *Pseudoepimastopora* spp. and *Connexia slovenica* Kochansky, 1979. In addition, *Anthracoporella* sp. was illustrated by Krainer (1993b, fig. 19), Kahler & Krainer (1993, pl. 67, fig. 3), Samankassou (1997, fig. 7) and Forke et al. (1998, pl. 2, fig. 4, pl. 3, fig. 1-2); *"Archaeolithophyllum" lamellosum* Wray, 1964 figured by Forke et al. (ibid., pl. 2, fig. 6).

Pseudo-algae: *Ungdarella* ex gr. *uralica* Maslov, 1956 with preserved attachment basket, *Claracrusta* sp., *Tubiphytes* ex gr. *obscurus* Maslov, 1956 (Pl. 1, fig. 2). *Ramovsia* sp. has been illustrated by Kahler & Krainer (1993, pl. 6, fig. 1), and Forke et al. (1998, pl. 2, fig. 6), but has not been observed in the studied samples.

Smaller foraminifers: *Diplosphaerina inaequalis* (Derville, 1931), *Tuberitina bulbacea* Galloway & Harlton, 1928 (Pl. 1, fig. 3), *Spireitlina conspecta* (Reitlinger, 1950) (Pl. 1, fig. 5-6), *S.* cf. *bashkirica* (Rauser, 1949), *Endothyra bowmani* Phillips 1846 emend. Brady, 1876 emend. China, 1965 (Pl. 1, fig. 7-8), *E.* ex *gr. bowmani* (Pl. 1, fig. 9), *Endothyranella protracta* Rauser, 1938 (Pl. 1, fig. 10), *Bradyina costifera* Baryshnikov in Baryshnikov et al., 1982 (Pl. 2, fig. 1), *B. sikhanica* Morozova, 1949 (Pl. 2, fig. 2-3), *B. lucida* Morozova, 1949 (Pl. 2, fig. 9-10, 13-16, 18), *B. compressa* Morozova, 1949 (Pl. 2, fig. 7), *B.*

3 - HOMANN 1972 (LPL, Gr. B, UPL)		
Solenopora centurionis	pl. 1, fig. 1	Recrystallized *Parachaetetes*
Solenopora texana	pl. 1, fig. 2	*Claracrusta* ?
Permocalculus cf. *tenellus*	pl. 1, fig. 3	*Succodium* or *Eugonophyllum*
Ungdarella uralica	pl. 1, fig. 4	*Ungdarella uralica*
Gymnocodium bellerophontis	pl. 1, fig. 5	Indeterminate
Archaeolithophyllum missouriense	pl. 1, fig. 6	*Archaeolithophyllum missouriense*
Solenopora sp.	pl. 1, fig. 7	*Pseudochaetetes*
Gymnocodium cf. *gracile*	pl. 1, fig. 8	*Permocalculus* sp.
Archaeolithophyllum sp.	pl. 2, fig. 9	*Anchicodium* sp.
Garwoodia gregaria	pl. 2, fig. 10	Indeterminate
Komia abundans	pl. 2, fig. 11	*Stacheoides* ?
Cuneiphycus johnsoni	pl. 2, fig. 12	*Eflugelia johnsoni*
Anchicodium magnum	pl. 2, fig. 13	*Anchicodium magnum*
Eugonophyllum johnsoni	pl. 2, fig. 14	*Eugonophyllum johnsoni*
Hikorocodium elegantae	pl. 2, fig. 15	Indeterminate
Litostroma oklahomense	pl. 2, fig. 16	Indeterminate
Succodium duisbergi n. sp.	pl. 3, fig. 17	*Succodium* or *Eugonophyllum* ?
Orthriosiphon sp.	pl. 3, fig. 18	Indeterminate
Atractyliopsis carnica	pl. 3, fig. 19	*"Atractyliopsis carnica"*
Neoanchicodium catenoides	pl. 3, fig. 20-22	*Neoanchicodium catenoides*
Anthracoporella spectabilis	pl. 3, fig. 23	*A. spectabilis*
Anatolipora carbonica	pl. 3, fig. 24	*Gyroporella* ?
Epimastopora alpina	pl. 4, fig. 25	*Epimastopora alpina*
E. kanumai	pl. 4, fig. 26	*E. kanmerai*
E. minima	pl. 4, fig 27	*Pseudoepimastopora* sp.
E. kansaensis	pl. 4, fig 28	Indeterminate
E. piae	pl. 4, fig. 29	*E. alpina*
E. piae	pl. 4, fig. 31	*Macroporella* ? sp.
E. ketini	pl. 4, fig. 30	*Gyroporella* ? sp.
E. hunzaensis	pl. 4, fig. 32	Indeterminate
Pseudoepimastopora likana	pl. 4, fig. 33	*Ps. likana*
Ps. japonica	pl. 5, fig. 34	*Ps* . sp.
Ps. kroatica n. sp.	pl. 5, fig. 35	*Ps.* sp.
Ps. iwaizakiensis	pl. 5, fig. 36	*Ps.* sp.

ORIGINAL NAME	FIGURATION	RECOMMENDED NAME
Ps. likana	pl. 5, fig. 37	*Ps. likana*
Ps. kroatica n. sp.	pl. 5, fig. 38	*Ps. likana*
E. alpina	pl. 5, fig. 39	*Ps. likana*
Mizzia cornuta	pl. 5, fig. 40	*Gyroporella* sp.
Atractyliopsis carnica	pl. 5, fig. 41	*Mizzia* sp.
Gyroporella igoi	pl. 6, fig. 42	*Gyroporella igoi*
Gyroporella symmetrica	pl. 6, fig. 43	*Globuliferoporella piai*
Likanella cf. *spinosa*	pl. 6, fig. 44	*Connexia slovenica*
Anatolipora carbonica	pl. 6, fig. 45	Aperture of *Climacammina*
Macroporella maxima	pl. 6, fig. 46	*Macroporella* sp.
Mizzia velebitana	pl. 6, fig. 47	*Mizzia velebitana*
E. cf. *ketini*	pl. 6, fig. 48	*E.* sp.
Mizzia yabei	pl. 6, fig. 49-50	*Mizzia yabei*
Goniolinopsis cf. *hexagona*	pl. 6, fig. 51	*Climacammina* sp.
Palaeochara ? *pecki*	pl. 7, fig. 52-53	Multithecoporinae
Anatolipora (?) sic cf. *carbonica*	pl. 7, fig. 54	Polyaxone spicules
Vermiporella nipponica	pl. 7, fig. 55	*Pseudovermiporella* cf. *graiferi*

arctica Pinard & Mamet, 1998 (Pl. 2, fig. 6, 8, 11, 17), *Bradyinelloides major* (Morozova, 1949) (Pl. 2, fig. 4-5), *Pseudobradyina pulchra* Reitlinger, 1950 (Pl. 2, fig. 12), *Hemidiscus carnicus* Schellwien, 1898 emend. Vachard & Krainer, 2001 (= *Lasiodiscus tenuis* Reichel, 1945) (Pl. 1, fig. 15-17), *Asselodiscus primitivus* Mamet & Pinard, 1992 (Pl. 1, fig. 18), *Pseudovidalina modificata* (Potievskaya, 1962) (Pl. 1, fig. 20), *P. multihelicis* Pinard & Mamet, 1998 (Pl. 1, fig. 19), *Climacammina sp.* (Pl. 1, fig. 21), *Cribrogenerina* (?) *elegans* (von Moeller, 1879) sensu Schellwien, 1898 emend. Vachard & Krainer, 2001 (Pl. 1, fig. 22), *C.* (?) ex gr. *elegans* [= *C.* (?) *gigas* (Suleimanov, 1949), = *C.* (?) *sphaerica* (Potievskaya, 1962)] (Pl. 1, fig. 23, 25?, 27), *Deckerella* cf. *tenuissima* Reitlinger, 1950 (Pl. 1, fig. 24, 28), *Tetrataxis* spp., *Polytaxis maxima* (Schellwien, 1898) (Pl. 1, fig. 14), *Globivalvulina bulloides* (Brady, 1876) (Pl. 1, fig. 11-12), *Calcitornella heathi* Cushman & Waters, 1928 (Pl. 1, fig. 26), *Palaeonubecularia* ex gr. *fluxa* Reitlinger, 1950 (Pl. 1, fig. 13), *Syzrania bella* Reitlinger, 1950, *S. gigas* Stepanova, 1997 (Pl. 1, fig. 36), *Syzranella* sp. (Pl. 1, fig. 30), *Vervilleina bradyi* (Spandel, 1901) (Pl. 1, fig. 32), *Nodosinelloides potievskayae* Mamet & Pinard, 1996 (Pl. 1, fig. 31, 33-35), *N. longa* (Lipina, 1949) (Pl. 1, fig. 29).

Fusulinids: *Schubertella* sp., *Schellwienia* sp.

The observed assemblage is almost identical to that of the Auernig or Carnizza Formations, it differs only by the appearance of some *Bradyina* and *Bradyinelloides* species. Therefore this assemblage is characteristic for the Orenburgian. Furthermore Forke et al. (1998) described an *"Arenovidalina"* sp. 1, near the Carnizza Fm./LPL boundary. We identified this species only in the Grenzland Formation. If confirmed, this form is a possible further marker for distinguishing biostratigraphically the LPL from the

ORIGINAL NAME	FIGURATION	RECOMMENDED NAME
Salopekiella cf. *velebitana*	pl. 7, fig. 56-58	*Homannisiphon morikawai*
Girvanella catenoides	pl. 8, fig. 59	*Claracrusta catenoides*
Osagia sp.	pl. 8, fig. 60	
Girvanella permica	pl. 8, fig. 61	*Ellesmerella permica*
Osagia sp.	pl. 8, fig. 62	Indeterminate
Girvanella ducii	pl. 8, fig. 63	*Girvanella* (?) sp.
Girvanella texana	pl. 9, fig. 64	Indeterminate
Girvanella permica	pl. 9, fig. 65	*Ellesmerella permica*
Collenella guadalupiensis	pl. 9, fig. 66	*"Archaeolithophyllum" lamellosum*
Stromatolithen	pl. 9, fig. 67	*Archaeolithoporella hidensis*
Stromatolithen	pl. 9, fig. 68	Stromatolites
Aeolisaccus dunningtoni	pl. 9, fig. 69	*Earlandia* sp.
Aeolisaccus cf. *dunningtoni*	pl. 9, fig. 70	Indeterminate Porcelaneous
Tubiphytes obscurus	pl. 10, fig. 71	Indeterminate
Litostroma oklahomense	pl. 10, fig. 72-74	Indeterminate
Tubiphytes obscurus	pl. 10, fig. 75-76	*Tubiphytes obscurus*

4 - FLUGEL 1980 (UPL)		
Ammovertella inversa	pl. 1, fig. 1	*Ammovertella inversa*
Globivalvulina ? sp.	pl. 1, fig. 2	*Globivalvulina* ex gr. *bulloides*
Hemidiscus carnicus	pl. 1, fig. 3	*Hemidiscus carnicus* passing to *Mesolasiodiscus*
Climacammina sp.	pl. 1, fig. 4	*Cribrogenerina* (?) ex gr. *elegans*
Geinitzina sp.	pl. 1, fig. 5	*Protonodosaria longissima*
Monogenerina sp.	pl. 1, fig. 6	Palaeotextulariidae indeterminate
Calcitornella sp.	pl. 1, fig. 7	*Calcitornella* sp.
Tetrataxis cf. *maxima*	pl. 1, fig. 8	*Tetrataxis* ex gr. *paraconica*
Tetrataxis sp.	pl. 1, fig. 9	*Tetrataxis* sp.
Hedraites sp.	pl. 1, fig. 10	*Hedraites* sp.
Tetrataxis sp. with *Tuberitina* sp.	pl. 1, fig. 11	*Tetrataxis* sp. with *Eotuberitina* sp.

5 - BRENCKLE & WAHLMAN 1994		
ORIGINAL NAME	REFERENCES	RECOMMENDED NAME
Conilalia modificata ?	fig. 4:10	*Pseudovidalina modificata*

6 - FORKE 1995		
Ammovertella sp.	pl. 16, fig. 1	*Ammovertella* sp.
Calcitornella sp.	pl. 16, fig. 2	*C. heathi*
Tuberitina sp.	pl. 16, fig. 3	*Mendipsia conili*
Eolasiodiscus sp.	pl. 16, fig. 4	*Hemidiscus carnica*
Endothyra sp.	pl. 16, fig. 5	*E.* gr. *bowmani*
Bradyina sp.	pl. 16, fig. 6	*B. lucida*
Lunucammina sp.	pl. 16, fig. 7	*Nodosinelloides mirabilis*
Lunucammina sp.	pl. 16, fig. 8	*Geinitzina postcarbonica*
Pseudovidalina sp.	pl. 16, fig. 9	*Ps. minor*
Eonodosaria sp.	pl. 16, fig. 10	*Nodosinella pinardae*
Palaeotextularia sp.	pl. 16, fig. 11	*Palaeotextularia* sp.
Climacammina sp.	pl. 16, fig. 12	*Deckerella* sp.
Cribrogenerina sp.	pl. 16, fig. 13	*C.* (?) ex gr. *elegans*
Tetrataxis sp.	pl. 16, fig. 14	*Tetrataxis* sp.

Auernig Group.

