Early Cretaceous borings from Stramberk (Czechoslovakia)

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Early Cretaceous borings from Štramberk (Czechoslovakia)

Spodnokřídové stopy vrtavých organismů ze Štramberka (Czech summary)

(*6 text-figs., 10 plates*)

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Traces of boring organisms have been found at the locality Štramberk (northern Moravia, Czechoslovakia) on the walls of fissures of the Štramberk Limestone, on boulders of the fissure filling and in bioclasts. The rich assemblage includes the ichnotaxa *Circolites kotoucensis* ichnogen. et ichnosp. nov., *Entobia solaris* ichnosp. nov., *E. astrologica* ichnosp. nov., *E. laquea*, *E. megastoma*, *E. ovula*, *E.* aff. *ovula*, *E. paradoxa*, *E. retiformis*, *Gastrochaenolites* ichnosp. A, ichnosp. B, *Planavolites homolensis* ichnogen. et ichnosp. nov., *Rogerella pattei*, *Trypanites* ichnosp., ?echinoid grooves, ichnogen. et ichnosp. indet. The walls of narrow deep fissures, which developed in the Early Cretaceous in an elevation built up predominantly of the Štramberk Limestone (Tithonian – lower Berriasian) represented an environment of exceptional physical parameters (insufficient illumination). This gave rise to borings of unusual morphology (shallow subsurface character of camerate *Entobia* forms).

Introduction

The Štramberk locality (northern Moravia, Czechoslovakia) is one of the tectonically isolated huge limestone bodies of late Jurassic to early Cretaceous age. The richness of fossil finds, intricate sedimentological history and tectonics have been the subject of many-years' palaeontological and geological investigations (Zittel 1868, Remeš 1904, Houša 1964, 1965, 1974, 1983, 1987, Eliáš - Stráník 1963 et al.). The most detailed and most comprehensive are the works of Houša, which provide a complete conception of the unusually complicated geological development of the Štramberk Limestone bodies and the sedimentary units accompanying them. The accumulation of the Štramberk Limestone (Tithonian, lower Berriasian) on the top of the Baška elevation, formed dominantly of bioherm detritus, was emerged three times in the late Berriasian and Valanginian during eustatic movements, and was affected by fracturing and karstifying. During the rising of water level the limestone boulders, the walls of deep and narrow fissures, and block surfaces served as rock substrates. At the present time they make it possible to study a number of various phenomena (types of abrasion and erosion, epibiont assemblages, stromatolitic crusts, sedimentation of micritic limestones, boring of animals), which contributes to the knowledge of the history of Štramberk Limestone bodies. Houša (1992) described in detail and interpreted these features of fossil surfaces of the Štramberk Limestone. The objective of my paper is to contribute to this description by a systematic compilation of boring traces.

Acknowledgement. I am obliged to Dr. V. Houša (Geological Inst. Czech Acad. Sci., Praha) for introducing me in the problems of the theme, for information about his own field study results and ichnofossil finds, and for many useful comments and consultations.

Material and methods

The Kotouč quarry in Štramberk, from which all boring finds here described are derived, is a large, about 1000 m long and 300 m high exposure; with regard to this size several partial localities have been distinguished. In this paper a code system is used for individual fissures, layers, etc., which was applied by Houša (1992) and in his other written and published papers and reports.

Field investigations which led to discovering the traces of the activity of boring organisms were made by Dr. Houša together with Dr. O. Nekvasilová, Dr. J. Žítt and others during the years 1960–1990 and by the author in 1991. Small boulders and bioclasts bearing borings from the fissures have been deposited in the collections. This simple process, however, could be used in the case of borings from the walls of fractures and large boulders only sporadically, because they were by no means available for their preparation from the compact limestone mass. (The field work is complicated by limestone quarrying, inaccessibility of occurrences in the walls of quarry levels and slumping of blocks along fissures and fracture filling). A substantial part of borings has therefore been documented in situ by measuring, drawing, photographs and latex casts. Latex casts and current methods of preparation have also been used for materials deposited in collections.

Foregoing investigations

Houša (1974) described and pictured epibionts and borings from the boulders at locality Š-12, but he did not designate these borings by formal ichnotaxonomic names. (The modern literature dealing with this problem did not exist at that time). Houša (1974) distinguished five morphological types of borings:

1. Large depressions 2–6.5 cm in diameter, broadly of rounded outline, with somewhat irregular bottom. Its rounded hollows were probably produced by organisms consuming the cover of microorganisms living on the rock surface.

These depressions are called by formal ichnotaxonomic name and in the systematic part are described as *Planavolites homolensis* ichnogen. name and ichnosp. nov.

2. Approximately hemispherical depressions, many subcircular, mostly 4 to 9 mm in diameter and 2 to 5 mm deep.

They obviously represent in part *Gastrochaenolites* ichnosp. B and in part open chambers of camerate entobians.

3. Trough-shaped, roughly straight canals 2 to 4 mm broad and 1 to 3 mm deep, usually forming subparallel pairs.

Very probably we are concerned here with galleries of *Entobia megastoma* and partly with borings described as ?echinoid grooves.

4. Minute rounded passages to grooves about 5 mm in diameter and smaller, usually slightly curved, some of them dichotomously branched.

Undoubtedly, they are exploratory threads of diverse ichnospecies of entobians.

5. Fine pits and hollows, less than 0.1 mm in diameter, which give rise to the rugged rock surface. This structure is evidently the result of biogenic and chemical effects on the limestone.

Numerous descriptions of borings on boulder and fissure surfaces are also found in the manuscript field documentation of Dr. Houša, e.g. of *Entobia solaris,* termed as star-like boring from locality Š-84 (Houša 1992).

Houša (in Špinar. ed. 1965) pictured borings of cirripedians (*Rogerella*) in the rostrum of a belemnite from the filling of "První" fissure. The boring *Podichnus* ichnosp. in the shells of brachiopod *Lacunosella hoheneggeri* was described by Nekvasilová (1976).

