

Microfossils of the Paseky Shale (Lower Cambrian, Czech Republic)

Mikrofossilie paseckých vrstev
(spodní kambrium, Česká republika)
(Czech summary)



(2 text-figs., 4 plates)

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The microfossil assemblages - the filaments of Cyanobacteria, filamentous algae, acritarchs, Prasinophyceae and crustacean remains - were discovered and taxonomically evaluated from insoluble organic residues of the Paseky Shale (Lower Cambrian, Příbram-Jince Basin, Barrandian area). Well preserved and diversified microfossils are present in all the samples collected at the locality Kočka. The assemblages are composed of common leiosphaerids (40-90 % of the specimens), cyanobacterial/algal filaments (30-65 % of the specimens), rare acritarchs (0-1,0 % of the specimens) and solitary animal remains. The general character of the Paseky Shale Assemblage differs strikingly from both Precambrian and Middle Cambrian microfossil assemblages of the Bohemian Massif. The genus *Ceratophyton*, originally established as acritarch, has been classed as homologous to modern crustacean exoskeletal remains.

Key words: Bohemia, Barrandian area, Lower Cambrian, Paseky Shale, organic-walled microfossils

Material and methods

Samples were collected in the Paseky Shale at the following five localities: Hora Kočka in Brdy Mts. (14 samples studied), Hora Tok in Brdy Mts. (2 samples studied), Medalův mlýn at Čenkov (4 samples studied), Nepomuk at Rožmitál (2 samples studied), and Pičín (3 samples studied). Samples from the locality Kočka contain diversified, moderately to well preserved microfossils. The organic content in samples from other localities - Tok, Medalův Mlýn, Pičín and Nepomuk - involves only rare and generally poorly preserved specimens.

The material studied belongs to the silty shales and grey shales that involve rarely preserved remains of arthropods of *Kodymirus* Havlíček et Chlupáč, 1965 and also some of the other remains of merostomats (*Kockurus* gen. nov.) and phylocarids (*Vladicaris* gen. nov., Chlupáč, present paper). They represent the oldest fauna so far known from the Bohemian Massif (Havlíček 1968, Chlupáč et al. 1995, Kukul 1995).

The microscopic content of the shales was preliminarily systematically, stratigraphically and environmentally evaluated in the previous years (see e.g. Fatka - Konzalová 1993, Konzalová - Fatka 1995). The present paper is based upon an earlier identification by the authors and deals with the taxa assignment in more detail.

All samples were subjected to standard palynological preparation techniques and were sieved at 10 µm. The material was not oxidized.

Systematic part

I. Filamentous microfossils

Phyllum Cyanobacteria
Genus *Botuobia* Pjatiletov 1979

Type species: *Botuobia wernadskii* (Shepeleva 1960) Pjatiletov 1979.

Botuobia sp.

Pl. I, fig. 3

1995 *Botuobia* Pjatiletov: Konzalová - Fatka, p. 78, pl. 1, fig. 9.

Material: Four specimens.

Genus *Palaeolyngbya* Schopf 1968

Type species: *Palaeolyngbya barghoorniana* Schopf 1968.

Palaeolyngbya sp.

1995 *Palaeolyngbya* Schopf: Konzalová - Fatka, p. 78. Material: Four specimens.

Genus *Polytrichoides* Hermann 1974 emend. Hermann 1976 in Timofeev et al. 1976

Type species: *Polytrichoides lineatus* Hermann 1974 emend. Knoll et al. 1991.

