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FAVREINA CARPATICA N. ICHNOSP. (CRUSTACEAN MICROCOPROLITE) FROM THE MIDDLE JURASSIC OF RUCĂR-BRAN ZONE (SOUTHERN CARPATHIANS, ROMANIA)

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Abstract. The new crustacean microcoprolite, *Favreina carpatica*, is described from the Middle Jurassic of Rucăr-Bran zone, South Carpathians. It is the ichnospecies with the highest number (about 280) of longitudinally arranged canals passing through the rod-shaped microcoprolite. *Favreina carpatica* was found in reddish to brown-carbonate sediments.

Riassunto. Viene descritto il nuovo microcoprolite di crostaceo, *Favreina carpatica*, proveniente dal Giurassico Medio della Zona Rucăr-Bran dei Carpazi meridionali. Si tratta dell'ichnospecie con il più alto numero (circa 280) di canali disposti longitudinalmente attraverso il microcoprolite di forma allungata. *Favreina carpatica* si rinviene in sedimenti carbonatici da rossastri a marroncini.

Introduction

Microcoprolites of decapod crustaceans are characterized by differently shaped canals passing internally through the rod-shaped coprolite body. The cross-sectional shape of the canals is diagnostic, being circular in coprolites referred to the ichnogenus *Favreina*, but crescent-shaped in those referred to *Palaxius*, or triangular in *Parafavreina*. A general introduction concerning the classification of crustacean microcoprolites, with special regard to the shape and arrangement pattern of the canals in cross section, is given by Brönnimann (1972). Crustacean microcoprolites were described from numerous localities from the Palaeozoic and Mesozoic shallow water deposits on the world. While such microcoprolites occur rarely from the Palaeozoic rocks (Senowbari-Daryan 1988; Senowbari-Daryan et al. 1992; Masse & Vachard 1996), they can be very abundant and even rock-forming components in Mesozoic and Cenozoic deposits (e.g. Scoffin 1973; Dondi & Papetti 1966). The earliest certain crustacean microcoprolite ichnotaxon is known from the Carboniferous (Masse & Vachard 1996). *Favreina prima*, described by Herbig (1993) as an even oldest crustacean microcoprolites from Late Devonian clasts from Morocco is quite similar to the Rhaetian-Liassic species *Parafavreinia thoronetensis* Brönniman, Caron & Zaninetti, 1972. Subsequently, Senowbari-Daryan & Bernecker (2000) noted that the foraminifera associated with *Favreina prima* indicate a possibly Triassic age of the Moroccan coprolite-bearing clasts. At least three genera of crustacean coprolites - *Lercarina* Senowbari-Daryan 1988, *Favreina* Brönnimann 1955, *Palaxius* Brönniman & Norton 1960 - are known from the Upper Paleozoic deposits.

Geological setting and description of the studied sections

The South Carpathians are built up of a succession of nappes and thrust sheets with a very complicated tectonic structure, within the Carpathian Folded Belt.

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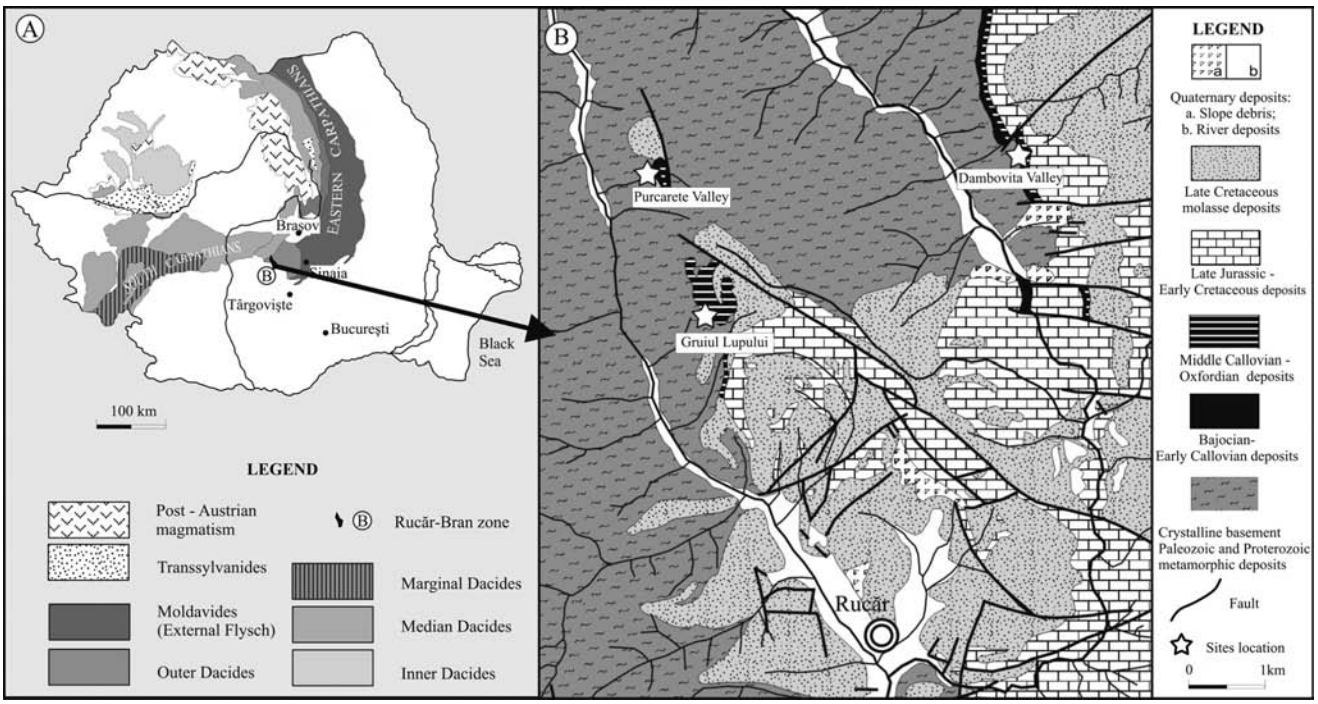