Assemblages of borings from the Štramberk locality and their palaeoenvironmental significance

The assemblages of ichnofossils (borings) from hard substrates are designated as Trypanites ichnofacies (Frey and Pemberton 1984, Frey, Pemberton and Saunders 1990, and others). However, disregarding the fact that a great majority of hard substrates develops along the shore (rocky bottoms, very coarse-grain rocks, cliffs, limestone hardgrounds) this ichnofacies is predetermined by the type of substrate and not by the level of the physical energy of the environment in relation to bathymetry. A relevant attempt to bridge over this gap is the study of Bromley and D'Alessandro (1990), in which the shallow-water and abyssal borings are distinguished. One of in contrast,the conclusions of this study is that the shallow-water assemblages (*Entobia* in particular) are characterized by high diversity and thus a lower density of individual ichnotaxa; the deep-sea entobians display a low diversity and frequently a considerable density. Other ichnogenera show a different trend: in deep-sea environment both their density and diversity are limited.

In the Kotouč quarry the diversity of borings is best observable on huge boulders from the fissure fillings. In contrast, the fissure wall at the locality Š-84 contains a large number of *Entobia solaris* specimens and only sporadic other borings. Narrow fissures, several tens of metres deep were evidently an environment of special physical parameters (lower wave and current activity, little light) so that the conditions were similar to those of greater depths. The lack of light is probably the main reason of unusual morphology of the successors of *Entobia* on fissure walls (for details see the notes to *Entobia*).

The borings (in addition to the existence of rockgrounds and the presence of the appropriate organisms in the biocoenosis) demonstrate an essential difference between the walls of fissures and the surface of boulders, which were falling into fissures mostly from the shallow-water environment with a high physical energy and sufficient day-light. Borings on the boulders show different degrees of preservation, varying from abraded rounded forms to fresh and undamaged. In the former case the abrasion apparently occurred before the fall of the boulder into the fissure, whereas the good preservation is a result of a very short transport (fall) into the fissure and its rapid covering with sediments.

The scheme described is at the Štramberk locality often complicated by the presence of several generations of borings of different ichnotaxonomic composition and degree of preservation on one surface. The description and interpretation of these phenomena is the subject of the complex analysis of fossil surfaces (Houša 1992).

The conclusions that can be drawn from the study of borings are in good agreement with the above-mentioned idea of the geological development of the Štramberk Limestone bodies (Houša 1983).

Systematic part

Circolites ichnogen. nov.

1965 Echinoid borings; A. Radwański, p. 167
1969 Echinoid borings; A. Radwański, p. 137
1970 Echinoid borings; A. Radwański Pl. I, figs. a,b
1975 Echinoid borings; T. P. Crimes in R. W. Frey (ed.) Figs. 7, 2, p. 118
1979 Echinoid pits; F. T. Fürsich, p. 32, 36

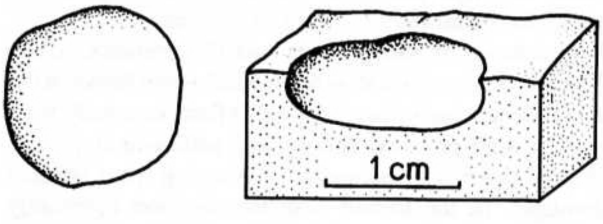
Type ichnospecies: *C. kotoucensis* ichnosp. nov.

Diagnosis: Shallow, roughly circular pits in carbonate substrates. The peripheral edge of the pit is sharp, the walls of the pit are perpendicular to or overhanging the substrate surface. The edges of some pits are undulated, the pit bottom is moderately concave. The diameter of pit is usually 10 to 40 mm, their depth 3 to 10 mm. They were formed by boring echinoids. The pits often occur in major groups, in some cases touching one another.
Occurrence: Jurassic to Recent.
Ichnospecies: only type ichnospecies.

Circolites kotoucensis ichnosp. nov.

Pl. IX, fig. 4; text-fig. 1

Synonymy: see the synonymy of the ichnogenus.
Type horizon and locality: Lower Cretaceous (late Berriasian, Valanginian); fissure wall at locality Š-84 in Kotouč quarry, Štramberk.
Holotype: Specimen pictured in Pl. IX, fig. 4, studied on a cast made in situ, deposited in author's collection (Geol. Inst. Czech Acad. Sci.), no. RM 006.
Material: 15 finds (collected or documented by casting or photographed in situ) at localities Š-84 (boulders from the filling and wall of the fissure) and Š-53 (boulder from the fissure filling).



1. *Circolites kotoucensis* ichnogen. et ichnosp. nov. Schematic drawing after the specimens from Š-84 locality (the wall of fissure)

Description, occurrence: see the diagnosis of the ichnogenus.
Remarks: Borings of echinoids designated as "echinoid pits" or "echinoid borings" have not yet been denoted by the formal ichnological name. In my opinion, however, this formal designation is quite justified in respect of the characteristic morphology and relatively abundant occurrence.

Entobia Bronn, 1837

D i a g n o s i s : Borings in carbonate substrates consisting of single chambers or of a network, more often boxwork of chambers and galleries connected to the surface by several or numerous apertures. Morphology changes markedly with ontogeny. During the growth the galleries gradually increase their diameter; in other (camerate) forms inflation produces closely interconnected chambers in regular distances. In other forms the chamber development is restricted to early ontogenic stage. There are also forms in which no cameration is developed. The surface of borings is covered with cuspate microsculpture, which may be absent in gerontic specimens. Fine apophyses (initial form of exploratory threads) arise from all or most surfaces in the system (Bromley and D'Alessandro 1984).