Polytrichoides lineatus Hermann 1974 emend. Knoll et al. 1991

Pl. I, fig. 2

- 1974 *Polytrichoides lineatus* Hermann: Hermann, p. 7-8, pl. 6, figs. 3, 4.
 1985 *Polytrichoides lineatus* Herm.: Ragodzina - Siverzeva in Sokolov - Ivanovskij., p. 144.
 1985 *Polytrichoides lineatus* Herm.: Jankauskas in Sokolov - Ivanovskij, p. 146, pl. 61, fig. 3.
 1989 *Polytrichoides lineatus* Hermann: Jankauskas et al., p. 119-120, pl. 30, figs. 5-7.
 1991 *Polytrichoides lineatus* Hermann: Hofmann - Jackson, p. 12-13, figs. 11.13-11.17.
 1991 *Polytrichoides lineatus* Hermann: Knoll, et al., p. 563, figs. 4.3, 4.5.
 1992 *Polytrichoides lineatus* Hermann: Zang - Walter, p. 315-316, pl. 17, figs. A-E.
 1994 *Polytrichoides lineatus* Hermann: Leiming - Weiguo, p. 98, 102, figs. 4b, 5m.
 1994 *Polytrichoides lineatus* Hermann: Hofmann - Jackson, p. 12-13, figs. 11.13-11.17.
 1994 *Polytrichoides lineatus* Herm.: Vejs - Petrov, pl. 1, fig. 23, pl. 2, figs. 25, 27.
 1995 banded tubular sheaths: Konzalová - Fatka, p. 78, pl. 1, fig. 8
 Material: About thirty specimens of different length.

Description: Elongated filamentous aggregates of closely crowded nonseptate, more or less parallel, filaments.

Remarks: This species and genus are known only from rocks of Riphean and Vendian age.

Genus *Rectia* Jankauskas 1989

Type species: *Rectia costata* (Jankauskas 1980) Jankauskas 1989.

Rectia cf. *costata* (Jankauskas 1980) Jankauskas 1989

Text-fig. 1

- 1980 *Siphonophycus costatus* sp. nov.: Jankauskas, p. 108-109, pl. 12, figs. 1, 10.
 1989 *Rectia costata* (Jankauskas) Jankauskas nom. nov.: Jankauskas et al., p. 121, pl. 41, fig. 1, 5, 8.

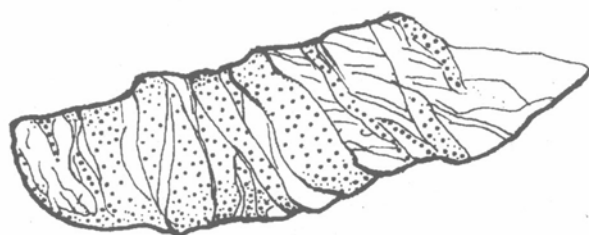


Fig. 1. *Rectia* cf. *costata* (Jankauskas) Jankauskas

Material: Ten specimens of different length.

Genus *Siphonophycus* Schopf 1968, emend. Knoll - Swett - Mark 1991

Type species: *Siphonophycus kestron* Schopf 1968.

Remarks: The classification scheme of Butterfield et al. (1994, p. 62-64) is applied. On the basis of geometrically increasing diameter the following taxa within the genus *Siphonophycus* were recognized: *S. septatum* = 1-2 μm , *S. robustum* = 2-4 μm , *S. typicum* = 4-8 μm , *S. kestron* = 8-16 μm , *S. solidum* = 16-32 μm .

Siphonophycus septatum (Schopf 1968) Knoll et al. 1991

- 1968 *Tenuofilum septatum* sp. nov.: Schopf, p. 679, figs. 10-12, table 3.
 1991 *Tenuofilum septatum* Schopf: Hofmann - Jackson, p. 367, figs. 6, 7.1, 7.2.
 1991 *Siphonophycus septatum* (Schopf): Knoll et al., p. 565, fig. 10.2.
 1994 *Siphonophycus septatum* (Schopf) Knoll et al.: Hofmann - Jackson, p. 10, figs. 10, 11.1-11.4.
 Material: More than 600 specimens of different length.

Siphonophycus robustum (Schopf 1968) Knoll et al. 1991

Pl. IV, fig. 3

- 1968 *Eomycetopsis robusta* sp. nov.: Schopf, p. 685, figs. 2, 3, pl. 83, figs. 1-4.
 1991 *Siphonophycus robustum* (Schopf): Knoll et al., p. 565, figs. 10.3, 10.5.
 1994 *Siphonophycus robustum* (Schopf) Knoll et al.: Hofmann - Jackson, p. 10, figs. 10, 11.5.
 Material: More than 1 200 specimens of different length.