The Carboniferous/Permian boundary, which is emplaced a few meters below the top of the LPL by Kahler & Krainer (1993) and Krainer & Davydov (1998), cannot be located on the basis of smaller foraminifer.

Fossil assemblage of the Grenzland Formation.

The Grenzland Formation contains the first typical Permian assemblage including the following taxa:

Algae: *Girvanella* sp., *Ortonella* sp., *Parachaetetes* sp., *Archaeolithophyllum* sp., *Permocalculus* sp., *Anthracoporella* sp., *Epimastopora* sp., *Pseudoepimastopora* sp., *Globuliferoporella piai* (Kordé, 1951) (Pl. 3, fig. 8), *Neoanchicodium catenoides* Endo in Endo & Kanuma, 1954, other Phylloid algae, *Gyroporella* sp.

Pseudo-algae: *Ellesmerella permica* (Pia, 1937) emend. Mamet & Roux in Mamet et al., 1987 (= *Girvanella subparallela* Flügel & Flügel-Kahler, 1980) (Pl. 3, fig. 1-3), *Eflugelia* sp., *Claracrusta* sp., *Tubiphytes* sp.

Smaller foraminifers: *Diplosphaerina* sp., *Tuberitina* sp., *Earlandia* ex gr. *elegans* (Rauser & Reitlinger in Rauser & Fursenko, 1937), *Spireitlina conspecta* (Reitlinger, 1950) (Pl. 4, fig. 2), *Endothyra* ex gr. *similis* Rauser & Reitlinger in Rauser et al., 1936, *E.* ex gr. *bowmani* Phillips, 1846 emend. Brady, 1876 emend. China, 1965, *Endothyranella* sp., *Tetrataxis* sp., *Globivalvulina* ex gr. *bulloides* (Brady, 1876), *Cribrogenerina* (?) ex gr. *elegans* (von Moeller, 1879) sensu Schellwien, 1898 [= *C.* (?) *gigas* (Suleimanov, 1949)], true *Cribrogenerina* (Pl. 4, fig. 13), *Climacammina* sp., *C.* (?) sp. with quartzose agglutinate (or *Bigenerina*? sp.) (Pl. 4, fig. 10, 14), *Pseudovidalina* cf. *minor* Pinard & Mamet, 1998, *Pseudoagathammina* (?) *regularis* (Lipina, 1949), *P.* (?) sp. 3 (Pl. 4, fig. 22-23), *Calcitornella* sp., *Palaeonubec-*

7 - FORKE et al. 1998 (UPL)		
Syzrania sp.	pl. 4, fig. 1	*Syzrania* sp.
Tezaquina sp.	pl. 4, fig. 2	*Vervilleina bradyi*
Nodosinelloides sp.	pl. 4, fig. 3	*Nodosinelloides potievskayae*
Raphconilia sp.	pl. 4, fig. 4	*Pseudovidalina modificata*
Bradyina sp.	pl. 4, fig. 5	*Bradyina nautiliformis*
Endothyra sp.	pl. 4, fig. 6	*Endothyra* ex gr. *similis*
Pseudopaleospiroplectammina sp.	pl. 4, fig. 7	*Spireitlina tokmovensis*
Eolasiodiscus sp.	pl. 4, fig. 8	*Hemidiscus carnicus*
Globivalvulina sp.	pl. 4, fig. 9	*Globivalvulina* ex gr. *bulloides*
Tetrataxis sp.	pl. 4, fig. 10	*Tetrataxis* sp.
Calcitornellid foraminifer	pl. 4, fig. 11	*Calcitornella heathi*
Neohemigordius sp.	pl. 4, fig. 12	*Arenovidalina* sp. 1
Neohemigordius sp.	pl. 4, fig. 13	*Arenovidalina sverdrupensis*
Asselodiscus ? sp.	pl. 4, fig. 14	*Asselodiscus* sp.

ularia sp., *Pseudovermiporella* (?) cf. *graiferi* (Baryshnikov in Baryshnikov et al., 1982) (Pl. 4, fig. 25), *P. nipponica* (Endo in Endo & Kanuma, 1954) (Pl. 4, fig. 26), *Hemigordius schlumbergeri* (Howchin, 1895) (Pl. 5, fig. 25), *H. longus* Grozdilova, 1956 (Pl. 5, fig. 12-14), *H.* sp., "*Arenovidalina*" sp. 1 (Pl. 5, fig. 1), "*A.*" *tenuitheca* (Kireeva, 1958) (Pl. 5, fig. 2, 5-6), *Syzrania* sp., *Nodosinelloides potievskayae* Mamet & Pinard, 1996, *N. longa* (Lipina, 1949), *N.* sp., *Protonodosaria longissima* (Suleimanov, 1949), *Geinitzina postcarbonica* Spandel, 1901, *G. multicamerata* Lipina, 1949 (Pl. 7, fig. 18), *Pachyphloia* (?) aff. *crassisepta* (Lin, 1984).

Fusulinids: *Nankinella* sp., *Staffella* sp., *Schubertella* sp., *Boultonia* sp., *Quasifusulina* sp., *Sakmarella moelleri* (Schellwien, 1908), *Sphaeroschwagerina* sp.

The Grenzland Formation is characterized by the appearance of very rare *Geinitzina postcarbonica*, *Pseudovermiporella* sp. and *Pachyphloia* (?) sp. In the studied samples the Gymnocodiacean *Permocalculus* is also present, but the most ancient specimen of this algal genus, called *Gymnocodium* cf. *gracile* by Homann (1972, pl. 1, fig. 8), was reported from the LPL.

"*Arenovidalina*" sp. 1 was only determined in samples of the Grenzland Formation (see the previous remark concerning its presence mentioned by Forke et al. 1998). The Bradyinidae disappear completely and definitively in the studied samples. *Pseudovidalina* is lacking but re-appears in the UPL (see below). Oolitic facies is common (Krainer, 1993b, fig. 25); the sparitized small oolites of the Grenzland and UPL Formations were erroneously interpreted as " algal spores " by Flügel (1966, pl. 5, fig. 1, pl. 7, fig. 3; 1977, pl. 4/4; 1979, pl. 1, fig. 5). Among the algae and pseudo-algae, the first abundance of *Globuliferoporella* and *Neoanchicodium catenoides* is noticeable; both taxa range up to the Trogkofel Group (Flügel & Flügel-Kahler 1980). The complex biopisolites of the *Ottonosia-type*, abundant in the UPL (Flügel, 1966, pl. 7, fig. 4; 1977, pl. 4/1-3; 1979, pl. 1, fig. 4), first appear in the Grenzland Formation (see also Krainer 1993b, fig. 22).

"*Girvanella*" *subparallela* is abundant. The wall of this species as well as that of *Ellesmerella permica* (Pia, 1937) Mamet et al., 1987 emend. herein is characteristic of a porcelaneous foraminifer; therefore we consider these two taxa, both originally described in Carnic Alps, as synonyms.

Fossil assemblage of the Upper *Pseudoschwagerina* Limestone (UPL) Formation.

The richest fossil assemblage (cyanobacteria, algae, pseudo-algae, smaller foraminifers) of the Rattendorf Group is yielded by the UPL Formation of Zweikofel and Garnitzenbach sections.

Cyanobacteria: *Girvanella* sp., *Koivaella permica* Chuvashov, 1974 (Pl. 3, fig. 7), *Archaeolithoporella hidensis* Endo, 1961, *Bacinella* sp., *Renalcis* sp. (Pl. 3, fig. 5-6).

Algae: *Archaeolithophyllum missouriense* Johnson, 1956, "*A.*" *lamellosum* Wray, 1964, *Parachaetetes* sp., *Permocalculus* sp., *Anchicodium* sp., *Neoanchicodium catenoides* Endo in Endo & Kanuma, 1954, *Globuliferoporella piai* (Kordé, 1951), *Homannisiphon morikawai* (Endo, 1954) n. gen. n. comb. (Pl. 3, fig. 13-16), *Anthracoporella* sp., *Epimastopora alpina* Kochansky & Herak, 1960, *E. kanumai* Endo in Endo & Kanuma, 1954, *Pseudoepimastopora* sp., *Macroporella* sp., "*Atractyliopsis*" *carnica* Flügel, 1966 (Pl. 3, fig. 11), *Mizzia cornuta* Kochansky & Herak, 1960, *Gyroporella symmetrica* Johnson, 1951 non Chuvashov, 1974, *G. nipponica* Endo & Hashimoto, 1955, *G.* sp., *Connexia slovenica* Kochansky, 1979 (Pl. 3, fig. 9-10).

Pseudo-algae: *Ellesmerella permica* (Pia, 1937) (= "*Girvanella*" *subparallela* Flügel & Flügel-Kahler, 1980) (Pl. 3, fig. 4), *Claracrusta catenoides* (Homann, 1972)

emend. Vachard, 1980, *Eflugelia johnsoni* (Flügel, 1966) emend. Vachard in Massa & Vachard, 1979 (Pl. 3, fig. 12), *Ungdarella* ex gr. *uralica* Maslov, 1956, *Tubiphytes obscurus* Maslov, 1956 (including the morphotype *T. carinthiacus* Flügel, 1966).

Smaller foraminifers: *Diplosphaerina* sp., *Tuberitina* sp., *Earlandia* sp., *Spireitlina conspecta* (Reitlinger, 1950) (Pl. 4, fig. 1, 3-4), *Endothyra* ex gr. *similis* Rauser & Reitlinger in Rauser et al., 1936 (Pl. 4, fig. 5), *E.* ex gr. *bowmani* Phillips, 1846 emend. Brady, 1876 emend. China, 1965 (Pl. 4, fig. 11), *Endothyranella* sp. (Pl. 4, fig. 12), *Neoendothyra* (?) sp. (Pl. 4, fig. 6, 15), *Tetrataxis* sp., *Polytaxis* sp., *Globivalvulina* ex gr. *bulloides* (Brady, 1876) (Pl. 4, fig. 7), *G.* cf. *graeca* Reichel, 1945, *G.* sp. 1 (Pl. 4, fig. 8-9), *Cribrogenerina* (?) ex gr. *elegans* (von Moeller, 1879) sensu Schellwien, 1898 [= *C.* (?) *gigas* (Suleimanov, 1949)], *Climacammina* cf. *magna* Roth & Skinner, 1930, *C.* sp., *Hemidiscus carnicus* Schellwien, 1898 emend. Vachard & Krainer, 2001 (= *Lasiodiscus* tenuis Reichel, 1945), *Asselodiscus primitivus* Mamet & Pinard, 1992 (Pl. 5, fig. 31, 39-40), *Pseudovidalina* cf. *minor* Pinard & Mamet, 1998 (Pl. 5, fig. 28-30, 32-38), *Pseudoagathammina* (?) *regularis* (Lipina, 1949) (Pl. 4, fig. 16-17, 19-21), *P.* (?) cf. *pseudoseptata* (Lipina, 1949) (Pl. 4, fig. 18), *Glomospirella* (?) sp. (Pl. 5, fig. 24), *Calcitornella* sp., *Palaeonubecularia* ex gr. *fluxa* Reitlinger, 1950 (Pl. 4, fig. 24), *Pseudovermiporella* sp., *Hemigordius schlumbergeri* (Howchin, 1895) (Pl. 5, fig.

PLATE 1

Fossil assemblage of Lower Pseudoschwagerina Limestone Formation (LPL) from the Schulterkofel section (except Bradyinidae).

Fig. 1 - *Gyroporella nipponica* Endo & Hashimoto, 1955. Oblique section showing the characteristic laterals, Schulterkofel, LPL Formation, Orenburgian, sample SK 89; x 36.

Fig. 2 - *Tubiphytes* ex gr. *obscurus* Maslov, 1956. Oblique section, with scarce agglutinated spicules, Schulterkofel, LPL Formation, Orenburgian, sample SK 65; x 36.

Fig. 3 - *Tuberitina bulbacea* Galloway & Harlton, 1928. Longitudinal section. Schulterkofel, LPL Formation, Orenburgian, sample SK 11; x 90.

Fig. 4 - *Epimastopora* sp. Oblique section, Schulterkofel, LPL Formation,Orenburgian, sample SK 89; x 36.

Fig. 5-6 - *Spireitlina conspecta* (Reitlinger, 1950). Two transverse equatorial sections, Schulterkofel, LPL Formation; x 90. Fig. 5 - Early Asselian, sample SK 141; Fig 6 - Orenburgian, sample SK 94.

Fig. 7-8 - *Endothyra bowmani* Phillips, 1846 emend. Brady, 1876 emend. China, 1965 Schulterkofel, LPL Formation; x 90; Fig. 7 - Transverse equatorial section, Orenburgian, sample SK 119. Fig. 8 - Subaxial section, early Asselian, sample SK 156.

Fig. 9 - *Endothyra* ex gr. *bowmani* Phillips, 1846 emend. Brady, 1876 emend. China, 1965. Subtransverse section, Schulterkofel, LPL Formation, Orenburgian, sample SK 60; x 90.

Fig. 10 *Endothyranella protracta* Rauser, 1938 emend. Pinard & Mamet, 1998. Axial section, Schulterkofel, LPL Formation, Orenburgian, sample SK 59; x 90.