R e m a r k s : Compared with the material described by Bromley and D'Alessandro (1984, and others) from the Miocene, Pliocene and Pleistocene of southern Italy, a high percentage of entobians in Štramberk, particularly from fissure walls, has a pronouncedly surface character – the boring was developing mainly at the level of substrate surface (see text-fig. 4). Most chambers open widely towards the surface and exploratory threads usually follow the substrate surface; the entire boring then shows a character of negative relief. This conclusion is not a result of a less perfect technique of boring casting relative to the work of Bromley and D'Alessandro (1984); the small vertical articulation of borings from fissures has been verified several times on rock fracture. The small vertical size also concerns the ichnospecies which in other morphological features agree with those described by Bromley and D'Alessandro (1984, 1989). In my opinion, the cause of this phenomenon is most likely the deficiency of day-light in deep and narrow fissures, which limited the occurrence of predators common in shallow-water environment. The long-time existence of fissures led then to the development of unusual, energetically more advantageous mode of boring. This explanation is also supported by the fact that entobians from boulders which fell into the fissures have more often the character of common inner boring (see text-fig. 3). Bromley and D'Alessandro (1984, p. 230–232) also mention the possibility of day-light effect on the morphology of entobians. Another plausible reason may be the steep inclination of the substrate in fissures.

I c h n o s p e c i e s represented at the Štramberk locality: *E. solaris* ichnosp. nov.; *E. astrologica* ichnosp. nov.; *E. laquea* Bromley and D'Alessandro, 1984; *E. megastoma* (Fischer, 1868); *E. ovula* Bromley and D'Alessandro, 1984; *E.* aff. *ovula, E. paradoxa* (Fischer, 1866); *E. retiformis* (Stephenson, 1952).

Entobia solaris ichnosp. nov.

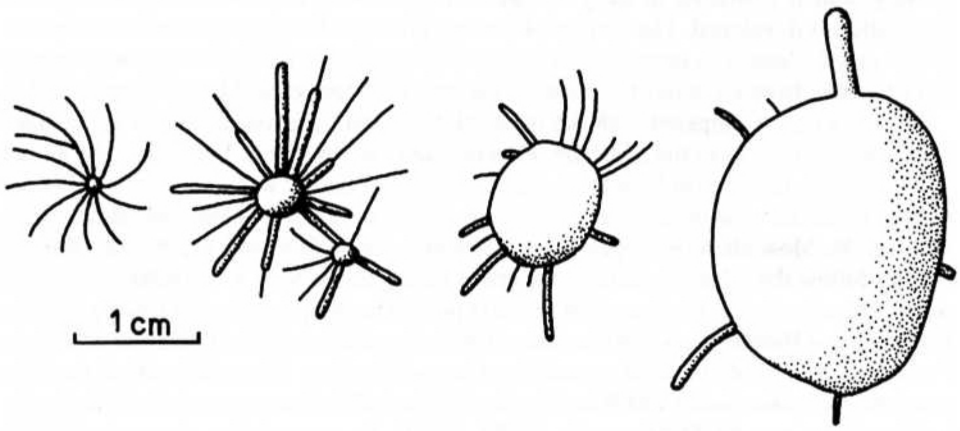
Pl. I, figs. 1–6; Pl. II, figs. 3–6; Pl. III, fig. 6, Pl. IV, figs. 1–6; text-fig. 2

H o l o t y p e : specimen figured on Pl. II, fig. 3, deposited in the collections of National Museum, Prague, no. O 5955.

T y p e h o r i z o n and l o c a l i t y : Lower Cretaceous (Upper Berriasian, Valanginian); fissure wall at locality Š-84 in Kotouč quarry, Štramberk.

M a t e r i a l : More than 30 specimens documented in situ (photographs, latex cast) or deposited in collections.

D e s c r i p t i o n : System of borings consisting usually of one chamber (of 5 chambers at the most) of spherical or hemispherical form of straight, or moderately curved, exceptionally branching exploratory threads. The chamber (or chambers) is immediately connected with the environment by a broad aperture whose diameter is generally about one half that of the chamber. In hemispherical chambers the apertures and chambers have diameters of the same size. From the aperture the exploratory threads run radially, following the surface of the substrate. There are usually 5 to 20 in number. In case they are straight, Pl. I, figs. 1, 4, the boring has a star-like shape. They are, however, regularly bent (from the chamber to the margin of the boring and all turn either to left or right) and the boring is then of a "weather-cock" shape. Exploratory threads and chambers of small



2. *Entobia solaris* ichnosp. nov. Schematic drawing of the presumed growth phases after the specimens from Š-84 locality (the wall of fissure and the boulder from fissure filling)

or minute diameters represent the growth phase A. During the further growth the diameter of the chamber increases and the exploratory threads are "rebored" to a larger common width. The specimen in Pl. I, fig. 4 demonstrates that the "re-boring" to a larger diameter is not gradual but it occurs at a time, from the chamber towards the ends of threads. This growth of boring I regard as equivalent to growth phases B–D of Bromley and D'Alessandro (1984). The concluding phase E is probably represented by specimen on Pl. III, fig. 6: huge hemispherical chamber, which "consumed" the major part of the surrounding exploratory system.

If there are more than one chamber in the specimen, these are interconnected by exploratory threads and later by wider passages (Pl. I, fig. 6; Pl. IV, fig. 5).

The diameter of chamber (chambers) in early growth phases is 1–2 mm, in the supreme stage (Pl. II, fig. 6; Pl. III, fig. 6) 15–25 mm. The diameter of the whole on-chamber boring, including exploratory threads usually ranges from 10 to 30 mm.

R e m a r k s : *Entobia solaris* ichnosp. nov. differs essentially in morphology from other entobian ichnospecies, i.e. in its apparently simple star-like shape, which offers a number of interpretations. The study of a large amount of material, however, allowed to document the existence of growth phases typical of entobians. The uniform "weather-cock" bending of exploratory threads in some individuals demonstrates that the boring is the product of one single organism and that it is not of the "*Trypanites* type" (= exploratory threads), i.e. a chamber reworked by invading organisms (as it is known e.g.in chambers bored by pelecypods). The borings of *E. solaris* having several chambers are morphologically more allied with other entobians and thus complement suitably the wide range of entobian morphology. It should be added that all entobian specimens from locality Š-84 (fissure wall) have a surface character. It cannot be excluded that at another locality with different physical parameters of the environment *E. solaris* would have another morphology with a larger portion of vertical components. In this way it would approach other, usually one-chamber entobians (e.g. *E. gigantea* B. and D'A. 1989, *E. magna* B. and D'A. 1989).