Siphonophycus typicum (Herman 1974) Butterfield 1994

Pl. II, figs. 2, 3; Pl. III, figs. 4, 7

- 1974 *Leiothrichodes typicus* gen. et sp. n.: Herman, p. 7, pl. 6, figs. 1-2.
 1980 *Eomycetopsis rimata* sp. nov.: Jankauskas, p. 111-112, pl. 12, fig. 11.
 1994 *Siphonophycus typicum* (Hermann) n. comb.: Butterfield in Butterfield et al., p. 66, figs. 23B-D, 26B, H, I. (see for further synonymy).
 Material: More than 8000 specimens of different length.

Siphonophycus kestron Schopf 1968

Pl. I, fig. 4; Pl. II, figs. 4, 5

1968 *Siphonophycus kestron* sp. nov.: Schopf, p. 671, pl. 80, figs. 1-3.

1991 *Siphonophycus kestron* Schopf: Hofmann - Jackson, p. 368, figs. 5.9, 5.10, 6 (partim).

1995 opaque unbranched filament: Konzalová - Fatka, pl. 1, fig. 7.

Material: More than 10 000 specimens of different length.

Siphonophycus solidum (Golub 1979) Butterfield 1994
Pl. I, figs. 1, 5; Text-fig. 2

1994 *Siphonophycus solidum* (Golub.) n. comb.: Butterfield in Butterfield et al., p. 67, figs. 25H-I, 27D; (see for further synonymy).

Material: About 50 specimens of different length.

"Spiromorphes"

Pl. II, figs. 6, 7

1989 "Spiromorphes": Baudet et al., p. 144, pl. 2, figs. 20-25.

Material: Four more or less complete specimens.

II. Acritarchs

Group Acritarcha Evitt 1963

Genus *Adara* Fombella 1977

Type species: *Adara matutina* Fombella 1977.

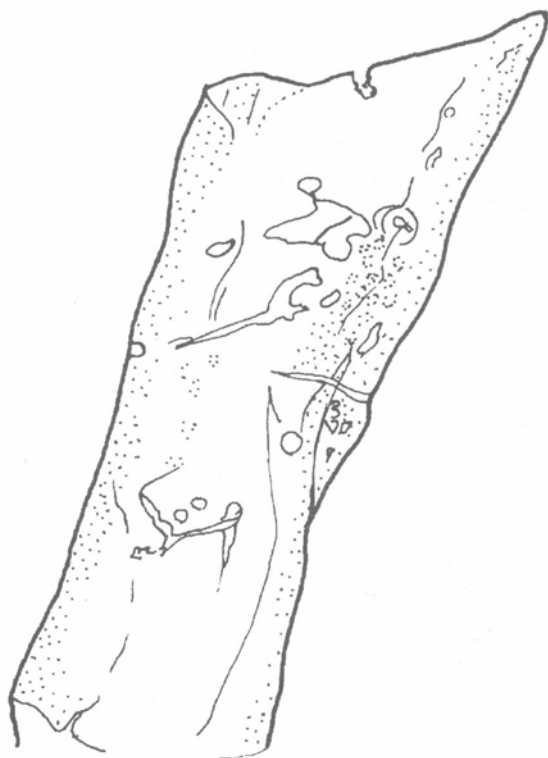


Fig. 2. *Siphonophycus solidum* (Golub.) Butterfield

Adara sp.

Pl. II, fig. 1; Pl. III, figs. 5, 6

1989 *Adara* sp. A: Baudet et al., p. 136, 145.

Material: Three specimens.

Remarks: Morphologically comparable specimens were found from the Vampire Formation (northwestern Canada) which is correlated with the Lukati and Vergale regional stages of the East European Platform.

Genus *Leiosphaeridia* Eisenack 1958

emend. Downie - Sarjeant 1963

Type species: *Leiosphaeridia baltica* Eisenack 1958.