Fig. 1 - Location of the studied sections: A) Position of the Rucăr-Bran zone within the Southern Carpathians (based on the geotectonic map of Romania, Săndulescu 1984). The Getic Unit represents the sedimentary cover of the Mediane Dacides of the Southern Carpathians. B) Location of the studied sections (Purcărete Valley, Gruiul Lupului, Dâmboviţa Valley) on the geological outline map of the Rucăr-Bran zone (based on Patrulius 1969).

The studied Jurassic sequence belongs to the sedimentary cover of the Getic Unit (Fig. 1A), one of the main geotectonic units of the Median Dacides that are interpreted as remnants of the strongly deformed European continental margin (Săndulescu 1984, 1994). The sedimentary cover of the Getic Domain is represented by Triassic-Lower Cretaceous sediments, with an evolution related to the tectonic history of the Getic-Supragetic continental crust (Iancu et al. 2005). Within the Getic Domain, thin, condensed sequences were formed during the Middle-Late Jurassic interval.

The studied Jurassic sections are located in the Rucăr-Bran zone, an area with very complicated tectonics, bounded by the **Iezer-Papuşa and Făgăraş Mountains** to the west, and by the **Leaota and Bucegi Mountains** to the south-east. These sections comprise mixed carbonate-siliciclastic condensed sequences developed within the Bajocian-Tithonian time interval. As the result of the rather complicated tectonics, different parts of the succession are exposed in the different sections. This succession has been studied in three sections situated in the western and central parts of the Rucăr-Bran zone: Purcărete Valley, Gruiul Lupului and Dâmboviţa Valley (Fig. 1B).

The Middle Jurassic successions from this area have been described previously by Simionescu (1899), Patrulius (1969) and Patrulius et al. (1980). They belong to the Cheia Formation (Bajocian – Bathonian) and to the Gruiul Lupului Formation (Callovian), according to Patrulius (1969) and Patrulius et al. (1980). The Bajocian-Oxfordian deposits are well bedded and dip at 10-12° towards the NW. The lower part of the succession belongs to the Cheia Formation; in the base, it is represented by conglomerates (4-5 m), followed by 12.5-15.0 m thick lithic sandstones and sandy limestones with thin, discontinuous, quartzitic micro-conglomerate intercalations. The topmost part of the Cheia Formation is marked by a sharp, strongly mineralized hardground unconformity with 1 to 3 cm thick ferruginous laminated crusts.

Following on top of the Cheia Formation, the basal Gruiul Lupului Formation (Callovian) is represented by thick-bedded (from less than 1 m to almost 5 m-thick) mass-flow breccias containing coarse to medium angular metamorphic rock fragments and limestone clasts derived from the underlying lithostratigraphic unit (Cheia Formation). These breccias are overlain by bioclastic calcarenites (1 m) and red to pink bioclastic, micritic and pelmicritic limestone (1.5 m) containing numerous ammonites (see Simionescu 1899) documenting the Middle to Late Callovian age of this rocks. The topmost part of the pink limestone show sub-horizontal, irregular cavities of variable (0.3-0.5 m) thickness, filled with red bioclastic micritic limestones containing numerous microcoprolites of the new *Favreina* species. This level has been observed only in the Purcărete Valley section. The thickness of the Gruiul Lupului Formation is variable within the studied

