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TAXONOMY OF VISEAN MARINE CALCAREOUS ALGAE, FERNIE, BRITISH COLUMBIA (CANADA)

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Abstract. Reports a diverse microflora from the Late Viséan Opal Member, Fernie, Rocky Mountains, Canada. A shallow-water limestone level yields forty identifiable taxa of green and red algae associated with *microproblematica*. Four species are new: *Cabrieropora opalae*, *Cribrokamaena ferniensis*, *Koninckopora pachytheca* and *Moravammina*? *enigmatica*. Inferred sedimentation is open marine, in normal salinity, from the middle part of the euphotic zone, within the fair-weather wave zone. A semi-restricted lagoon located nearby provides floated calcispheres. The high diversity is due to the excellent preservation of the thalli which were protected by a thin early coating of bacterial micrite.

Riassunto. Viene illustrata una microflora di età Viseano superiore, proveniente dal Opal Member, Fernie, Rocky Mountains, Canada. Un livello di calcari di acque basse ha fornito quaranta taxa riconoscibili di alghe verdi e rosse associate con *microproblematica*. Quattro specie sono nuove: *Cabrieropora opalae*, *Cribrokamaena ferniensis*, *Koninckopora pachytheca* and *Moravammina*? *enigmatica*. L'ambiente di sedimentazione viene considerato di mare aperto a salinità normale, nella parte mediana della zona fotica entro la fascia di onde normali. Una laguna in parte confinata, situata non lontano, forniva calcisfere flottate. L'elevata diversità è dovuta alla eccellente conservazione dei talli, che furono protetti da un precoce sottile inviluppo di micrite di origine batterica.

Introduction

Algae are major contributors in the formation of Paleozoic carbonate platforms (Wray 1977). However their recognition and identification is often debatable and much debated (Riding 1991).

At this time our major problems are manyfold:

1. it is difficult to compare the morphology of algal (and presumed algal) thalli with modern counterparts (Cózar & Vachard 2004); while Jurassic and younger taxa are related to modern forms, Paleozoic algae are vastly different.

2. A vexing aspect for the sedimentologist is that most Paleozoic algae are poorly or only partly calcified and therefore do not fossilize well; associated fossils such as echinoderms, brachiopods and trilobites have various skeletal compositions, but are mineralogically rather stable; they have a fair chance to survive as fossils.

3. Algal mechanisms of calcification are poorly understood (photosynthesis, exopolymeric substrates, micrite entrapment...); the role of cyanobacterial activity remains hypothetical; microbialites are convenient scientific jargon which hide our ignorance (see the Symposium organized by Camoin & Gautret 2004).

In spite of this rather pessimistic introduction, the following is an attempt to describe an unusual floral association observed in the Viséan Opal Member of the Canadian Cordillera.

Material and Stratigraphy

The Opal Member of the Mount Head Formation crops out in the Rocky Mountains in the Southwestern part of Alberta and the Southeastern part of British Columbia (Macqueen & Bamber 1968; Richards et al. 1999). It grades laterally to the Marston and Carnarvon members (Macqueen et al. 1972). Illustrations of the different microfacies and the microfossils are to be found in Mamet (1976).

The upper part of the Opal Member is rhythmic with lime grainstones to darker weathering skeletal lime packstones and wackestones that contain numerous solitary and colonial corals. These corals belong to the assemblage IV of Sando & Bamber (1985) (*Faberophyllum*

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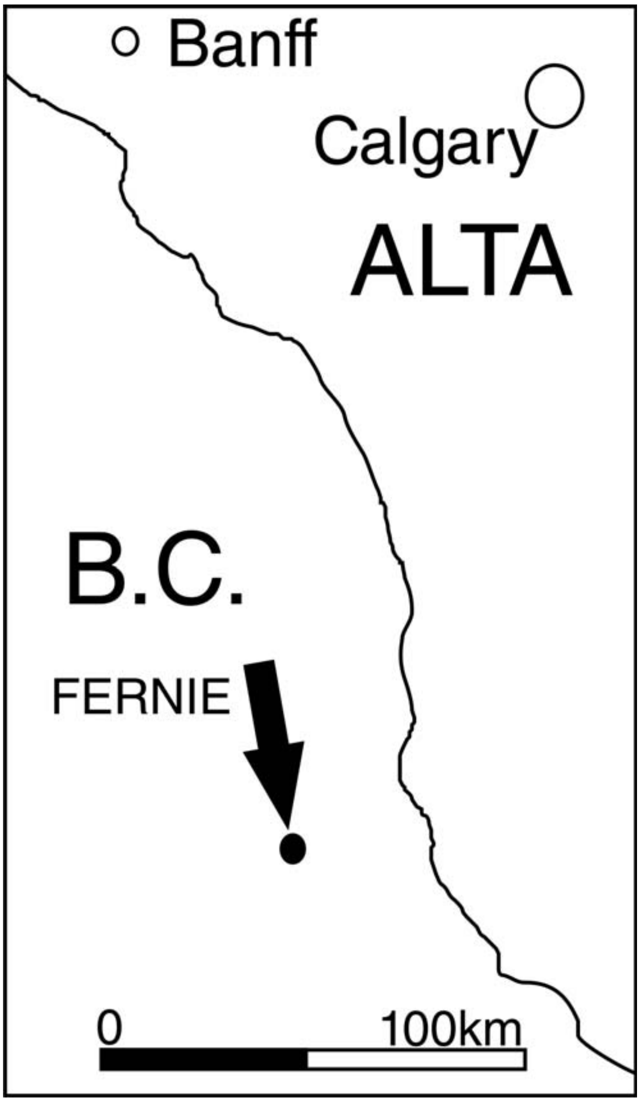


Fig. 1 - Geographic location of the Fernie Section. B.C. for British Columbia, ALTA for Alberta.

Zone). The large *Siphonodendron arizelum* (Crickmay) characterizes the upper Opal and its lateral equivalents in the Carnarvon Member.

Foraminifers are equally abundant. The acme of the genus *Eoendothyranopsis robusta* (McKay and Green), *Eo. macra* (Zeller), *Eo. utahensis* mixed with the first representatives of *Globoendothyra* of the group *Gl. globulus* (d'Eichwald) points to Late Viséan (Zone 14 and boundary between Zones 14 and 15).

The general sedimentation took place in a neritic, low to medium energy, proximal ramp setting (Richards et al. 1999)

Samples from the Fernie section (Lizard Range, B. C., N. 49 27'40"/115 07'05" W. (Fig. 1) were initially collected by E. W. Bamber of the Canadian Geological Survey (1991). He sent the samples to the University of Montreal for microfossil identification. The observed microfossils were exceptionally well-preserved. This led to a second period of collection (1997) in preparation of excursions organized during the 14th Congress on the Carboniferous and Permian held in Calgary. Finally, a third round was organized during a field trip of that Congress (August, 1999) led by B. Richards, B. Mamet and E. W. Bamber. The three collections of samples 193114-193115 yielded about 100 thin-sections and provided 180 photographs of microflora.

Taxonomy

This chapter deals with the description of and the references for forty identifiable algal taxa and a few forms that remain in open nomenclature. Classification of higher ranks is left in vernacular as it is still in a state of flux.

In the list are an added discussion of *Moravammina*? *enigmatica* n. sp. and a description of the incertae sedis *Tubisalebra*.

1. *Aoujgalia richi* Mamet and Roux, 1978.
2. *Aoujgalia variabilis* Termier and Termier, 1950.
3. *Asphaltina* ? *bangorensis* Mamet and Roux, 1978.
4. *Asphaltina cordillerensis* Mamet *in* Petryk and Mamet, 1972.
5. *Asphaltinella horowitzi* Mamet and Roux, 1978.
6. *Cabrieropora opalae* n. sp.
7. *Calcisphaera laevis* Williamson, 1881.
8. *Calcisphaera pachysphaerica* (Pronina, 1963).
9. *Crassikamaena foraminosa* Brenckle, 1985.
10. *Crassikamaena*? *inceptoris* Ivanova *in* Bogush et al., 1990.
11. *Crassikamaena* ? aff. *kurgarensis* Ivanova *in* Bogush et al., 1990.
12. *Cribrokamaena citrosa* Brenkle, 1985.
13. *Cribrokamaena ferniensis* n. sp.
14. *Cribrokamaena furcillata* Brenckle, 1985.
15. *Epistacheoides nephroformis* Petryk and Mamet, 1972.
16. *Epistacheoides*? *peratrovichensis* (Mamet and Pinard 1985).
17. *Exvotarisella* sp.
18. *Exvotarisella index* (Ehrenberg *emend* von Möller, 1879).
19. *Fasciella kizilia* Ivanova, 1973.
20. "*Fourstonella*" *johnsoni* (Flügel, 1966).
21. *Frostereyella rozovskaiae* (Mamet and Roux, 1975).
22. *Issinella devonica* Reitlinger, 1954.
23. *Koninckopora inflata* (de Koninck, 1842).
24. *Koninckopora mortelmansi* Mamet, 1973.
25. *Koninckopora pachytheca* n. sp.
26. Lanciculeae (undetermined, related to *Lanciculina*).
27. Litanaiae (undetermined, related to *Pseudolitanaia*).
28. *Loomisella petryki* Mamet and Bergeron, 1992.
29. *Moravammina* ? *enigmatica* n. sp.
30. *Nostocites vesiculosa* Maslov, 1929.
31. *Orthriosiphonoides salterensis* Petryk *in* Petryk and Mamet, 1972.
32. *Orthriosiphonoides tenuiramosa* Mamet and Rudloff, 1972.
33. *Palaeoberesella* aff. *P. lahuseni* (von Möller, 1879).
34. *Palaeocancellus cancellatus* (Williamson, 1881).
35. *Parathurammina* of the group *P. spinosa* (Williamson, 1881).
36. *Proninella gracilis* Vachard *in* Meissami et al., 1978.
37. *Pseudostachoides loomisi* Petryk and Mamet, 1972.
38. «*Radiosphaera*» *basilica* Reitlinger, 1957.
39. *Stacheoidella spissa* (Petryk and Mamet, 1972).
40. *Stacheoides tenuis* Petryk and Mamet, 1972.
41. *Ungdarella uralica* Maslov, 1956.

Green algae (Chlorophycophytes)

Udoteaceans

Genus *Orthriosiphonoides* Petryk in Petryk and Mamet, 1972

Orthriosiphonoides salterensis Petryk in Petryk and Mamet, 1972

Pl. 1, Fig. 4

1972 *Orthriosiphonoides salterensis* O. D. Petryk *in* Petryk and Mamet, p. 776, pl. 2, fig.. 10-14, pl. 3, fig. 4-5.

1972 *Orthriosiphonoides salterensis* Petryk *in* Petryk and Mamet - Mamet and Rudloff, p. 855, pl. 4, fig. 8-9.

1976 *Orthriosiphonoides salterensis* Petryk *in* Petryk and Mamet - Mamet, pl. 22, fig. 1.
1977 *Orthriosiphonoides salterensis* Petryk *in* Petryk and Mamet - Armstrong and Mamet, p. 104, pl. 38, fig. 11-12.
1983 *Orthriosiphonoides salterensis* Petryk *in* Petryk and Mamet - Bassoulet et al., p. 534, pl. 11, fig. 4-5.
1988 *Orthriosiphonoides salterensis* Petryk *in* Petryk and Mamet - Flügel and Herbig, pl. 46, fig. 6-9?

Description. Thallus stout, erect, annular, verticillated, reaching 1-2 mm in diameter. The cortex is perforated by numerous, slightly curved, dichotomous branches (40-50 μm). They are regularly spaced. Interspace of the same magnitude as the diameter of the branches.

Remark. The illustration shows the terminal disposition of the branches on the surface of the thallus.

Stratigraphic distribution. The species is described from the Viséan of North America and Morocco. Similar specimens are observed in the Middle Carboniferous (Alaska).

Orthriosiphonoides tenuiramosa
Mamet and Rudloff, 1972
Pl. 1, Fig. 1

1972 *Orthriosiphonoides tenuiramosa* O. D. Mamet and Rudloff - p. 86, pl.4, fig. 12-15.
1991 *Orthriosiphonoides tenuiramosa* Mamet and Rudloff - Riding, p. 381, fig. 3V.
1997 *Orthriosiphonoides* sp. - Harris et al., fig. 9,7.

Description. Thallus stout, annular, sharply verticillated, reaching 1.5 mm in diameter. Cortex with a vestibule followed by a radiating tuft of numerous thin laterals (15-20 μm diameter). There are 13-16 laterals per axial section.

Remark. As for the illustration of *O. salterensis*, our Pl. 1, fig. 1 shows the terminal disposition of the laterals on the surface of the thallus.

Comparison. The general morphology of the two species is quite similar but the disposition of the laterals is characteristic.

Stratigraphic distribution. Quite scarce. Only known from the Carboniferous (Viséan-Moscovian) of the North American Cordillera.

Genus *Loomisella* Mamet and Bergeron, 1992

Loomisella petryki Mamet and Bergeron, 1992
Pl. 1, Fig. 11

1992 *Loomisella petryki* O. D. Mamet and Bergeron - p. 198-199, pl. 1, fig. 1-13.

Description. Cylindrical erect udoteacean. Diameter around 600-800 μm. Primary tubes cylindrical. Secondary branches inserted at low angle from the primaries. They end in a sphere from which depart numerous tufts of tertiary and quaternary branches. Quaternary tubes are concave and enlarge progressively in diameter.

Stratigraphic distribution. *Loomisella* is prolific in the Middle Viséan (Loomis Member, Mt. Head Formation) but scarce in the Late Viséan. The genus is at present only recognized in the North American Cordillera (Alberta, British Columbia).

Undetermined Litanaiae
(Compare with *Pseudolitanaia* Mamet and Préat, 1994)
Pl. 1, fig. 2

Description. Thallus fragment showing regular, unconstricted medular tubes, giving birth to simple laterals.

Remark. Although the unique section is quite poor, it can be reasonably attributed to a *Pseudolitanaia* Mamet and Préat, 1994. The genus has only been observed in the Devonian and the Litanaiae (*Litanaia*, *Paralitaniaia*, *Abacella*, *Amicus*, *Trelonella*, *Botryella*) 'disappear' at the Frasnian extinction. However, recent discoveries of Litanaiae-like thalli suggest that the extinction was not complete and that some remnants of the tribe are still present in Early Carboniferous time.

Undetermined Lanciculeae
(Compare with *Lanciculina* Shuysky in Shuysky and Shirshova, 1985)
Pl. 1, fig. 3

Description. Thallus erect, verticillated, a succession of 'calices' that contain the secondaries derived from the axial primaries. Diameter of calices around 600 μm. Numerous unconstricted medullar tubes (at least 20). Secondary tubes arched, derived from the primaries and of similar diameter.

Comparison. Our unique section, by the presence of numerous central tubes is reminiscent of *Lanciculina*. However, the shape of the calix is undetermined.

Stratigraphic distribution. The preceding remark also applies to this taxon. The youngest Lanciculeae are restricted in the literature to the Late Devonian.

Dasycladales
Cyclocrinids
Genus *Koninckopora* Lee, 1912

Koninckopora inflata (de Koninck, 1842)
Pl. 1, fig. 10

1842 *Calamopora inflata* O. D. de Koninck - p. 10, pl. A, Fig. 8a-b.

For the synonyms prior to 1978, see Emberger, 1976, p. 46 and Jansa et al., 1978. Add:

1978 (Non) *Conicopora* (sic) *inflata* (de Koninck) - Sido, pl. 9, fig.1.

1980 *Koninckopora inflata* (de Koninck) - Buchroithner et al., p. 23, pl. 4, fig. 8-9.

1984 *Koninckopora inflata* de Koninck (sic) - Somerville and Strank, fig. 5M.

1985 *Koninckopora inflata* (de Koninck) - Mamet and Pinard, pl. 5, fig. 4-5.

1987 *Koninckopora inflata* (Lee) (sic) - Shuysky, pl. 14, fig. 6.

1988 *Koninckopora* sp. - Deloffre, pl. 3, fig. 17-18.

1989 (Non) *Koninckopora inflata* (de Koninck) - Davies et al., fig. 9K.

1990 *Koninckopora inflata* (de Koninck) (*pars*) - Bogush et al., pl. 15, fig. 5-6, (non) pl. 16, fig. 2

1991 *Koninckopora inflata* (de Koninck) - Vachard and Fadli, pl. 1, fig. 16.

1991 *Koninckopora inflata* (de Koninck) - Vachard and Tahiri, pl. 3, fig. 10.

1991 *Koninckopora* sp. - Fontaine et al., pl. 7, fig. 6, pl. 22, fig. 6-7.

1993 *Koninckopora inflata* (de Koninck) - Chuvashov et al., pl. 10, fig. 16.

1994 *Koninckopora inflata* (de Koninck) - Herbig and Mamet, pl. 10, fig. 6.

1996 (Non) *Koninckopora inflata* (de Koninck) - Skompski, pl. 13, fig. 4.

1997 *Koninckopora inflata* (de Koninck) - Brenckle and Page, pl. 5, fig. 28.

1998 *Koninckopora* sp. - Gallagher, fig. 8-7.

2004 *Koninckopora inflata* (de Koninck) - Brenckle, pl. 7, fig. 9.

2004 *Koninckopora inflata* (de Koninck) - Cózar and Somerville, fig. 13-2.

2005 *Koninckopora inflata* (de Koninck) - Cózar and Somerville, pl. 1, fig. 14.

Description. Thallus important, non-verticillated, with a slender, elongated to massive cylindrical medulla. Cortex two-layered, comparatively thin, perforated by regular pores. There are 4 to 8 alveolae per linear millimeter with a diameter range from 190-260 µm. Cortex thickness ranges from 150 to 200 µm.

Stratigraphic distribution. Cosmopolitan in all known Viséan basins. Scarce in Early Viséan, then the most abundant dasycladale in shallow-water Mid-Late Viséan carbonates. Fontaine et al. (1991) were the first to notice that in Southeast Asia, the species is still present in the Serpukhovian. In fact, Zones 17-18-19 are still replete with *inflata* in southern China (Liuzhou). Thus the notion *Koninckopora* = Viséan should be revised.