Remarks: The taxonomy within the genus *Leiosphaeridia* has been rather chaotic. Recent consideration between taphonomic effects and size of the body modified systematics of this form-genus (Lindgren, 1981, 1982; Jankauskas et al., 1989 and Hofmann - Jackson, 1994). Only two taxa are applied for the Paseky Shale material:

Leiosphaeridia minutissima (Naumova 1949) emend. Jankauskas in Jankauskas et al. 1989 and *L. ternata* (Timofeev 1966) emend. Michajlova - Jankauskas in Jankauskas et al. 1989

Leiosphaeridia minutissima (Naumova 1949) emend. Jankauskas 1989

Pl. III, figs. 2, 3

1949 *Leiotriletes minutissimus* sp. nov.: Naumova, p. 52-53, pl. 1, figs. 1, 2, pl. 2, figs. 1, 2.

1989 *Leiosphaeridia minutissima* (Naumova) comb. nov., emend.: Jankauskas, in Jankauskas et al., p. 79-80, pl. 9, figs. 1-4, 11; (see for further synonymy).

1990 *Leiosphaeridia riphiana*: Fensome et al., p. 284.

1994 *Leiosphaeridia minutissima* (Naumova) Jankauskas in Jankauskas et al.: Hofmann - Jackson, p. 21, figs. 15.9-15.15, 16.

1995 *Leiosphaeridia* sp. "type A": Konzalová - Fatka, p. 79, pl. 1, fig. 1.

1995 *Leiosphaeridia* sp. "type B": Konzalová - Fatka, p. 79, pl. 1, figs. 2, 3.

Material: More than 19 000 specimens in different state of preservation.

Description: Small to middle-sized vesicles (dimensions ranging from 4 to 63 μm in diameter) spherical to ellipsoidal. Vesicle wall thin to very thin, surface smooth.

Remarks: Numerous specimens show more or less visible reticulum - like pattern which might be caused secondarily by microcrystalline imprints (Pl. III, fig. 2).

Leiosphaeridia ternata (Timofeev 1966) emend. Michajlova - Jankauskas 1989

1966 *Turuchanica ternata* sp. nov.: Timofeev, p. 45, pl. 9, fig. 8.

1989 *Leiosphaeridia ternata* (Timofeev) comb. nov., emend.: Michajlova - Jankauskas in Jankauskas et al., p. 81, pl. 11, figs. 2-4, pl. 12, figs. 4, 5, 8; (see for further synonymy).

1992 *Leiosphaeridia ternata* (Timofeev) Michajlova - Jankauskas in Jankauskas et al.: Zang - Walter, p. 299, pl. 12, figs. F-I.

1994 *Leiosphaeridia ternata* (Timofeev) Michajlova - Jankauskas in Jankauskas et al.: Hofmann - Jackson, p. 22, figs. 16, 17.5-17.7.

Material: About 350 specimens in different state of preservation.

Description: Small to middle-sized vesicles (dimensions ranging from 14 to 41 μm in diameter), sphaerical to ellipsoidal. Vesicle wall thick, surface smooth. Most of specimens preserved with radially oriented ruptures.

Genus *Retisphaeridium* Staplin, Jansonius - Pocock 1965

Type species: *Retisphaeridium dichamerum* Staplin, Jansonius - Pocock 1965.

Retisphaeridium sp.

Pl. III, fig. 1

1995 *Retisphaeridium* sp.: Konzalová - Fatka, p. 79, 81, pl. 1, fig. 6.

Material: Three well preserved specimen and several incomplete vesicles.

Remarks: The oldest figured specimens of the genus were established in the Lower Cambrian (Martin in Young et al., 1994, Vidal - Peel, 1993). The Paseky Shale specimens are closer to the morphotype *R. howellii* Martin 1983 than to the type species *R. dichamerum* Staplin et al. 1965. This genus has not been so far documented from the Precambrian rocks.

Genus *Sinianella* Yin 1980 emend. Zang in Zang - Walter 1992

Type species: *Sinianella uniplicata* Yin 1980.

Sinianella cf. *uniplicata* Yin 1980 emend. Zang 1992

1980 *Sinianella uniplicata* gen. et sp. nov.: Yin, pl. 1, figs. 37, 38, text-fig. 4.