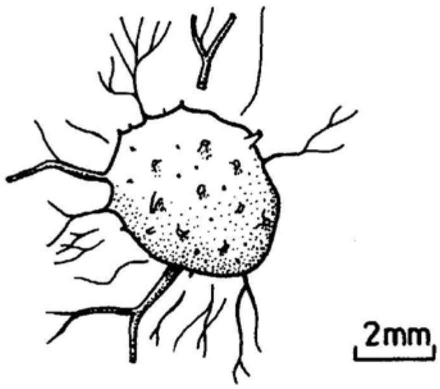
Entobia astrologica ichnosp. nov.

Pl. VIII, fig. 3; text-fig. 3

Holotype: Specimen on Pl. VIII, fig. 3 (the cast is in author's collection in Geol. Inst., Czech Acad. Sci., Prague; no. RM 018).

Type horizon and type locality: Lower Cretaceous (upper Berriasian to Valanginian); boulder from the fissure filling, below Š-84 locality, Kotouč quarry at Štramberk.

Material: Four specimens were studied in situ at the type locality, latex casts were made of three of them.



3. *Entobia astrologica* ichnosp. nov. Schematic drawing after five specimens known so far from Š-84 locality

Description: A system of borings consisting of one chamber widely open towards the surface and a dense network of exploratory threads. The chamber is roughly spherical or ellipsoidal, but it does not show a geometrical regularity, which is characteristic of the early stages of *E. solaris*. The size of chambers ranges from 2.5 to 11 mm. Exploratory threads run zig-zag and are roughly radial. They either start from the aperture or from the whole surface of the chamber even into the substrate. The threads abundantly ramify dichotomously ("chondritically"). Their diameter varies between 0.1 and 0.5 mm and in some cases it decreases gradually from the chamber to the proximal end. The small number of finds does not permit to distinguish the individual growth phases and to discuss the variability of individual ichnospecies in more detail either.

Remarks: *E. astrologica* differs from *E. solaris* in a less regular shape of the chamber. The exploratory threads differ in their zig-zag course, ramifying and their presence within the substrate. From another form, one-chamber *E. gigantea* Bromley and D'Alessandro 1989, our form differs in smaller dimensions and the existence of a prominent chamber even in earlier ontogenetic stages (in *E. gigantea* a marked oval chamber is constituted as late as in phase D).

Entobia laquea Bromley and D'Alessandro, 1984

Pl. III, fig. 6; Pl. V, fig. 1; Pl. VIII, fig. 1; Pl. X, fig. 1

Material: Five boring systems on a huge boulder from the fissure filling at locality Š-84, studied on latex casts made in situ.

Description: Camerate boring, in the highest stage (phases C–D) formed of very minute smooth chambers, widely open towards the surface, interconnected by their protrusions. The chambers build upshort arcuate or closed chains, which produce a "lace-like" form of the boring. The A and B growth phases are well developed as prominent branched exploratory threads with inflations at the sites of the future chambers. The usual size of chambers is 0.7–2 mm and of the systems 35 mm.

Remarks: The boring described agrees in morphology completely with *E. laquea* described by Bromley and D'Alessandro (1984).

Entobia megastoma (Fischer, 1868)

Pl. VII, fig. 4; Pl. VIII, fig. 2

Material: One extensive boring system on a small boulder (5 × 7 × 13 cm) from the fissure filling beneath locality Š-84.

Description: Non-camerate boring composed of an irregular boxwork system of galleries widely open towards the surfaces. Galleries are roughly cylindrical usually 2–5 mm in diameter and often ramifying. Their surface is smooth, occasionally with pits (nodes on the casts) c. 1 mm in diameter. Exploratory threads (growth phase A) are almost lacking, galleries of different diameters represent growth phases B–D. The maximum dimension of the whole system of borings almost agrees with that of the boulder (13 cm).

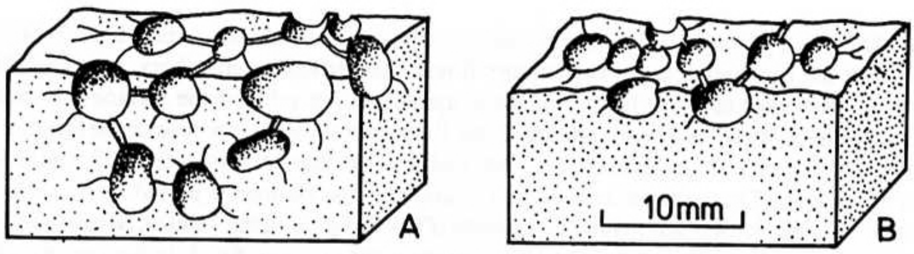
Remarks: The boring described coincides with *E. megastoma* as was described by Bromley and D'Alessandro (1984).

Entobia ovula Bromley and D'Alessandro, 1984

Pl. III, figs. 1, 4; Pl. V, figs. 3, 4; Pl. VI, figs. 3, 4; Pl. IX, fig. 1; Pl. X, figs. 2, 6; text-fig. 4

Material: 15 boring systems (studied mostly from latex casts made in situ) from a boulder in the fissure beneath Š-84, from the wall of Š-84 fissure, from a boulder under Š-85 and from the clasts derived from the filling of a fissure at locality Š-12.

Description: Camerate system of borings formed of chambers roughly of spherical or oval shape and usually of a thin network of curved, little branching exploratory threads. The chambers are mostly 3–7 mm large, in the highest growth stage (phase D) closely crowded and touching one another. In the preceding growth stage (phase C) they are connected by short intercameral canals 0.5–0.8 mm in diameter. The surface of chambers is smooth, here and there with very fine apophyses. At Š-84 locality (wall of the fissure) the exploratory threads follow the substrate surface freely communicating with the environment (text-fig. 4B). At other localities, if the vertical dimension of the boring on rock fractures was examined, the presence of chambers and corresponding boxwork of exploratory threds has been assessed up to 10 mm under the substrate surface (text-fig. 4A). These chambers and threads are generally filled with clear crystalline calcite.