Fig. 11-12 - *Globivalvulina bulloides* (Brady, 1876). Schulterkofel, LPL Formation, Orenburgian; x 90; Fig. 11 - Transverse section, sample SK 97; Fig. 12 - Axial section, sample SK 114.

Fig. 13 - *Palaeonubecularia* ex gr. *fluxa* Reitlinger, 1950. Axial section. Schulterkofel, LPL Formation, Orenburgian, sample SK 118; x 90.

Fig. 14 - *Polytaxis maxima* (Schellwien, 1898). Axial section. Schulterkofel, LPL Formation, Orenburgian, sample SK 119; x 36.

Fig. 15-17- *Hemidiscus carnicus* (Schellwien, 1898) emend. Vachard & Krainer, 2001. Schulterkofel, LPL Formation, Orenburgian; x 90. Fig. 15 - Typical axial section, sample SK 114; Fig. 16 - Axial section looking like *Eolasiodiscus*, sample SK 38; Fig. 17 - Oblique section, sample SK 113.

Fig. 18 - *Asselodiscus primitivus* Mamet & Pinard, 1992. Axial section, Schulterkofel, LPL Formation, Orenburgian, sample SK 57; x 90.

Fig. 19 - *Pseudovidalina multihelicis* Pinard & Mamet, 1998. Axial section, Schulterkofel, LPL Formation, Orenburgian, sample SK 98; x 90.

Fg. 20 - *Pseudovidalina modificata* (Potievskaya, 1962). Axial section, Schulterkofel, LPL Formation, early Asselian, sample SK 141; x 90.

Fig. 21 - *Climacammina* (sensu stricto) sp. Axial section, Schulterkofel, LPL Formation, Orenburgian, sample SK 112; x 36.

Fig. 22 - *Cribrogenerina* (?) *elegans* (von Moeller, 1879) sensu Schellwien 1898 emend. Vachard & Krainer, 2001. Axial section, Schulterkofel, LPL Formation, Orenburgian, sample SK 115e; x 36.

Fig. 23, 27 - *Cribrogenerina* (?) ex gr. *elegans* (von Moeller, 1879) sensu Schellwien 1898 emend. Vachard & Krainer, 2001 (= *C.* (?) *sphaerica* Potievskaya, 1962). Schulterkofel, LPL Formation, Orenburgian; x 36; Fig. 23 - Subaxial section, sample SK 39; Fig. 27 - Oblique section, sample SK 80.

Fig. 24, 28 - *Deckerella* cf. *tenuissima* Reitlinger, 1950. Schulterkofel, LPL Formation, Orenburgian; x 36; Fig. 24 -Axial section, sample SK 115 e/2; Fig. 28 - Subaxial section, sample SK 96.

Fig. 25 - *Cribrogenerina* (?) sp. Oblique section through two cribrate apertures. Schulterkofel, LPL Formation, Orenburgian, sample SK 121; x 36.

Fig. 26 - *Calcitornella heathi* Cushman & Waters, 1928. Axial section, Schulterkofel, LPL Formation, Orenburgian, sample SK 66; x 90.

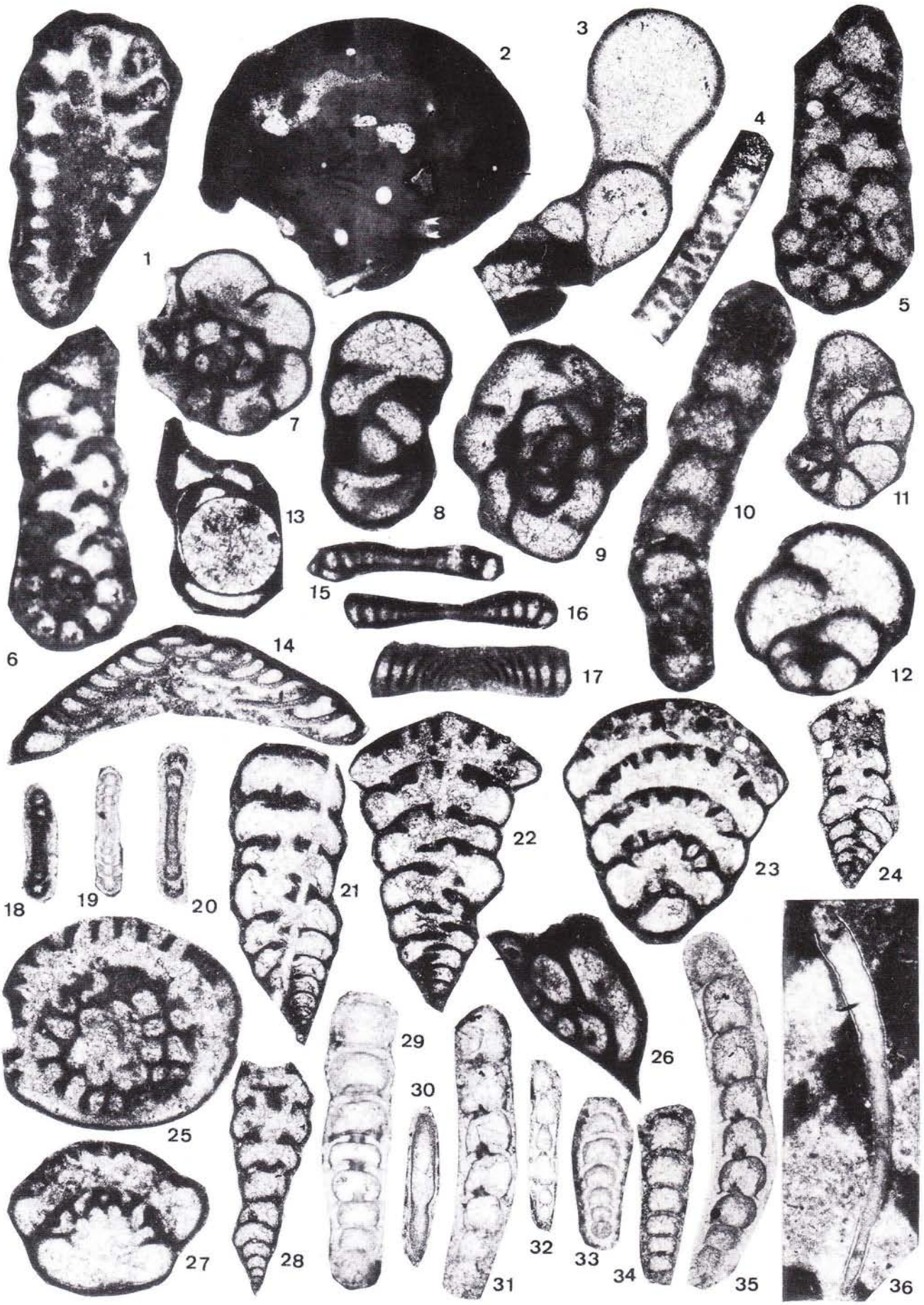
Fig. 29 - *Nodosinelloides longa* (Lipina, 1949). Typical axial section showing the apertures, Schulterkofel, LPL Formation, Orenburgian, sample SK 88; x 36.

Fig. 30 - *Syzranella* sp. Oblique section, Schulterkofel, LPL Formation, Orenburgian, sample SK 118; x 36.

Fig. 31, 33-35 - *Nodosinelloides potievskayae* (Mamet & Pinard, 1996). Schulterkofel, LPL Formation, Orenburgian; x 90; Fig. 31 - Subaxial section, sample SK 114; Fig. 33 - Young axial section, sample SK 119; Fig. 34 - Subaxial section, sample SK 82; Fig. 35 - Typical axial section, sample SK 122.

Fig. 32 - *Vervilleina bradyi* (Spandel, 1901). Subaxial section, Schulterkofel, LPL Formation, Orenburgian, sample SK 118; x 36.

Fig. 36 - *Syzrania gigas* Stepanova 1997. Large longitudinal section, Schulterkofel, LPL Formation, Orenburgian, sample SK 75; x 36.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8, 18-19), *H.* ex gr. *harltoni* Cushman & Waters, 1928 (Pl. 5, fig. 11), *H.* cf. *ovatus* Grozdilova, 1956 (Pl. 5, fig. 20-21), *H.* cf. *permicus* Grozdilova, 1956 (Pl. 5, fig. 9), *H. saranensis* Baryshnikov in Baryshnikov et al., 1982 (Pl. 5, fig. 10, 23), *H.* (?) sp. (Pl. 5, fig. 26-27), *"Arenovidalina"* cf. *tenuitheca* (Kireeva, 1958) (Pl. 5, fig. 3-4), *"A." sverdrupensis* (Pinard & Mamet, 1998) (Pl. 5, fig. 7, 15-17, 22), *Syzrania* sp. (Pl. 5, fig. 41), *Syzranella* sp. (Pl. 5, fig. 42), *Nodosinelloides potievskayae* Mamet & Pinard, 1996 (Pl. 5, fig. 43-48, 56; Pl. 6, fig. 3), *N. longa* (Lipina, 1949) (Pl. 5, fig. 49-53), *N. mirabilis* (Lipina, 1949) (Pl. 6, fig. 1, 6, 8-11; Pl. 7, fig. 1, 3-4, 22, 28), *N.* cf. *pinardae* Groves & Wahlman, 1997 (= *Nodosaria grandis* Lipina, 1949; preoccupied) (Pl. 7, fig. 20-21, 24-25), *Protonodosaria longissima* (Suleimanov, 1949) (Pl. 6, fig. 17-19, 22, 24-25, 27-29; Pl. 7, fig. 6, 29), *P. elegantissima* (Suleimanov, 1949) (Pl. 6 , fig. 31), *P. "kamaensis"* (Baryshnikov in Baryshnikov et al., 1982) (Pl. 6, fig. 13, 16, 23), *P.* sp. (Pl. 7, fig. 2), *Frondicularia* cf. *turae* Baryshnikov in Baryshnikov et al., 1982 (Pl. 7, fig. 5, 10), *F.* (?) sp. 1 (Pl. 5, fig. 54-55), *F.* (?) sp. 2 (Pl. 6, fig. 14, 20), *Geinitzina postcarbonica* Spandel, 1901 (Pl. 6, fig. 21, 26; Pl. 7, fig. 7-9, 15-16), *G.* ex gr. *postcarbonica* [*G. lepida* Lin, 1984 (Pl. 6, fig. 12, 30; Pl. 7, fig. 12, 27) and *G.* aff. *lingulaeformis Lipina*, 1949 (Pl. 7, fig. 30)], *G.* cf. *ichnousa* Sellier de Civrieux & Dessauvagie, 1965 (Pl. 6, fig. 33), *G. multicamerata* Lipina, 1949 (Pl. 6, fig. 2, 4-5, 15, 32; Pl. 7, fig. 11, 13-14, 23, 26), *G.* aff. *inflata* K. V. Miklukho-Maclay, 1954 (Pl. 6, fig. 7), *G.* aff. *primitiva* Potievskaya, 1962 (Pl. 6, fig. 37-39), *Pachyphloia* (?) aff. *crassisepta* (Lin, 1984) (Pl. 6, fig. 34-36; Pl. 7, fig. 17), *Pseudolangella* aff. *fragilis* Sellier de Civrieux & Dessauvagie, 1965 (Pl. 7, fig. 19).

Fusulinids: *Nankinella* sp., *Staffella* sp., *Pseudoreichelina* sp., *Eoschubertella* sp., *Schubertella* sp., *Biwaella* sp., *Boultonia* sp., *Quasifusulina* sp., *Pseudochusenella* sp., *Sakmarella moelleri* (Schellwien, 1908), *Darvasites* sp., *Zellia* sp.

The UPL Formation is characterized by: (a) the reappearance of small *Pseudovidalina* (these successive Lazarus effects concerning the Pseudovidalinids have been observed until the late Permian, for example in Turkey, by Zaninetti et al. 1981; and previously the acme of the Pseudovidalinidae was erroneously considered as late Permian by Altiner 1988); (b) the species *"Arenovidalina" sverdrupensis*, which can be proposed as an index fossil; (c) the abundance of *Pseudovermiporella*; (d) the great diversification of the Nodosarioides, particularly of *Geinitzina*; (e) the presence of *Syzrania*, up to the top of the UPL of the Carnic Alps probably like in Urals where *Syzrania* disappears only in the Artinskian; (f) the abundance of *Neoanchicodium*; (g) the importance of complex biopisolites (i. e. oncoids or *Ottonosia* auct.) composed of *Claracrusta catenoides*, *Girvanella* sp. and *"Archaeolithophyllum" lamellosum* around a nucleus of *Anchicodium* sp.; (h) almost all the algae and pseudoalgae range until the Trogkofel Formation: *Anchicodium, Neoanchicodium, Anthracoporella, "Atractyliopsis" carnica, Connexia, Epimastopora, Globuliferoporella, Ellesmerella permica and "Archaeolithophyllum" lamellosum* (Flügel & Flügel-Kahler, 1980); (i) the first abundance of *Tubiphytes* and *Archaeolithoporella* is characteristic for the upper part of the UPL in the Zweikofel section; these microproblematica are builders only in the Trogkofel Group (Flügel 1981; Forke 1995); (j) the presence of *Renalcis*, which is generally known from Cambrian to middle Carboniferous (Vachard et al., 1989). It was reported from the late middle Permian (early Midian) of Jebel Tebaga (Tunisia) by Vachard & Razgallah (1988). For the first time, *Renalcis* is discovered in early Permian deposits.