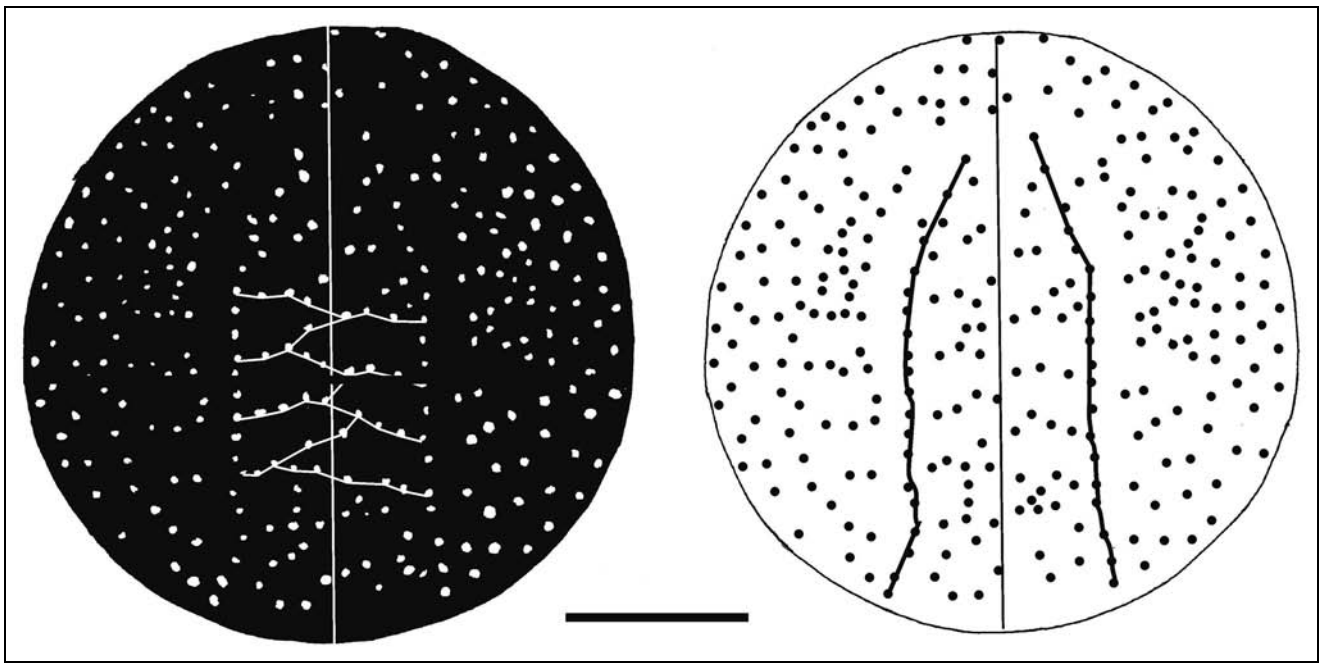

Fig. 2 - *Favreina carpatica* n. ichnosp. Holotype (see Pl. 1, Fig. A.). A) Cross section showing numerous circular canals without an overall symmetrical arrangement. The lines within the V-shaped canal arrangement show the zigzag-like arrangement of the internal canals. No canals are present directly to the outside of the two lines of the V-pattern. B) The lines show the symmetrical arrangement of the canals on both sides of the V-shaped structure. Scale bar = 0.2 mm.