4. *Entobia ovula* Bromley and D'Alessandro, 1984. Schematic drawing. A. Specimen from the boulder fallen down the fissure (Š-85 locality); B. Specimen from the wall of fissure (Š-84 locality)

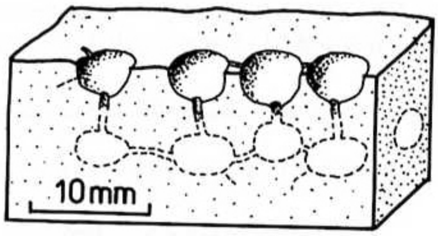
Remarks: The finds described agree completely in the form, size, arrangement of chambers and similarity of growth phases with *E. ovula* as it has been described by Bromley and D'Alessandro (1984) from the Miocene, Pliocene and Pleistocene of southern Italy.

Entobia aff. *ovula* Bromley and D'Alessandro, 1984

Pl. III, fig. 3; Pl. V, fig. 2; Pl. VIII, fig. 4; text-fig. 5

Material: Four finds on a huge boulder from the fissure filling, locality Š-84, studied on latex casts made in situ.

Description: Boring systems consisting of a small number (1–4) chambers widely open to the surface, and sporadic, chaotically dispersed exploratory threads (growth phase A is suppressed). Chambers, if more numerous, are arranged in a line (Pl. V, fig. 2) or in a close cluster (Pl. III, fig. 3). Their dimension and form agree with the taxon described above, *E. ovula*. From the basal part of every chamber runs out a canal, 0.6–0.8 in diameter, perpendicularly into the substrate. We are concerned here probably with intercameral canals trending to other chambers in the limestone boulder. The presence of these chambers, however, by preparation of the boulder by technical means was not possible.



5. *Entobia* aff. *ovula* Bromley and D'Alessandro, 1984. Schematic drawing after the finds from Š-84 locality (boulder from the fissure filling). Assumed parts of boring by a stroked line

Remarks: The finds described agree in clustering, the size and form of chambers, and in the suppression of early growth phases with *E. ovula*, as it is described above. They differ from it in a small number of chambers and are therefore designated provisionally as *E.* aff. *ovula*.

Entobia paradoxa (Fischer, 1866)

Pl. VII, figs. 1–3

Material: Four boring systems documented in situ on the wall of fissure Š-84.

Description: Camerate system of surface and closely subsurface borings composed of the horizontal net of exploratory threads and irregular chambers, very broadly of oval, often even amoebic form. Numerous apophyses extend from the surface of chambers in all directions. The growth phases A and B are represented by a very dense labyrinth of exploratory threads, locally inflating into embryos of chambers (Pl. VII, fig. 3, on the left). Phases C and D are shown as chambers contacting one another or joined by short threads or by longer, thicker intercameral channels (Pl. VII, fig. 3; in the centre). Some neighbouring chambers unify, constituting bizarre formations (Pl. VII, fig. 2; in the centre). Phase E is lacking. The usual size of chambers is 1–3 mm, the size of the whole systems 10–40 mm.

Remarks: The systems described can be identified with *E. paradoxa*, as it was described by Bromley and D'Alessandro (1984). The only difference consists in that their specimens generally have the chambers in two tiers under the surface, whereas the Štramberk systems have horizontal near surface structure.

Entobia retiformis (Stephenson, 1952)

Pl. II, fig. 1

Material: The only find from the wall of fissure Š-84 (studied on latex cast prepared in situ).

Description: Camerate boring of surface character (analogously to most finds on the wall of Š-84 fissure). The highest growth phase C is formed of a tier of six small oval smooth chambers which touch each other or are connected by very short constrictions. The chambers in the middle of tiers are larger (2.5 mm) than the marginal (1.2 mm). The tier continues sideways by slightly curved exploratory thread, 0.5 mm wide. From the largest chamber of the specimen lead roughly perpendicularly to the centre of the tier thin exploratory threads with one well developed small chamber and one chamber in the initial state (growth phases A–B). The length of the whole specimen 14 mm.

Remarks: The single find agrees in the presence of minute blister-like chambers and the morphology of growth phases A–B with *E. retiformis*, as it was described by Bromley and D'Alessandro (1987) from the Pliocene to Pleistocene of southern Italy.

Gastrochaenolites Leymerie, 1842

Synonymics, diagnosis: See Kelly and Bromley (1984).

Gastrochaenolites ichnosp. A

Pl. X, fig. 6

Material: Three finds from locality Š-84 (large boulder in the fissure filling) documented in situ by latex casts.

Description: Ball-shaped boring with big aperture and suppressed neck region. The chamber is egg-shaped, divided by a shallow narrow groovers or low ridge into two halves symmetric along the plane containing the longer axis of the chamber. The dimensions of the boring pictured on Pl. X, fig. 6: depth 8 mm, width of the chamber 9 mm, length 12 mm.

R e m a r k s : The small amount of material does not allow the ichnospecies classification. The appurtenance to the ichnogenus *Gastrochaenolites* follows from the overall shape of the chamber and its longitudinal division into two halves, which reflects the symmetry of its maker (pelecypods *Gastrochaena* and others, see e.g. Kelly and Bromley 1984). This longitudinal division of the chamber is characteristic e.g. of *G. cor* Bromley and D'Alessandro 1987, *G. cluniformis* Kelly and Bromley 1984, *G. dijugus* Kelly and Bromley 1984 et al.

Gastrochaenolites ichnosp. B

Pl. VI, figs. 3, 4

M a t e r i a l : Several tens of finds from localities Š-84 (boulders from the fissure filling, sporadically from the wall), Š-6, Š-12, Š-53, Š-69 (boulders).