Conclusions.

The assemblage of the smaller foraminifers of

PLATE 2

Bradyinids of the Lower *Pseudoschwagerina* Limestone (LPL), Schulterkofel section.

Fig. 1 - *Bradyina costifera* Baryshnikov in Baryshnikov et al., 1982. Transverse equatorial section, Schulterkofel, LPL Formation, Orenburgian, sample SK 36; x 36.

Fig. 2-3 - *Bradyina sikhanica* Morozova, 1949. Schulterkofel, LPL Formation, Orenburgian; x 36; Fig. 2 - Axial section, sample SK 26/4; Fig. 3 -Transverse section, sample SK 67.

Fig. 4-5 - *Bradyinelloides major* (Morozova, 1949). Schulterkofel, LPL Formation, early Asselian, sample SK 156; x 36; Fig. 4 - Subtransverse section; Fig. 5 - Oblique section.

Fig. 6, 8, 11, 17 - *Bradyina arctica* Pinard & Mamet, 1998. Four axial sections, Schulterkofel, LPL Formation, Orenburgian; x 36; Fig. 6 - sample SK 26/2; Fig. 8 - sample SK 35; Fig. 11 - sample SK 98; Fig. 17 - sample SK 98.

Fig. 7 - *Bradyina compressa* Morozova, 1949. Axial section, Schulterkofel, LPL Formation, early Asselian, sample SK 136; x 90.

Fig. 9-10, 13-16, 18 - *Bradyina lucida* Morozova, 1949. Schulterkofel, LPL Formation; x 36; Fig. 9 - Transverse section, early Asselian, sample SK 155; Fig. 10 - Subtransverse section, Orenburgian, sample SK 122; Fig. 13 - Axial section, early Asselian, sample SK 158; Fig. 14 - Transverse section, Orenburgian, sample SK 122; Fig. 15 - Axial section, Orenburgian, sample SK 26/4 (adjacent to the *B. sikhanica* of the Fig. 2); Fig. 16 - Axial section, Orenburgian, sample SK 27; Fig. 18 - Transverse section, early Asselian, sample SK 158.

Fig. 12 - *Pseudobradyina pulchra* Reitlinger, 1950. Oblique section, Schulterkofel, LPL Formation, Orenburgian, sample SK 94a; x 90.


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the LPL Formation is completely identical to the Auernig Formation. Only one assemblage was identified for the Orenburgian. Any modification of these groups can be observed at the Permian/Carboniferous boundary.

The Grenzland Formation is characterized by the appearance of the genus *Geinitzina*. It is probably a world datum, as well as the appearance of very primitive *Pachyphloia* (?) sp. More locally, the appearance of *Pseudovermiporella* can be noticed. It is probably descended from *Hedraites* which is also present in the Carnic Alps during the late Carboniferous Auernig Group (Vachard & Krainer 2001), and the disappearance of the Bradyinidae very diversified in the Auernig Group and in the LPL.

The UPL contains all the taxa which are present in the Grenzland Formation or earlier. This period is especially transitional for the algae and pseudo-algae, but *Homannisiphon morikawai* (Endo, 1954) n. gen. n. comb. seems rather characteristic of this period. Further investigations in the Trogkofel Group are necessary for testing the validity of the local appearance of *Neoendothyra* (?), the beginning of the local acme of *Tubiphytes* and *Archaeolithoporella*, and diversity of the Hemigordiidae and Nodosarioidea. There is probably also a local disappearance of the genera *Spireitlina*, *Endothyranella* and *Syzrania*, all ranging from the middle Carboniferous to the early Permian.

The boundary between the Orenburgian and Asselian, as well as between the Asselian and Sakmarian is difficult to establish based on the local assemblages of smaller foraminifers.

Selected systematical paleontology

Description of a biostratigraphically important green alga.

Division **Rhodophycophyta** or **Chlorophycophyta** ?

Order, family and tribe undetermined

Genus *Homannisiphon* n. gen.

Type species. *Ortonella morikawai* Endo, 1954.

Derivatio nominis. Dedicated to Wolfgang Homann, eminent micropaleontologist of the Carnic Alps. Genus masculine.

Synonyms. *Ortonella Garwood*, 1914 (pars), *Hedstroemia* Rothpletz, 1913 (pars), *Garwoodia* Wood, 1941 (pars), *Salopekiella* Milanovic, 1965 (pars), *Thaiporella* Endo, 1966 (pars), *Epimastopora* Pia, 1937 (pars).

Diagnosis. Thallus cordifom (= heart-shaped). Sparitized skeleton probably formerly aragonitic. Radiate threads beginning at the base of the thallus and diverging toward the apex, dichotomously branching several times. Tube cylindrical with some swollen parts corresponding rather to the cellular files of Gymnocodiaceae than Chlorophyta. Deltoid extremities are other common character with the Gymocodiaceae. Conceptacles not obvious (Fig. 4).

Composition. *Homannisiphon morikawai* (Endo, 1954), *H. uralica* (Chuvashov, 1974), *H.* aff. *uralica* in Vachard et al. in press (probably two new species), *H. latifibrosa* (Endo in Endo & Kanuma, 1954, as *Ortonella*), *H.* (?) *uralica* Shuysky, 1973 (as *Hedstroemia*) with three remarks: (a) prioritary upon *H. uralica* (Chuvashov) emend. herein, (b) *Garwoodia orbiculata* Shuysky, 1973 is probably composed of more altered specimens of "*Hedstroemia*" *uralica*, and (c) in general some other *Garwoodia* of the literature can belong to *Homannisiphon*.

Comparisons. The new genus corresponds exactly to *Thaiporella* sensu Chuvashov, 1974, but not to the definition and reconstruction of this genus by Endo (1966). It differs from *Ortonella*, *Hedstroemia* and *Garwoodia*, by the type of calcification of the wall (sparitized and not microgranular), and is distinct from

PLATE 3

Important algae and pseudo-algae of Grenzland Formation and Upper *Pseudoschwagerina* Limestone (UPL).

Fig. 1-4 - *Ellesmerella permica* (Pia, 1937) emend. Mamet et al., 1987 emend. herein (= "*Girvanella*" *subparallela* Flügel & Flügel-Kahler, 1980); Fig. 1 - Longitudinal section encrusting a Phylloid alga, Garnitzenbach, Grenzland Formation, late Asselian, sample GB 10; x 36; Fig. 2 - Typical longitudinal section, Garnitzenbach, Grenzland Formation, late Asselian, sample GB 13; x 90; Fig. 3 - Longitudinal to tranverse section, Garnitzenbach, Grenzland Formation, late Asselian, sample GB 5; x 36; Fig. 4 - Longitudinal section, Zweikofel, UPL Formation, early Sakmarian, sample ZK 50, x 90.

Fig. 5, 6 - *Renalcis* sp. Two transverse sections, Zweikofel, UPL Formation, early Sakmarian, sample ZKO 20; x 90.

Fig. 7 - *Koivaella permica* Chuvashov, 1974. Longitudinal section, Zweikofel, UPL Formation, early Sakmarian, sample ZK 215x; x 90.

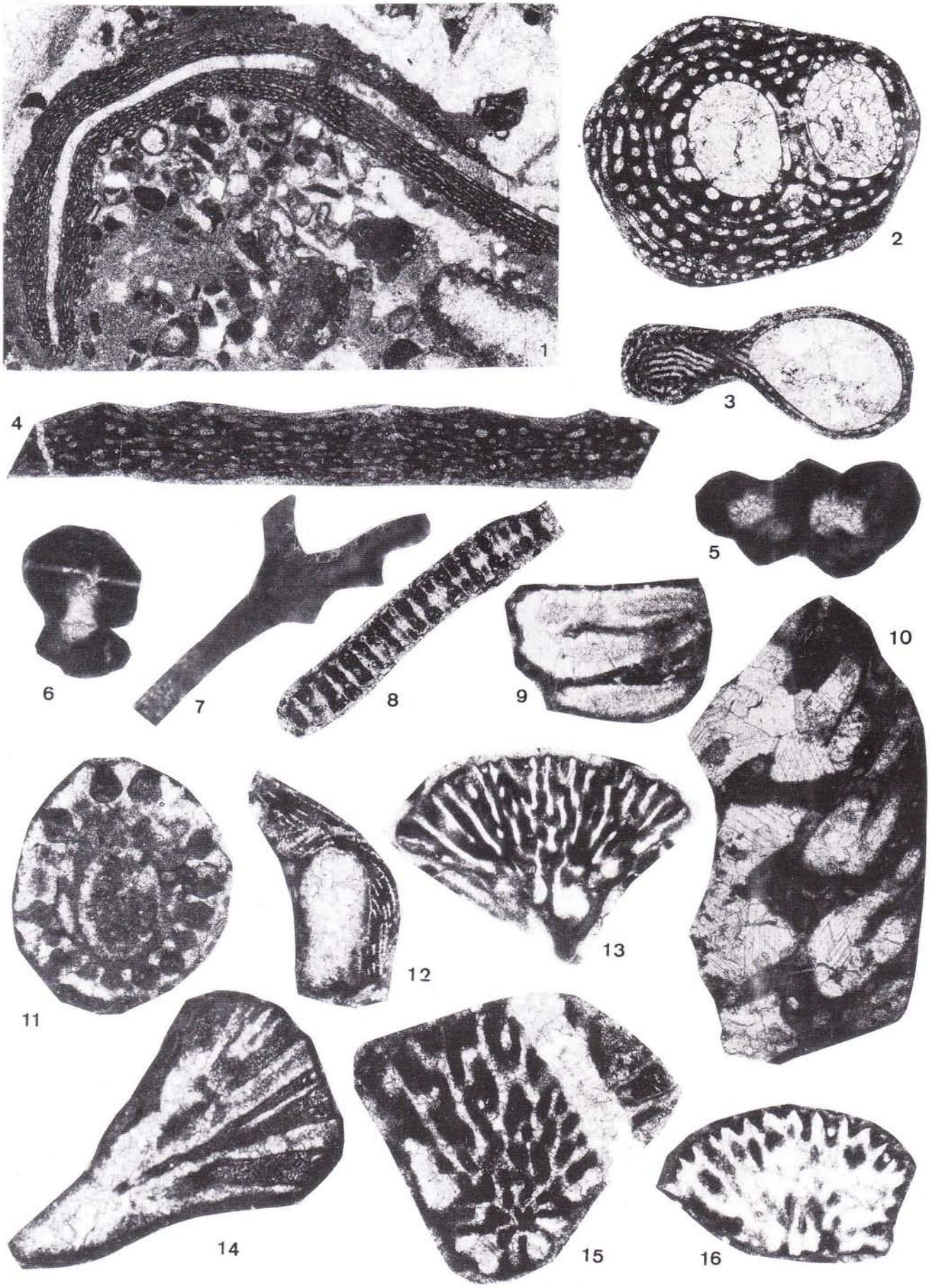
Fig. 8 - *Globuliferoporella piai* (Kordé, 1951) n. comb. (= *Globuliferoporella symmetrica* sensu Chuvashov, 1974 = *Gyroporella symmetrica* Flügel, 1966 non Johnson, 1951). Longitudinal section, Garnitzenbach, Grenzland Formation, late Asselian, sample GB 5; x 36.

Fig. 9-10 - *Connexia slovenica* Kochansky, 1979 (= *C. carniapulchra* Flügel & Flügel-Kahler, 1980); Zweikofel, UPL Formation, early Sakmarian, sample ZKO 32; x 36; Fig. 9 - An isolated verticille; Fig. 10 - Several superimposed verticilles.

Fig. 11 - "*Atractyliopsis*" *carnica* Flügel, 1966. Transverse section, Zweikofel, UPL Formation, early Sakmarian, sample ZKO 10; x 36.

Fig. 12 - *Eflugelia johnsoni* (Flügel, 1966). Longitudinal section, Zweikofel, UPL Formation, early Sakmarian, sample ZKO 10; x 36.

Fig. 13-16 - *Homannisiphon morikawai* (Endo, 1954) n. gen. n. comb. UPL Formation, early Sakmarian; x 36; Fig. 13 - Axial section showing the characteristc ramifications, Zweikofel, sample ZK 77; Fig. 14 - A fragment of longitudinal section, Garnitzenbach, sample GB 50; Fig. 15 - Subaxial section, Garnitzenbach, sample GB 51; Fig. 16 - Oblique section with the deltoid terminations, Zweikofel, sample ZK 88.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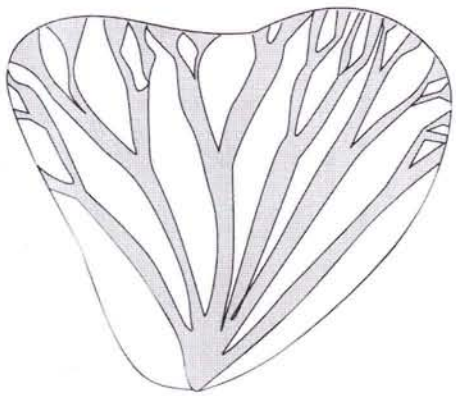

Fig. 4 - Reconstruction of *Homannisiphon* n. gen. (approximative sacale x30).