Koninckopora mortelmansi Mamet, 1973

Pl. 1, fig. 5

1973 *Koninckopora mortelmansi* O. D. Mamet - p. 105-106, pl. 2, fig. 4-6.

1974 *Koninckoporoides monteaglensis* O. D. Rich - p. 368, pl. 2, fig. 10, 12, 13, 18, pl. 5, fig. 1-2.

1975 *Koninckopora macropora* Maslov 1956 - Malakhova (*pars*), p. 84, pl. 7, fig. 2 and 4, (non 3).

1975a *Koninckopora mortelmansi* Mamet - Mamet and Roux, p. 256-257, pl. 8, fig. 4-13.

1976 *Koninckopora mortelmansi* Mamet - Bless et al., pl. 10, fig. 1.

1978 (Non) *Conicopora mortalensis* (sic) Mamet - Sido, pl. 9, fig. 2.

1981 *Koninckopora mortelmansi* Mamet - Vachard, pl. 35, fig. 1, 6 ("Cette espèce est celle qui foule le plus au pied le rattachement de *Koninckopora* aux Dasycladales").

1981 *Koninckopora mortelmansi* Mamet - Mamet and Martinez, pl. 3, fig. 1, 9.

1988 *Koninckopora* cf *K. mortelmansi* Mamet - Hance, pl. 3, fig. 2-3.

PLATE 1

All illustrated fossils derived from uppermost levels of the Opal Member, Mount Head Formation, Fernie Ski Lift section, Lizard Range, British Columbia. Zone 14, Late Viséan. Samples GSC 193114 and 193115, 2.1 m and 5.5 m below the top of the Opal Member, in contact with the Carnarvan Member. The exception is Pl. 7, fig. 16, Celechowice, Czech Republic, Givetian. For each sample, we give the number engraved on the slide, the number of the University of Montreal collection and the magnification.

Green algae (Chlorophycophytes)

Udoteaceans

Fig. 1 - *Orthriosiphonoides tenuiramosa* Mamet and Rudloff, 1972. 193115P, University of Montreal 935/4, x 41.

Fig. 2 - Undetermined Litanaiae. Compare with *Pseudolitanaia* Mamet and Préat, 1994. 193114H, University of Montreal 868/20, x 97. Shows two medullar tubes and the departing cortical tubes.

Fig. 3 - Undetermined Lanciculae. Compare with *Lanciculina* Shuysky *in* Shuysky and Shirshova, 1985. 193114O, University of Montreal 871/12, x 97. The diverse and prolific Devonian Lanciculae become nearly extinct at the end of the Frasnian. Carboniferous occurrences are exceptional.

Fig. 4 - *Orthiosiphonoides salterensis* Petryk *in* Petryk and Mamet, 1972. 193114M, University of Montreal 870/22, x 97.

Dasycladales

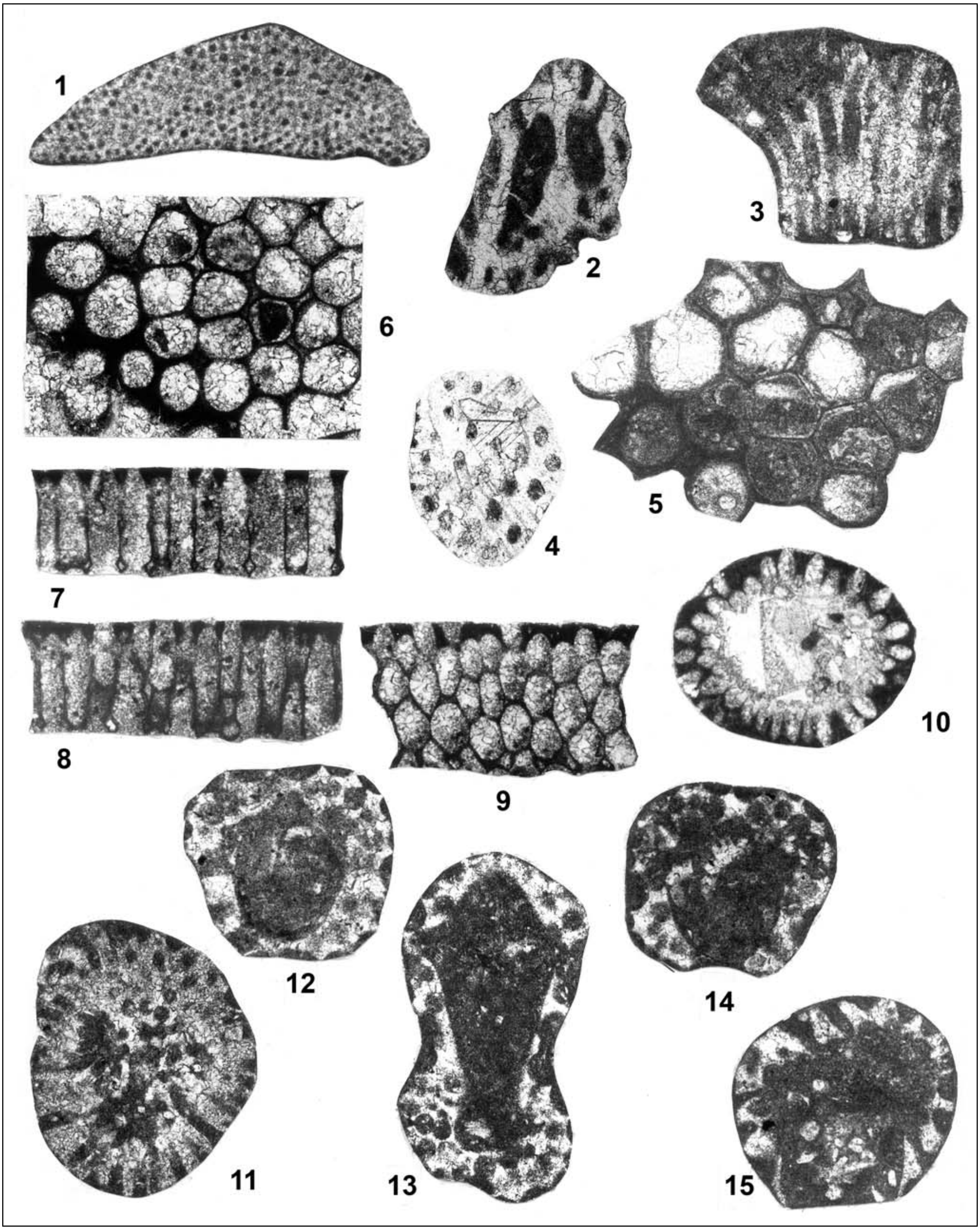
Fig. 5 - *Koninckopora mortelmansi* Mamet, 1973. 193115K, University of Montreal 872/6, x 63.

Fig. 6-9 - *Koninckopora pachytheca* n. sp. Fig. 6 - 193115P, University of Montreal 935/2, x 77; Fig. 7 - 193115R, University of Montreal 934/30, x 41, type of new species; Fig. 8 - 193115S, University of Montreal 934/20, x 41; Fig. 9 - 193115W, University of Montreal 934/33 x 41.

Fig. 10 - *Koninckopora inflata* (de Koninck, 1841). 193115R, University of Montreal 934/29, x 41.

Fig. 11 - *Loomisella petrykii* Mamet and Bergeron, 1992. 193114X, University of Montreal 790/23B, x 63.

Fig. 12-15 - *Forsterleyella rozovskaiae* (Mamet and Roux, 1975). Fig. 12 - 193114D, University of Montreal 790/23, x 97; Fig. 13 - 193114D, University of Montreal 871/13, x 77; Fig. 14 - 193115, University of Montreal 780/17, x 63; Fig. 15 - 193114B, University of Montreal 790/14, x 97.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1991 *Koninckopora mortelmansii* Mamet - Vachard and Tahiri, pl. 3, fig. 10.

1992 *Koninckopora* sp. - Vachard and Berkhli, pl. 2, fig. 17.

1992 *Koninckopora* cf *mortelmansi* Mamet - Somerville et al., fig. 5g, 7m.

1995 *Koninckopora mortelmansi* Mamet - Sanchez-Chico et al., p. 72, pl. 3, fig.6.

1996 *Konincokpora mortelmansi* Mamet - Somerville et al., fig. 9, A-B (*pars*).

2003 *Koninckopora mortelmansi* Mamet - Brenckle and Milkina, pl. 3, fig.5.

2004 *Koninckopora mortelmansi* Mamet - Brenckle, pl. 7, fig. 10.

Description. Thallus very important, grossly cylindrical, reaching a few centimeters, with a corresponding medulla. Cortex perforated by irregular pores, 300-500 µm in diameter. Interpores two-layered, fragile.

Stratigraphic distribution. Cosmopolitan in all known Carboniferous basins. Abundant in Middle to Late Viséan (Zones 13-16). Does not reach the Serpukhovian.

Koninckopora pachytheca n. sp.

Pl. 1, figs 6-9

Type of the new species. Pl.1, fig. 7 (here designated).
Derivatio nominis. From the thick calcified cortex.

Description. Cyclocrinid perforated by regular, cylindrical alveoles. Length, 1 mm and more. Thickness of cortex 650-850 µm. Cell walls two layered. A thick continuous micritic inner layer (10-18 µm) and a thin (often dissolved) 10-20 µm outer prismatic layer. There are 4-8 alveoles per linear millimeter. Their diameter ranges from 170-250 µm. The tips of the interpores have a characteristic lozenge shape.

Comparison. By the regular shape of the pores, the new species is similar to *K. inflata*. This is further substantiated by a similar diameter (Mamet and Roux 1975a report 190-260 µm). However, the thallus of *K. pachytheca* is thicker by a factor of 2. The prismatic layer is also less developed.

Stratigraphic distribution. Only recognized in the Late Viséan Zones 14 and 15 from the central part of the North American Cordillera: Alberta, Wyoming, Montana, Utah.

Tribe Aciculellid

Genus *Frostereyella* Elliott, 1988

Frostereyella rozovskaiae (Mamet and Roux, 1975a)

Pl. 1, figs 12-15, pl. 2, figs 1-5

1966 *Coelosporella wetheredii* Wood - Conil and Lys, p. 207, pl. 1, fig. 2.

1975a *Sphinctoporella*? *rozovskaiae* Mamet and Roux O. D., p. 260, pl. 11, fig. 7-13.

1984 *Kulikia rozovskaiae* (Mamet and Roux) - Skompski, p. 430-433, fig. 2, e-f, fig. 3, a-b, fig. 4,b.

2005 *Kulikia rozovskaiae* (Mamet and Roux) - Cózar and Somerville, pl. 1, fig. 2, 9.

Description. Succession of verticillated segments with key-shaped longitudinal cavities that are circular in axial section. Indented periphery. Numerous (12-14) rows of spherical "endospore" cavities probably derived from a thin vestibule. Diameter of thallus, 500-550 µm. Maximum medullar width 350 µm, usually 300 µm. "Endospores" 40-50 µm in diameter. Poorly calcified cortex, 60-100 µm thick.

Comparison. When the new species *rozovskaiae* was erected, it was tentatively assigned to *Sphinctoporella*. There was, at that time, no available genus that correctly fit the observed morphology. Later, Skompski (1984) assigned the species to *Kulikia* Golubtsov 1961, by emending the genus. Ivanova (1994) further emended *Kulikia*. Both authors seem to be unaware of the existence of *Frostereyella* Elliott, 1988 who had already noted the resemblance of his new taxon with *Kulikia* ("Calcification full of spherical cavities believed to be similarly organized to those of *Kulikia*"). The most obvious difference between the two taxa is the shape of the medulla.

Stratigraphic distribution. Late Viséan and Serpukhovian. Occidental Tethys and American Cordillera. *Sphinctoporella*, *Kulikia* and *Frostereyella* have similar stratigraphic distributions and belong to a new tribe, yet to be proposed.

Velebetellid

Genus *Cabrieropora* Mamet and Roux, 1975a

Cabrieropora opalae n. sp.

Pl. 2, figs 6-21

Type of the new species. Pl. 2, fig. 16 (here designated).
Derivatio nominis. From the Opal Member.

Description. Thallus cylindrical, a succession of numerous, irregular verticils. Medulla poorly annulated, nearly continuous. Diameter of thallus 330-400 µm in the proximal part, slowly reduced to 300 µm in the distal part. Height of verticils, 2/3 of the thallus diameter. Medulla comparatively thin. Thickness of poorly calcified cortex, 100-120 µm. In axial sections, ten to twelve vestibular branches giving 20-25 µm-thick secondaries.

Stratigraphic distribution. Very common in the Opal Member, Mt. Head Formation, Late Viséan, British Columbia. Also known from similar horizons in Alberta, usually associated with the *Koninckopora-Stacheoides-Epistacheoides* algal flora. *Eovelebitella*, *Cabrieropora* and *Windosoporella* are morphologically related.

Calcispheres

Genus *Palaeocancellus* Derville, 1952

Palaeocancellus cancellatus (Williamson, 1881)

Pl. 2, fig. 22

1881 *Calcisphaera cancellata* Williamson O. D. - p. 521, pl. 20, fig. 79.

1931 *Cytosphaera cancellata* Williamson - Derville, p. 140, pl. 18, fig. 81.

1942 (Non?) *Calcisphaera cancellata* Williamson - Derville, p. 361-365, pl. 7, fig. 4.

1950 *Cancellus cancellatus* (Williamson) - Derville, p. 471, pl. 24, fig. 5.

1952 *Palaeocancellus cancellatus* (Williamson) - Derville, p. 236-237.

1964 *Palaeocancellus cancellatus* (Williamson) - Conil and Lys, p. 45, pl. 6, fig. 69.

1970 *Palaeocancellus cancellatus* (Williamson) - Hallett, p. 888, pl. 2, fig. 9.

Description. Strongly perforated calcisphere. Diameter 80-110 µm. Calcified wall thin, uneven, around 5-10 µm. Pores straight, numerous.

Comparison. Easily distinguished from *Palaeocancellus canaliculatus* Derville, 1952 by the multitude of pores.

Stratigraphic distribution. Viséan. Eurasia. North America.

Genus *Parathurammina* Bykova in Bykova and Polenova, 1955

Parathurammina of the group **P. spinosa** (Williamson, 1881)

Pl. 2, fig. 23

1881 *Calcisphaera spinosa* Williamson, O. D. - p. 522, pl. 20, fig. 71, 73, 76 (non 75, 77).

1950 *Parathurammina spinosa* Lipina, O. D. - p. 117-118 (synonym-homonym)

For the references up to 1970, see Armstrong and Mamet, 1977, p. 20 and add:

1971 *Parathurammina spinosa* "Lipina" - Braznikhova and Vdovenko, p. 126, pl. 2, fig. 15-17.

1972 *Parathurammina* cf *spinosa* "Lipina" - Mountjoy and Toomey *in* Mountjoy and Mackenzie, pl. 7, fig. 1-2.

1974 *Parathurammina spinosa* "Lipina" - Manukalova-Grebeniuk, p. 17, pl. 3, fig.1.

1974 *Parathurammina* cf *spinosa* "Lipina" - Monostori, p. 222, pl.I, fig.15.

1976 *Parathurammina* of the group P. *spinosa* (Williamson) - Mamet, pl. 14, fig.8, pl. 34, fig.1, pl. 60, fig. 5-12.

1978 *Parathurammina spinosa* "Lipina" - Jurkiewicz and Zakowa, p. 38, pl. 8, fig. 7.

1981a *Parathurammina* cf *spinosa* "Lipina" - Zukalova, p. 83-84, pl.8, fig.1-2.

1981b *Parathurammina spinosa* "Lipina"- Zukalova, pl. 30, fig.2.

1986 *Parathurammina spinosa* "Lipina" - Friakova and Zukalova, pl. 5, fig. 4.

1999 *Parathurammina spinosa* (Williamson) - Mamet et al., pl. 5, fig. 11.

2000 *Parathurammina spinosa* (Williamson) - Cózar and Rodriguez, p. 112, fig. 4B.

2002 *Parathurammina spinosa* (Williamson) - Herbig *in* van Ameron et al., pl. 3, fig. 5.

Description. A "spiny Calcisphere", with numerous regular thin, hollow spines. Diameter variable, around 100-200 µm. Micritized wall, rather thin, 10-20 µm. Number and length of spines hard to estimate as they are fragile and usually broken. The form is often heavily micritized and appears rather "clumsy."

Stratigraphic distribution. Mid-Devonian to mid-Carboniferous. Cosmopolitan. Abundant in semi-restricted to restricted lagoons. Floats in adjacent open marine environments.

Genus "*Radiosphaera*" Reitlinger, 1957

"Radiosphaera" basilica Reitlinger, 1957

Pl. 2, fig. 24

1957 *Radiosphaera basilica* Reitlinger O. D. - p. 775, pl. 1, fig. B

1962 *Radiosphaera basilica* Reitlinger - Bogush and Yuferev, p. 214, pl. 99, fig. 27.

1966 *Radiosphaera basilica* Reitlinger - Braznikhova and Rostovceva, p. 9, pl.1, fig. 2-5, 10-12.

1967 *Radiosphaera basilica* Reitlinger - Braznikhova et al., p. 197, pl. 4, fig. 7.

1970 *Radiosphaera basilica* Reitlinger - Bogush and Yuferev, p. 105, pl. 9, fig. 15.

1971 *Radiosphaera basilica* Reitlinger - Reitlinger *in* Menner and Reitlinger, p. 206, pl. 5, fig. 3-5.

1971 *Radiosphaera basilica* Reitlinger - Braznikhova and Vdovenko, p. 124, pl. I, fig. 2-5.

1974 *Radiosphaera basilica* Reitlinger - Manukalova-Grebeniuk, p. 12, pl. 1, fig. 10-11.

1975 *Radiosphaera basilica* Reitlinger - Nesterova, pl. 4, fig. 10-13.

1976 "*Radiosphaera*" aff. *R. basilica* Reitlinger - Mamet, pl. 14, fig. 5.

1977 *Radiosphaera basilica* Reitlinger - Vachard, pl. 8, fig. 4.

1980 *Radiosphaera basilica* Reitlinger - Youvcheva, p. 12, pl. 1, fig. 21-22.