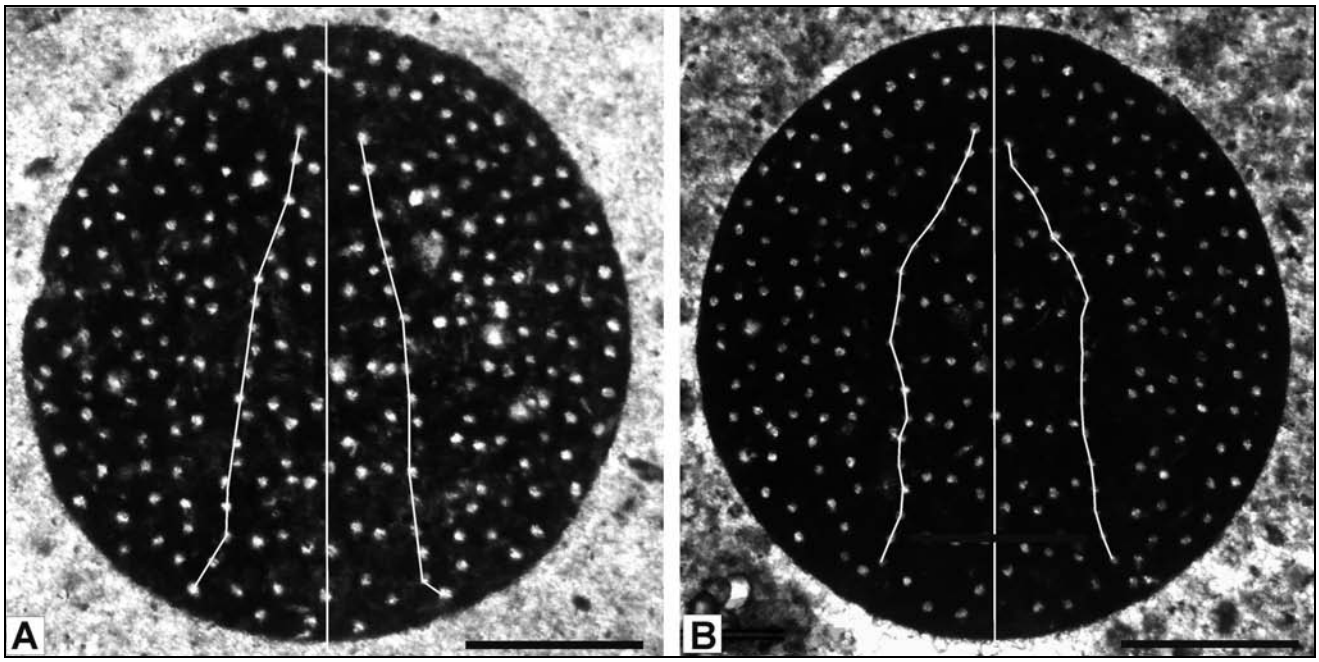

Fig. 3 - *Favreina carpatica* n. ichnosp. A) Cross section of a paratype (Pl. 2, Fig. B) showing the symmetrical arrangement of about 18 canals (two white marked lines). B) Cross section of a paratype (see 3.A) showing the canals on two symmetrically arranged lines. The specimen clearly shows the absence of canals around the two lines. Scale bar = 0.2 mm.

sections, ranging from about 5 m in Purcărete Valley to more than 40 m in Gruiu Lupului. Covering the Gruiul Lupului Formation, the 1 to 3 m-thick red to grey cherty limestones with jasper intercalations belong to the Oxfordian interval.

Systematic description

Phylum **Crustacea** Pennant, 1777

Class **Malacostraca** Latreille, 1802

Order **Decapoda** Latreille, 1802

Ichnofamily Favreinidae Vialov, 1978

Ichnogenus *Favreina* Brönnimann, 1955

Type species: *Favreina salevensis* (Paréjas, 1948).

Remarks. The ichnogenus *Favreina* is characterized by the circular cross-sectional outline of the canals. Specimens of *Faverina* – just as other crustacean ichnogenera – cannot be determined in longitudinal sections. *Favreina* is the most abundant crustacean coprolite ichnotaxon, known from the Permian to the Miocene (Elliott 1962; Dondi & Papetti 1966). At least 25 ichnospecies of the genus are known, listed with their stratigraphic ranges by Molinari Paganelli et al. (1980) and Senowbari-Daryan & Kuss (1992).

Favreina carpatica n. ichnosp.

Pl. 1, A-F; Pl. 2, A-L; Figs 2-3

Derivatio nominis: from the Carpathians that include the type locality.

Holotype: The specimen illustrated in Pl. 1, A and in Fig. 2, thin section VP 35.7D, Nr. LPB III art 148.

Paratypes: The specimens figured in Pl. 1, B-F and Pl. 2, A-L, respectively Fig. 3, thin section VP 35.7D, Nr. LPB III art 148.

Locus typicus: Purcărete Valley, north of Rucăr, South Carpathians (Fig. 1B).

Stratum typicum: Middle Jurassic (Upper Callovian).

Diagnosis: Species of *Favreina* with about 280 canals passing through the rod-shaped coprolite. Cross section of coprolite is circular. A distinctive feature of the species is the arrangement of 18-20 canals on either side of a V-shaped line of canals. The plane of symmetry extends through the middle of the V-shaped sets of canals.

Material: More than 30 specimens in cross sections (a large number of "associated" longitudinal sections, which are not diagnostic, are not in included).

Depository: The material is deposited in the Laboratory of Paleontology collection, University of Bucharest, Nr. LPB III art 148, thin section VP 35.7D.

Description. It is unclear whether the longitudinal sections of the rod-shaped microcoprolites extend along the length of the coprolite, or they are only fragments. Regardless, the microcoprolite has an almost circular outline in cross section and reaches a diameter of about 0.5-0.8 mm (0.6 mm in most of the specimens), perpendicular to the plane of symmetry; in some specimens, the diameter along the symmetry axis is somewhat larger than that perpendicular to it. Each cross-section exhibits a large number (about 280) of canals passing longitudinally through the microcoprolite; the number of canals counted in the holotype is 280 (Pl. 1, A; Figs 2-3), but it can vary slightly in the paratypes. The canals are arranged parallel to each other in the longitudinal sections (Pl. 1, D, F).