Salopekiella by the absence of a central cavity, the absence of verticilles and the multiple ramifications of the laterals. In fact *Homannisiphon* is very different of *Salopekiella*, and of all true Dasycladales. Some characters summarized in the diagnosis can require also a comparison with the Gymnocodiacean red algae.

Occurrence. Late Carboniferous of Japan (Yayamadake Subgroup, probably late Kasimovian/early Gzhelian in age). Relatively characteristic of the UPL Formation, early Sakmarian of the Carnic Alps (Homann 1972 and this study; and questionably in the Trogkofel Limestone of the Karawanken Mountains: Kochansky 1970). Sakmarian of the Urals (Chuvashov 1974; Kulik 1978), very rare specimens in the Kubergandian and Midian (Middle Permian) of the Batain Plain in Oman (Vachard et al., in press). The early Devonian (Emsian) form called *Hedstroemia uralica* Shuysky 1973, seems to belong to *Homannisiphon*, but its tubules are more closely arranged and polygonal in section.

Homannisiphon morikawai

(Endo, 1954) n. gen. n. comb.

Pl. 3, fig. 13-16

1954 *Ortonella Morikawai* Endo, p. 219-220, pl. 19, fig. 8-9.
1957 *Ortonella morikawai* Endo, p. 296, pl. 43, fig. 4-5.
1963 *Ortonella morikawai* - Johnson, p. 131, pl. 16, fig. 6-7, pl. 76, fig. 5-8.
1970 *Ortonella morikawai* - Kochansky, p. 212 (in Slovene), 240 (in German), pl. 22, fig. 1-2, pl. 24, fig. 1-2.
1972 *Salopekiella* cf. *S. velebitana* - Homann, p. 230-231, pl. 7, fig. 56-58.
1974 *Thaiporella uralica* Chuvashov, p. 19-20, pl. 5, fig. 1-2 (non fig. 3, holotype = *Homannisiphon uralica* n. comb.; refigured pl. 14, fig. 14 by Chuvashov et al., 1993).
1976 *Ortonella morikawai* - Emberger, p. 92 (cum syn.).

PLATE 4

Various smaller Foraminifers from Grenzland Formation and Upper *Pseudoschwagerina* Limestone (UPL).

Fig. 1-4 - *Spireitlina conspecta* (Reitlinger, 1950). Four transverse sections; Fig.1 - Zweikofel, UPL Formation, early Sakmarian, sample ZK 205; x 90; Fig. 2 - Zweikofel, Grenzland Formation, early Sakmarian, sample ZK 26; x 90; Fig. 3 - Zweikofel, UPL Formation, early Sakmarian, sample ZK 72; x 90; Fig.4 - Trogkofel, UPL Formation, early Sakmarian, sample OPS 1; x 90.
Fig. 5 - *Endothyra* ex gr. *similis* Rauser & Reitlinger in Rauser et al., 1936. Zweikofel, UPL Formation, early Sakmarian, sample ZK 75; x 90.
Fig. 6, 15 - *Neoendothyra* (?) sp. Zweikofel, UPL Formation, early Sakmarian; x 90; Fig.6 - Oblique section, sample ZK 215; Fig. 15 - Subaxial section, sample ZK a.
Fig. 7 - *Globivalvulina* ex gr. *bulloides* (Brady, 1876). Transverse section, Zweikofel, UPL Formation, early Sakmarian, sample ZK 232; x 90.
Fig. 8-9 - *Globivalvulina* sp. 1. Zweikofel, UPL Formation, early Sakmarian; x 36. Fig. 8 - Axial section, sample ZKO 22; Fig. 9 - Transverse section, sample ZKO 21.
Fig. 10, 14 - Intermediate between *Climacammina* and *Bigenerina* sp., Zweikofel, Grenzland Formation, late Asselian; x 36; Fig. 10 - Transverse section, sample ZK 26; Fig. 14 - Subaxial section, sample ZK 25.
Fig. 11 - *Endothyra* ex gr. *bowmani* Phillips, 1846 emend. Brady, 1876 emend. China, 1965. Axial section, Zweikofel, UPL Formation, early Sakmarian,sample ZKa; x 90.
Fig. 12 - *Endothyranella* sp. Axial section, Zweikofel, UPL Formation, early Sakmarian, sample ZK 99 G; x 90.
Fig. 13 - True *Cribrogenerina* sp. Axial section, Zweikofel, Grenzland Formation, late Asselian, sample ZK 26; x 36.
Fig. 16-17, 19-21 - *Pseudoagathammina* (?) *regularis* (Lipina, 1949); Fig. 16 - Axial section, Garnitzenbach, UPL Formation, early Sakmarian, sample GB 66; x 90; Fig. 17 - Axial section with well conspicuous proloculus, Garnitzenbach, UPL Formation, early Sakmarian, sample GB 67; x 90; Fig. 19 - Axial section, Zweikofel, UPL Formation, early Sakmarian, sample ZK 70; x 90; Fig. 20 - Subquadrate subaxial section, Garnitzenbach, UPL Formation, early Sakmarian, sample GB 37; x 90; Fig. 21 - Rounded subaxial section, Garnitzenbach, UPL Formation, early Sakmarian, sample GB 41; x 90.
Fig. 18 - *Pseudoagathammina* (?) cf. *pseudoseptata* (Lipina, 1949). Axial section, Garnitzenbach, UPL Formation, early Sakmarian, sample GB 148; x 90.
Fig. 22-23 - *Pseudoagathammina* (?) sp. 3. Garnitzenbach, Grenzland Formation, late Asselian, sample GB 15; x 90; Fig. 22 - Young specimen; Fig. 23 - Mature specimen.
Fig. 24 - *Palaeonubecularia* ex gr. *fluxa* Reitlinger, 1950 Longitudinal section (compare with *Apterrinella* sp. figured in Kochansky, 1970b: pl. 7, fig. 1 only, the other ones are *Calcitornella*), Zweikofel, UPL Formation, early Sakmarian, sample ZK 57; x 36.
Fig. 25 - *Pseudovermiporella* (?) cf. *graiferi* (Baryshnikov in Baryshnikov et al., 1982). Axial section, with badly obvious pits, Garnitzenbach, Grenzland Formation, late Asselian, sample GB 47; x 36.
Fig. 26 - *Pseudovermiporella nipponica* (Endo in Endo and Kanuma, 1954). Typical longitudinal section, Garnitzenbach, Grenzland Formation, late Asselian, sample GB 20; x 36.


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1977 *Ortonella morikawai* - Flügel, p. 318 (not illustrated).
1978 *Ortonella* cf. *morikawai* - Kulik, p. 190-191, pl. 3, fig. 2.
1988 *Epimastopora ?* - Fontaine et al., pl. 13, fig. 1.
non 1996 *Ortonella morikawai* - Sano & Kanmera, pl. 59, fig. 10.

Description. Fragments of thalli generally triangular in shape. Wall white microsparitized; threads filled by dark micritic cement. Threads rectilinear (Pl. 3, fig. 14) or undulating (other specimens) ; dichotomous and diverging from the base (Fig. 4).

Dimensions. Length of remains up to 2.00 mm; width of remains = 1.10-2.00 mm; pore diameter = 0.03-0.10 mm; interpore calcification thickness = 0.01-0.10 mm; diameter of the deltoid terminations up to 0.013 mm.

Occurrence. UPL Fm. of the Carnic Alps (Homann, 1972); Trogkofel Formation of Slovenia (Kochansky, 1970); late Carboniferous of Japan (Endo, 1954, 1957); Sakmarian of the Urals (Chuvashov, 1974; Kulik, 1978) and west Thailand (Fontaine et al., 1988).

History of Bradyinids

As indicated in Fig. 5, in the Carnic Alps Bradyinids are rather scarce in the lower Meledis For-

PLATE 5

Other groups of smaller foraminifers from Grenzland Formation and Upper *Pseudoschwagerina* Limestone (UPL).

Fig. 1 - *"Arenovidalina"* sp. 1. Axial section, Garnitzenbach, Grenzland Formation, late Asselian, sample GB 8; x 90.

Fig. 2-6 - *"Arenovidalina"* cf. *tenuitheca* (Kireeva, 1958) emend. Pinard & Mamet, 1998; Fig. 2 - Axial section, Garnitzenbach, Grenzland Formation, late Asselian, sample GB 15; x 90; Fig. 3 - Axial section, Garnitzenbach, UPL Formation, early Sakmarian, sample GB 127; x 90; Fig. 4 - Axial section, Zweikofel, UPL Formation, early Sakmarian, sample ZK 204; x 36; Fig. 5 - Transverse section, Garnitzenbach, Grenzland Formation, late Asselian, sample GB 18; x 90; Fig. 6 - Axial section, Garnitzenbach, Grenzland Formation, late Asselian, sample GB 4; x 36.

Fig. 7, 15-17, 22 - *Arenovidalina sverdrupensis* (Pinard & Mamet, 1998). UPL Formation, early Sakmarian; Fig. 7 - Axial section, Garnitzenbach, sample GB 101; x 90; Fig. 15 - Subaxial section, Zweikofel, sample ZK 204x, x 36; Fig. 16 - Subaxial section, Garnitzenbach, sample GB 127; x 36; Fig. 17 - Subaxial section, Zweikofel, sample ZK 86, x 36; Fig. 22 - Subaxial section, Zweikofel, sample ZK 95, x 36.

Fig. 8, 18-19, 25 - *Hemigordius schlumbergeri* (Howchin, 1895); Fig. 8 - Axial section, Garnitzenbach, UPL Formation, early Sakmarian, sample GB 129; x 90; Fig. 18 - Axial section, Zweikofel, UPL Formation, early Sakmarian, sample ZK 125; x 36; Fig. 19 - Subaxial section, Zweikofel, UPL Formation, early Sakmarian; sample ZK 173; x 90; Fig. 25 - Oblique section, Garnitzenbach, Grenzland Formation, late Asselian, sample GB 18; x 90.

Fig. 9 - *Hemigordius* cf. *permicus* Grozdilova, 1956. Sparitized axial section(compare with H. aff. *longus* in Kochansky, 1970b, pl. 7, fig. 6), Zweikofel, UPL Formation, early Sakmarian, sample ZK 153; x 90.

Fig. 10, 23 - *Hemigordius saranensis* Baryshnikov in Baryshnikov et al., 1982. Zweikofel, UPL Formation, early Sakmarian, sample ZK 202; x 90; Fig. 10 - Axial section; Fig. 23 - Oblique section.

Fig. 11 - *Hemigordius* ex gr. *harltoni* Cushman & Waters, 1928. Subaxial section, Zweikofel, UPL Formation, early Sakmarian, sample ZK 69; x 90.

Fig. 12-14 - *Hemigordius longus* Grozdilova, 1956. Three axial sections, Garnitzenbach, Grenzland Formation, late Asselian; x 90; Fig. 12 - sample GB 19; Fig. 13 - sample GB 19; Fig. 14 - sample GB 15.

Fig. 20-21 - *Hemigordius* cf. *ovatus* Grozdilova, 1956. UPL Formation, early Sakmarian; x 90; Fig. 20 - Partially recrystallized axial section, Garnitzenbach, sample GB 127; Fig. 21 - Axial section, Zweikofel, sample ZK 210x.

Fig. 24 - *Glomospirella* (?) sp. Axial section, Zweikofel, UPL Formation, early Sakmarian, sample ZK 7e; x 90.

Fig. 26-27 - *Hemigordius* (?) tending to *Neodiscus* sp. Garnitzenbach, UPL Formation, early Sakmarian , sample GB 150; x 90. Fig. 26 - Partially recrystallized axial section; Fig. 27 - Axial section.

Fig. 28-30, 32-38 - *Pseudovidalina* cf. *minor* Pinard & Mamet, 1998. UPL Formation, early Sakmarian. Fig. 28 - Axial section, Garnitzenbach, sample GB 37; x 90; Fig. 29 - Axial section, Garnitzenbach, sample GB 166; x 90; Fig. 30 - Subaxial section, Trogkofel, sample OPS 4b; x 90; Fig. 32 - Axial section, Trogkofel, sample OPS 5; x 90; Fig. 33 - Axial section, Garnitzenbach, sample GB 145; x 90; Fig. 34 - Axial section, Garnitzenbach, sample GB 152; x 90; Fig. 35 - Axial section, Zweikofel, sample ZK a; x 90; Fig. 36 - Axial section, Garnitzenbach, sample GB 57; x 90; Fig. 37 - Axial section, Garnitzenbach, sample GB 78; x 90; Fig. 38 - Axial section, Trogkofel, sample OPS 4; x 270.

Fig. 31, 39-40 - *Asselodiscus primitivus* Mamet & Pinard, 1992. UPL Formation, early Sakmarian. Fig. 31, Axial section, Garnitzenbach, sample GB 70 (2); x 90; Fig. 39 - Axial section, Zweikofel, sample ZK 35; x 270; Fig. 40 - Subaxial section, Zweikofel, sample ZK 196; x 270.