1982 Radiosphaerid calcispheres. Brenckle et al., p. 65, pl. 8, fig. 19-22, 24-27.

1987 Radiosphaerid calcispheres. Brenckle and Groves, pl. 12, fig. 15.

1988 *Radiosphaera basilica* Reitlinger - Wang *in* Yu, p. 160, pl. 39, fig. 6, 15-16.

Description. A two-layered calcisphere. Inner dark micritic layer, thin (5 µm) and a thicker, irregular outer layer of radially arranged, yellowish calcite prisms. Reported presence of an axial canal is debatable. Average diameter 140-180 µm. Central cavity around 100 µm.

Discussion. Although widely accepted and used, *Radiosphaera* Reitlinger is invalid and preoccupied (Loeblich & Tappan 1988, p. 728). The taxon can reasonably be transferred to the botanical realm (Reitlinger called it "sphere" without further precision) but it is void as having no holotype designation. *Radiosphaera* is similar to *Asterosphaera* published in the same article six lines further. But *Asterosphaera* has no holotype designation either. Perhaps the term "Radiosphaerid Calcisphere" proposed by Brenckle et al. (1982) is an appropriate solution to the taxonomic problem.

Stratigraphic distribution. The genus thrives in lagoons where it can be as abundant as *Calcisphaera*. The progressive smothering of the clear prisms is probably due to erosion. Mid-Devonian to mid-Carboniferous. Cosmopolitan.

Genus *Calcisphaera* Williamson, 1881

Calcisphaera laevis Williamson, 1881

Pl. 2, fig. 25

1881 *Calcisphaera laevis* Williamson O. D. - p. 521, pl. 20, fig. 70.

1931 *Granulosphaera laevis* Williamson - Derville, p. 133-134.

1938 (non) *Granulosphaera laevis* Williamson - Paul, p. 280.

1950 *Archaesphaera crassa* Lipina, O. D. - p. 121, pl. 1, fig. 17.

1955 Formal designation by Andrews, as type of the genus, p. 123.

1962 *Archaesphaera grandis* Lipina - Bogush and Yuferev, p. 73-74, pl. I, fig. 5.

1964 *Pachysphaera dervillei* Conil and Lys, O. D. - p. 43 (*pars*), fig. 60, 65.

1966 *Archaesphaera grandis* Lipina - Bogush and Yuferev, p. 74, pl. I, fig. 3, pl. 3, fig. 40.

1971 *Calcisphaera laevis* Williamson - Mamet and Saurin, pl. 16, fig. 2, 6.

1972 *Calcisphaera laevis* Williamson - Mamet and Armstrong, fig. 5D.

1973 *Calcisphaera laevis* Williamson - Mamet, p. 110, pl. 3, fig. 4, 9, 10.

1973 *Calcisphaera laevis* Williamson - Browne and Pohl, p. 191, pl. 22, fig. 4-7.

1973 *Calcisphaera pachysphaerica* - (Pronina)-Braznikhova and Vdovenko, pl. 1, fig. 24.

1975 *Calcisphaera laevis* Williamson - Armstrong and Mamet, fig. 11, E-F.

1976 *Calcisphaera laevis* Williamson - Armstrong and Mamet, pl. I, fig.5, pl. 2, fig. 4.

1976 *Calcisphaera laevis* Williamson - Mamet, pl. 12, fig. 4, pl. 14, fig. 11, pl. 70, fig. 4, pl. 84, fig.. 12, pl. 91, fig. 1-2.

1978 *Calcisphaera laevis* Williamson - Bamber and Mamet. pl. 3, fig. 1, pl. 4, fig. 4.

1983 *Calcisphaera laevis* Williamson - Groves, p. 30, pl. 10, fig. 12-13.

1985 *Calcisphaera laevis* Williamson - Mamet and Pinard, pl. 1, fig. 11.

1986 *Calcisphaera laevis* Williamson - Mamet et al., p. 31, pl. 12, fig. 12.

1986 Calcispheres - Groves, p. 492, fig. 9-15.

1987 *Calcisphaera laevis* Williamson - Brenckle and Groves, p. 121, fig. 21.

1994 *Calcisphaera laevis* Williamson - Herbig and Mamet, pl. 11, fig. 7.

1995 *Calcisphaera laevis* Williamson - Altiner and Savini, pl. 4, fig. 1-2.

1996 *Calcisphaera laevis* Williamson - Mamet, pl. I, fig. 15-17.

1998 *Calcisphaera laevis* Williamson - Mamet, p. 21, pl. 3, fig. U-T.

2000 *Calcisphaera laevis* Williamson - Cózar and Rodriguez, p. 109-110, fig. 4C.

2002 *Calcisphaera laevis* Williamson - Herbig *in* van Ameron et al., pl.3, fig. 1-3.

Description. Regular, smooth, micritic hollow sphere, with very fine perforations. Diameter 100-150 µm. Wall 15-20 µm thick. Absence of functional aperture.

Remark. It is probable that specimens reported in the literature as *Archaesphaera crassa* Lipina, 1950 ought to be transferred to *Calcisphaera laevis* Williamson, 1881. Calcispheres are common in lagoons, therefore heavily micritized and the pores are not identifiable.

Origin. There has been a long controversy concerning the nature of Calcispheres. While as early as

PLATE 2

Green algae (Chlorophycophytes) cont'd

Dasycladales

Fig. 1-5 - *Frosterleyella rozovskaiae* (Mamet and Roux, 1975). Fig. 1 - 193115A, University of Montreal 791/6, x 97; Fig. 2 - 193114O, University of Montreal 871//11, x 97; Fig. 3 - 193114, University of Montreal 780/13, x 97; Fig. 4 - 193114, University of Montreal 868/0, x 97; Fig. 5 - 193114M, University of Montreal, 870// 18, x 97.

Fig. 6-21 - *Cabrieropora opalae* n. sp. Fig. 6 - 193114E, University of Montreal 791/2, x 97; Fig. 7 - 193114H, University of Montreal, 869/0, x 97; Fig. 8 - 193114N, University of Montreal, 870/24, x 97; Fig. 9 - 193114C, University of Montreal, 790/12, x 97; Fig. 10 - 193114H, University of Montreal 869/1, x 97; Fig. 11 - 193114K, University of Montreal 870/13, x 97; Fig. 12 - 193114B, University of Montreal, 790/// 133, x 97; Fig. 13 - 193114I, University of Montreal 869/10, x 97; Fig. 14 - 193114L, University of Montreal 870/14, x 97; Fig. 15 - 193114O, University of Montreal 871/7, x 97; Fig. 16 - 193114E, University of Montreal 791/1, x 97, type of new species; Fig. 17 - 193114N, University of Montreal, 871/6, x 97; Fig. 18 - 193114H, University of Montreal 868/21, x 97; Fig. 19 - 193114B, University of Montreal, 790/16, x 97; Fig. 20 - 193115P, University of Montreal 934/23, x 97; Fig. 21 - 193115R, University of Montreal 934/32, x 97.

Dasycladale kysts (Calcispheres of Williamson)

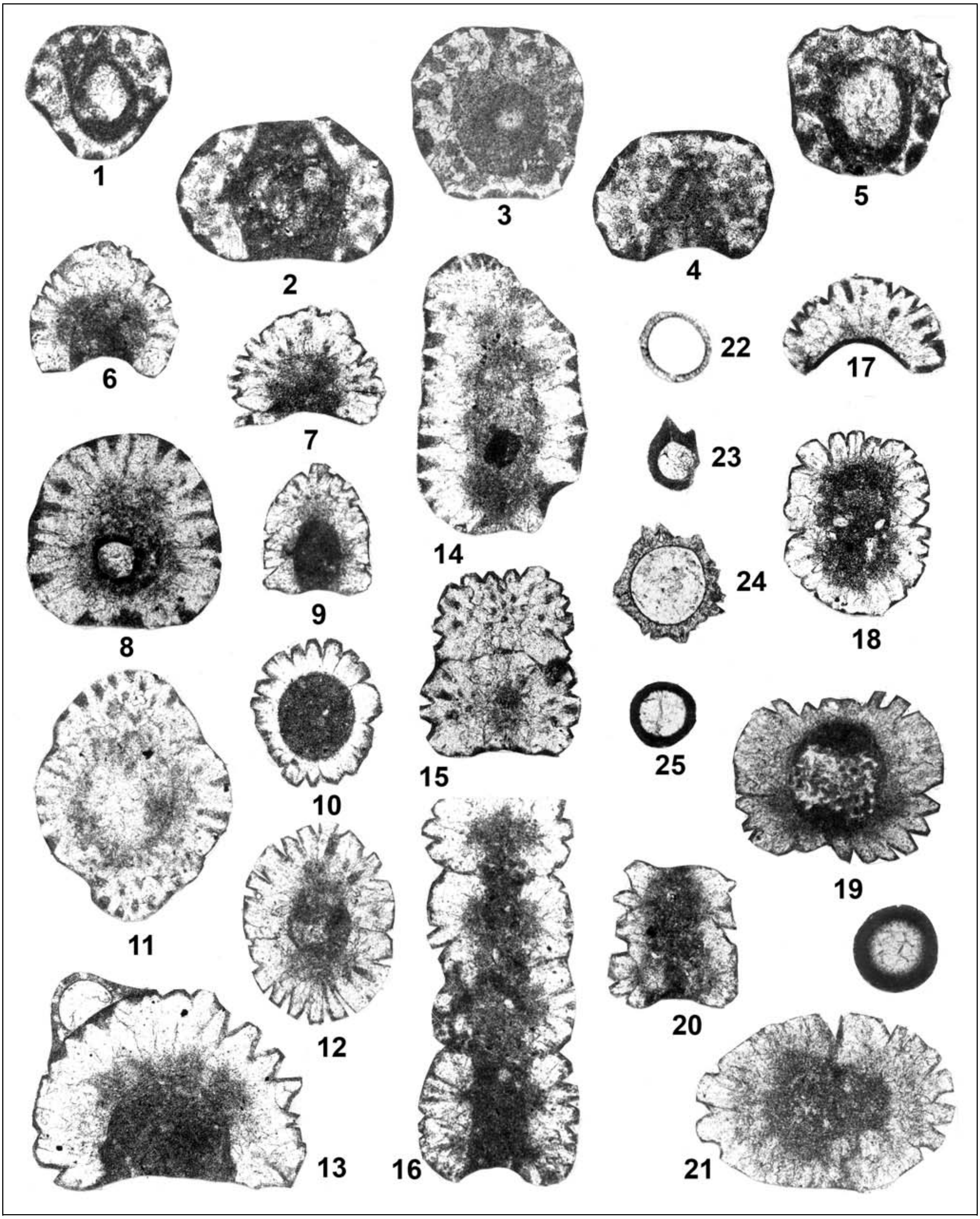
Fig. 22 - *Palaeocancellus cancellatus* (Williamson, 1881). 193114I, University of Montreal 69/6, x 97.

Fig. 23 - *Parathurammina* of the group of *P. spinosa* (Williamson, 1881). 193114F, University of Montreal 868/77, x 97.

Fig. 24 - '*Radiosphaera*' *basilica* Reitlinger, 1957. 193115P, University of Montreal Ru 4/12, x 97.

Fig. 25 - *Calcisphaera laevis* Williamson, 1881. 193115R, University of Montreal Ru 4/25, x 97.

Fig. 26 - *Calcisphaera pachysphaerica* (Pronina, 1963). 193115R, University of Montreal Ru 4/26, x 97.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1929, Cayeux proposed that they were dasycladale kysts (see also Derville 1942, 1950, 1952; Rupp 1966; Armstrong & Mamet 1977; Mamet 1998), the Russian school has always considered them to be foraminifers, an opinion shared by Conil & Lys (1968). After a period of taxonomic instability, the genus is now stabilized and the type designation by Andrews (1955) is generally accepted.

Stratigraphic distribution. The most prolific algal constituent in Devonian-Carboniferous lagoons. Much more scarce in the Early Permian where it peters out. Forms "blooms" from Givetian to Viséan.

Calcisphaera pachysphaerica (Pronina, 1963)
Pl. 2, fig. 26

1948 *Pachysphaera* Rauzer-Chernoussova, OBJ, *Non. nud*., p. 37.

1963 *Archaesphaera*? *pachisphaerica* (sic) Pronina, O. D.- p. 125-126, pl. I, fig. 14-15.

1964 *Pachysphaera dervillei* Conil and Lys, O. D., OBJ, invalid, p. 43, pl. 6, fig. 57-60, 62?, 63, 64 (non 61).

1964 *Pachysphaera polydermoides* Conil and Lys, O. D., (*pars*), p. 43-44, pl. 6, fig. 67, (non) 68.

1964 *Pachysphaera dervillei* Conil and Lys - Conil and Pirlet, pl. 1, fig. 1.

1968 *Pachysphaerina pachysphaeroides* Pronina - Conil and Lys, p. 501, pl. 3, fig. 40.

1969 *Pachysphaerina dervillei* Conil and Lys - Conil and Lys *in* Conil et al., p. 57.

1970 *Calcisphaera pachysphaerica* (Pronina) - Mamet, pl. 4, fig. 1.

1971 *Calcisphaera pachysphaerica* (Pronina) - Mamet and Saurin, pl. 16, fig. 6.

1971 *Calcisphaera* type 1 - Flügel and Hötzl, fig. 4 (only).

1972 *Calcisphaera pachysphaerica* (Pronina) - Mamet and Armstrong, fig. 5-E, fig. 6-B, E.

1973 *Calcisphaera pachysphaerica* (Pronina) - Mamet, p. 110, pl. 3, fig. 8, 12, 13.

1975 *Pachysphaerina dervillei* Conil and Lys - Brunner, p. 28.

1976 *Calcisphaera pachysphaerica* (Pronina) -Mamet, pl. 23, fig. 1-4, pl. 26, fig. 2, pl. 32, fig. 3-4, pl. 33, fig. 2-4, pl. 36, fig. 1-4, pl. 41, fig.1, pl. 47, fig. 2, pl. 95, fig. 11.

1977 *Pachysphaerina pachysphaerica* (Pronina) - Vachard, p. 163, pl. 8, fig. 10.

1978 *Pachysphaera dervillei* Conil and Lys - Sido, pl. 1, fig. 5.

1979 *Pachysphaera dervillei* Conil and Lys - Mansourian, p. 55, pl. 1, fig. 4-6.

1981 *Calcisphaera pachysphaerica* (Pronina) - Igo and Adachi, p. 104-105, pl. 5, fig. 12.

1985 *Calcisphaera pachysphaerica* (Pronina) - Mamet and Pinard, pl. 1, fig. 12.

1986 *Pachysphaerina pachysphaerica* (Pronina) - Vachard and Tellez-Giron, pl. 3, fig. 3, 6.

1988 *Pachysphaerina pachysphaerica* (Pronina) - Hance, p. 29, pl. 4, fig. 23-24.

1991 *Pachysphaerina pachysphaerica* (Pronina) - Vachard and Beckary, p. 325, pl. 4, fig. 32.

1993 *Pachysphaerina* - Sabirov *in* Rauzer-Chernoussova et al., p. 32, pl. 6, fig. 5.

1994 *Calcisphaera pachysphaerica* (Pronina) - Herbig and Mamet, pl. 11, fig. 7.

1996 *Calcisphaera pachysphaerica* (Pronina) - Mamet, pl. 1, fig. 18-20.

2000 *Calcisphaera pachysphaerica* (Pronina) - Cózar and Rodriguez, p. 110, fig. 4D.

2001 *Calcisphaera pachysphaerica* (Pronina) - Mamet and Stemmerick, fig. 3C.

2002 *Calcisphaera pachysphaerica* (Pronina) - Herbig *in* van Ameron et al., pl. 3, fig. 4.

2003 *Pachysphaerina pachysphaerica* (Pronina) Vachard et al. pl. I, fig. 1-2.

Description. A hollow micritic sphere. Diameter 180-240 µm. Thickness of calcified envelope 20-30 µm. Thin perforations. No functional aperture.