The distinctiveness of the microcoprolite is given not only by the large number of the longitudinal canals (the highest count of canals in any known crustacean microcoprolite), but even more so by the symmetrical arrangement of about 18-20 canals on both sides of a V-shaped line of canals. The plane of symmetry (shown as a white line in all specimens in Pl. 1 and Pl. 2) dissects precisely the V-shaped arrangement of the canals (Figs 2-3). Also noteworthy are the narrow areas that abut the sides of the V-shaped canal sets, extending parallel to their lines, areas that do not show any canals. Inside the V-shaped canal sets, the canals are arranged along zigzag, albeit not symmetrical, lines (Fig. 2A). All specimens show this feature, although it is hardly recognizable in some of them (Pl. 2, L). Due the very high number of canals, it is impossible to ascertain whether all the other canals are arranged symmetrically on both sides of the plane of symmetry. Finally, almost all surveyed specimens exhibit the linear arrangement of one or two peripheral canals.

Comparison. The vast majority of *Favreina* ichnospecies are characterized by 100 canals, more or less, passing through the coprolite. The following ichnospe-

PLATE 1

Fig. A-F - *Favreina carpatica* nov. ichnosp. from the Middle Jurassic of Purcărete Valley, Rucăr-Bran zone, Southern Carpathians. All specimens from thin section VP 35.7D, Scale in all specimens = 0.2 mm. A) Holotype. Cross section exhibiting a large number (280) of canals without a well recognizable overall arrangement pattern of all canals around the symmetry plan, although some of the canals appear arranged symmetrically on both sides of the symmetry plan (compare Text-Figs. 2-3). For the zigzag-like arrangement of the canals within the two lines, see Text-Fig. 3. B) Paratype. The two black circular areas in the upper part are not seen in other specimens. Note the arrangement of the canals in two lines around the symmetry plan, and their zigzag-patterned arrangement within the two lines. C) Section through three specimens. The white line shows the symmetry plan in one specimen. The symmetrically arranged canals are not recognizable along neither of the lines in the oblique section, and are largely indistinct in the second cross-section. D) Longitudinal section showing the paralelly arranged canals. E) Thin section photograph showing numerous specimens of *Favreina carpatica* nov. ichnosp. demonstrating the abundance of this ichnospecies in the Middle Jurassic deposits of Purcărete Valley, Rucăr-Bran zone, Southern Carpathians. F) Sections through two specimens (longitudinal and oblique). The oblique section shows some inclusions embedded within the coprolite.

PLATE 2

Fig. A-L - *Favreina carpatica* nov. ichnosp. from the Middle Jurassic of Purcărete Valley, Rucăr-Bran zone, Southern Carpathians. The white line in all specimens indicates the symmetry plan. Note in all figures the arrangement of the canals along lines on both sides of the symmetry plan, as well as their zigzag-like arrangement within the two lines. Figs. C, E, H and K show the areas lying directly outside of the linear canal sets, lacking other canals. A-I, L, thin section VP 35.7D; J, thin section VP 35.7-1; K, thin section 35.7B. Scale in all specimens = 0.2 mm.