1986 Unnamed specimen: Damassa - Knoll, figs. 5A, E.

1992 *Sinianella uniplicata* Yin: Zang, p. 103, pl. 5, fig. H.

1992 *Sinianella uniplicata* Yin nov. emend.: Zang in Zang - Walter, p. 309-310, pl. 8, figs. A-I.

Material: Three specimens.

Description: Elliptical to bottle-shaped central body bearing one pronounced process, counter-part of the vesicle rounded.

Remarks: Both, the solitary specimens and chains of vesicles were observed.

Genus *Skiagia* Downie 1982 emend. Moczydlowska 1991

Type species: *Skiagia scottica* Downie 1982.

Skiagia cf. *insigne* (Fridrichsone 1971) Downie 1982 Pl. III, fig. 7

1971 *Hystrichosphaeridium* (?) *insigne* sp. nov.: Fridrichsone, p. 14-16, pl. 2, figs. 10-22.

1974 *Baltisphaeridium insigne* (Fridrichsone) comb. nov.: Volkova, p. 195, pl. 27, figs. 5-7.

1978 *Hystrichosphaeridium insigne* Fridrichsone: Tynni, pl. 7, fig. 69.

1979 *Baltisphaeridium insigne* (Fridrichsone) Volkova: Volkova et al., p. 10, 37, pl. 4, figs. 1-5.

1982 *Skiagia insigne* (Fridrichsone) comb. nov.: Downie, p. 263-264.

1988 *S. insigne*: Hagenfeldt, p. 153-155.

1989 *Skiagia insigne*: Moczydlowska, p. 17.

1989a *Skiagia insigne* (Fridrichsone) Downie: Hagenfeldt, p. 116-119, pl. 5, figs. 3, 4.

1989c *S. insigne*: Hagenfeldt, p. 7, 9.

1990 *B. insigne*: Eklund, p. 25, 26, 33.

1990 *Skiagia insigne* (Fridrichsone) Downie: Vidal - Nystuen, p. 198, 212, figs. 16 B, C.

1993 *Skiagia insigne*: Jankauskas, pl. 1.

1991 *Skiagia insigne* (Fridrichsone) Downie: Moczydlowska, p. 67-68, pl. 7, fig. I.

1992 *Skiagia insigne*: Lenzion - Jankauskas, p. 523.

1992 *Skiagia insigne* (Fridrichsone) Downie: Moczydlowska - Vidal, p. 25, figs. 6, c, d.

1993 *Skiagia insigne*: Jankauskas, str. 73.

Material: Two incompletely preserved specimens.

Remarks: Morphologically very characteristic processes enable reliable determination of incomplete specimens.

Specimens recalling resemblance with *Volkovia* Downie and *Aliumella* Fanderfl. have not been documented for the poor preservation in the material studied.

III. Animal rests

Phyllum Crustacea

Genus *Ceratophyton* Kirjanov, 1979 in Volkova et al., 1979

Type species: *Ceratophyton vernicosum* Kirjanov, 1979 in Volkova et al., 1979.

Ceratophyton vernicosum Kirjanov, 1979 in Volkova et al., 1979

Pl. III, fig. 8

1979 *Ceratophyton vernicosum* sp. nov.: Kirjanov, in Volkova et al., p. 35, 36, pl. 38, figs. 1-3, 5, 6, 10, 12.

1980 *Ceratophyton vernicosum* Kirjanov: Paskiaviciene, p. 47, pl. 8, figs. 1-3, pl. 9, fig. 5, pl. 14, fig. 10.

1981 *Ceratophyton vernicosum* Kirjanov: Korkutis, p. 82, fig. 2,7.

1981 *Ceratophyton vernicosum* Kirjanov: Vidal, p. 233.

1983 *Ceratophyton vernicosum* sp. nov.: Kirjanov, in Volkova et al., p. 43, 45, pl. 38, figs. 1-3, 5, 6, 10, 12.

1985 *Ceratophyton vernicosum* Kirjanov: Volkova in Sokolov, p. 137, 138, pl. 52, fig. 6.