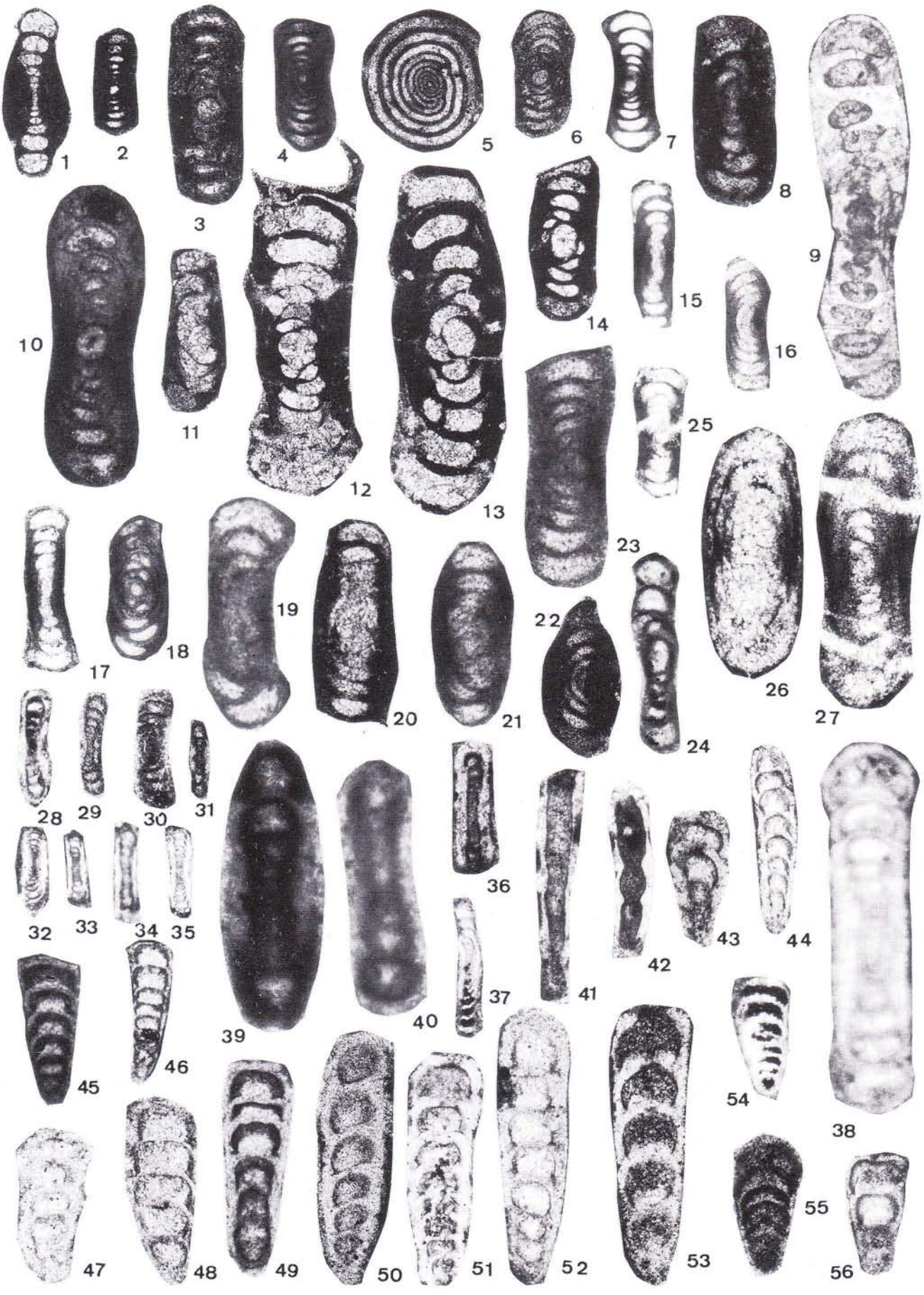
Fig. 41 - *Syzrania* sp. Axial section, Zweikofel, UPL Formation, early Sakmarian, sample ZK 93; x 90.

Fig. 42 - *Syzranella* sp. Broken axial section, Zweikofel, UPL Formation, early Sakmarian, sample ZK 83; x 90.

Fig. 43-48, 56 - *Nodosinelloides potievskayae* Mamet & Pinard, 1996. UPL Formation, early Sakmarian; x 90; Fig. 43 - Subaxial section, Garnitzenbach, sample GB 3; Fig. 44 - Axial section, Garnitzenbach, sample GB 37; Fig. 45 - Axial section, Zweikofel, sample ZK 132; Fig. 46 - Axial section, Garnitzenbach, sample GB 171; Fig. 47 - Axial section, Garnitzenbach, sample GB 41; Fig. 48 - Axial section, Garnitzenbach, sample GB 165; Fig. 56 - Axial section,Garnitzenbach, sample GB 5.

Fig. 49-53 - *Nodosinelloides longa* (Lipina, 1949). UPL Formation, early Sakmarian; x 90; Fig. 49 - Axial section, Zweikofel, sample ZK 218y; Fig. 50 - Oblique section, Garnitzenbach, sample GB 36; Fig. 51 - Axial section, Garnitzenbach, sample GB 74; Fig. 52 - Axial section, Zweikofel, sample ZK 99a; Fig. 53 - Axial section, Zweikofel, sample ZK 35.

Fig. 54-55 - *Frondicularia* (?) sp. 1. UPL Formation, early Sakmarian; x 90; Fig. 54 - Axial section, Zweikofel, sample ZK 188; Fig. 55 - Axial section, Garnitzenbach, UPL Formation, early Sakmarian, sample GB 57.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AGE	FORMATIONS	ASSEMBLAGES
EARLY SAKMARIAN	UPL	Confirmation of the local disappearance
ASSELIAN	GRENZLAND	Local disappearance
ORENBURGIAN	LPL	*Bradyina costifera, B. sikhanica, B. lucida, B. compressa, B. arctica, Bradyinelloides major, Pseudobradyina pulchra*
	CARNIZZA	Ecological absence
	AUERNIG	*Bradyina nautiliformis, B. samarica, B. lucida, B. compressa, B. arctica, B. pseudonautiliformis, Pseudobradyina pulchra*
GZHELIAN	CORONA	*Bradyina lucida*
	PIZZUL	*Bradyina compressa, B. lucida*
KASIMOVIAN	LATE MELEDIS	*B. nautiliformis, B. lucida, B. cf. arctica, Bradyinelloides pseudonautiliformis, Pseudobradyina pulchra*
	EARLY	*Bradyina samarica*

Fig. 5 - Recapitulative table of the Bradyinids assemblages in the Auernig and Rattendorf Groups in the Carnic Alps.

mation. Their first acme is observed in the upper Meledis Fm. In the Pizzul and Corona Formations, Bradyinids are rare, due to the predominance of siliciclastic sediments. For the same reason, Bradyinids seem to disappear in the Carnizza Formation. Both Auernig and LPL Formations are very rich in Bradyinids. The LPL can be distinguished as an informal "late Orenburgian", and tentatively characterized by the appearance of *Bradyina costifera*, *B. sikhanica* and *Bradyinelloides major.*

History of Lasiodiscoidea

Lasiodiscoidea include the families Lasiodiscidae and Pseudovidalinidae. Three genera are present: *Hemidiscus* (=*Lasiodiscus* = *Eolasiodiscus* auct. pro parte) with *Hemidiscus carnicus*; *Asselodiscus* with *A. primitivus* locally characteristic of the late Orenburgian-early Sakmarian interval, and *Pseudovidalina* spp. (Fig. 6). *P. modificata* and *P. multihelicis* are both characteristic of the local Orenburgian and early Asselian (from the Auernig Fm. to the LPL). *P.* cf. *minor* indicates Asselian and early Sakmarian age.

PLATE 6

Nodosarioidea of Grenzland Formation and Upper Pseudoschwagerina Limestone (UPL).

Fig. 1, 6, 8-11 - *Nodosinelloides mirabilis* (Lipina, 1949). UPL Formation, early Sakmarian; Fig. 1 - Axial section, Garnitzenbach, sample GB 163; x 36; Fig. 6 - Axial section, Trogkofel, sample OPS 1; x 90; Fig. 8 - Axial section, Garnitzenbach, sample GB 61; x 90; Fig. 9 - Axial section, Zweikofel, sample ZK 217; x 90; Fig. 10 - Axial section, Zweikofel, sample ZK 75; x 90; Fig. 11 - Axial section, Garnitzenbach, sample GB 63; x 90.

Fig. 2, 4-5, 15, 32 - *Geinitzina multicamerata* Lipina, 1949. UPL Formation, early Sakmarian; x 90; Fig. 2 - Longitudinal section, Trogkofel, sample OPS 1; Fig. 4 - Longitudinal section, Trogkofel, sample OPS 1; Fig. 5 - Oblique section, Trogkofel, sample OPS 4b; Fig. 15 - Oblique section, Zweikofel, sample ZK 193; Fig. 32 - Subaxial section, Zweikofel, sample ZKO 7.

Fig. 3 - *Nodosinelloides potievskayae* Mamet & Pinard, 1996. Axial section, Garnitzenbach, UPL Formation, early Sakmarian, sample GB 174; x 90.

Fig. 7 - *Geinitzina* aff. *inflata* K. V. Miklukho-Maclay, 1954. Axial section, Zweikofel, UPL Formation, early Sakmarian, sample ZK 27; x 90.

Fig, 12, 30 - *Geinitzina lepida* Lin, 1984. UPL Formation, early Sakmarian; x 90; Fig. 12 - Axial section, Zweikofel, sample ZK 65; Fig. 30 - Axial section, Garnitzenbach, sample GB 171.

Fig. 13, 16, 23 - *Protonodosaria "kamaensis"* (Baryshnikov in Baryshnikov et al., 1982) Considered here as a Protonodosaria, *"Nodosaria" bella kamaensis* is preoccupied by *Protonodosaria kamaensis* Miklukho-Maclay, listed by Pinard & Mamet (1998, p. 18). UPL Formation, early Sakmarian; x 90; Fig. 13 - Subaxial section, Zweikofel, sample ZK 210x; Fig. 16 - Axial section, Zweikofel, UPL Formation, early Sakmarian, sample ZK 55;

Fig. 14, 20 - *Frondicularia* (?) sp. 2. Two axial sections, Zweikofel, UPL Formation, early Sakmarian; 90; Fig. 14 - sample ZK 95; Fig. 20 - sample ZK 70.

Fig. 17-19, 22, 24-25, 27-29 - *Protonodosaria longissima* (Suleimanov, 1949). UPL Formation, early Sakmarian; x 90; Fig. 17 - Axial section (compare with *Geinitzina* sp. in Flügel, 1980, pl. 1, fig. 5), Zweikofel, sample ZK 178; Fig. 18 - Axial section, Zweikofel, sample ZK (gross); Fig. 19 - Axial section (compare with *Geinitzina* sp. in Flügel, 1971, pl. 4, fig. 5), Zweikofel, sample ZK 203x; Fig. 22 - Subaxial section, Garnitzenbach, sample GB 46; Fig. 24 - Longitudinal section, Zweikofel, sample ZK 205x; Fig. 25 - Axial section, Trogkofel, sample OPS 1; Fig. 27 - Axial section, Zweikofel, sample ZK 36; Fig. 28 - Immature axial section, Zweikofel, sample ZK 205x; Fig. 29 - Young axial section (differing from *N. netschajewi* by the thin wall), Trogkofel, sample OPS 5.

Fig. 21, 26 - *Geinitzina postcarbonica* Spandel, 1901. UPL Formation, early Sakmarian; x 90; Fig. 21 - Oblique section, Garnitzenbach, sample GB 37; Fig. 26 - Oblique section, Zweikofel, sample ZK 161. Fig. 23 - Subaxial section, Garnitzenbach, sample GB 37/1.

Fig. 31 - *Protonodosaria elegantissima* (Suleimanov, 1949). Axial section, Garnitzenbach, Grenzland Formation, sample GB 18; x 90.

Fig. 33 - *Geinitzina* cf. *ichnousa* Sellier de Civrieux & Dessauvagie, 1965. Axial section, Trogkofel, UPL Formation, early Sakmarian, sample OPS 4b; x 90.

Fig. 34-36 - *Pachyphloia* (?) aff. *crassisepta* (Lin, 1984). UPL Formation, early Sakmarian; x 90. Fig. 34 - Axial section, Zweikofel, sample ZK 8; Fig. 35 - Oblique section, Garnitzenbach, sample GB 60; Fig. 36 - Axial section, Garnitzenbach, sample GB 57.

Fig. 37-39 - *Geinitzina* aff. *primitiva* (Potievskaya, 1962) UPL Formation, early Sakmarian; x 90. Fig. 37 - Axial section, Zweikofel, sample ZK 80; Fig. 38 - Young subaxial section, Garnitzenbach, sample GB 43; Fig. 39 - Axial section, Garnitzenbach, sample GB 132.


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AGES	FORMATIONS	ASSEMBLAGES
EARLY SAKMARIAN	UPL	*Pseudovidalina* cf. *minor*, *Asselodiscus primitivus*, *Hemidiscus carnicus*
ASSELIAN	GRENZLAND	*Pseudovidalina* cf. *minor*
ORENBURGIAN	LPL	*Pseudovidalina multihelicis*, *Pseudovidalina modificata*, *Asselodiscus primitivus*, *Hemidiscus carnicus*
	CARNIZZA	Ecological absence
	AUERNIG	*Pseudovidalina multihelicis*, *Pseudovidalina media*, *Pseudovidalina modificata*, *Hemidiscus carnicus*
GZHELIAN	CORONA	*Hemidiscus* sp.
	PIZZUL	
KASIMOVIAN	LATE MELEDIS	*Hemidiscus carnicus*
	EARLY	Local (?) absence

Fig. 6 - Recapitulative table of the Lasiodiscoid assemblages in the Auernig and Rattendorf Groups in the Carnic Alps.