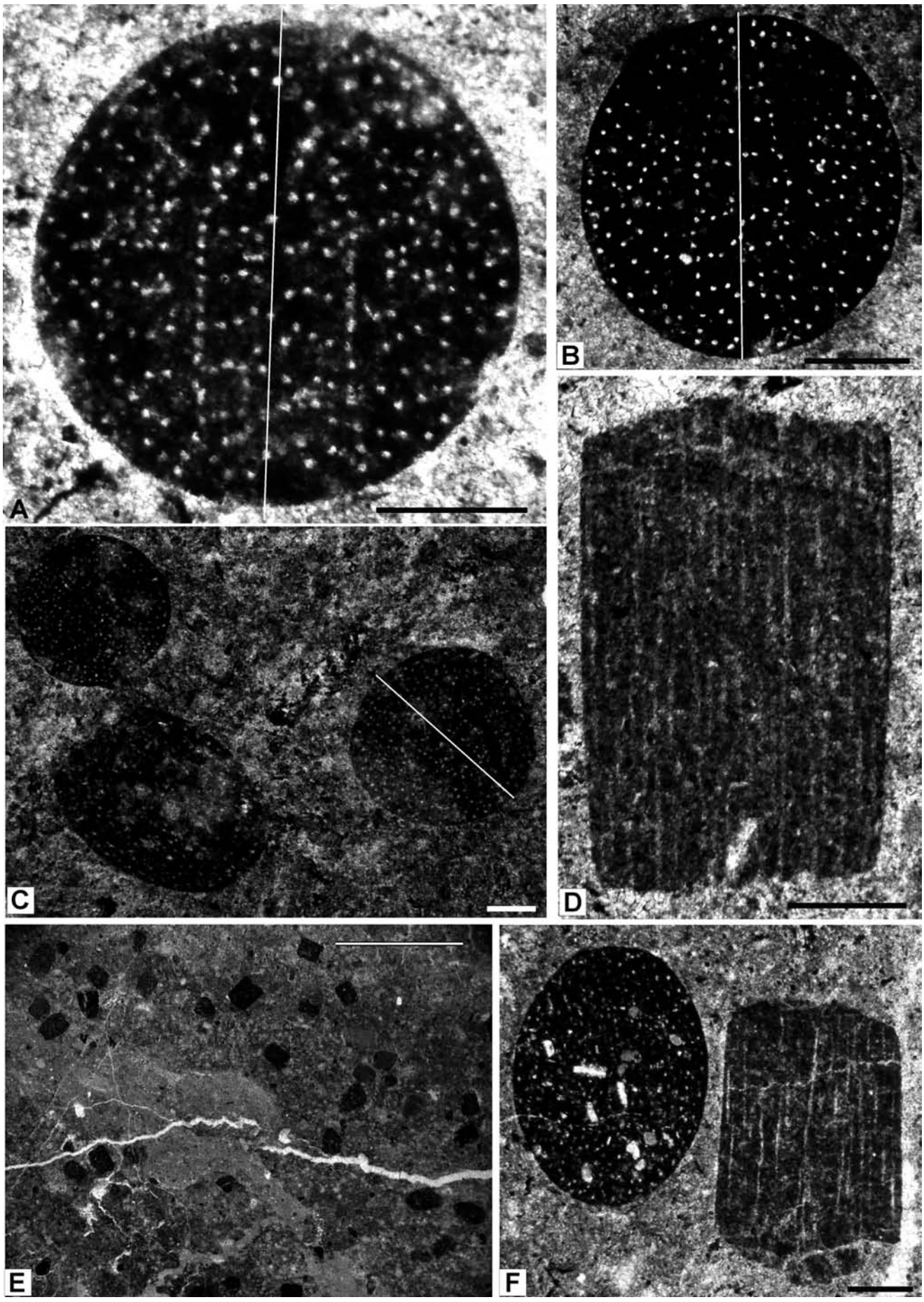

PLATE 1

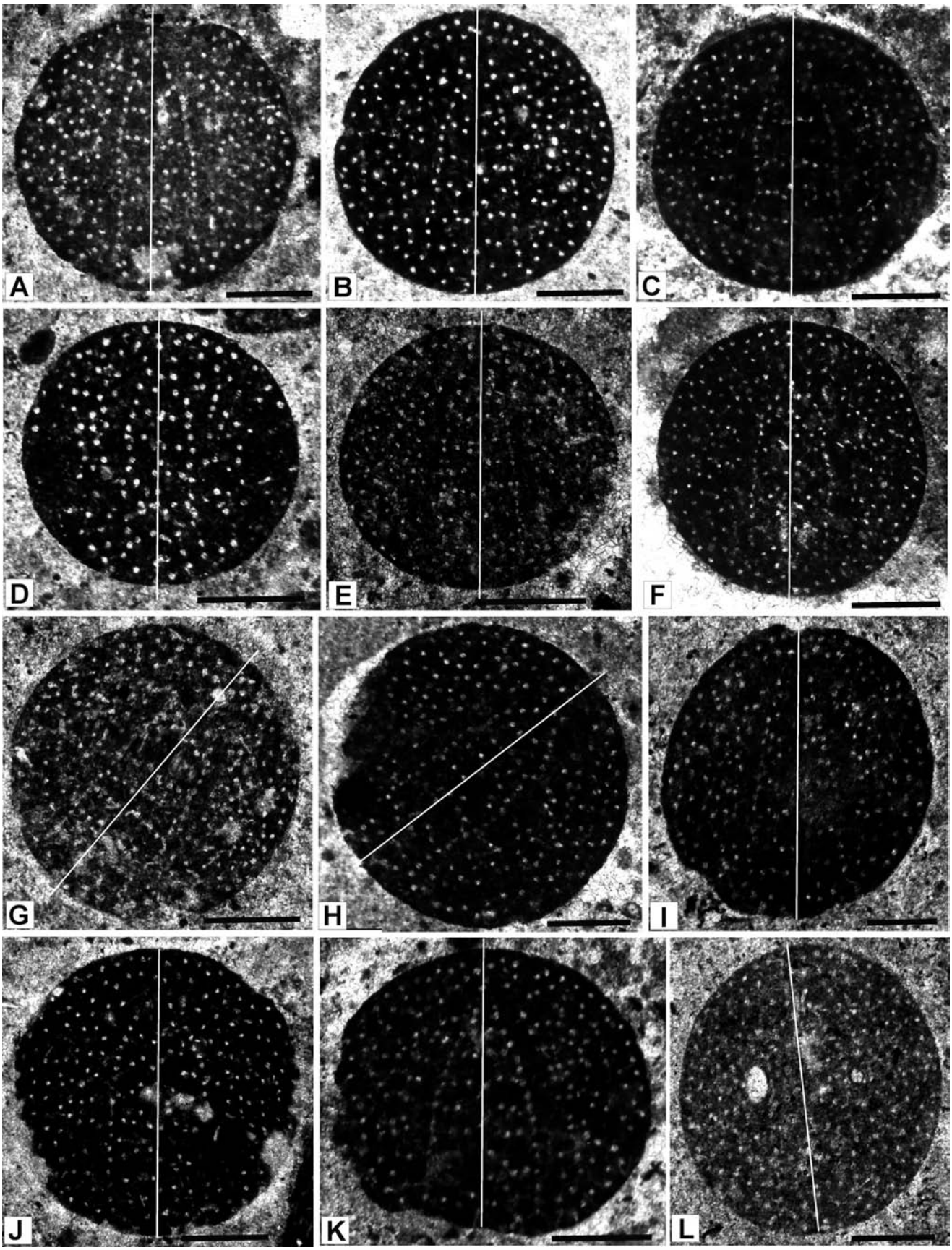

PLATE 2

cies exhibit about, or more than, 100 canals and thus may be compared with *F. carpatica* nov. ichnosp.:

– *Favreina agnulata* Senowbari-Daryan & Kuss, 1992 (erroneously given as *F. fastigiformis* in Tab. 1 by the authors), with about 200 canals (Cretaceous);

– *Favreina prusensis* (Paréjas, 1948), with about 66-136 canals (Jurassic);

– *Favreina tabasensis* Brönnimann, 1977, with about 114 canals (Jurassic-Cretaceous);

– *Favreina multicanalis* (Förster & Hillebrandt, 1984), with an uncertain number of canals (Upper Jurassic);

– *Favreina peruviensis* Blau, Rosas & Senff, 1994, with about 100 canals (Jurassic);

– *Favreina fendiensis* Brönnimnann & Zaninetti, 1972, with about 194 canals (Jurassic); and

– *Favreina omanensis* Senowbari-Daryan & Bernecker, 2000, with 106-119 canals (Triassic).

Favreina carpatica nov. ichnosp. differs from all the above mentioned ichnospecies not only by the significantly higher number of the canals, but also by their arrangement pattern.

In contrast to *Favreina carpatica* nov. ichnosp., with a symmetrical arrangement of at least some canals, these are completely asymmetrical in *Favreina multicanalis*, or at least a symmetrical arrangement cannot be easily recognized (Förster & Hillebrandt 1984, see also Helm & Schülke 2004: fig. 4). All ichnospecies of *Favreina* with a relatively high (more than 100) number of canals are known from the Jurassic and Cretaceous, except *Favreina omanensis* from the Late Triassic. Also remarkable is the Late Triassic species *Parafavreina huaricolcanensis* Senowbari-Daryan & Stanley, 1986, with more than 100 