1986 *Ceratophyton vernicosum*: Paskiaviciene, p. 129-137.

1986 *Ceratophyton vernicosum*: Mens - Pirrus p. 358.

1986 *Ceratophyton vernicosum*: Moczydlowska - Vidal, p. 207.

1987 *Ceratophyton vernicosum* Kirjanov: Knoll - Swett, p. 906, 907, 911, 922, fig. 8.2.

1989 *Ceratophyton vernicosum*: Moczydlowska, p. 16.

1991 *Ceratophyton vernicosum* Kirjanov: Moczydlowska, pl. 15, fig. E.

1992 *Ceratophyton vernicosum* Kirjanov: Jankauskas - Lenzion, p. 520, 523.

1993 *Ceratophyton vernicosum* Kirjanov: Jankauskas, p. 73.

1993 *Ceratophyton vernicosum* Kirjanov: Wright et al. p. 261, figs. 4: a, b, h.

1994 Undetermined form: Leiming - Weiguo, fig. 6-k.

1995 *Ceratophyton* sp.: Konzalová - Fatka, p. 81, pl. 1, fig. 12.

Material: One complete and three poorly preserved specimens.

Remarks: Three species have been assigned recently to the genus *Ceratophyton*: *C. vernicosum* Kirjanov, 1979, *C. duplicum* Paskiaviciene, 1980 and *C. groetlingboensis* Hagenfeldt, 1989.

C. duplicum is characterized by a double-walled body and has been described from the Lower Cambrian Lontova Formation of Lithuania and Belarus. *C. groetlingboensis*, established in the Lower Cambrian of Sweden and Poland, is generally smaller than the type species.

Stratigraphic range: *C. vernicosum* occurs in the Lontova and Rovno regional stages (and acritarch horizons) of the East European Platform and in their stratigraphic equivalents in other areas (e.g. Spitzbergen,

Knoll - Swett, 1987, British Islands, Wright et al., 1993).

Remarks on the systematic positions of the genus *Ceratophyton*

It seems meaningful to exclude the morphogenus *Ceratophyton* from the group Acritarcha and transfer it into the animal kingdom. The morphological similarity with the remains of undoubted crustacean origin is evident. Within the animal kingdom, they are assignable to Copepods. There is no obvious difference between the fossil and modern specimens assigned to Copepods. They were described and figured as "palynomorph" types 4 and 5 by Waveren (1994, pl. 2, fig. 5,7, p. 7,8) from the recent sediments of Indonesia. The parts of comparable morphology are distinguished as copepod exopodite segments. The comparison is also very probable due to the other animal remains of Crustacea in the Paseky Shale.

Conclusions

The microfossil assemblage of the Paseky Shale differs distinctly from all assemblages known up to now from the Barrandian area. It represents a unique community within the Bohemian Precambrian and Palaeozoic sequences. It is hardly comparable with records of either Lower Cambrian time-equivalent assemblages or with the Precambrian biotas.

Lower Cambrian assemblages usually contain between 10 and 95 % of acritarchs (Downie, 1982, Moczydlowska, 1991, Knoll et Swett 1987 a.o.), while the amount of this group in the Paseky Shale ranges from 0 to 0.8 %. On the other hand, filamentous microfossils comprise 32 to 65 % in the Paseky Shale but in the Cambrian assemblages only exceptionally contain more than 10 % of them.

Generally, the Paseky Shale assemblage of microfossils seems to be more related to the composition of the Precambrian communities. Nevertheless, the Cambrian age of the Paseky Shale is proved by the presence of skeletonised macrofossils and typical Cambrian acritarch genera (e.g. *Adara*, *Retisphaeridium*).

How can the origin of such an assemblage be explained? Most probably by the specific conditions e.g. restricted marine environment. The limited influence of marine environment may be responsible for the atypical composition: extremely low content of acritarchs in combination with very common leiosphaerids and filamentous microfossils. The recorded microbiota most probably reflects a restricted facies of special paleobiocommunity and also fits well with the finds of macrofossils and depositional environment.