D e s c r i p t i o n : Borings of wide ball, spherical drop- or cherry stone-like shapes, usually with a wide aperture, often closely crowded, overlapping, damaged by erosion and further boring. The normal size of chambers is 3–12 mm, the surface is smooth.

R e m a r k s : The ichnospecies classification of these borings of simple shape, variable dimensions and often incompletely preserved on the basis of the material is difficult. Similar material from other formations and localities has been described e.g. by Radwański (1970), Bromley (1975), Fürsich (1979). In some cases (chiefly in secondarily damaged borings), however, it is difficult to say whether they are not only fragments of camerate entobians.

Planavolites ichnogen. nov.

D i a g n o s i s : Flat, considerably large depressions of irregular oval or very elongated form, occurring on the surface of a firm limestone substate. The outline is undulated, sometimes lobate, even with pointed prejections. The bottom is rounded, more or less smooth, in some individuals with flat protrusions or depressions. The walls are usually steep, perpendicular or slightly overhanging; borings often occur in large groups. The usual dimension at the surface of the substrate is c. 50 mm, depth 10–15 mm.

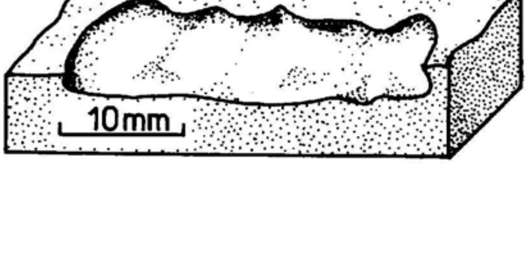
Planavolites homolensis ichnosp. nov.

Pl. IX, fig. 5; text-fig. 6

H o l o t y p e : Specimen on Pl. IX, fig. 5 (the cast is deposited in the author's collection, Geol. Inst. Czech Acad. Sci., (no. RM 037).

T y p e h o r i z o n and l o c a l i t y : Lower Cretaceous, upper Berriasian to Valanginian (boulder from the filling of fissure Š-84, Kotouč quarry in Štramberk).

M a t e r i a l : Five finds are available (boulders, casts) from Š-84, Š-85 and a boulder below Mezikra block and, in addition, descriptions of former occurrences at localities Š-12 (Houša 1974) and Š-65 (Houša 1992).



6. *Planavolites homolensis* ichnogen. et ichnosp. nov. Schematic drawing after two specimens from the "Mezikra" block

D e s c r i p t i o n : See diagnosis of the ichnogenus. Horizontal dimensions of borings from the Kotouč quarry range from 10 to 95 mm (Houša 1992).

R e m a r k s : The boring was described and interpreted by Houša (1974, 1992) but it has not been named either formally or unformally. According to Houša (1992), the maker of the boring was obviously an organism gnawing at algae on the limestone. A plot with a smoothed surface suitable to consumation of algae could have been extended by several generations. It may be assumed that even several individuals of makers – chitons, gastropods, echinoids – were living in larger borings.

Rogerella Saint-Seine, 1951
Rogerella pattei (Saint-Seine, 1954)

Pl. X, fig. 1; Pl. III, fig. 5

M a t e r i a l : Rostrum of belemnite with about 90 borings *R. pattei* from the filling of the "První" fissure. One find documented by latex cast from a huge boulder beneath locality Š-84.

D e s c r i p t i o n : Minute borings of almond shape with slot-like aperture. The longer axis trends diagonally into the substrate. The specimens on the rostrum of belemnite (Pl. III, fig. 5) are subparallel with the rostrum axis and their number is roughly the same over its whole surface (the apertures are usually 1–2 mm apart). The dimensions of these individuals: the depth of boring 0.6–1.8 mm, length (in the direction of aperture) 1.5–3.0 mm, width <1 mm, length of the aperture 0.5–2.0 mm. The boring walls are smooth.

Borings of the same morphology and somewhat larger dimensions occur individually also on other surfaces. A specimen was documented by latex cast on a boulder below locality Š-84 (Pl. X, fig. 1). It is 6 mm deep, 4 mm long and 1.2 mm broad.

R e m a r k s : Houša (in Špinar 1965) pictured the above-described rostrum of belemnite with borings in Pl. X-107 as burrows of boring cirripedians of the order *Acrothoracica*. These organisms are generally regarded as tracemakers of *Rogerella* (Radwański 1970, Bromley 1975). The borings agree in their characteristic morphology, bulk occurrence and orientation with *R. pattei,* as it was described e.g. by Bromley and D'Alessandro (1987).

Trypanites Mägdefrau, 1932
? Trypanites ichnosp.

Pl. III, fig. 2

M a t e r i a l : A group of more than 100 tubular borings on an area of c. 2 × 2 cm, on a huge boulder below locality Š-84 (documented by latex cast in situ).

D e s c r i p t i o n : Surface of the Štramberk limestone covered with apertures of tubules directed diagonally or more or less perpendicularly into the substrate. Their diameter is 0.2–0.4 mm, their apertures are usually about 1 mm apart. To follow the course of the tubule inside the boulder is impossible because of its large size and compactness.

R e m a r k s : With respect to incomplete knowledge of the morphology of the finds, their assignment to the ichnogenus *Trypanites* (diagnosis, descriptions and figures see in Bromley and D'Alessandro 1987, Fürsich 1979 and other) must be regarded as provisional. It should be taken into consideration that similar circular apertures towards the firm substrate may be found even in other, morphologically more complicated ichnospecies *Conchotrema* Teichert, 1945, *Maeandropolydora* Voigt, 1965, maybe also *Entobia* Bronn, 1837.

? echinoid grooves

Pl. IX, figs. 2, 3

Material: Four finds documented by latex casts on a boulder below locality Š-84. Besides, some descriptions of former occurrences are available (Houša 1974, 1992).