canals, but the outlines of the canals (i.e., whether triangular or circular) are not clearly visible. In case this ichnotaxon will be shown to belong to *Favreina*, it also differs from *F. carpatica* n. ichnosp. by the lower number of the canals and by their different arrangement pattern.

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REFERENCES

Blau J., Rosas S. & Senff M. (1994) - *Favreina peruviensis* n. sp., ein Crustaceen-Mikrokoprolith aus dem Lias von Peru. *Paläont. Z.*, 68(3/4): 521-527.

Brönnimann P. (1955) - Microfossils incertae sedis from the Upper Jurassic and Lower Cretaceous of Cuba. *Micropaleontology*, 1: 28-57.

Brönnimann P. (1972) - Remarks on the classification of fossil Anomuran coprolites. *Paläont. Z.*, 46(1/2): 99-103.

Brönnimann P. (1977) - A new favreine coprolite (Crustacea, Decapoda) from the Jurassic of Iran and the Cretaceous of the Dinarids, Jugoslavia. *Paläont. Z.*, 51(1-2): 94-101.

Brönnimann P., Caron J.P. & Zaninetti L. (1972) - *Parafavreina* n. gen., a new thalassinid anomuran (Crustacea, Decapoda) coprolite genus from the Triassic and Liassic of Europe and North Africa. *Mitt. Ges. Geol. Bergbaustud. Österr.*, 21: 914-956.

Brönnimann P. & Norton P. (1960) - On the classification of fossil fecal pellets and description of new forms from Cuba, Guatemala and Libya. *Eclogae Geol. Helv.*, 53(2): 832-842.

Brönnimann P. & Zaninetti L. (1972) - New names for favreine and parafavreine thalassinis anomuran (Crustacea Decapoda) coprolites from the Jurassic of Greece and Algeria. *Paläont. Z.*, 46(3-4): 221-224.

Dondi L. & Papetti I. (1966) - Segnalazione di coprolite nel Miocene dell'Italia Meridionale. *Geol. Romana,* Vol. 1966: 55-68.