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Mikrofosilie paseckých vrstev (spodní kambrium, Česká republika)

Z mohutné sekvence převážně klastických sedimentů v podloží středního kambria příbramsko-jinecké pánve se podařilo získat vzácné společenstvo mikrofosilií tvořené filamenty cyanobakterií, řas, schránkami akritarch, prasinofyt a živočišnými zbytky, náležející pravděpodobně korýšům. Jako jediný fosiliferní člen uvnitř celé sekvence se ukázaly pouze pasecké břídlíce. V jejich společenstvu převažují druhy rodu *Leiosphaeridia* (40-90 % nálezů), časté jsou zbytky filamentosních cyanobakterií a řas (30-65 % nálezů). Vzácněji se vyskytují morfologicky diferencovanější akritarcha (např. *Skiagia*, *Adara*, do 1 % nálezů) a útržky živočišných tkání. Mezi živočišné zbytky přerazujeme i rod *Ceratophyton* Kirjanov, který morfologicky stojí nejbližší exopodovým segmentům dnešních klanonožců (*Copepoda*). Celkový charakter společenstva paseckých břídlíc se svým složením - převahou filament, přítomností druhů leiosferid v asociaci s několika rody kambrických akritarch - liší od prekambriických a středně kambrických biot různých oblastí, včetně Českého masívu.

Neobvyklé složení společenstva paseckých břídlíc odráží specifické podmínky v době sedimentace, nejspíše omezený vliv mořského prostředí. Nejlépe zachované a diverzifikované společenstvo pochází z lokality Kočka, ostatní lokality (Tok, Medalův mlýn, Pičín a Nepomuk) poskytly dosud pouze ojedinělé nálezy nepříznivě zachovaných fosilií.

Explanation of plates

Plate I

- 1, 5. *Siphonophycus solidum* (Golub.) Butterfield, x1200.
2. *Polytrichoides lineatus* Hermann emend. Knoll et al., x1200.
3. *Botuobia* sp., x1200.
4. *Siphonophycus kestron* Schopf, x1200.

Photos by the authors

Plate II

1. *Adara* sp., x670.
- 2, 3. *Siphonophycus typicum* (Hermann) Butterfield, x670.
- 4, 5. *Siphonophycus kestron* Schopf, x670.
- 6, 7. "Spiromorphes", x1200.

Photos by the authors

Plate III

1. *Retisphaeridium* sp., x1200.
- 2, 3. *Leiosphaeridia minutissima* (Naumova) emend. Jankauskas. x1200.
4. *Siphonophycus typicum* (Hermann) Butterfield, x670.
- 5, 6. *Adara* sp. specimen at two optical levels, x1200.
7. *Siphonophycus typicum* (Hermann) Butterfield associated with *Skiagia* cf. *insigne* (Fridrichsone) Downie, x1200.
8. *Ceratophyton vernicosum* Kirjanov in Volkova et al., x1200.

Photos by the authors

Plate IV

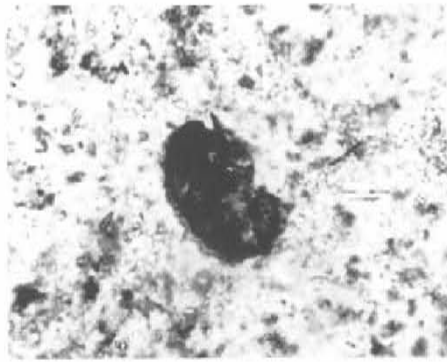
Stereoscanning micrographs.

- 1, 2, 4 - 6. *Siphonophycus* sp. div., 3. *Siphonophycus robustum* (Schopf) Knoll et al. - different types of preservation. 1 - x600, 2, 3 - x2000, 4 - x2800, 5 - x1000, 6 - x3000.