Discussion. *C. laevis* and *C. pachysphaera* are the most abundant Calcispheres in Devonian-Carboniferous lagoons and related restricted environments. They are often associated with non-marine ostracods and mollusks. Hyper- or hyposaline conditions are highly unfavorable to Foraminifera and there is therefore little

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PLATE 3

Green algae (Chlorophycophytes)

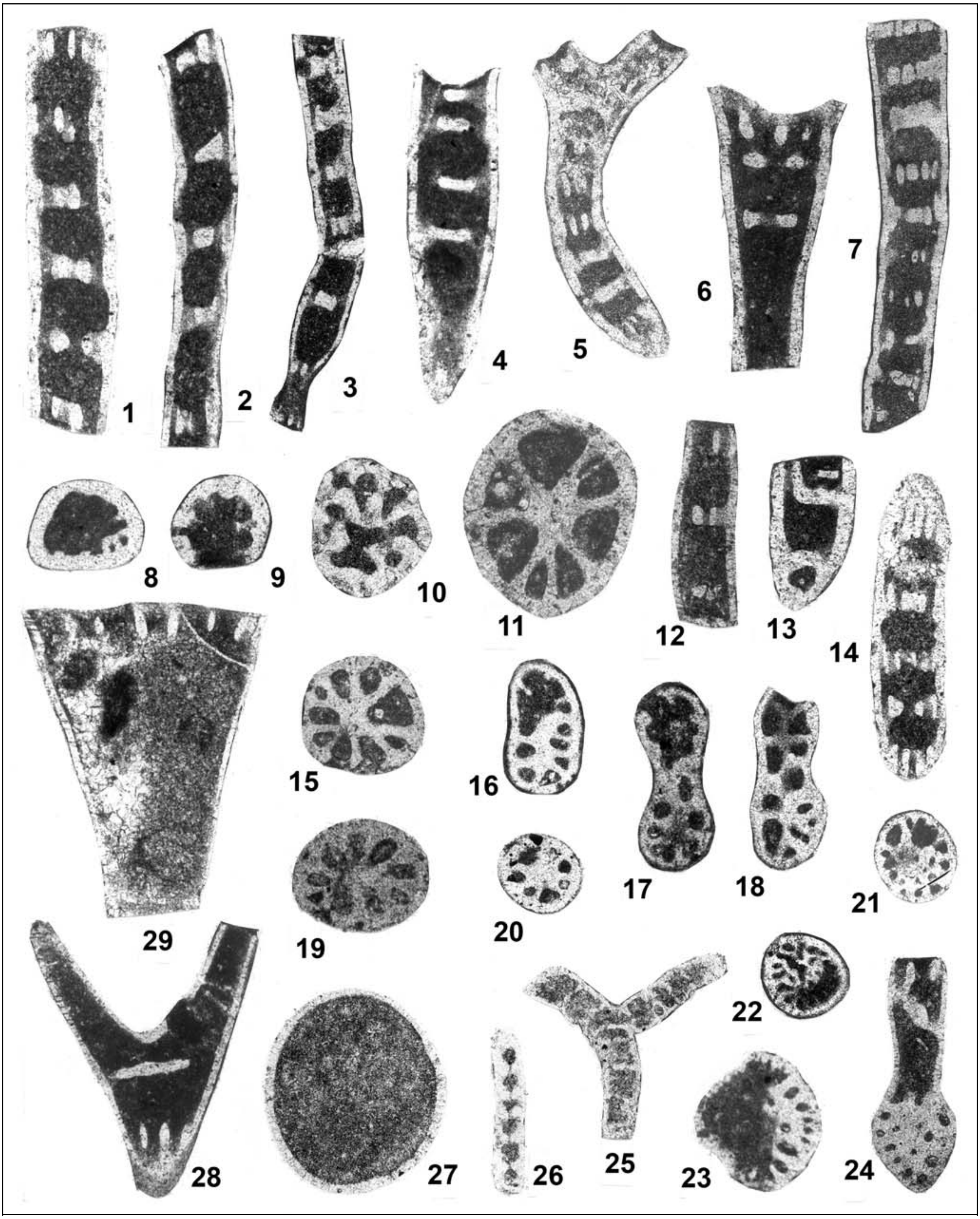
Palaeosiphonocladales (Issinellids and Paleoberesellids)

Fig. 1-20 - *Cribrokamaena citrosa* Brenckle, 1985. Fig. 1 - 193115J, University of Montreal 872/0, x 97; Fig. 2 - 193115D, University of Montreal 791/14, x 97; Fig. 3 - 193115H, University of Montreal 869/23, x 77; Fig. 4 - 193115C, University of Montreal 791/10, x 97; Fig. 5 - 193115, University of Montreal 780/18, x 97; Fig. 6 - 193115P, University of Montreal 934/22, x 97; Fig. 7 - 193114, University of Montreal 780/12, x 77; Fig. 8 - 193114K, University of Montreal 870/12, x 97; Fig. 9 - 193115Q, University of Montreal 935/8, x 97; Fig. 10 - 193114F, University of Montreal 868/13, x 97; Fig. 11 - 193114, University of Montreal 945/27, x 121; Fig. 12 - 193115A, University of Montreal 791//7, x 97; Fig. 13 - 1193115P, University of Montreal 935/6, x 97; Fig. 14 - 193115H, University of Montreal 870/0, x 97; Fig. 15 - 193115E, University of Montreal 791/18, x 97; Fig. 16 – 193114O, University of Montreal 871//14, x 97; Fig. 17 - 193115P, University of Montreal 935/9, x 97; Fig. 18 - 193115K, University of Montreal 872/3, x 97; Fig. 19 - 193115A, University of Montreal 791/3, x 97; Fig. 20 - 193114M, University of Montreal 870/21, x 97.

Fig. 21-25 - *Cribrokamaena furcillata* Brenckle, 1985. Fig. 21 - 193114M, University of Montreal 871/1, x 97; Fig. 22 - 193115K, University of Montreal 872/4, x 97; Fig. 23 - 193114F, University of Montreal 868/4, x 97; Fig. 24 - 193115F, University of Montreal 869/19, x 97; Fig. 25 - 193114P, University of Montreal 869/4, x 97.

Fig. 26 - *Palaeoberesella* aff. *P. lahuseni* (von Möller, 1879). 193115, University of Montreal 870/2, x 77.

Fig. 27-29 - *Cribrokamaena ferniensis* n. sp. Fig. 27 - 193115F, University of Montreal 868/14, x 97; Fig. 28 - 193115P, University of Montreal 934/18, x 97; Fig. 29 - 193115D, University of Montreal 791/16, x 97, type of new species.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to substantiate a protozoan affinity. For history, see Armstrong & Mamet (1977), Wray (1977); and Mamet (1998). The subfamily Pachysphaerininae Sabirov, 1987 is unfounded.

Stratigraphic distribution. The species is cosmopolitan and abundant, hence is useful for approximate recognition of the Tournaisian-Viséan boundary (see Hance 1988). It is quite scarce in uppermost Tournaisian beds, but the Viséan is replete with the species. *C. pachysphaerica* slowly peters out in mid-Carboniferous time.

Issinellid or Palaeoberesellid?

Genus *Cribrokamaena* Brenckle, 1985

Cribrokamaena citrosa Brenckle, 1985

Pl. 3, figs 1-20, pl. 4, figs 1-7

1981 *Issinella devonica* Reitlinger - Mamet and Roux (*pars*), p. 154-155 (*pars*), pl. 1, fig. 7, 9-15, 19-20 (only).

1985 *Cribrokamaena citrosa* Brenckle O. D. - p. 58-60 (*pars*), pl. I, fig. 1-4, 6-10, 12-22, 24-37, 39-45, pl. 2, fig. 1-2, 4-7, 9, 11, pl. 3, fig. 1-15.

1997 *Cribrokamaena citrosa* Brenckle - Brenckle and Page, pl. 5, fig. 6-13.

Description. Branched thallus, of slightly curved cylindrical tubes. Diameter of axial section, 100-200 µm, with extremes reaching 300 µm. Partitions obliquely perforated by 6, 8, 12 calcified rays. They have the same thickness as the wall (25-40 µm). Wall perforated by thin, straight pores.

Remark. As Brenckle noted, there is a striking variability of all the observable parameters (diameter, thickness partitions). *Issinella* thalli also divide and should not be confused with similar branching observed in *Kamaena*.

Stratigraphic distribution. Only recognized in the Viséan and mostly in the Late Viséan (Zones 14-15). Restricted to North America: American and Canadian Cordillera, Midcontinent. Locally abundant in high energy grainstones.

Cribrokamaena furcillata Brenckle, 1985

Pl. 3, figs 21-25

1985 *Cribrokamaena furcillata* Brenckle O. D. - p. 60, pl. 3, fig. 16-27.

1997 *Cribrokamaena furcillata* Brenckle - Brenckle and Page, pl. 5, fig. 14 (reproduction of 1985, fig. 22).

Description. Thallus small, branched, composed of regular cylindrical tubes. Diameter 40-100 µm. Medulla occupies 75% of the total width. Partitions perforated by numerous, irregular, oblique pores (12-20). Cortex thin, inferior to 10 µm, making difficult identification of the pores.

Remark. This species is readily distinguished by its small size and slender, regular shape. Vachard (1991) has suggested that *furcillata* could belong to *Kamaena*, but this conflicts with the presence of perforated partitions.

Stratigraphic distribution. Mid to Late Viséan. Scarce. For geographic extent, see the map of Brenckle (1985) and add Idaho, Alberta and British Columbia.

Cribrokamaena ferniensis n. sp.

Pl. 3, figs 27-29

Type of the new species. Pl. 3, fig. 29 (here designated).
Derivatio nominis. From Fernie.

Description. Thallus stout, cylindrical, branching, reaching 400-500 µm in diameter. Medulla very important reaching 90-95 % of the thallus, while the cortex is very thin (20 µm) considering the size. Cortex perforated by numerous pores (120-150 per linear millimeter). No identifiable conceptacles.

Comparison. Compared to *citrosa*, the new species has a much bigger medulla compared to a thin cortex and a profusion of pores.

Stratigraphic distribution. Late Viséan. Up to now restricted to Fernie (British Columbia).

Genus *Palaeoberesella* Mamet and Roux, 1974

Palaeoberesella aff. **P. lahuseni** (von Möller, 1879)

Pl. 3, fig. 26

For comparison:

1879 *Palaeoberesella lahuseni* von Möller O. D. - p. 75, pl. 5, fig. 6-7.

and consult a complete taxonomic list in:

2004 *Palaeoberesella lahuseni* von Möller - Mamet and Villa, p. 163-164.

Affine taxa are:

1974 *Palaeoberesella* aff. *P. lahuseni* (von Möller) - Mamet and Roux, p. 144, pl. 2, fig. 11-19.

1983 *Palaeoberesella* aff. *P. lahuseni* (von Möller) - Mamet and Roux, p. 74, pl. 5, fig. 1, 3, 4, 8, 12, 13, 15.

1988 *Palaeoberesella lahuseni* (von Möller) - (*pars*) Ivanova and Bogush, pl. 17, fig. 2 (non 3-4).

1990 *Palaeoberesella lahuseni* (von Möller) - Bogush et al., pl. 8, fig. 10 (only)

1994 *Palaeoberesella lahuseni* (von Möller) - Vachard and Clément, pl. 2, fig. 4 (non 10).

1999 *Palaeoberesella* aff. *P. lahuseni* (von Möller) - Mamet et al., pl. 4, fig. 3-4.

2002 *Palaeoberesella* aff. P. *lahuseni* (von Möller) - Mamet, p. 497, pl. 1, fig. 8.

Description. A tiny *Palaeoberesella*. Diameter 80-100 µm, with a wall thickness of 12-18 µm.

Remark. It is conceivable that the distinction between the aff. *lahuseni* and the thicker *lahuseni* is artificial as they are often observed together.

Stratigraphic distribution. Cosmopolitan. Rare in mid-to late-Devonian. Very abundant in Early Carboniferous (Tournaisian-Viséan).

Genus *Crassikamaena* Brenckle, 1985

Crassikamaena foraminosa Brenckle, 1985

Pl. 4, figs 8-9, 17-18

1985 *Crassikamaena foraminosa* Brenckle, O. D. - p. 62-66, pl. 3, fig. 28-44, fig. 4, fig. 1-16.

1990 *Crassikamaena foraminosa* Brenckle - Bogush et al., pl. 8, fig. 14-15.

2003 (non) *Stylaella foraminosa* (Brenckle) - Berchenko, p. 19, pl. 10, fig. 18, 27-28.

Description. Thallus curved, irregular, grossly cylindrical. Diameter variable (100-180 μm). Wall equally variable (20-40 μm). Septation very irregular, often massive, perforated by many straight pores. Septa delimit irregular cells.

Comparison. Our specimens appear stouter than Brenckle original material. However his plate 4, fig. 14 is much thicker than the rest of the paratypes. *Evlania*? *scabrosa* Vachard (1981), could be related to *foraminosa*, considering the curious partition shape. The material is unfortunately dissolved and the nature of the pores (if any) is conjectural.

Stratigraphic distribution. The species is known from the American Midcontinent, the American Cordillera and the Omolon Massif in northeastern Asia. Givetian to Viséan.

Crassikamaena? aff. **C. inceptoris** Ivanova in Bogush et al., 1990

Pl. 4, fig. 11

Compare with:

1990 *Crassikamaena inceptoris* Ivanova O. D. - *in* Bogush et al., pl. 8, fig. 16-17.

Description. Thallus irregular, cylindrical. Diameter 150-200 μm. Cortex thin, 20 μm, perforated by numerous, thin pores. Septation poorly developed, forming irregular cells. Septal perforations are sometimes observed.

Comparison. Easily distinguished from *foraminosa* by the scarcity of irregular septation. The attribution to *Crassikamaena* remains tentative.

Stratigraphic distribution. Reported by Ivanova from the *Quasiendothyra kobeitusana* Zone, which is now considered as latest Devonian. Central Asia. Viséan of Alberta.

Crassikamaena aff. **kurganensis** Ivanova in Bogush et al., 1990

Pl. 4, figs 14-15

Compare with:

1990 *Crassikamaena kurganensis* Ivanova *in* Bogush et al., O. D. - p. 99, pl. 9, fig. 1-3.

Description. Thallus irregular, grossly cylindrical. Diameter 100-150 μm. Cortex 25-30 μm perforated by thin pores, here obscured by calcite cleavages. Irregular septation characteristic. Sometimes long protrusions, sometimes reduced to feeble expansions of the cortex. Shape of cells variable.

Stratigraphic distribution. Originally reported from the *Quasiendothyra kobeitusania* Zone, as the preceding taxon.

Genus *Exvotarisella* Elliott, 1970

Exvotarisella index (Ehrenberg, 1854 emend. von Möller, 1879)

Pl. 4, fig. 19

1854 *Nodosinella index* Ehrenberg O. D. - pl. 37, fig. 10 (type lost).

1879 *Nodosinella index* Ehrenberg emended by von Möller - p. 74-75, pl. 2, fig. 7, pl. 5, fig. 8.

For the synonymy see Mamet and Roux, 1983, p. 73 and add:

1986 *Exvotarisella maponi* Elliott - Skompski, p. 161-163,, pl. 7, fig, 4-8, pl. 88, fig. 1, 6-8.

1987 *Exvotarisella index* (Moeller) (sic) - Shuysky, pl. 16, fig. 8.

1988 *Exvotarisella* - Deloffre, pl. I, fig. 16.

1988 *Exvotarisella index* (Ehrenberg) - Ivanova *in* Chuvashov, pl. 2, fig. 1-3.

1988 *Exvotarisella index* (Ehrenberg) - Ivanova and Bogush *in* Dubatolov, pl. 15, fig. 11-13, pl. 16, fig. 19.

1991 *Exvotarisella index* (Ehrenberg) - Vachard, pl. 5, fig. 5.

1994 *Exvotarisella index* (Ehrenberg) - Chuvashov et al., pl.10, fig. 5.

1993 *Exvotarisella index* Moëller (sic) - Rauzer-Chernoussova et al., p. 24, fig. 16.

1994 *Exvotarisella index* (Ehrenberg) - Vachard and Clément, p. 306, pl. 3, fig. 5-6.

1995 *Exvotarisella index* (Ehrenberg) - Sanchez-Chico et al., p. 74, pl. I, fig. 12-16.

1996 *Exvotarisella index* (Ehrenberg) - Sebbar and Mamet, pl. 2, fig. 9.

1996 *Exvotarisella* sp. - Madi et al., pl. 24, fig. 7-8.

2004 *Exvotarisella index* (Ehrenberg) - Brenckle, pl. 6, fig.16.

Description. Thallus cylindrical, highly calcified. Cortex variable, diameter from 150-400 μm, usually 200-300 μm. Medulla divided by irregular, blunt partitions. They delimit irregular cavities, that become subquadratic in the center. Thickness of cortex around 20-30 μm. Primary pores regular, divided into bundles of secondaries (and sometimes further dichotomous tertiaries).

Stratigraphic distribution. Common and cosmopolitan. Famennian to Baschkirian and abundant in the Viséan.

Exvotarisella? sp.

Pl. 4, fig. 10

Description. Thallus cylindrical, heavily calcified. Medullar cavity, half of the thallus diameter. Partitions blunt. Cortex thick (up to 60 µm perforated by thick pores with oblique insertion).

Comparison. Oblique pore insertion is normally not observed among *Exvotarisella.* A possible explanation is that the thallus has been extensively leached. The oblicity would be the result of partial destruction of the pore dichotomic end.

Stratigraphic distribution. This puzzling taxon has only been observed three times.

Genus *Issinella* Reitlinger, 1954

Issinella devonica Reitlinger, 1954

Pl. 4, figs 12-14

1954 *Issinella devonica* Reitlinger O. D. - p. 80, pl. 22, fig. 14.

For the synonymy see Mamet and Roux, 1981, p. 154. Note that only pl. II, fig. 1, 6, 7, 16-18 should be considered as typical *Issinella devonica*, the remainder ought to be transferred to *Cribrokamaena* Brenckle, 1985. To the list, add the following references:

1980 *Issinella devonica* Reitlinger - Berchenko and Kotlyar, pl. 2, fig. 7-8.

1981 *Issinella devonica* Reitlinger - Mamet and Martinez, pl. 2, fig. 2-3.

1983 *Issinella devonica* Reitlinger - Cnudde and Mamet, pl. 1, fig. 8.

1985 *Issinella devonica* Reitlinger - Roux, p. 569-570, pl. 3, fig. 1-2 (with part of the reconstruction).

1988 *Issinella devonica* Reitlinger - Ivanona and Bogush *in* Dubatolov, pl. 14, fig, 1-2.

1990 *Issinella devonica* Reitlinger - Saltovskaja, p. 116, pl. 36, fig. 9-11, pl. 37, fig. 9-13.

1990 *Issinella devonica* Reitlinger - Bogush et al., p. 110-111, pl. 12, fig. 5-7, 9, 16.

1991 *Issinella devonica* Reitlinger - Riding, fig. 1G.

1992 *Issinella devonica* Reitlinger - Mamet and Préat, pl. 1, fig. 10, 12, 17.

1992 *Issinella devonica* Reitlinger - Racki and Sobon-Podgorska, fig. 5 E-G.

1994 *Luteotubulus licis* Malakhova - Vachard, pl. 3, fig. 1-10.

1995 *Issinella devonica* Reitlinger - Sanchez-Chico et al., p. 75, pl. 1, fig. 4-5.

1996 *Issinella devonica* Reitlinger - Sebbar and Mamet, pl. 2, fig. 10.

1999 *Issinella devonica* Reitlinger - Sebbar and Mamet, pl. 2, fig. 7.

2003 *Issinella devonica* Reitlinger - Brenckle and Milkina, pl. 2, fig. 5.

2003 *Issinella devonica* Reitlinger - Berchenko, p. 26, pl. 8, fig. 11-13.

Description. Thallus cylindrical, tubular, divided by binary fission. External diameter 100-400 µm, exceptionally more. Cortex (20-90 µm) hyaline perforated by numerous pores, which are cylindrical, undivided and perpendicular to the cortex.

Stratigraphic distribution. Cosmopolitan and very abundant. Mid Devonian to Bashkirian. Reports by Sebbar and Mamet (1999) extend the range into the Moscovian of Algerian Sahara.