Elliott G. F. (1962) - More microproblematica from the Middle East. *Micropaleontology* 8(1): 29-44.

Förster R. & Hillebrandt A. von (1984) - Das Kimmeridge des Profeta-Jura in Nordchile mit einer Mecochirus-Favreina-Vergesellschaftung (Crustacea, Decapoda - Ichnogenus). *Mitt. Bayer. Staatssalg. Paläont. His. Geol.*, 24: 67-84.

Helm C. & Schülke I. (2004) - Crustaceen-Koprolithen aus dem Korallenoolith (Oxfordium, Niedersächsisches Becken, NW-Deutschland). *N. Jb. Geol. Paläont. Mh.*, 2004(8): 496-512.

Herbig H. G. (1993) - First Upper Devonian Crustacean coprolites (*Favreina prima* n. sp.) from Northern Morocco. *J. Paleont.*, 67(1):98-103.

Iancu V., Berza T., Seghedi A., Gheuca I. & Hann HP. (2005) - Alpine polyphase tectono-metamorphic evolution of the South Carpathians: a new overview. *Tectonophysics,* 410: 337-365. doi: 10.1016/j.tecto.2004.12.038

Latreille P. A. (1802) - Histoire naturelle, générale et particuliére, des erustacés et des insectes, Vol. 3. F. Dufart, Paris, 468 pp.

Masse P. & Vachard D. (1996) - A crustacean coprolite, *Palaxius salataensis*, in the Upper Carboniferous of the southern Urals. *N. Jb. Geol. Paläont. Mh.*, 1996(8): 490-494.

Molinari Paganelli V., Pichezzi R. M. & Tilia Zuccari A. (1980) - Il coprolite di crostacei - Rassegna bibliografica ed annotazioni tassonomiche Part I: Genere *Fa-*

vreina. *Boll. Servizio Geol. d'Italia, Vol* C (1979), pp. 409-454.

Paréjas E. (1948) - Sur quelques coprolithes de Crustacés. *Archives des Sciences,* 1(3): 512-520.

Patrulius D. (1969) - Geologia Masivului Bucegi şi a Culoarului Dâmbovicioara. *Ed. Acad. Rep. Soc. România, Bucureşti*, 321 pp.

Patrulius D., Popa E., Avram E., Baltres A., Pop G., Iva M., Antonescu E., Dumitrică P. & Iordan M. (1980) - Studiul petrologic şi biostratigrafic complex al formaţiunilor jurasice şi neocomiene din Carpaţii Românești şi Dobrogea în vederea evaluării potenţialului de resurse minerale. *Sectorul Leaota-Braşov-Munţii Perşani. Raport* IGG, Tema Nr. 47/1979.

Săndulescu M. (1984) - Geotectonica României. Ed Tehnică, Bucureşti, 336 pp.

Săndulescu M. (1994) - Overview on Romanian geology. *Rom. J. Tecton. Reg. Geol*., 75: 3-15.

Scoffin T. P. (1973) - Crustacean faecal pellets, *Favreina*, from the Middle Jurassic of Eigg, Inner Hebrides. *Scott. J. Geol*., 9(2): 145-146.

Senowbari-Daryan B. (1988) - *Lercarina tintinnicanalia* n. gen., n. sp. (Crustaceen Koprolith) aus dem unteren Perm von Sizilien. *Mitt. Ges. Geol. Bergbaustud. Österr*., 34/35: 301-309.

Senowbari-Daryan B. & Bernecker M. (2000) - Crustacean microcoprolites from the Upper Triassic, Oman. *Bull. Soc. Paleont. Ital.*, 39(1): 13-20.

Senowbari-Daryan B. & Kuss J. (1992) - Anomuren-Koprolithen aus der Kreide von Ägypten. *Mitt. Geol.-Paläont. Inst. Univ. Hamburg*, 73: 129-157.

Senowbari-Daryan B. & Stanley G. D., Jr. (1986) - Thalassinid anomuran microcoprolites from Upper Triassic carbonate rocks of central Peru. *Lethaia*, 19: 343-354.

Senowbari-Daryan B., Weidlich O. & Flügel E. (1992) - Erster Nachweis von "Favreinen" (Crustaceen-Koprolithen) aus dem Perm: Oberperm, Oman-Berge. *Paläont. Z*., 66(1/2): 187-196.

Simionescu I. (1899) - Studii geologice şi paleontologice din Carpaţii sudici, III. Fauna callovian ă din Valea Lupului (Rucăr). *Acad. Rom. Publ. Fond. Vasile Adamachi,* 3: 42 pp.

Vialov O. S. (1978) - Favreinidae (coprolites of Crustacea) from Turonian of the Lower Amudaria. *Paleont. Sbornik*, 15: 58-67 (in Russian).