Description: Straight or moderately curved grooves with rounded bottom on a boulder below locality Š-84 parallel with the substrate surface. Their width slightly varies or is stable (3–9 mm), the depth is 2.5–8 mm. The maximum length assessed is 9 cm. One groove is terminated by finger-shaped rounding (Pl. IX, fig. 3). The surface is more or less smooth, often damaged by further borings (exploratory threads of entobians a.o.).

Remarks: A boring of simple morphology may be produced by a number of makers. Frey and Pemberton (1984) figure a similar trace as an echinoid groove characteristic of the Trypanites ichnofacies.

ichnogen. et ichnosp. indet.

Pl. X, figs. 3, 4

Material: Three finds (documented by latex casts made in situ) from locality Š-84 (huge boulder from the fissure filling).

Description: Tubules 1.2–1.6 mm in diameter extend from two large chambers of entobians (? *E. solaris*, *E. astrologica*) into the substrate, approximately parallel with or moderately diagonally to its surface. They have an unusual multilobate "stump-shaped" widening of aperture. The length of tubules and their continuation into the substrate are unknown.

Remarks: In my opinion the borings represent dwelling structures of reliably indetermined organisms which inhabited the relinquished chambers of entobians. The explanation that these tubes are a component of the exploratory system of entobians does not seem reliable because a "stump-shaped" aperture has not yet been observed in any ichnospecies of entobians.

Translated by H. Zárubová

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Spodnokřídové stopy vrtavých organismů ze Štramberka

Stopy vrtavých organismů byly na lokalitě Štramberk (severní Morava) nalezeny na stěnách rozsedlin štramberského vápence, na balvanech z výplně rozsedlin a v bioklastech. Bohaté společenstvo zahrnuje ichnotaxony *Circolites kotoucensis* ichnogen. et ichnosp. nov., *Entobia solaris* ichnosp. nov., *E. astrologica* ichnosp. nov., *E. laquea*, *E. megastoma*, *E. ovula*, *E.* aff. *ovula*, *E. paradoxa*, *E. retiformis*, *Gastrochaenolites* ichnosp. A, ichnosp. B, *Planavolites homolensis* ichnogen. et ichnosp. nov., *Rogerella pattei*, *Trypanites* ichnosp., ?echinoid grooves, ichnogen. et ichnosp. indet. Stěny úzkých hlubokých rozsedlin, které vznikly ve spodní křídě v elevaci tvořené převážně štramberským vápencem (tithón – spodní berrias), představovaly prostředí s výjimečnými fyzikálními parametry (nedostatečné prosvětlení), které podnítily vznik vrteb neobvyklé morfologie (mělce podpovrchový charakter kamerátních forem ichnorodu *Entobia*).

Explanation of plates

Photos by the author. Deposition of material: O – palaeontological collections of the National Museum, Praha;

RM – author's collection in the Geological Institute, Czech Acad. of Sci., Praha; VH – collection of Dr V. Houša in the same institution.

Plate I

1–6: *Entobia solaris* ichnosp. nov.; latex casts made in situ; 1 – RM 005, ×2.0; 2 – RM 028, ×3.8; 3 – RM 012, ×2.6; 4 – RM 002, ×2.3; 5 – RM 007, ×2.5; 6 – RM 008, ×2.5. Early Cretaceous, Kotouč quarry near Štramberk, the wall of fissure at locality Š-84.

Plate II

1: *Entobia retiformis* (Stephenson, 1952); latex cast made in situ; RM 029, ×3.6.
2: *Entobia* ichnosp.; latex cast of early growth phase made in situ; RM 029 B, ×4.1. 3–6: *Entobia solaris* ichnosp. nov.; 3 – latex cast made from the collected sample; O 5955, ×2.5; 4–6 casts made in situ; 4 – RM 031, ×3.3; 5 – RM 003, ×2.4; 6 – RM 032, ×2.0. Locality Š-84, the wall of fissure.

Plate III

1, 4: *Entobia ovula* Bromley and D'Alessandro, 1984; latex casts made in situ; 1 – RM 002, ×2.6; 4 – RM 030, ×2.0. 2: ?*Trypanites* ichnosp.; latex cast made in situ, RM 026, ×3.5. 3: *Entobia* aff. *ovula* Bromley and D'Alessandro, 1984; cast made in situ; RM 017, ×3.6. 5: *Rogerella pattei* (Saint-Seine, 1954); surface and longitudinal fracture of a belemnite rostrum with borings; VH, ×2.3. 6: *Entobia laquea* Bromley and D'Alessandro, 1984, near the surface of a large chamber of *Entobia* cf. *solaris* ichnosp. nov.; cast made in situ; RM 014, ×1.7. Localities: 1–3, 6: Š-84, boulder from fissure filling; 2: Š-84, wall of fissure; 5 – filling of the "První" fissure.

Plate IV

1–6: *Entobia solaris* ichnosp. nov.; various morphological forms; field photographs; all ×2.8. Locality Š-84, wall of fissure.

Plate V

1: *Entobia laquea* Bromley and D'Alessandro, 1984; field photograph of the specimen whose cast is figured on Pl. X, fig. 1; ×2.5. 2: *Entobia* aff. *ovula* Bromley and D'Alessandro, 1984, field photograph, ×2.3. 3, 4: *Entobia ovula* Bromley and D'Alessandro, 1984; field photograph, ×2.5. Localities: 1–2: Š-84, boulder from fissure filling; 3–4: Š-84, wall of fissure.

Plate VI

1–2: Complex boring composed from the chambers, passages and exploratory threads of various entobian ichnospecies; field photograph; ×2.7. 3–4: Complex boring where the chambers of *Entobia ovula* Bromley and D'Alessandro, 1984 and *Gastrochaenolites* ichnosp. B predominate; field photograph; 3 – ×0.7; 4 – ×2.8. Locality Š-84, boulder from fissure filling.

Plate VII

1–3: *Entobia paradoxa* (Fischer, 1866); latex casts made in situ; 1 – RM 001 B, C; ×1.8; 2 – RM 001 A, ×2.4; 3 – RM 001 B, ×2.7. 4: *Entobia megastoma* (Fischer, 1868); latex cast of the collected specimen; VH, ×2.8. Localities: 1–3: Š-84, wall of fissure; 4: Š-84, small boulder from fissure filling.