Complexification of the attached porcelaneous foraminifers (Fig. 7, Pl. 1, Fig. 2, 13, 26; Pl. 3, Fig 1-4; Pl. 4, Fig. 24-26).

During the Permian various taxa which are characterized by its porcelaneous wall, if well preserved, present a morphologic convergence, symbiosis and/or coevolution with algae. They include: *Ellesmerella, Tubiphytes* (see Vachard et al. in press for more details on this genus), *Ramovsia* and *Pseudovermiporella* (Fig. 7). These forms are probably very important for the theoretical paleobiology.

Order Foraminiferida

Suborder Miliolina

Family Calcivertellidae Loeblich & Tappan, 1964

nomen translat. Reitlinger in Vdovenko et al., 1993

Genus *Ellesmerella* Mamet & Roux in Mamet et al., 1987

Type species. *Girvanella permica* Pia, 1937

Emended diagnosis. Colonial porcelaneous foraminifer, forming flat nodules or biopisolites, composed of encrusting, horizontal, short, closely arranged, parallel tubules, with constant diameter and very slight sutures. The ramifications or pseudo-ramifications reported by the authors probably indicate the break up and regeneration of some tubules. The wall is typical for porcelaneous foraminifers, i. e. brownish when well preserved (it is frequently the case in the material of the Carnic Alps; and it can be also supposed for the specimens illustrated by Mamet et al. 1987; particularly pl. 3, fig. 11). Many other illustrations are true *Girvanella* and are excluded of this taxon (see a former compilation of Vachard & Montenat, 1981, p. 27). "*Girvanella permica*" is also frequently misinterpreted as complex biopisolites (oncoids) composed of true *Girvanella* and *Claracrusta* (see for example Lys et al. 1978, pl. 6, fig. 1).

Composition. Monospecific because of the proposed synonymy of *E. permica* and *E. subparallela* n. comb.

Occurrence. Late Asselian and early Sakmarian of the Carnic Alps (Austria/Italy) (many authors and this

PLATE 7

Nodosarioidea of Grenzland Formation and Upper *Pseudoschwagerina* Limestone (UPL).

Fig. 1, 3-4, 22, 28 - *Nodosinelloides mirabilis* (Lipina, 1949). UPL Formation, early Sakmarian; x 90; Fig. 1 - Axial section, Garnitzenbach, sample GB 12 (1); Fig. 3 - Axial section, Garnitzenbach, sample GB 52; Fig. 4 - Axial section, Garnitzenbach, sample GB 165; Fig. 22 - Oblique section, Zweikofel, sample ZK 193; Fig. 28 - Axial section, Zweikofel, sample ZK 207x.

Fig. 2 - *Protonodosaria* sp. Axial section, Garnitzenbach, UPL Formation, early Sakmarian, sample GB 70 (2); x 90.

Fig. 5, 10 - *Frondicularia* cf. *turae* (Baryshnikov in Baryshnikov et al., 1982). UPL Formation, early Sakmarian; x 90; Fig. 5 - Axial section, Garnitzenbach, sample GB 134; Fig. 10 - Axial section, Zweikofel, sample ZK 222.

Fig. 6, 29 - *Protonodosaria longissima* (Suleimanov, 1949). UPL Formation, early Sakmarian; x 90; Fig. 6 - Axial section, Garnitzenbach, sample GB 163; Fig. 29 - Axial section, Zweikofel, , sample ZK 95.

Fig. 7-9, 15-16 - *Geinitzina postcarbonica* Spandel, 1901. UPL Formation, early Sakmarian; x 90; Fig. 7 - Axial section, Garnitzenbach, sample GB 163; Fig. 8 - Subaxial section, Garnitzenbach, sample GB 13; Fig. 9 - Subaxial section, Zweikofel, sample ZK 222x; Fig. 15 - Axial section, Garnitzenbach, sample GB 3; Fig. 16 - Axial section, Zweikofel, sample ZK 168.

Fig. 11,13-14,18,23,26 - *Geinitzina mulicamerata* Lipina, 1949. UPL Formation, early Sakmarian (Fig. 18 excepted); x 90; Fig. 11 - Oblique section, Zweikofel, sample ZK 38; Fig. 13 - Oblique section, Garnitzenbach, sample GB 55; Fig. 14 - Oblique section, Trogkofel, sample PS; Fig. 18 - Oblique section, Garnitzenbach, Grenzland Formation, late Asselian, sample GB 20; Fig. 23 - Oblique section, Zweikofel, sample ZK 217; Fig. 26 - Subaxial section, Zweikofel, sample ZK 185.

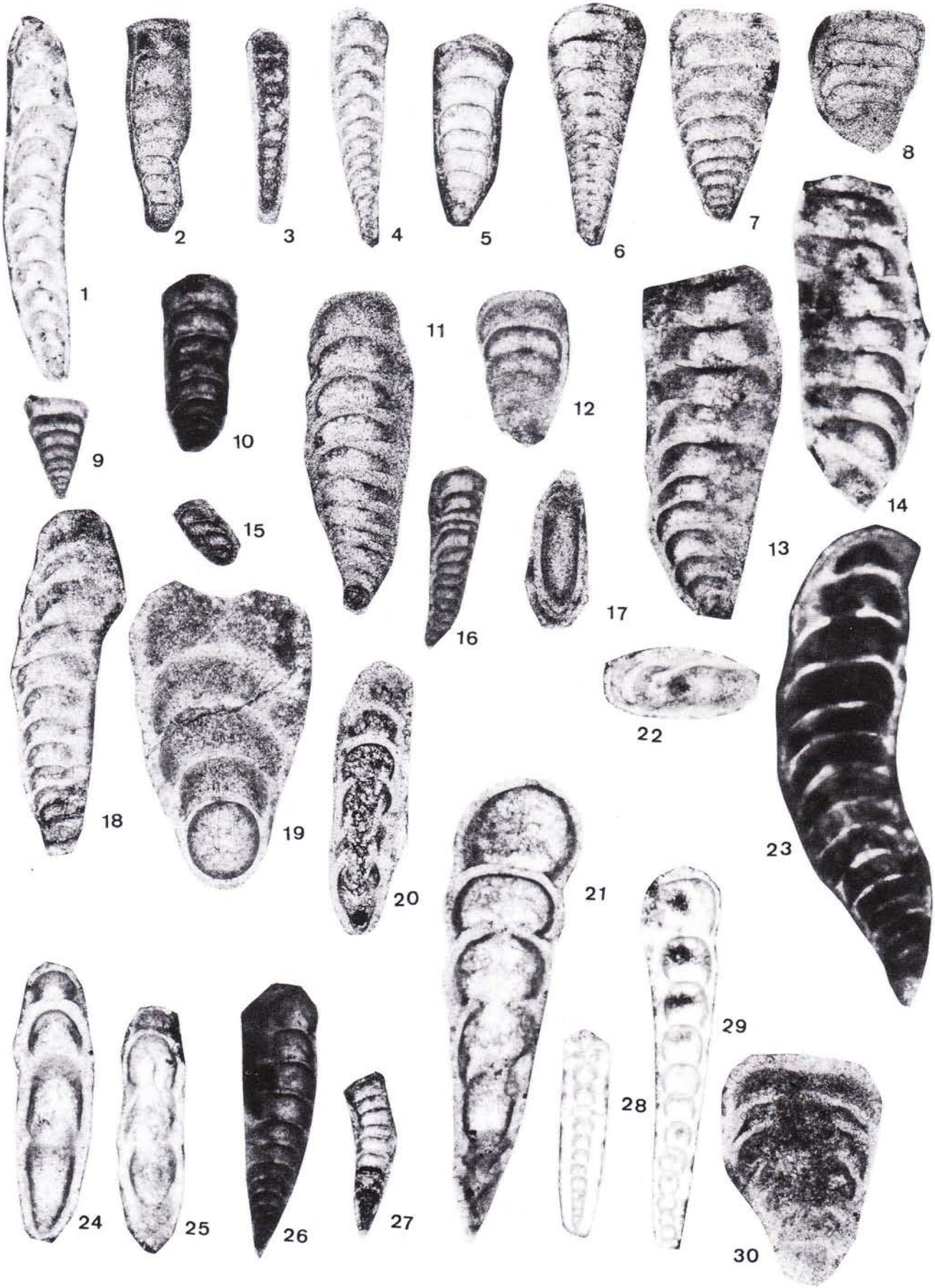
Fig. 12, 27- *Geinitzina lepida* Lin, 1984. UPL Formation, early Sakmarian; x 90; Fig. 12 - Subaxial section. Zweikofel, sample ZKO 10; Fig. 27 - Oblique section, Garnitzenbach, sample GB 49.

Fig. 17 - *Pachyphloia* (?) aff. *crassisepta* (Lin, 1984). Axial section, Zweikofel, UPL Formation, early Sakmarian, sample ZK 67; x 90.

Fig. 19 - *Pseudolangella* aff. *fragilis* Sellier de Civrieux & Dessauvagie, 1965. Axial section with large proloculus, Zweikofel, UPL Formation, early Sakmarian, sample ZK 75; x 90.

Fig. 20-21, 24-25 - *Nodosinelloides* cf. *pinardae* Groves & Wahlman, 1997 (= *Nodosaria grandis* Lipina, 1949; preoccupied). Four subaxial sections, UPL Formation, early Sakmarian; x 90; Fig. 20 - Trogkofel, sample OPS 4; x 90; Fig. 21 - Zweikofel, sample ZK 79; Fig. 24 - Trogkofel, sample OPS 6; Fig. 25 - Garnitzenbach, UPL Formation, early Sakmarian, sample GB 55.

Fig. 30 - *Geinitzina* aff. *lingulaeformis* Lipina, 1949. Subaxial section, Zweikofel, UPL Formation, early Sakmarian, sample ZK 78; x 90.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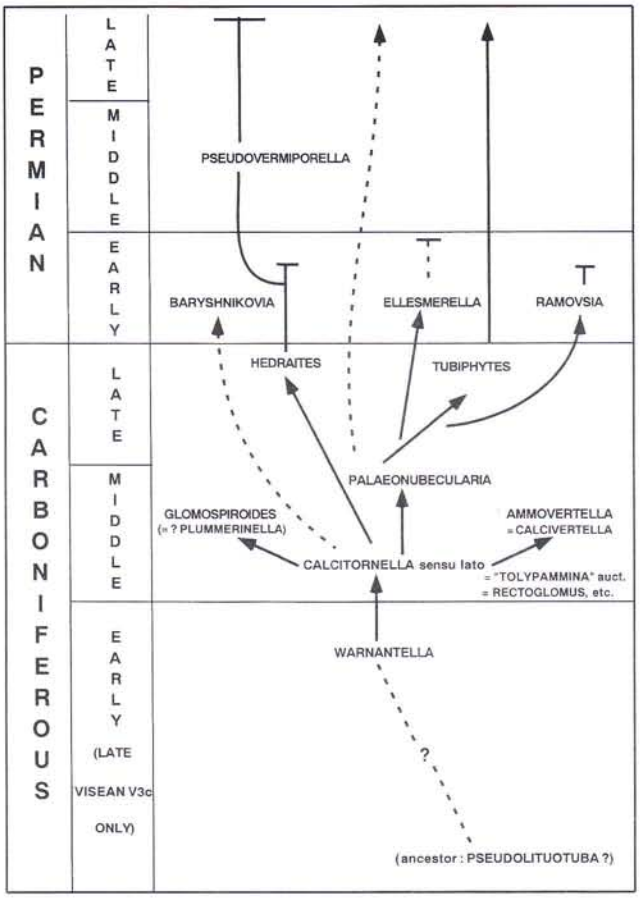

Fig. 7 - Hypothetical phylogeny of various attached porcelaneous foraminifers converging (or narrowly associated) with algae.

study), late Sakmarian of Italy (Flügel & Flügel-Kahler, 1980). Asselian of Croatia (Sremac & Aljinovic, 1997). Early Permian of Turkey (Flügel, 1966; unpublished material of C. Okuyucu), Greece (Caridroit et al., 2000), Iran (Jenny-Deshusses, 1983; Partoazar, 1995), Afghanistan (Vachard, 1980), China (Zhou & Flügel, 1986). Sakmarian of Canada (Mamet et al., 1987). Early Permian of Texas (re-interpretation of Henbest, 1963).