Photos by Ing. A. Langrová, M. Kozumpliková
(Geological Institute, Academy of Sciences, Praha)



For explanation see p. 61



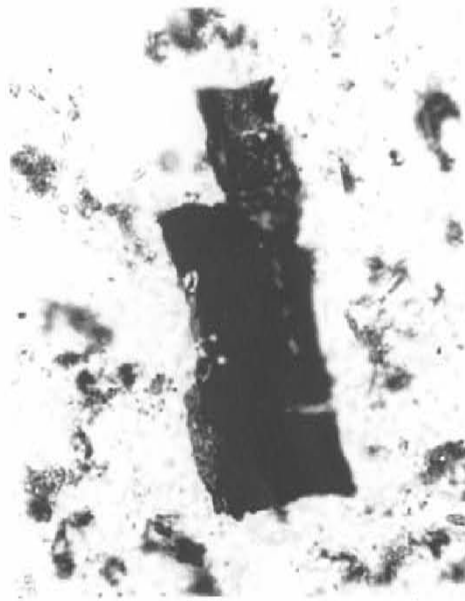
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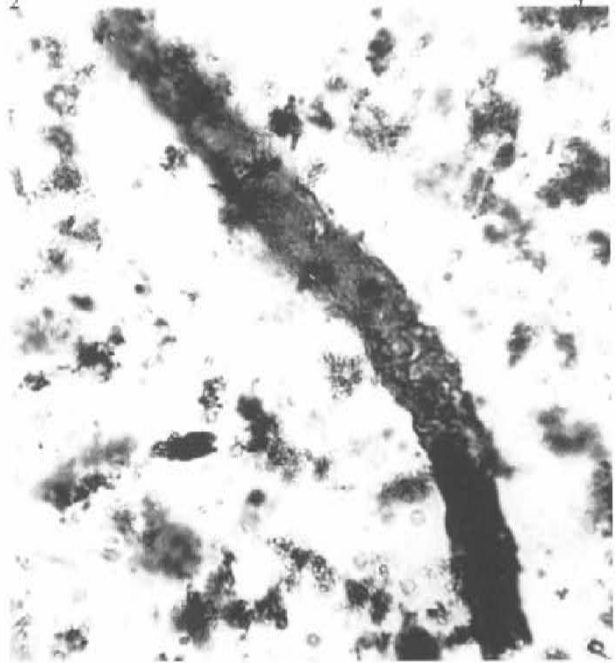
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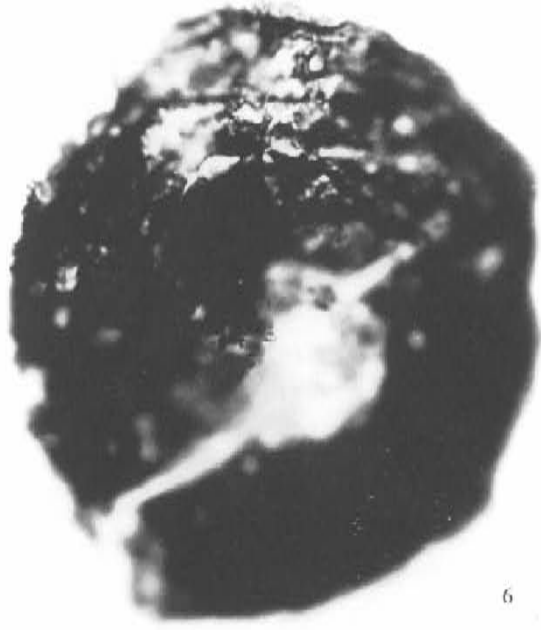
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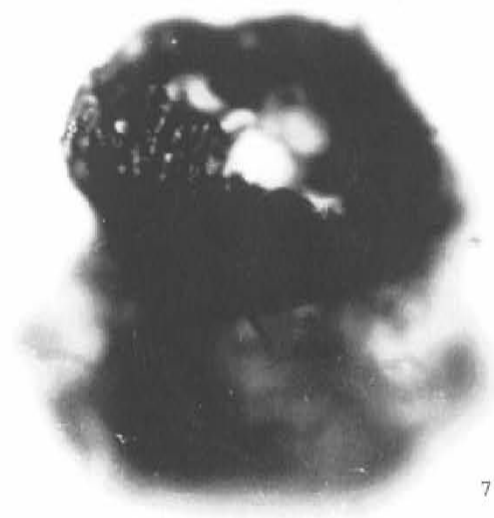
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