Rhodophytes

Cuneiphycids

Genus *Fourstonella*? Cummings, 1955b or *Cuneiphyc*us? Johnson, 1960 or *Efluegelia* ? (Vachard in Massa and Vachard, 1979)

"Fourstonella"? johnsoni (Flügel, 1966)

Pl. 5, figs 1-5

1966 *Cuneiphycus johnsoni* Flügel O. D. - p. 17-19, pl. 2, fig. 1-5.

PLATE 4

Green algae (Chlorophycophytes) cont'd

Palaeosiphonocladales (Issinellids and Palaeoberesellids)

Fig. 1-7 - *Cribrokamaena citrosa* Brenckle, 1985. Fig. 1 - 193115E, University of Montreal 731/17, x 97; Fig. 2 - 193115I, University of Montreal 871/ 19,77; Fig. 3 - 193115B, University of Montreal 791/9, x 97; Fig. 4 - 193114O, University of Montreal 871/10, x 97; Fig. 5 - 193115F, University of Montreal, 869/18, x 121; Fig. 6 - 193115J, University of Montreal 872/1, x 63; Fig. 7 - 193115P, University of Montreal 934/15, x 63.

Fig. 8, 9, 17, 18 - *Crassikamaena foraminosa* Brenckle, 1985. Fig. 8 - 193114W, University of Montreal 871/4, x 97; Fig. 9 - 193114O, University of Montreal 871/ 17, x 97; Fig. 17 - 193115H, University of Montreal 870/1, x 97; Fig. 18 - 193114I, University of Montreal, 869/5, x 77.

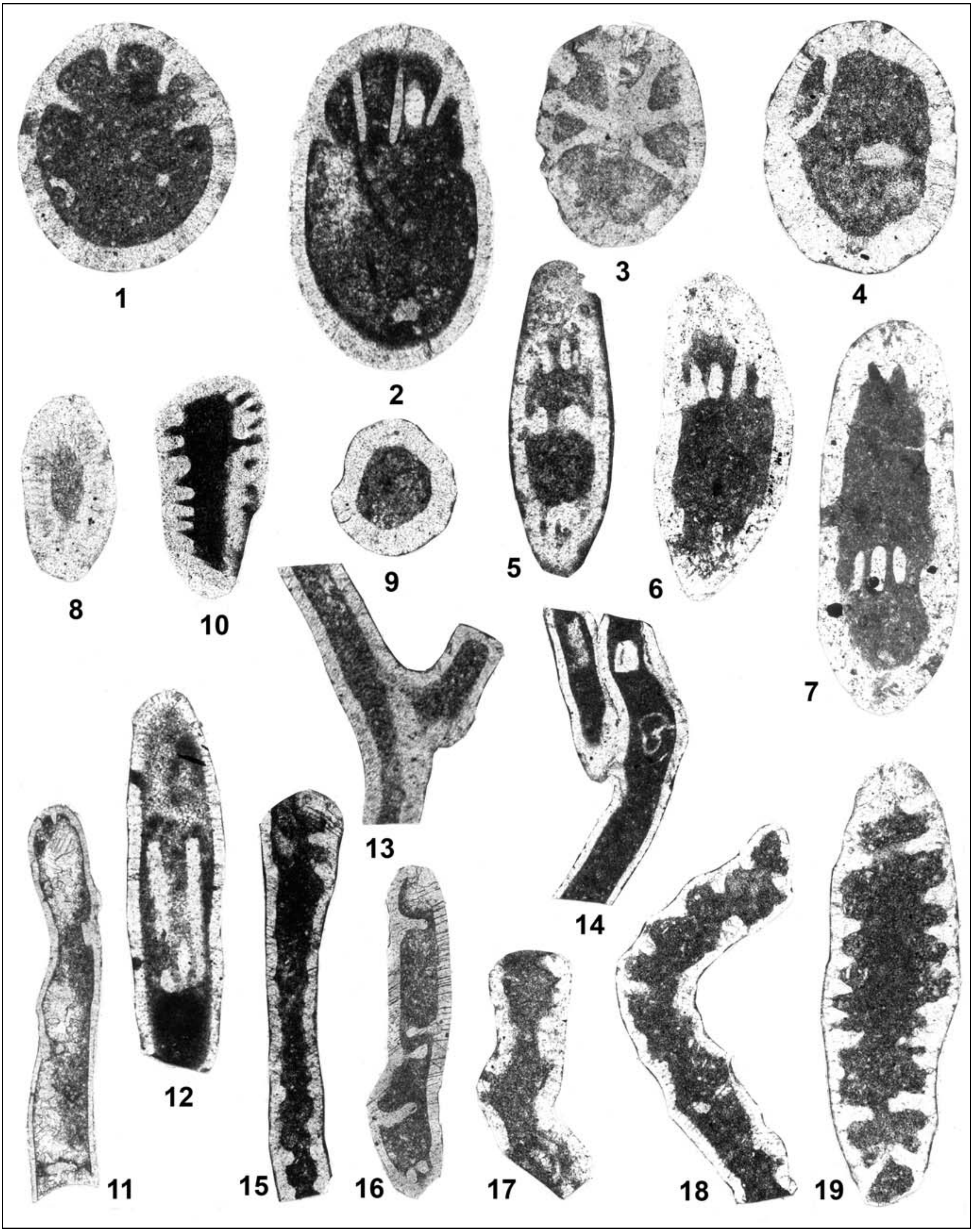
Fig. 10 - *Exvotarisella* ? sp. 193115K, University of Montreal 872/5, x 97.

Fig. 11 - *Crassikamaena* ? aff. *C. inceptoris* Ivanova *in* Bogush *et al*., 1990. 193115, University of Montreal 780/19, x 30.

Fig. 12-14 - *Issinella devonica* Reitlinger, 1954. Fig. 12 - 193115D, University of Montreal 791/15, x 77; Fig. 13 - 193115I, University of Montreal 871/ 20, x 97; Fig. 14 - 193114, University of Montreal, 870/20, x 63.

Fig. 15, 16 - *Crassikamaena*? aff. *C. kurganensis* Ivanova *in* Bogush *et al*., 1990. Fig. 15 - 193115F, University of Montreal 869/17, x 63; Fig. 16 - 193115, University of Montreal 780/20, x 63.

Fig. 19 - *Exvotarisella index* (Ehrenberg, 1854, emend von Möller, 1879). 193114H, University of Montreal 868/22, x 97.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1969 *Cuneiphycus* sp. cf. *C. johnsoni* Flügel - Toomey, p. 1318, pl. 151, fig. 3-4.

1972 *Cuneiphycus johnsoni* Flügel - Homann, p. 165-169, pl. 2, fig. 12.

1974 *Cuneiphycus johnsoni* Flügel - Chuvashov, p. 32, pl. 21, fig. 1-8.

1977 *Cuneiphycus johnsoni* Flügel - Mamet and Roux, p. 238, pl. 9, fig. 8-11.

1978 *Cuneiphycus johnsoni* Flügel - Mamet and Roux, p. 83, pl. 7, fig. 11-12.

1979 *Eflugelia* (sic) *johnsoni* (Flügel) - Vachard *in* Massa and Vachard, p. 34, pl. 9, fig. 10.

1980 *Eflugelia* (sic) *johnsoni* (Flügel) - Flügel, pl. 7, fig. 2, pl. 9, fig. 1.

1980 *Eflugelia* (sic) *johnsoni* (Flügel) - Flügel and Flügel-Kahler, p. 163-164, pl. 8, fig. 9-10.

1981 *Efluegelia johnsoni* (Flügel) - Ramovs and Kochansky-Devidé, p. 97, pl. 1, fig. 2 (*nom. corr.*)

1981 *Eflugelia* (sic) *johnsoni* (Flügel) - Vachard and Montenat, p. 60, pl. 9, fig. 1, pl. 10, fig. 1-3, 5-6, pl. 12, fig. 10.

1982 *Efluegelia johnsoni* (Flügel) - Milanovic, pl. 7, fig. 10, pl. 10, fig. 3.

1983 *Eflugelia* sp. (sic) - Groves, p. 29-30, pl. 8, fig. 6-9

1985 *Cuneiphycus johnsoni* Flügel - Mamet et Pinard, pl. 1, fig. 18-21. Pl. 3, fig. 1.

1986 *Fourstonella johnsoni* Flügel - Groves p. 488, fig. 8/3-8.

1986 *Eflugelia* (sic) *johnsoni* (Flügel) - Skompski, p. 268-269, fig. 6, pl. 10, fig. 1-2.

1987 *Cuneiphycus johnsoni* Flügel - Mamet et al., p. 55-56, pl. 28, fig. 5-10.

1989 *Eflugelia* (sic) *johnsoni* (Flügel) - Vachard et al., p. 707, pl. 2, fig. 3.

1989 *Eflugelia* (sic) *johnsoni* (Flügel) - Sebbar and Lys, pl. 1, fig. 7.

1990 *Eflugelia* (sic) *johnsoni* (Flügel) - Sebbar, pl. 1, fig. 5

1993 *Eflugelia* (sic) *johnsoni* (Flügel) - Vachard et al., pl. 2, fig. 6-8.

1993 *Eflugelia* (sic) *johnsoni* (Flügel) - Chuvashov et al., pl. 12, fig. 14.

1995 *Eflugelia* (sic) *johnsoni* (Flügel) - Forke, pl. 15, fig. 8.

1996 *Eflugelia* (sic) *johnsoni* (Flügel) - Vachard and Maslo, pl. 1, fig. 11.

2001 *Eflugelia* (sic) *johnsoni* (Flügel) - Vachard and Krainer, pl. 3, fig. 12.

2002 *Cuneiphycus* ? *johnsoni* Flügel (or *Fourstonella* ?) - Mamet, pl. 6, fig. 9.

2003 *Eflugelia* (sic) *johnsoni* (Flügel) - Vachard et al., pl. 2, fig. 6-8.

2003 *Cuneiphycus*? *johnsoni* Flügel (or *Fourstonella* ?) - Khodjanyazova and Mamet, pl. 5, fig. 4.

2004 *Eflugelia* (sic) *johnsoni* (Flügel) - Cózar and Rodriguez, fig. 9-16.

Description. Thallus attached to a support. Shapes vary from hemispherid to citroid according to growth and orientation of the cells. If the support is planar, the thallus grows in one direction and appears hemispheric. If the support is cylindrical, the thallus grows in three dimensions and becomes lemon-shaped. Length millimetric. Laminae regular, up to 10-12 rows of subquadratic small cells, 20 µm in height. There are 20-25 cells per linear millimeter. Calcification variable.

Remarks. We tentatively follow the opinion of Groves (1986) as the original position of *Cuneiphycus-Fourstonella* remains obscure. The type of *Cuneiphycus* is lost and attempts to secure material from Texas have not been conclusive. *Fourstonella* filaments are both uni- and multidirectional and have been confused for protozoan cells. Various morphologies are easily recognizable but their taxonomic value is open to discussion.

Stratigraphic distribution. Cosmopolitan and recognized in Eurasia-Africa-North America-Australia. Lower Carboniferous to Upper Permian.

Stacheins

Genus *Epistacheoides* Petryk and Mamet, 1972

Epistacheoides nephroformis Petryk and Mamet, 1972

Pl. 5, figs 16-17

1972 *Epistacheoides nephroformis* Petryk and Mamet, O. D. - p. 789, pl. 8, fig. 1-10.

For synonymy, see Mamet and Roux, 1978, p. 82 and add:

1985 *Epistacheoides nephroformis* Petryk and Mamet - Mamet and Pinard, pl. 3, fig. 6.

1987 *Epistacheoides nephroformis* Petryk and Mamet - Brenckle and Marchant, pl. 5, fig. 3-7.

1990 *Epistacheoides taimyricus* Ivanova O. D. - *in* Bogush et al., p. 131-132, pl. 30, fig. 4-7.

PLATE 5

Red algae (Rhodophycophytes) and algal microproblematics.

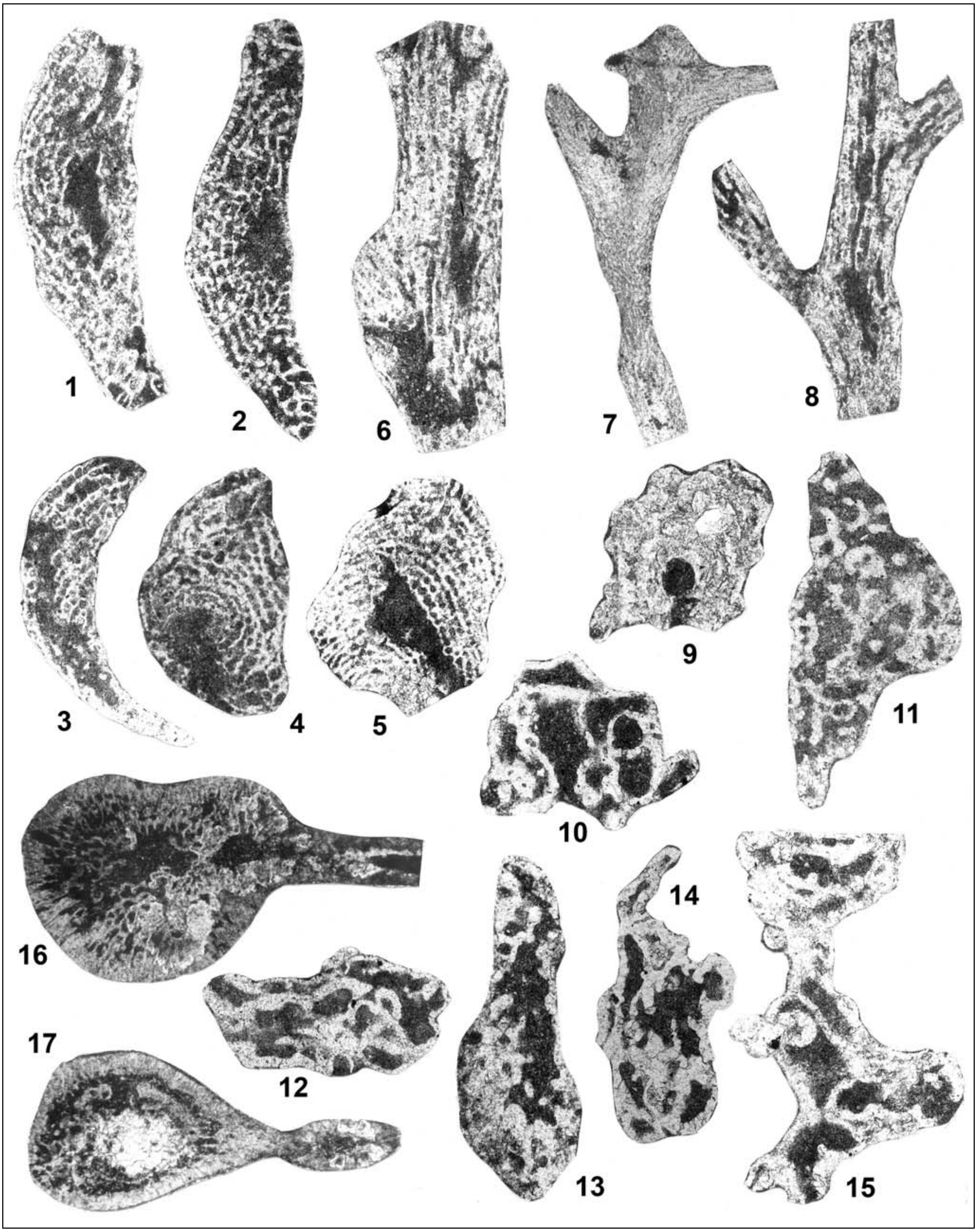
Fig. 1-5 - '*Fourstonella johnsoni*' (Flügel, 1966) (or *Cuneiphycus*? or *Efluegelia* ?). Fig. 1 - 193115I, University of Montreal 871/24, x 63; Fig. 2 - 193115H, University of Montreal 869/24, x 93; Fig. 3 - 193114M, University of Montreal 870/19, x 97; Fig. 4 - 193115B, University of Montreal 791/8, x 97; Fig. 5 - 193114H, University of Montreal 868/24, x 97.

Fig. 6-8 - *Ungdarella uralica* Maslov, 1956. Fig. 6 - 193115I, University of Montreal 871/21, x 63; Fig. 7 - 193115, University of Montreal 780/16, x 25; Fig. 8 - 193115I, University of Montreal 871/25, x 63.

Fig. 9 - *Fasciella kizilia* Ivanova, 1956. 193114M, University of Montreal 871/2, x 97.

Fig. 10-15 - *Asphaltina horowitzi* Mamet and Roux, 1978. Fig. 10 - 193114F, University of Montreal 868/11, x 97; Fig. 11 - 193114I, University of Montreal 869/13, x 97; Fig. 12 - 193114I, University of Montreal 869/14, x 97; Fig. 13 - 193114I, University of Montreal 869/12, x 77; Fig. 14 - 193114G, University of Montreal 868/19, x 97; Fig. 15 - 193114H, University of Montreal 869/2, x 97.

Fig. 16, 17 - *Epistachoides nephroformis* Petryk and Mamet, 1972. Fig. 16 - 193115P, University of Montreal 934/31, x 30; Fig. 17 - 193115P, University of Montreal 934/34, x 30.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1991 *Epistacheoides nephroformis* Petryk and Mamet - Ouarhache et al., pl. 2, fig. 7.

1991 *Epistacheoides nephroformis* Petryk and Mamet - Vachard and Tahiri, pl. 13, fig. 18.

1993 (?) *Epistacheoides* ex. gr. *nephroformis* Petryk and Mamet - Vachard et al., p. 78, pl. 3, fig. 4

1995 *Epistacheoides nephroformis* Petryk and Mamet - Sanchez-Chico et al., p. 78, pl. 4, fig. 11.

1996 *Epistacheoides nephroformis* Petryk and Mamet - Skompski, pl. 13, fig. 1-3.

Description. Thallus encrusted, its shape depending on the support. Strong peri-hypothallic differentiation. Perithallic cells, strongly encrusted, regular, in one or two rows (25-50 μm). Pores straight, radial, 10-15 μm thick. Hypothallic cells irregular, vesiculose. Irregular protuberances. Wall hyaline but partially micritized. The thallus can reach a millimeter or slightly more.