Ellesmerella permica (Pia, 1937)

Mamet & Roux, 1987 emend. herein

Pl. 3, fig. 1-4

1937 *Girvanella permica* Pia, p. 820, pl. 9, fig. 1.
1963 *Girvanella permica* - Johnson, pl. 78, fig. 3.
1963 *Ottonosia incrustata* - Henbest, pl. 6, fig. 2 (only).
1966 *Girvanella permica* - Flügel, p. 45-51, pl. 7, fig. 4, pl. 8, fig. 4-5.
1970 *Girvanella* sp. B - Kochansky p. 210, 238, pl. 19, fig. 2-4.
1972 *Girvanella permica* - Homann, p. 243-245, pl. 8, fig. 61, pl. 9, fig. 65 (cum syn.).
1977 *Girvanella permica* - Flügel, p. 318 (not illustrated).
1979 porostromate algae of the type *Girvanella subparallela* - Flügel, pl. 1, fig. 8.
1980 *Girvanella subparallela* Flügel & Flügel-Kahler, p. 166-167, pl. 11, fig. 1-2, 4.
1980 *Girvanella permica* - Vachard, p. 323 , pl. 7, fig. 4.
1981 *Girvanella permica* - Vachard & Montenat, p. 27 (not illustrated).
1983 *Girvanella* (?) *permica* - Jenny-Deshusses, p. 160, pl. 16, fig. 1, pl. 24, fig. 2.
1986 Porostromate algae *Garwoodia* sp. - Zhou & Flügel, pl. 42, fig. 6.
1986 Tubular encrusting foraminifera or algal filaments - Zhou & Flügel, pl. 43, fig. 9.
1987 *Ellesmerella permica* - Mamet & Roux in Mamet et al., p. 15-16, pl. 3, fig. 9-11.
1995 *Girvanella subparallela* - Forke, p. 241, pl. 17, fig. 7.
1995 *Girvanella permica* - Partoazar, pl. 1, fig. 1, pl. 6, fig. 13, pl. 8, fig. 11.
1997 *Girvanella permica* - Sremac & Aljinovic, pl. 3, fig. 6.
1997 Thick cyanobacterial crusts - Sremac & Aljinovic, pl. 3, fig. 7.
2000 *Ellesmerella permica* - Caridroit et al., p. 415 (not illustrated)

Description. Morphotypes of *E. permica* are very numerous, according to the shapes of the supports. Dimensions are: height = 0.012-0.022 mm; width = 0.060-0.100 mm; wall thickness = 0.010-0.020 mm; proloculus or initial stage were not observed. The dimensions correspond to that of Pia, 1937 with a height of 0.015-0.040 mm and Mamet et al., 1987: height = 0.012-0.038 mm, but that of Flügel & Flügel-Kahler, 1980, for *G. subparallela* are anormally overestimated with 0.080 and 0.090 mm.

Discussion. This genus is very similar in shape to the Girvanellids, but by the type of wall and growth, it looks like the Jurassic encrusting Nubeculariidae. According to the great variety of morphologies, *G. permica* does not differ of *G. subparallela*, whose colonies may appear more regular.

Occurrence. That of the genus. The type locality indicated by Pia, 1937 is "Uggowitz bei Tarvis im Kanaltal" (Uggowitz near Tarvis/Tarvisio, Kanaltal/Val Canale, Italy); the age is probably latest Sakmarian (upper Trogkofel Limestone).

Genus *Pseudovermiporella* Elliott, 1958

Type species. *Pseudovermiporella sodalica* Elliott, 1958

Composition. *Pseudovermiporella nipponica* (Endo in Endo & Kanuma, 1954) (many synonyms), *P. elliotti* Erk & Bilgütay, 1970; *P. sodalica* Elliott, 1958 (many synonyms), *P. longa* Praturlon, 1963, *P.* (?) cf. *graiferi* (Baryshnikov in Baryshnikov et al., 1982).

Description. Attached tubular porcelaneous foraminifer. Wall with deep cylindrical pits not connected with the internal part of the chamber. Proloculus unknown. Terminal rounded aperture.

Discussion. Although often considered as an alga (for example: Granier & Deloffre, 1994), the true nature of this attached foraminifer was established already in 1963 by Henbest (see also Loeblich & Tappan, 1964). *Pseudovermiporella* is probably derived from *Hedraites* by the deepening of the external pits of the wall. This latter genus existed, at least, since the Kasimovian in the Meledis Formations of the Carnic Alps (Vachard & Krainer, 2001). The evolution of the group is probably complete there (Fig. 7).

Occurrence. As in the Carnic Alps, the genus appears probably in the late Asselian. It disappears at the summit of the Permian (Vachard unpublished), and was often reported from the Dorashamian (latest Permian).

Pseudovermiporella (?) cf. graiferi

(Baryshnikov in Baryshnikov et al., 1982)

Pl. 4, fig. 25

1966 *Vermiporella nipponica* - Flügel, pl. 8, fig. 3 (only).
1970 *Apterrinella* sp. div. - Kochansky, pl. 18, fig. 10 (only, not fig. 3-6, 9 = *Calcitornella*).
1972 *Vermiporella nipponica* - Homann, pl. 7, fig. 55 (non p. 231-235).
1977 *Hedraites* sp. - Toomey et al, fig. 8L (not fig. 8K a true *Hedraites*).
1980 *Pseudovermiporella nipponica* - Flügel & Flügel-Kahler, p. 156, pl. 10, fig. 8.
1982 *Tolypammina graiferi* Baryshnikov in Baryshnikov et al., p. 11, pl. 1, fig. 8, 12-13.

Description. This colony looks like many *Tolypammina* of the literature, but the thick wall is evidently porcelaneous. The pits are scarce, only a few are visible but unquestionably present (therefore the attribution to *Pseudovermiporella* is probable but not entirely secure). Dimensions: length of colony = 2.80 mm; width of colony = 1.40 mm; whorls: 5 or more; proloculus = 0.24 mm; heigth of the last whorl = 0.28 mm; wall thickness: from 0.01 mm at the first whorl to 0.16 mm at the last whorl.

Occurrence. Early Artinskian of Preurals of Perm; late Asselian (Grenzland Formation; this study) and Sakmarian (Trogkofel Limestone; Flügel, 1966) of Carnic Alps; Late Pennsylvanian of New Mexico (Toomey et al., 1977).

Pseudovermiporella nipponica (Endo, 1954)

Pl. 4, fig. 26

1954 *Vermiporella* (?) *nipponica* Endo in Endo & Kanuma, p. 191-192, pl. 13, fig. 2-5.
1960 *Vermiporella nipponica* - Kochansky & Herak, p. 73-75, pl. 2, fig. 7-9, pl. 3, fig. 1-6.
1963 *Vermiporella nipponica* - Praturlon, p. 124-126, pl. 1, fig. 1-10.
1966 *Vermiporella nipponica* - Flügel, p. 43-45, pl. 8, fig. 1-2 (non fig. 3; see above).
1968 *Vermiporella nipponica* - Endo, p. 215, pl. 35, fig. 1-3.
1970 *Hedraites* sp. - Kochansky, pl. 18, fig. 7 (only, not fig. 8: a true *Hedraites*).
1972 *Vermiporella nipponica* - Homann, p. 231-235 (non pl. 7, fig. 55) (cum syn.).
1973 *Vermiporella nipponica* - Bozorgnia, pl. 43, fig. 10.
1976 *Vermiporella nipponica* - Emberger, p. 14, 16 (cum syn.).
1978 *Vermiporella nipponica* - Lys et al., pl. 7, fig. 1.
1981 *Pseudovermiporella* ex gr. *nipponica* - Vachard & Montenat, p. 73, pl. 2, fig. 8, pl. 14, fig. 1-2 (only).
1986 *Pseudovermiporella sodalica* - Zhou & Flügel, pl. 42, fig. 6.

Description. Test attached, large tubes, wall pierced by numerous closely set pores; interpores smaller than the pore diameter. According to Flügel (1966), Endo (1968), Homann (1972) *V. nipponica, V. sumatrana* and *V. sodalica* are synonyms; it is probable, but for us *V. sumatrana* Pia, 1937 is an *Anthracoporella*; at the contrary *Macroporella tetrapora* Pia, 1937 belongs to *Pseudovermiporella. P. sodalica* is significantly larger than *P. nipponica.*

Dimensions. Maximal length of tubes = 2.60 mm; heigth of tubes = 0.30-0.40 mm; wall thickness = 0.10 mm; pore diameter = 0.15 mm; interpore interval = 0.015mm.

Occurrence. In the UPL of the Carnic Alps (this study) and Trogkofel Limestone (Flügel, 1966). Probably cosmopolitan or at least Tethyan, from Sakmarian to Dorashamian.

FORMATIONS		ASSEMBLAGES
UPL		Hemigordius schlumbergeri, H. ex gr. harltoni, H. cf. ovatus, H. cf. permicus, H. saranensis, "Arenovidalina" cf. tenuitheca, "A." sverdrupensis
GRENZLAND		H. schlumbergeri, H. longus, H. sp., "Arenovidalina" sp. 1, "A." tenuitheca
LPL		Apparent absence (although the great biodiversity)
CARNIZZA		Ecological absence
AUERNIG		Apparent absence (although the great biodiversity)
CORONA		Ecological absence
PIZZUL		Hemigordius schlumbergeri
MELEDIS	LATE	Hemigordius sp.
	EARLY	Hemigordius harltoni

Fig. 8 - Recapitulative table of the Hemigordiids assemblages in the Auernig and Rattendorf Groups in the Carnic Alps.

Free porcelaneous foraminifer (Fig. 8; Pl. 5, fig. 1-27).

Hemigordiids are discussed (Vdovenko et al. 1993, Pronina 1994, Pinard & Mamet 1998), because *Hemigordius* itself is badly defined. The principal questions are the generic limit of *Hemigordius* (see Pinard & Mamet, 1998), and the name of the planispirally type of Hemigordiid tests. For us, the name *Neohemigordius* cannot be applied because these forms are characteristic of the late Permian (may be they appear in the latest Middle Permian, Vachard unpublished), and correspond to the ancestral form of the Involutinina (as already supposed by Loeblich & Tappan, 1988, p. 297).

Planispirally Hemigordiids were called *Neohemigordius* by Pinard & Mamet, 1998, *Arenovidalina* by Baryshnikov et al., 1982, *Permodiscus* by Milanovic, 1982 and probably *Hemigordiellina* by Deleau & Marie, 1999.

	FORMATIONS	ASSEMBLAGES
RATTENDORF GP	UPL	*Pachyphloia (?)* aff. *crassisepta*, *Pseudolangella* aff. *fragilis*, *Geinitzina postcarbonica*, *G.* ex gr. *postcarbonica*, *G.* spp., *Frondicularia* cf. *turae*, *F (?)* sp. 1 et sp. 2, *Protonodosaria longissima*, *P. elegantissima*, *P. "kamaensis"*, *Nodosinelloides mirabilis*, *Ns.* cf. *pinardae*, *Ns. potievskayae*, *Syzrania* sp., *Syzranella* sp.
	GRENZLAND	*Geinitzina postcarbonica*, *G. multicamerata*, *Pachyphloia (?)* aff. *crassisepta*, *Protonodosaria longissima*, *Nodosinelloides potievskayae*, *N. longa*, *Syzrania* sp.
AUERNIG GROUP	LPL	*Nodosinelloides longa*, *N. potievskayae*, *Vervilleina bradyi*, *Syzrania bella*, *S. gigas*, *Syzranella* sp.
	CARNIZZA	*Nodosinelloides potievskayae*
	AUERNIG	*Protonodosaria (?)* aff. *longissima*, *Nodosinelloides potievskayae*, *N.* aff. *longa*, *N. netschajewi*, *Vervilleina bradyi*, *Tezaquina clivuli*, *Syzrania confusa*, *S. bella*, *Syzranella* cf. *higginsi*
	CORONA	Ecological absence
	PIZZUL	*Syzrania* sp.
	MELEDIS LATE	
	MELEDIS EARLY	

Fig. 9 - Recapitulative table of the Nodosarioid assemblages in the Auernig and Rattendorf Groups in the Carnic Alps.

The type of wall and growth of the forms described herein are more similar to the *Arenovidalina* of Baryshnikov et al., 1982. But the term is inexact because true *Arenovidalina* are agglutinated Triassic forms. Before a complete revision, the name "*Arenovidalina*" is hypothetically used for these specimens.

The Permian species of "*Glomospira*" do neither belong to true *Glomospira* (an agglutinated genus), nor to *Pseudoglomospira* (microgranular). They are porcelaneous forms which probably can be assigned to *Pseudoagathammina* Lin et al., 1990 until a revision of this genus. This attribution concerns especially the *Glomospira* of Lipina (1949): *G. regularis*, *G. pseudoseptata*, *G. dublicata*.

The first diversification of the Nodosarioidea (Fig. 9; Pl. 1, fig. 22-36; Pl. 5, fig. 45-46; Pl. 6, fig. 1-39; Pl. 7, fig. 1-30).

During the period of deposition of the UPL (probably earliest Sakmarian, but latest Asselian is not completely excluded), the first diversification of the Permian Nodosarioidea took place. This period of the first acme was formerly identified with the Artinskian (Baryshnikov et al., 1982) or the Kungurian (Karavaeva, 1993).

Among the Nodosinelloids, *N. potievskayae* is progressively replaced by *N. mirabilis*. *Geinitzina postcarbonica* is most numerous and many variations of the group *G. postcarbonica* appear; some of them are probably really specific, like *G. multicamerata*. Based on the present state of knowledge, several taxa are difficult to classify, and are considered here at the limits of *Protonodosaria*, *Frondinodosaria* and *Lingulonodosaria*, or at the limits of *Geinitzina* and *Frondicularia* (see the previous discussion by de Civrieux & Dessauvagie, 1965). Only one specimen was found corresponding to *Pseudolangella* (or *Pseudoglandulina* of the literature) as a form announcing the second Midian/Dzhulfian group of nodosariacean genera (Sellier de Civrieux & Dessauvagie, 1965).

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