Remark. Differs from *Epistacheoides connorensis* by the regular perithallic cells.

Stratigraphic distribution. Widespread and rather abundant. Eurasia, Africa, North America. Middle Viséan to Bashkirian.

Genus *Epistacheoides*? Petryk and Mamet, 1972

Epistacheoides? peratrovichensis (Mamet and Pinard, 1985)

Pl. 6, fig. 4

1985 *Asphaltina peratrovichensis* Mamet and Pinard, O. D. - p. 99, pl. I, fig. 20, pl. 3, fig. 8, 10.

Description. Thallus encrusted, lemon-shaped. Hypothallus composed of concentric rows of a few cells. Perithallus poorly defined with cells communicating by thin radial pores (20-30 μm). Wall hyaline. Total diameter 450-500 μm.

Comparison. *Peratrovichensis* was erected on a material composed mostly of axial sections. It does not fit previously described Stacheinae and is here tentatively transferred to *Epistacheoides.* However, it lacks the characteristic strong hypo-perithallic differentiation. Compare also with *Stacheoides tenuis* in Malakhova, 1975, pl. 8, fig. 2 (only). For the time being, there is no adequate material for erecting a new genus.

Stratigraphic distribution. Observed up to now only in the northern part of the American Cordillera (Alaska, British Columbia). Late Viséan to Bashkirian.

Genus *Pseudostacheoides* Petryk and Mamet, 1972

Pseudostacheoides loomisi Petryk and Mamet, 1972

Pl. 6, figs 5-9

1972 *Pseudostacheoides loomisi* Petryk and Mamet, O. D. - p. 793-795, pl. 9, fig. 6-8.

1972 *Pseudostacheoides loomisi* Petryk and Mamet - Mamet and Rudloff, p. 89, pl. 6, fig. 12-14.

1974 (Non) *Pseudostacheoides loomisi* Petryk and Mamet - Rich, p. 372, pl. 4, fig. 7, 9, 12.

1979 (?) *Pseudostacheoides loomisi* Petryk and Mamet - Vachard *in* Massa and Vachard, pl. 2, fig. 4.

1983 *Pseudostacheoides* sp. - Vieslet, pl. 5, fig. 7.

1986 *Pseudostacheoides loomisi* Petryk and Mamet - Skompski, p. 269-270, p. 13, fig. 1-4.

1990 *Pseudostacheoides loomisi* Petryk and Mamet - Bogush et al., pl. 29, fig. 6-7.

1991 (?) *Pseudostacheoides loomisi* Petryk and Mamet - Vachard et al., pl. I, fig. 8.

1991 (?) *Pseudostacheoides loomisi* Petryk and Mamet - Vachard and Tahiri, pl. 9, fig. 3.

1996 *Pseudostacheoides loomisi* Petryk and Mamet - Sebbar and Mamet, pl. 3, fig. 8.

1998 *Pseudostacheoides loomisi* Petryk and Mamet - Sebbar, pl. 3, fig. 6.

Description. Encrusting, irregular, elongated *Pseudostacheoides*. Irregular zones of hypothallic cells, often dissolved. Characteristic elongated perithallic cells (height 20-30 μm) parallel to the periphery. Interlaminae quite uniform (30-40 μm), perforated by numerous radial pores (see pl. 6, fig. 5). There are about 100 pores per linear millimeter. Some exhibit dichotomy.

Stratigraphic distribution. Eurasia, North America, North Africa. Abundant in the Upper Viséan of the Sahara (Algeria, Morocco). Same distribution in Alberta and British Columbia (Opal Member, Carnarvon Mem-

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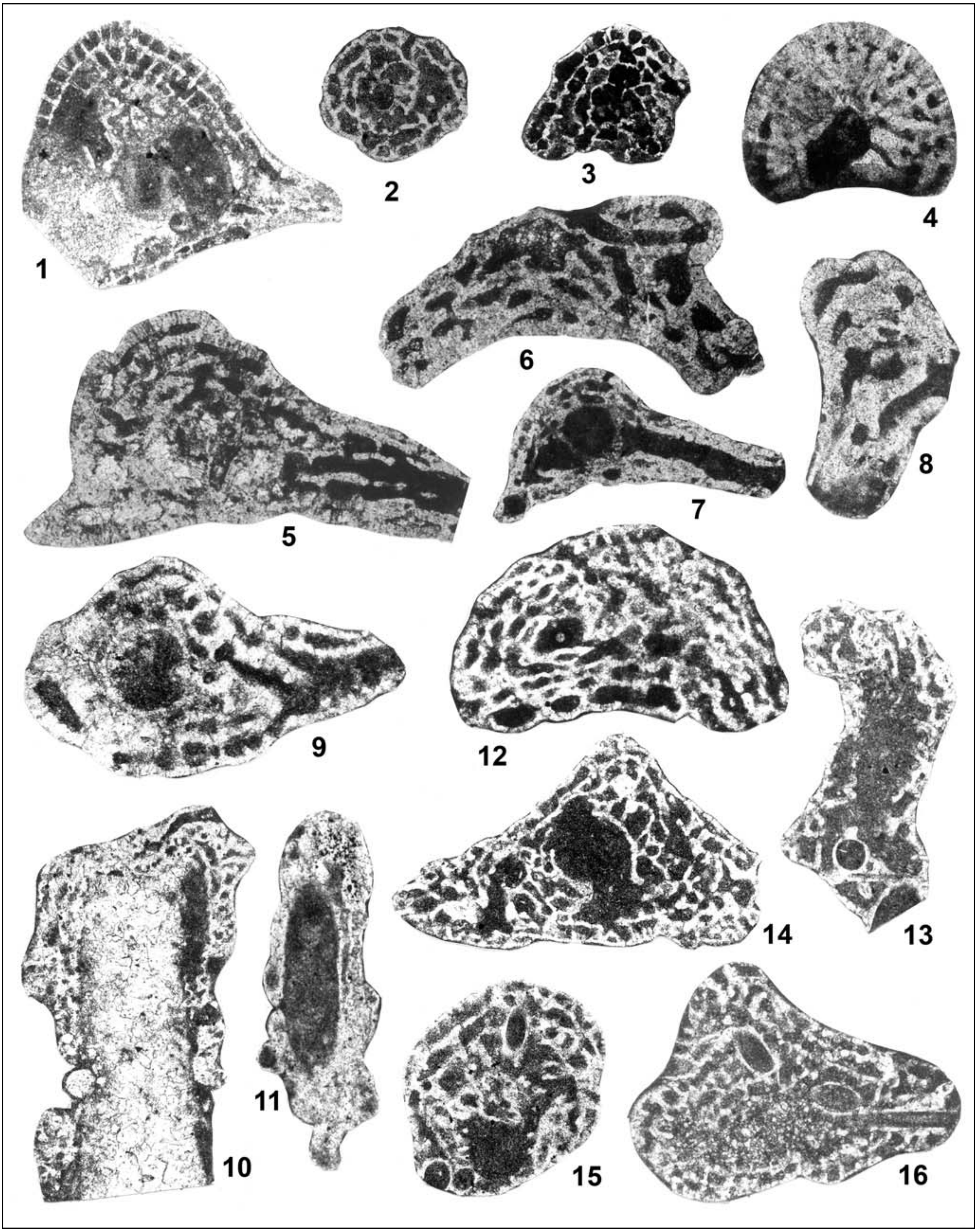
PLATE 6

Red algae (Rhodophycophytes)

Fig. 1	- *Aoujgalia variabilis* Termier and Termier, 1950. 193115P, University of Montreal 934/27, x 63.
Fig. 2, 3	- *Aoujgalia richi* Mamet and Roux. 1978. Fig. 2 - 193114G, University of Montreal, 868/14, x 97; Fig. 3 - 193114F, University of Montreal 868/8, x 97.
Fig. 4	- *Epistacheoides? peratrovichensis* (Mamet and Pinard, 1985). 193115J, University of Montreal 872/2, x 97.
Fig. 5-9	- *Pseudostacheoides loomisi* Petryk and Mamet, 1972. Fig. 5 - 193115, University of Montreal 945/25, x 97; Fig. 6 - 193115P, University of Montreal 935/11, x 77; Fig. 7 - 193114K, University of Montreal 870/10, x 97; Fig. 8 - 193115P, University of Montreal 945/10, x 97; Fig. 9 - 193115I, University of Montreal 871/22, x 77.
Fig. 10, 11	- *Stacheoidella spissa* (Petryk and Mamet, 1972). Fig. 10 - 193114O, University of Montreal 871/18, x 77; Fig. 11 - 193114A, University of Montreal 790/12, x 97.
Fig. 12-16	- *Stacheoides tenuis* Petryk and Mamet, 1972. Fig. 12 - 193114M, University of Montreal 870/23, x 77; Fig. 13 - 193114B, University of Montreal 790/18, x 97; Fig. 14 - 193114H, University of Montreal 868/23, x 77; Fig. 15 - 193114K, University of Montreal 870//8, x 97; Fig. 16 - 193115P, University of Montreal 934/17, x 77.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ber, Marston Member). Mid Viséan to Serpukhovian. Could reach the Bashkirian.

Genus *Stacheoidella* Mamet and Roux in Mamet et al., 1987

Stacheoidella spissa (Petryk and Mamet, 1972)

Pl. 6, figs 10-11

1972 *Stacheoides ? spissa* Petryk and Mamet, O. D. - p, 785, pl. 5, fig. 1-7 and reconstruction Text-fig. 5a, b.

1972 *Stacheoides ? spissa* Petryk and Mamet - Mamet and Rudloff, p. 90, pl. 7, fig. 16-17.

1976 *Stacheoides ? spissa* Petryk and Mamet - Mamet, pl. 50, fig. 1-2.

1983 "*Stacheoides*" *spissa* Petryk and Mamet - Groves, p. 28-29, pl. 8, fig. 1-4.

1985 *Stacheoides ? spissa* Petryk and Mamet - Mamet and Pinard, pl. I, fig. 17.

1987 *Stacheoidella ? spissa* (Petryk and Mamet) - Mamet et al., p. 47, pl. 23, fig. 12.

Description. Thallus important, composed of a few (3-4) continuous rows of reticulated laminae that encrust a dissolved support. Laminae separated by a thin (diagenetic?) micritic layer. Hypo-perithallic differentiation. Hypothallic cells subrounded. Perithallic cells irregular. Great variability from specimen to specimen (see Mamet et al. 1987).

Stratigraphic distribution. Viséan to Moscovian. Up to now only observed in North America (Midcontinent, American Cordillera, Canadian Arctic).

Genus *Stacheoides* Cummings, 1955a

Stacheoides tenuis Petryk and Mamet, 1972

Pl. 6, figs 12-16

1969 Algue? - Conil et al., pl. 1, fig. 3.

1972 *Stacheoides tenuis* Petryk and Mamet, O. D. - p. 787, pl. 6, fig. 1-6, pl. 7, fig. 1-6, 8.

1972 *Stacheoides tenuis* Petryk and Mamet - Mamet and Rudloff, p. 90, pl. 7, fig. 4-8.

1974 *Stacheoides tenuis* (*pars*) Petryk and Mamet - Rich, p. 371, pl. 4, fig. 1-3, 4?, non 5, 21.

1975 *Stacheoides tenuis* (*pars*) Petryk and Mamet - Malakhova, p. 86, pl. 8, fig. 4 (non 1-3).

1975 (Non) *Stacheoides tenuis* Petryk and Mamet - Termier et al., p. 84-85, pl. 10, fig. 6.

1976 *Stacheoides tenuis* Petryk and Mamet - Mamet, pl. 30, fig. 3, pl. 32, fig. 2, pl. 35, fig. 2, pl. 67, fig. 2.

1976 *Stacheoides* aff. *tenuis* Petryk and Mamet - Bogush and Yuferev *in* Dubatolov, pl. 6, fig. 2.

1977 *Stacheoides tenuis* Petryk and Mamet - Mamet and Roux, p. 225, pl. 2, fig. 10-14.

1977 *Stacheoides tenuis* Petryk and Mamet - Armstrong and Mamet, p. 106, pl. 38, fig. 8-10.

1977 *Stacheoides tenuis* Petryk and Mamet - Vachard *in* Perret and Vachard, p. 116, pl. 5, fig. 6.

1977a *Stacheoides tenuis* Petryk and Mamet - Termier et al., pl. 1, fig. 3, 5.

1977 *Stacheoides tenuis* (*pars*) Petryk and Mamet - Brenckle, pl. 4, fig. 13, 14 (non 15).

1977b *Stacheoides tenuis* Petryk and Mamet - Termier et al., p. 150, pl. 5, fig. 10.

1982 *Stacheoides* cf. *S. tenuis* Petryk and Mamet - Brenckle et al., p. 62, pl. 8, fig. 4-5.

1983 *Stacheoides* aff. *S. tenuis* Petryk and Mamet - Groves, p. 28, pl. 71, fig. 2, 4, 6, 8.

1983 *Stacheoides tenuis* Petryk and Mamet - Mamet and Roux, p. 83, pl. 8, fig. 15.

1985 *Stacheoides tenuis* Petryk and Mamet - Mamet and Pinard, pl. 3, fig. 2, 9.

1987 *Stacheoides tenuis* Petryk and Mamet - Mamet et al., p. 46, pl. 23, fig. 4-7.

1988 *Stacheoides tenuis* Petryk and Mamet - Ivanova and Bogush, pl. 17, fig. 10, pl. 18, fig. 1-4, pl. 19, fig. 6-7.

1990 *Stacheoides tenuis* Petryk and Mamet - Bogush et al., p. 130, pl. 28, fig. 9-13, pl. 29, fig. 11.

1993 *Stacheoides tenuis* Petryk and Mamet - Chuvashov et al., pl. 12, fig. 8.

1996 *Stacheoides tenuis* Petryk and Mamet - Sebbar and Mamet, pl. 3, fig. 12.

1997 *Stacheoides tenuis* Petryk and Mamet - Harris et al., fig. 9.15.

1998 *Stacheoides tenuis* Petryk and Mamet - Sebbar, pl. 3, fig. 7.

Description. Thallus attached, sessile, reticulated with horizontal and vertical elements that form an irregular lacy structure. A vague concentric arrangement is sometimes observed. No peri-hypothallic differenciation. Random protuberances due to fixation. Cells around 15-25 μm, often enlarged by recrystallization. Wall hyaline, probably perforated?

Stratigraphic distribution. Common and cosmopolitan. Abundant in the Viséan-Bashkirian and reaches the Early Permian in the Canadian Arctic.

Genus *Aoujgalia* Termier and Termier, 1950

Aoujgalia variabilis Termier and Termier, 1950

Pl. 6, fig. 1

1950 *Aoujgalia variabilis* Termier and Termier, O. D. - p. 38, pl. 2, fig. 26-27.

1972 *Aoujgalia variabilis* Termier and Termier - Petryk and Mamet, p. 791, pl. 9, fig. 1-5.

1972 *Aoujgalia variabilis* Termier and Termier - Mamet and Rudloff, p. 90, pl. 6, fig. 15-17.

1975 *Aoujgalia variabilis* (*pars*) Termier and Termier - Termier et al., p. 82-84, pl. 10, fig. 1-4, not the text-fig. 17.

1976 *Aoujgalia variabilis* Termier and Termier - Mamet, p. 66, pl. 45, fig. 3.

1977 *Aoujgalia variabilis* Termier and Termier - Mamet and Roux, p. 223, pl. 2, fig. 9.

1977b *Aoujgalia variabilis* (*pars*) Termier and Termier - Termier et al., p. 152-153, pl. 5, fig. 8, pl. 6, fig. 2, not the reconstruction.

1979 *Aoujgalia variabilis* Termier and Termier - Massa and Vachard, pl. 8, fig. 11, pl. 9, fig. 2.

1981 *Aoujgalia variabilis* Termier and Termier - Mamet and Martinez, pl. 3, fig. 6.

1982 *Aoujgalia variabilis* Termier and Termier - Brenckle et al., p. 60-61, pl. 7, fig. 5.

1983 *Aoujgalia variabilis* Termier and Termier - Mamet and Roux, p. 82, pl. 8, fig. 6.

1987 *Aoujgalia variabilis* Termier and Termier - Mamet et al., p. 49-50, pl. 25, fig. 1-2.

1987 (Non) *Aoujgalia variabilis* Termier and Termier - Brenckle and Marchant, pl. 5, fig. 2.

1988 *Aoujgaliida* - Verset, pl. 4, fig. 15.

1988 *Aoujgalia variabilis* Termier and Termier - Ivanova and Bogush *in* Dubatolov, pl. 19, fig. 3-5, pl. 20, fig. 5, 9.

1991 *Aoujgalia variabilis* Termier and Termier - Vachard and Tahiri, pl. 2, fig. 20.

1995 *Aoujgalia variabilis* Termier and Termier - Sanchez-Chico et al., p. 77, pl. 5, fig. 1-2.

1996 *Aoujgalia variabilis* Termier and Termier - Sebbar and Mamet, pl. 3, fig. 6.

1997 *Aoujgalia variabilis* Termier and Termier - Harris et al., fig. 9.19.

1999 *Aoujgalia variabilis* Termier and Termier - Sebbar and Mamet, pl. 2, fig. 15.

Description. Thallus fusiform attached on a cylindrical support. Axial section circular. Longitudinal section can have some irregularities. Regular rows of subquadratic to cuneiform cells. Size of the thallus depends on the number of cell rows (5-10) and ranges from 800 µm to 2 mm. Thickness of laminae 20-30 µm. Thin pores. Interlaminar spacing variable and highly calcified. There are 10-18 cells per linear millimeter.

Stratigraphic distribution. Eurasia, Australia, North America, North Africa. Very common in the mid- to late-Viséan. Scarce in Serpukhovian.

Aoujgalia richi Mamet and Roux, 1978

Pl. 6, figs 2-3

1978 *Aoujgalia richi* Mamet and Roux, O. D. - p. 81, pl. 5, fig. 1-14.

1985 *Aoujgalia richi* Mamet and Roux - Mamet and Pinard, pl. 1, fig. 16.

1986 *Aoujgalia* aff. *richi* Mamet and Roux - Skompski, p. 268, pl. 14, fig. 2.

1987 *Aoujgalia richi* Mamet and Roux - Mamet et al., p. 50, pl. 24, fig. 1-3.

1988 *Aoujgalia richi* Mamet and Roux - Ivanova and Bogush *in* Dubatolov, pl. 18, fig. 7-13, pl. 20, fig. 4.

1990 *Aoujgalia richi* Mamet and Roux - Bogush et al., p. 121, pl. 27, fig. 10-13.

1995 *Aoujgalia richi* Mamet and Roux - Sanchez-Chico et al., p. 77, pl. 5, fig. 3.

Description. Thallus lemon-shaped, attached to a cylindrical support. Faint peri-hypothallic differenciation. Irregular presence of some protuberances. Five to eight rows of cells. Rows are regular and thin, as are the partitions between the cells (10-15). Total diameter 300-400 µm.

Stratigraphic distribution. Eurasia. North Africa. Much less frequent than *A. variabilis*. Viséan to Bashkirian.

Ungdarellids

Genus *Ungdarella* Kordé, 1951

Ungdarella uralica Maslov, 1956 (non 1950)

Pl. 5, figs 6-8

For taxonomy, see 20 references in Mamet et al., 1987, p. 52 and add:

1979 (Non) *Ungdarella uralica* Maslov - Bensaid et al., pl. 16, fig. 4.

1980 *Ungdarella uralica* Maslov - Buchroithner et al., p. 26, pl. 26, fig. 1.

1981 *Ungdarella* ex gr. *uralica* Maslov - Vachard and Montenat, p. 65-66, pl. 11, fig. 1, 13.

1985 *Ungdarella uralica* Maslov - Mamet and Pinard, pl. 3, fig. 1.

1986a *Ungdarella uralica* Maslov - Nguyen, pl. 10, fig. 1.

1986b *Ungdarella uralica* Maslov - Nguyen, p. 138, pl. 15, fig. 7-8.

1988 *Ungdarella uralica* Maslov - Flügel and Kahler, p. 145, pl. 20, fig. 9.

1988 *Ungdarella uralica* Maslov - Fontaine and Suteethorn, pl. 77, fig. 8.

1989 *Ungdarella* ex. gr. *uralica* Maslov - Köylüoglu and Altiner, pl. 1, fig. 10.

1990 *Ungdarella uralica* Maslov - Sebbar, pl. 1, fig. 3.

1990 *Ungdarella uralica* Maslov - Bogush et al., p. 124, pl. 24, fig. 1-2, pl. 25, fig. 1-5.

1991 *Ungdarella uralica* Maslov - Riding, pl. 3, fig. R.

1992 *Ungdarella uralica* Maslov - Vachard and Berkhli, pl. 1, fig. 21, pl. 3, fig. 13-14.

1995 (Non) *Ungdarella uralica* Maslov - Pajic and Filipovic, pl. 50, fig. 2.

1996 *Ungdarella uralica* Maslov - Proust et al., pl. 1, fig. 2-3, pl. 2, fig. 10-11.

1996 *Ungdarella uralica* Maslov - Sebbar and Mamet, pl. 3, fig. 9.

1998 *Ungdarella uralica* Maslov - Sebbar, pl. 2, fig. 6.

2001 *Ungdarella uralica* Maslov - Mamet and Stemmerik, fig, 7, A-D.

2001 *Ungdarella uralica* Maslov - Vachard and Krainer, pl. 5, fig. 8.

2001 *Ungdarella* sp. - Minwegen, pl. 6, fig. 6.

2002 *Ungdarella uralica* Maslov - Mamet, pl. 6, fig. 2.

2003 *Ungdarella uralica* Maslov - Khodjanyazova and Mamet, pl. 5, fig. 6-7.

2003 *Ungdarella* sp. - Della Porta, fig. 4.5.A, pl. 4.1, fig. 6, 8, pl. 4.2, fig. 1, 3, 6-8.

2004 *Ungdarella uralica* Maslov - Mamet and Villa, p. 169, fig. 14j.

Description. Thallus important, cylindrical, rarely observed as dichotomous tufts. Diameter millimetric, but some thalli reach a centimeter. One or two rows of central hypothallic cells (15-20 µm). Multiple filaments of regular perithallic cells (up to 10) at low angle (10-20) from the hypothallus.

Stratigraphic distribution. All known Carboniferous basins (Mamet 1992). First appearance in the Viséan. Forms boundstones in the Bashkirian-Moscovian associated with *Komia*. Reaches the upper part of the Carboniferous and the ?Permian.

Algal microproblematics

The following seven taxa are problematical and their classification and position remain a subject of debate. However they are intimately associated with *bona fide* chlorophytes and rhodophytes and play a similar role in the sedimentation.

Genus *Fasciella* Ivanova, 1973

Fasciella kizilia Ivanova, 1973

Pl. 5, fig. 9

1973 *Fasciella kizilia* Ivanova O. D. - p. 39, pl. 21, fig. 1, pl. 27, fig. 1-6, pl. 34, fig. 4.

1973 *Shartymophycus fusus* Kulik O. D., p. 44-46, pl. 4, fig. 2-6 (published the same year but *kizilia* has a priority of a few months).

For bibliographical références (31) refer to Mamet, 2002, p. 501-502 and add:

1998 *Fasciella* sp. - Gallagher, fig. 8.6.

2003 *Fasciella kizilia* Ivanova - Groves et al., p. 385-387, fig. 6.6-8.

2004 *Fasciella kizilia* Ivanova - Vachard and Aretz, p. 658, fig. 8.11.

2004 *Fasciella* sp. - Cózar and Somerville, pl. 13, fig. 11.

Description. Thallus composed of multiple (5-10) concentric layers of undulating cells (up to 50 µm) encrusting a central host. The height of the cells depends on the calcification. Micritic separation between the layers is probably due to bacterial activity or by micrite entrapment. Layers recrystallized, yellowish, of ferroan calcite. Total diameter and length variable, depending on the number of layers. They reach 3-4 mm.

Discussion. The systematic position of *Fasciella* is not clear. Ivanova (1973) did not indicate any preference, while Kulik (1973) proposed a relation with the Chlorophyta. Shuysky (1987) coined it "alga of unknown systematic position." Kazmierczak & Kempe (1992) proposed a "microproblematic cyanobacterial biostructure", although it is clearly not a bacterium.

Stratigraphic distribution. Very common encruster in Eurasia and especially so in North Africa (the author used to call it "*Sahariella*", since it is so widespread in Algeria and Morocco, where it forms boundstones in the Late Viséan-Serpukhovian). Rather scarce in North American Cordillera.

Genus *Asphaltinella* Mamet and Roux, 1978

Asphaltinella horowitzi Mamet and Roux, 1978

Pl. 5, figs 10-15

1975 *Donezella* (?) sp. 1 - Vachard *in* Termier et al., p. 82, pl. 9, fig. 9 (only).

1978 *Asphaltinella horowitzi* Mamet and Roux O. D. - p. 78, pl. 4, fig. 2-6.

1981 *Asphaltinella horowitzi* Mamet and Roux - Mamet and Martinez, pl. 2, fig. 14.

1983 *Asphaltinella horowitzi* Mamet and Roux - Mamet and Roux, p. 81, pl. 8, fig. 11-14.

1987 *Asphaltinella horowitzi* Mamet and Roux - Mamet et al., p. 28, fig. 12-14, pl. 29, fig. 6-7, pl. 30, fig. 3-4.

Description. Thallus encrusting, of irregular shape and size (up to 1 mm), composed of irregularly twisted cylindrical tubes (lumen, 25-80 µm) disposed at random. Wall hyaline of uniform thickness (25-35 µm).

Remark. The original description does not report the presence of perforations. However our material suggests the existence of thin, micritized radial pores.

Stratigraphic distribution. Viséan to Bashkirian. Eurasia. North America. North Africa. Quite abundant in the Bashkirian Otto Fiord Formation, Canadian Arctic.

Asphaltinella? bangorensis Mamet and Roux, 1978

Pl. 7, figs 1-11

1975 *Globochaete* sp. Vachard *in* Termier et al., pl. 1, fig. 3.

1977 *Nostocites* ? sp. (*pars*) - Brenckle, pl. 4, fig. 11 (only).

1978 *Asphaltinella*? *bangorensis* Mamet and Roux O. D., p. 79, pl. 4, fig. 11-14.

2002 *Asphaltinella*? *bangorensis* Mamet and Roux - Mamet, p. 502, pl. 7, fig. 5-6.

Description. Thallus encrusting, composed of irregularly twisted cylindrical tubes. Lumen 20-40 µm. Unilayered wall, non-perforated, thickness 8-15 µm.

Remark. Some thalli have thin coatings of *Claracrusta* sp. It could be related to a "*Pokorninella*?".

Stratigraphic distribution. Eurasia, North America, North Africa. Late Devonian-Namurian.

Genus *Asphaltina* Mamet in Petryk and Mamet, 1972

Asphaltina cordillerensis Mamet in Petryk and Mamet, 1972

Pl. 7, fig. 13

1972 *Asphaltina cordillerensis* Mamet *in* Petryk and Mamet, O. D. - p. 795-797, pl. 10, fig. 3-6.

1972 *Asphaltina cordillerensis* Mamet *in* Petryk and Mamet - Mamet and Rudloff, p. 88, pl. 10, fig. 8-11.

1974 *Asphaltina cordillerensis* (pars) Mamet *in* Petryk and Mamet - Rich, p. 373, pl. 5, fig. 3-6 (only).

1975 *Asphaltina cordillerensis* Mamet *in* Petryk and Mamet - Armstrong and Mamet, p. 15, fig. 11G.

1975b *Asphaltina cordillerensis* Mamet *in* Petryk and Mamet - Mamet and Roux, p. 164, pl. 12, fig. 2.

1976 *Asphaltina cordillerensis* Mamet *in* Petryk and Mamet - Mamet, pl. 87, fig. 2.

1976 *Asphaltina agglomerata*? - Bogush and Yuferev, pl. 6, fig. 7.

1977 *Asphaltina cordillerensis* Mamet *in* Petryk and Mamet - Brenckle, pl. 4, fig. 18, 21.

1977 *Asphaltina cordillerensis* Mamet *in* Petryk and Mamet - Armstrong and Mamet, p. 109, pl. 39, fig. 12-14.

1978 (Non) *Asphaltina cordillerensis* Mamet *in* Petryk and Mamet - Jurkewiecz and Zakowa, p. 30, pl. 6, fig. 7.

1978 *Asphaltina cordillerensis* Mamet *in* Petryk and Mamet - Mamet and Roux, p. 78, pl. 4, fig. 8-10.

1981 *Asphaltina cordillerensis* Mamet *in* Petryk and Mamet - Vachard and Montenat, p. 67-68, pl. 11, fig. 2-3.

1981 *Asphaltina cordillerensis* Mamet *in* Petryk and Mamet - Nodine-Zeller, pl. 3, fig. 2.

1982 (Non) *Asphaltina cordillerensis* ? Mamet *in* Petryk and Mamet - Brenckle et al., p. 63-64, pl. 9, fig. 1-15, pl. 10, fig. 1-15.

1985 *Asphaltina cordillerensis* Mamet *in* Petryk and Mamet - Mamet and Pinard, pl. 1, fig. 7.

1986 *Asphaltina cordillerensis* Mamet *in* Petryk and Mamet - Groves, p. 492, fig. 8, 10-13.

1986 *Asphaltina cordillerensis* Mamet *in* Petryk and Mamet - Rich, pl. 9, fig. 3?, 8, 11.

1988 *Asphaltina* sp. - Ivanova and Bogush *in* Dubatolov, pl. 20, fig. 8.

1990 *Asphaltina cordillerensis* Mamet *in* Petryk and Mamet - Bogush et al., p. 117, pl. 16, fig. 3-5.

1991 *Asphaltina* sp. - Legrand-Blain and Poncet, p. 778.

1995 *Asphaltina cordillerensis* Mamet *in* Petryk and Mamet - Forke, pl. 15, fig. 6.

1996 *Asphaltina cordillerensis* Mamet *in* Petryk and Mamet - Sebbar and Mamet, pl. 1, fig. 13.

1996 *Asphaltina cordillerensis* Mamet *in* Petryk and Mamet Mamet, pl. 3, fig. 8-11.

1997 *Asphaltina cordillerensis* Mamet *in* Petryk and Mamet - Harris et al., fig. 9.24.

1997 *Asphaltina cordillerensis* Mamet *in* Petryk and Mamet - Brenckle and Page, pl. 2, fig. 23.

1997 *Asphaltina cordillerensis* Mamet *in* Petryk and Mamet - Brenckle et al., pl. 2, fig. 23.

Description. A cluster of millimetric, tightly interwoven cylindrical to subcylindrical tubes. Tubes are 150-300 µm in diameter. Wall two-layered, with a thin, regular micritic coating (5 µm) and a much thicker pseudo-fibrous ferroan layer (30-50 µm). Rare, irregular partitions are present.

Stratigraphic distribution. Cosmopolitan. A common encruster, very abundant in Viséan-Bashkirian time. It is particularly abundant in the mid-Carboniferous of Alaska where it forms boundstones (Wahoo Limestone, North Slope). Possible presence as early as Late Devonian and as late as Permian?

Genus *Proninella* Reitlinger in Menner and Reitlinger, 1971

Proninella strigosa (Vachard in Perret and Vachard, 1977)

Pl. 7, fig. 12

1974 *Nostocites* ? sp. (*pars*) - Rich, p. 368, pl. 3, fig. 1-2, 5, 8-9, 12-13 (only).

1974 *Proninella* sp. (*pars*) - Rich, p. 373, pl. 3, fig. 3, 6, 10-11, 14-15, 17-18(only).

1975 *Donezella*? sp. 1 (*pars*) - Vachard *in* Termier et al., p. 82, pl. 9, fig. 7-8 (only).

1977 *Pokorninella strigosa* (Vachard *in* Perret and Vachard) - p. 122-123, pl. 7, fig. 2-4.

1978 *Pokorninella gracilis* Vachard *in* Meissami et al. O. D. - (*pars*) p. 118-119, pl. 2, fig. 1-3, 4,7?, 8.

1978 *Proninella enigmatica* Mamet and Roux, O. D. - p. 83, pl. 7, fig. 1-5, 7-10.

1981 *Pokorninella*? sp. - Vachard, pl. 17, fig. 18.

1983 *Proninella gracilis* (Vachard *in* Meissami et al.) - Mamet and Roux, p. 100-102, pl. 5, fig. 15-24.

1983 *Proninella strigosa* (Vachard *in* Perret and Vachard) - Groves, p. 31, pl. 9, fig. 11-12.

1990 *Proninella enigmatica* Mamet et Roux - Bogush et al., pl. 10, fig. 20.

2002 *Proninella strigosa* (Vachard *in* Perret and Vachard) - Mamet, p. 502-503, pl. 7, fig. 7-8.

Description. Irregular tubular organism, apparently free, often bifurcated. Diameter 100-150 µm. Pseudo-septation sometimes blunt, sometimes regular, delimiting irregular-regular cavities. Cortex hyaline, 15-20 µm, finely perforated.

Remark. In the same thin-section, this microproblematic appears polymorphous. Thus the validity of the different taxa (*gracilis*, *enigmatica*, *strigosa*) is debatable.

Stratigraphic distribution. North America, Eurasia, North Africa. Latest Tournaisian-Viséan.

Genus *Moravammina* Pokorny, 1951

Moravammina segmentata Pokorny, 1951

Pl. 7, fig. 16

1951 *Moravammina segmentata* Pokorny, O. D. - p. 7, fig. 5a, b, fig. 6a, b, fig. 7 a, a.

1955 (Non) *Moravammina segmentata* Pokorny - Bykova *in* Bykova and Polenova, p. 25, pl. 6, fig. 1-3, pl. 8, fig. 1, 3-4.

1956 *Moravammina segmentata* Pokorny - Duszynska, p. 24-25, pl. 2, fig. 4-5.

1964 *Moravammina segmentata* Pokorny - Loeblich and Tappan, p. C319, fig. 233-1 (reproduction of Pokorny).

1974 *Moravammina segmentata* Pokorny - Mamet and Roux, pl. 7, fig. 19.

1979 *Moravammina segmentata* Pokorny - Poyarkov, p. 59, pl. 10, fig. 1.

1980 (Non) *Moravammina segmentata* Pokorny - Rich, p. 48, pl. 22, fig. 17.

1988 *Moravammina* sp. - Poncet, p. 82, pl. 5, fig. 5.

1991 *Moravammina segmentata* Pokorny - Vachard, p. 279.

1993 *Moravammina segmentata* Pokorny - Rauzer-Chernoussova et al., p. 78, fig. 14 a, a (reproduction of Pokorny).

Description. Sessile organism, attached to a cylindrical support (perhaps a Phaeophyte). Initial part follows the shape of the substrate and appears annular in longitudinal section. The erected, uncoiled part is also roughly cylindrical. The initial stadium is subdivided by 8-10 irregular pseudosepta at various angles from the wall. Uncoiled part similarly divided. Nature of original wall debatable as the type material from Celechowice is completely dissolved.

Discussion. Pokorny originally throught that *Moravammina* was a plurilocular foraminifer. The absence of a proloculus suggests that this is not the case. Pokorny erected, on the basis of this genus, the Moravaniminae (1951), that were followed by the Moravamminidae Loeblich & Tappan, 1961 and the superfamily Moravamminaceae Loeblich & Tappan, 1982. Further confusion is created by the order Moravamminida Termier et al. 1975 (see also Loeblich & Tappan 1988).

Attempts by the author to recollect the *locus typicus* were foiled by the Soviet invasion of Czechoslovakia in 1968. Some material was provided by Pokorny in 1972-73 and served as the basis of the publication of Mamet and Roux (1974).

Later, Jiri Kalvoda of Brno University guided us in the field (1994) and provided some of the original and unpublished thin-sections of Pokorny. The results of this lengthy investigation can be summarized as follows:

1. all the microfossils from Celechowice (*Moravammina*, but also *Vasicekia* and *Kettnerammina*) are recrystallized and the original wall replaced by neomorphic cement;

2. most of the hand-picked microfossils are fragmentary;

the identity of *Triangulinella* Mamet and Préat (1985a) with *Moravammina* by Vachard (1991) is unfounded;

3. the only convincing redescriptions of the genus are in Duszynska (1956), Poncet (1988) and Racki & Sobon-Podgorska, 1992. The nature of the genus is still debatable.

Recent illustration of *Moravammina* by Berchenko (2003), pl. 9, fig. 10, 12 does not fit the morphology of Pokorny's taxon.

Moravammina ? enigmatica n. sp.

Pl. 7, figs 17-19

Type of the new species. Pl. 7, fig. 17 (here designated).
Derivatio nominis. From its enigmatic nature.

Description. Sessile organism. Absence of proloculum. Inital coils, a probably cylindrical tube with variable blunt pseudosepta. Some are at right angles, some very oblique, delimiting a succession of irregular cavities, some elongated, some spherical. They number 15 in the most complete specimens. Wall regular, with a very progressive increase in thickness (up to 20 μm). Later portion uncoiled and partitioned by pseudoseptation. Wall of ferroan calcite perforated by thin radial pores.

Note. As previously mentioned, the wall nature of *Moravammina* remains obscure.

Stratigraphic distribution. Up to now, only recognized in the Late Viséan Opal, Marston and Carnarvon formations in Alberta and British Columbia where it is quite common.

Genus *Nostocites* Maslov, 1929

Nostocites vesiculosa Maslov, 1929

Pl. 7, figs 20-23

1929 *Nostocites vesiculosa* Maslov, O. D. - p. 1538, pl. 70, fig. 2-8, 10.

1963 *Nostocites vesiculosa* Maslov - Maslov *in* Orlov, p. 48, fig. 29.

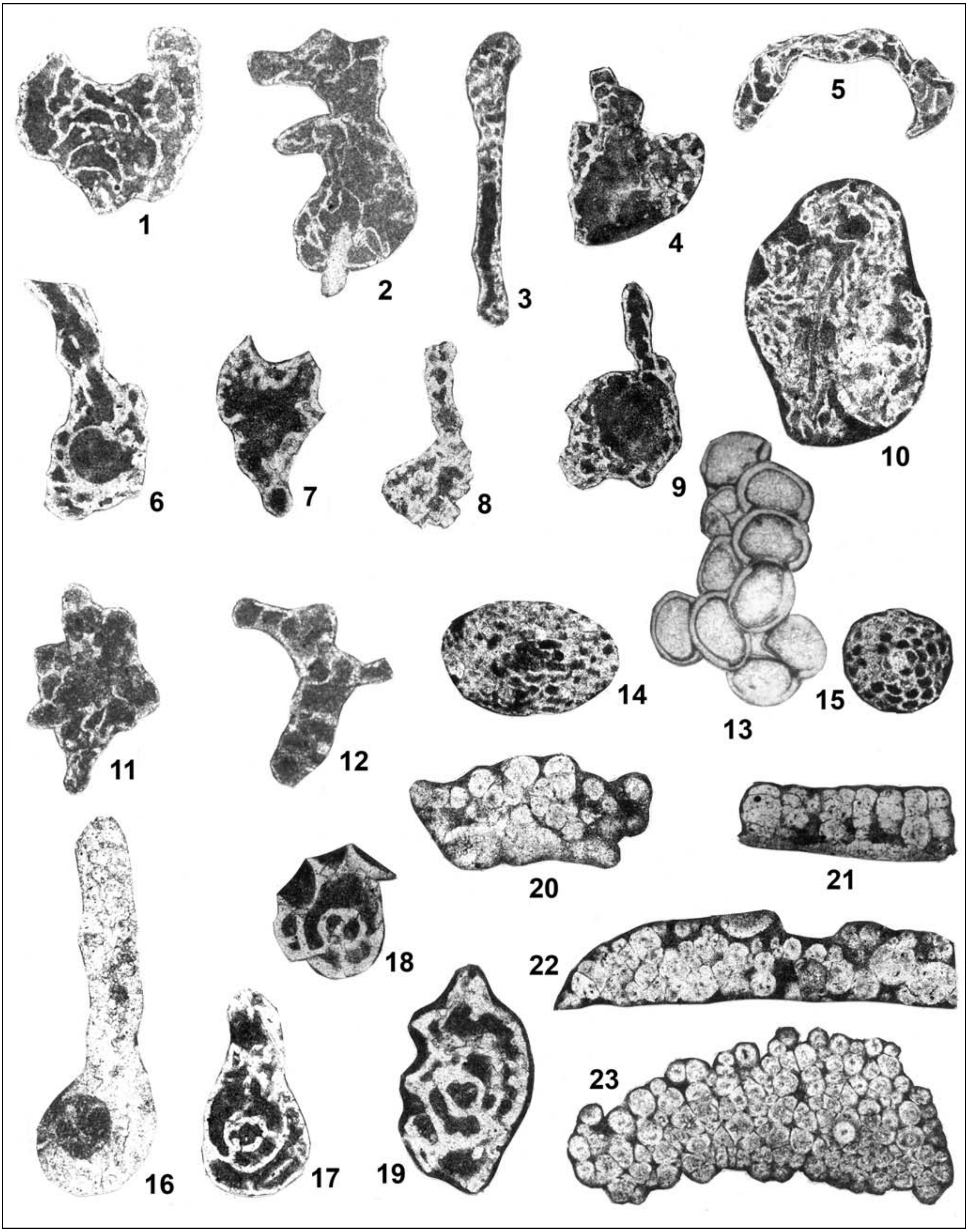
1972 *Globochaete alpina* Lombard - Zawidska, p. 467-472, pl. 1, fig. 1-2, pl. 2, fig. 1-2.

1973 *Globochaete alpina* Lombard - Linetskaya and Muromtseva, p. 25.

PLATE 7

Algal microproblematics and incertae sedis

Fig. 1-11	- *Asphaltinella ? bangorensis* Mamet and Roux, 1978. Fig. 1 - 193114, University of Montreal 780/15, x 97; Fig. 2 - 193114, University of Montreal 780/11, x 77; Fig. 3 - 193115P, University of Montreal 934/25; Fig. 4 - 193114F, University of Montreal 868/14, x 97; Fig. 5 - 193114F, University of Montreal 868/10, x 97; Fig. 6? - 193114, University of Montreal 791/0, x 97; Fig. 7? - 193114I, University of Montreal 868/8, x 97; Fig. 8 - 193114G, University of Montreal 869/16, x 97; Fig. 9 - 193114J, University of Montreal 870/4, x 97; Fig. 10 - 193114J, University of Montreal 870/5, x 97; Fig. 11 - 193115, University of Montreal 945/5, x 121.
Fig. 12	- *Proninella strigosa* Vachard *in* Perret and Vachard, 1977. 193115, University of Montreal 945/6, x 121.
Fig. 13	- *Asphaltina cordillerensis* Mamet *in* Petryk and Mamet, 1972. 193114J, University of Montreal 869/3, x 97.
Fig. 14, 15	- *Tubisalebra calamiformis* Bogush and Brenckle, 1982. Fig. 14 - 193114M, University of Montreal 870/18, x 77; Fig. 15 - 193115C, University of Montreal 791/12, x 97.
Fig. 16	- *Moravammina segmentata* Pokorny, 1951. Celechowice, Czech Republic, Givetian. CZH 52, University of Montreal 908/30, x 97.
Fig. 17-19	- *Moravammina enigmatica* n. sp. Fig. 17 - 193114I, University of Montreal 869//9, x 97, type of new species; Fig. 18 - 193114A, University of Montreal 790/11, x 97; Fig. 19 - 193114K, University of Montreal 870/11, x 97.
Fig. 20-23	- *Nostocites vesiculosa* Maslov, 1929 (*Globochaete alpina auctores*, *non* Lombard, 1945). Fig. 20 - 193114M, University of Montreal 871/3, x 97; Fig. 21 - 193114L, University of Montreal 790/21, x 97; Fig. 22 - 193114O, University de Montreal 871/15, x 97; Fig. 23 - 193115A, University of Montreal, 791/4, x 77.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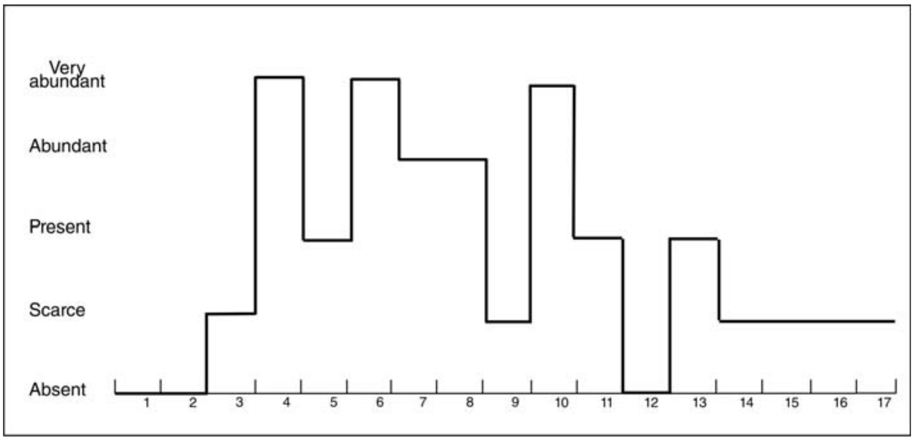

Fig. 2 - Relative abundance of algal microflora.
Cyanophytes. 1 - Girvanellids. Green algae. 2 - Pseudoudoteaceans (Nodular Codiaceans). 3 - Udoteaceans (*Orthriosiphon, Loomisella*). 4-7 Dasycladales. 4 - *Koninckopora*. 5 -*Cabrieropora*. 6 - *Kamaena*, *Cribrokamaena*, *Crassikamaena*, *Palaeoberesella*. 7 - *Issinella*. 8 - Calcispheres (*Calcisphaera*, 'Radiospheres', *Parathurammina*. Red algae. 9 - *Fourstonella*? 10 - Stacheins (*Stacheoides*, *Epistacheoides*, *Aoujgalia*, *Pseudostacheoides*). 11 - Ungdarellids. 12 - Solenoporids. Algal microproblematics. 13 - *Asphaltina*. 14 - *Proninella*. 15 - *Fasciella*. 16 - *Nostocites*. 17 - Moravamminids.

1974 *Globochaete alpina* (*pars*) Lombard - Tellez-Giron and Trejo, pl. 1, fig. 1 (only), pl. 2, fig. 1-2.
1978 *Nostocites vesiculosa* Maslov - Mamet and Roux, p. 80, pl. 6, fig. 1-3.
1980 *Globochaete alpina* Lombard - Moreno de Castro, pl. 1, fig. 1, pl. 2, fig. 1, pl. 3, fig. 2.
1981 *Nostocites vesiculosa* Maslov - Mamet and Martinéz. pl. 3, fig. 8.
1982 *Globochaete alpina* (*pars*?) Lombard - Skompski, p. 47-56, pl. 3, fig. 1-7 (aciniform association doubtful).
1983 *Nostocites vesiculosa* Maslov - Mamet and Roux, p. 98, pl. 9, fig. 9-13.
1983 *Nostocites vesiculosa* Maslov - Groves, p. 31-32, pl. 7, fig. 10-12.
1985 *Globochaete alpina* Lombard - Istchenko, p. 57-58, pl. 15, fig. 1-4.
1985 *Nostocites vesiculosa* Maslov - Mamet and Pinard, pl. 1, fig. 19.
1985 *Nostocites vesiculosa* Maslov - Herbig and Mamet, pl. 1, fig. 10.
1986 *Nostocites* sp. - Groves, p. 490, fig. 8-9.
1987 *Nostocites vesiculosa* Maslov - Mamet et al., p. 58, pl. 30, fig. 1-2.
1988 *Nostocites vesiculosa* Maslov - Mu and Zhang, p. 155, pl. 37, fig. 1-2.
1991 *Nostocites* ex gr. *vesiculosa* Maslov - Vachard and Beckary, p. 322, pl. 2, fig. 10.
1992 *Nostocites vesiculosa* Maslov - Mamet and Préat, pl. I, fig. 6.
1996 *Globochaete* sp. - Jones and Somerville, fig. 4B.
1996 *Globochaete alpina* Lombard - Skompski, pl. 16, fig. 4.
1996 *Nostocites vesiculosa* Maslov - Sebbar and Mamet, pl. 3, fig. 3.
2001 *Nostocites vesiculosa* Maslov - Mamet and Stemmerik, fig. 9G.
2001 *Nostocites vesiculosa* Maslov - Vachard *in* Vachard et al., p. 390-393, pl. 18-1.
2003 *Nostocites vesiculosa* Maslov - Khodjanyazova and Mamet, pl. 5, fig. 14.

Description. Sheet of regularly disposed cylindrical or barrel-shaped cells (diameter 40-60 µm) perforated by a central micritized pore (10 µm).

Stratigraphic distribution. Rare in the Devonian. Present in the Carboniferous-Early Permian. Earlier reports in the Ordovician (Maslov *in* Orlov 1963) or in the Silurian (Johnson 1963; Groves 1983) need to be confirmed.

Incertae sedis, perhaps related to the bryozoans?

Genus *Tubisalebra* Bogush and Brenckle, 1982

Tubisalebra calamiformis
Bogush and Brenckle, 1982
Pl. 7, figs 14-15

1982 *Tubisalebra calamiformis* Bogush and Brenckle, O. D. - p. 114-115, pl. 6, fig.. 2-7, pl. 7, fig. 1-8.
1983 *Tubisalebra calamiformis* Bogush and Brenckle - Groves, p. 33, pl. 10, fig. 14-17.
1987 *Tubisalebra calamiformis* Bogush and Brenckle - Brenckle and Groves, pl. 12, fig. 9.
1987 *Tubisalebra calamiformis* Bogush and Brenckle - Brenckle and Marchant, pl. 6, fig. 15.
1997 *Tubisalebra calamiformis* Bogush and Brenckle - Harris et al., fig. 9-21.

Description. Cylindrical, chevron-disposed central tubes longitudinally split in two or four, surrounded by subparallel individual tubes (between 15-30 µm). Total diameter around 200 µm. Wall two-layered.

Remark. In longitudinal section, *Tubisalebra* could be confused with *Girvanella* as they have a similar size. However, the wall of the Salebridae is not micritic and is reminiscent of the Bryozoa or the Brachiopoda.

Stratigraphic distribution. Scarce in the Carboniferous. North America. Egypt.

Conclusions

Diversity and abundance

The Cordilleran Viséan carbonate rocks of Alberta and British Columbia are generally favorable to the proliferation of thalli as they were formed in shallow-warm waters, within cycles repeated in the euphotic zone. The bulk of the flora is therefore quite diverse and abundant (Mamet 1992).

Figure 2 illustrates the relative abundance of the thalli at Fernie. It is impossible to precisely quantify the abundance as the taxa vary enormously in size. Thus a simple comparison scale of absent/scarce/present/very abundant is used.

As previously mentioned, the particularity of the Fernie flora is its high diversity. We have reported 40 specifically identifiable taxa and a few taxa in open nomenclature. Generally, for well-preserved Lower Carboniferous (Tournaisian-Viséan) carbonates, a dozen different species in one sample is exceptional. In most cases, the macroflora is dominated by a couple of taxa (e.g. *Koninckopora + Stacheoides, Fasciella + Issinella, Issinella + Palaeoberesella*) associated with a few minor representative.

Up to now, the greatest known diversity is that of the Los Caleros Bajas limestone (Spain) described by Mamet and Martinez (1981). It contains 20 specifically identifiable forms and eight in open nomenclature. This Paleotethyan assemblage is of the same age as the Fernie flora. Its high diversity can be explained by the mixing of reworked blocks derived from different environments in the platform.

This explanation cannot be proposed for Fernie as most of the algae show little reworking. Only kysts float over appreciable distances. Another observation is that many thalli are preserved by a micritic coating produced by cyanobacteria (see, for instance, Plate 2, fig. 6-21). Even poorly calcified taxa are prone to fossilization. This indicates that preservation is of paramount importance in our algal studies. Hence, environmental data derived from Paleozoic algae should be handled with utmost caution.

Paleogeography

Many Lower Carboniferous algae are widespread, hence their importance for reconstruction of paleobathymetry (e.g. *Koninckopora*). There are, however, endemic forms and they permit recognition of three interconnected floral realms: a rich and diverse "Paleotethys" with high endemism, an undiversified "Arctic" flora and an intermediate "North American" flora. We obviously do not know the distribution of the four new species observed and additional studies are necessary. To the extent of our limited knowledge, *Cribrokamaena ferniensis* and *Koninckopora pachytheca* are present in the North American Cordillera. *Asphaltina*? *bangorensis*, *Crassikamaena foraminosa*, *Cribrokamaena furcillata* and *Orthriosiphonoides tenuiramosa* are typical of North America and our assemblage should be considered as "North American".

Palaeoenvironment

The depositional environment of our studied samples can be described as an open marine facies, associated with fenestellid bryozoans, productid brachiopods, crinoids and lithostrotionid corals. The presence of Calcispheres is explained by the presence of a semi-restricted lagoon nearby. These kysts are therefore floated.

The salinity is normal-marine with absence of diagenesis (dolomitization, chertification). There is no trace of high-salinity, no evidence of sulfate-reduction. Sulfate pseudomorphs, bipyramidated quartz crystals are absent. Carbonates are quite pure and there is no evidence of pressure solution.

Sedimentation is in the euphotic zone (abundant Dasycladales), but not in its uppermost part [a remarkable absence of Cyanophyta or nodular codiaceans (Pseudoudoteaceae such as *Garwoodia*, *Ortonella*, *Bevocastria*)]. Reworking indicates fair-weather waves (FWWB); thus the middle part of the euphotic zone is a reasonable assumption (10-20 m depth).

The Fernie microflora is the most diverse Carboniferous algal assemblage ever reported in the literature. In spite of its exuberance, it yields no cyanophytes, no nodular codiaceans and no solenoporids. The bulk of the taxa is derived from dasycladales and stacheins. The inferred environment is open marine, of normal salinity and in the middle part of the euphotic zone.

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