Plate VIII

1: Complex boring containing a large chamber of *Entobia* cf. *solaris* ichnosp. nov., small oval chambers of *Entobia* cf. *ovula* Bromley and D'Alessandro, small irregular chambers of *Entobia laquea* Bromley and D'Alessandro, and the network of thin exploratory threads; latex cast made in situ; RM 014; ×1.4. 2: *Entobia megastoma* (Fischer, 1868); cast of the collected sample; VH; ×2.7. 3: *Entobia astrologica* ichnosp. nov.; cast made in situ; two chambers with radially arranged exploratory threads and a complex boring (namely exploratory threads of entobians); RM 018; ×2.6. 4: *Entobia* aff. *ovula* Bromley and D'Alessandro, 1984; cast made in situ; RM 020; ×1.8. Locality Š-84, boulder from fissure filling.

Plate IX

1: *Rogerella pattei* (Saint-Seine, 1954) (lenticular boring in the centre of figure) and *Entobia ovula* Bromley and D'Alessandro, 1984 (oval chambers); latex cast made in situ; RM 011; ×2.4. 2–3: ?echinoid grooves; casts made in situ; RM 015 and 016, ×2.1. 4: *Circolites kotoucensis* ichnogen. et ichnosp. nov.; latex cast made in situ; RM 006, ×2.4. 5: *Planavolites homolensis* ichnogen. et ichnosp. nov.; flat boring broken by fracturing and by original inhomogenity of the Štramberk Limestone; ×0.7. Localities: 1,4 – Š-84, wall of fissure; 2, 3, 5: Š-84, boulder from fissure filling.

Plate X

1: *Entobia laquea* Bromley and D'Alessandro, 1984; latex cast made in situ; RM 019, ×2.8. 2: *Entobia ovula* Bromley and D'Alessandro, 1984; cast made in situ; RM 004, ×2.6. 3, 4: Ichnogen. et ichnosp. indet., "stump-shaped" borings neighbouring with a large chambers of *Entobia* ichnosp.; cast made in situ; RM 023, ×3.1. 5: *Entobia* ichnosp.; chambers and network of exploratory threads on the surface of belemnite rostrum; latex cast of the collected sample; VH, ×2.6. 6: *Gastrochaenolites* ichnosp. A (large chamber in upper part of the figure) and *Entobia ovula* Bromley and D'Alessandro (smaller chambers with rare exploratory threads); cast made in situ; RM 021, ×2.9.

Localities: 1, 3, 4, 6 – Š-84, boulder from fissure filling; 2 – Š-84, wall of fissure; 5 – Š-12, filling of fissure.

RECENZE

A. Cendrero - G. Lüttig - F. Chr. Wolff (Edits.): **Planning the use of the Earth's surface.** – Lecture Notes in Earth Sciences, 42, 1–556. Springer, Berlin–Heidelberg–New York–London–Paris–Tokyo–Hongkong–Barcelona–Budapest, 1992.

Knížka je sborníkem příspěvků, přednesených na mezinárodním kolokviu v Santanderu ve Španělsku v roce 1989. Bylo pořádáno pod záštitou UNESCa za přispění řady komisí a subkomisí. Hlavní ekologická nebezpečí, která mohou postihnout lidstvo, jsou podle odborné literatury, tisku i sdělovacích prostředků tato: a) Nekontrolovaný růst lidské populace, b) oteplování podnebí a z toho vyplývající stoupání mořské hladiny, c) zvětšování tzv. „ozónové díry". Z vědeckých rozborů zcela jasně vyplývá, že technika by mohla zvládnout tzv. „skleníkový efekt" a potenciální oteplování, dodržování zákazu používání freonů by zamezilo růst ozónové díry, ale největším nebezpečím je rostoucí počet obyvatel planety. Z toho pak vyplývá nutnost používání větší a větší části zemského povrchu a všeobecná devastace. Proto je jedním z hlavních ekologických úkolů vědeckého plánování použití povrchu a všechny aspekty z toho vyplývající.

Sborník je rozvržen do pěti kapitol. První je úvodní a nastiňuje hlavní problémy zemského povrchu. Druhá kapitola se nazývá geoenvironmentální mapování, třetí se zabývá specifickými geofaktory životního prostředí. Ve čtvrté kapitole jsou shrnuta administrativní opatření a pátá kapitola je věnována syntézám. Z bohatého obsahu knihy vybereme některé závažnější aspekty, věnované především vztahu geologie a ekologie zemského povrchu.

Mapování geofaktorů je popsáno v pracích čtyř autorů. Většinou se zabývají obecnými záležitostmi, zajímavější jsou některé příklady použití různých měřítek pro mapování různých částí Evropy a Maroka. Velmi důležitá je propagace takových map a jejich používání neodborníky. S tímto problémem se ostatně setkáváme též u naší edice „padesátek" pro životní prostředí. Velmi důležité je grafické nastínění hierarchie mapování geofaktorů, včetně plánovacích orgánů a konzumentů. Práce zabývající se použitím počítačových metod zůstávají pouze na povrchu, právě tak jako diskuse metod dálkového průzkumu. Trochu podrobnější jsou příklady mapování geomorfologických rizik, kde jsou na přílohách ukázány různé možnosti grafického zobrazování. Práce o geologii velkoměst shrnuje bohužel jen nejdůležitější a nejpovšechnější zásady. Přitom tzv. „geologie velkoměst" je dnes velmi populární a oblíbenou disciplínou a je vydávána série monografií o geologii světových velkoměst. Ve výběru zatím převládají Spojené státy, ale zájem je i o evropské metropole. Z rizikových záležitostí je podrobnější článek věnován sesuvům. Svým detailním zpracováním se poněkud vymyká z rámce předchozích obecných konstatování. U geomorfologických analýz a rizik je i několik příkladů studií specifických oblastí, jako např. severního Španělska.

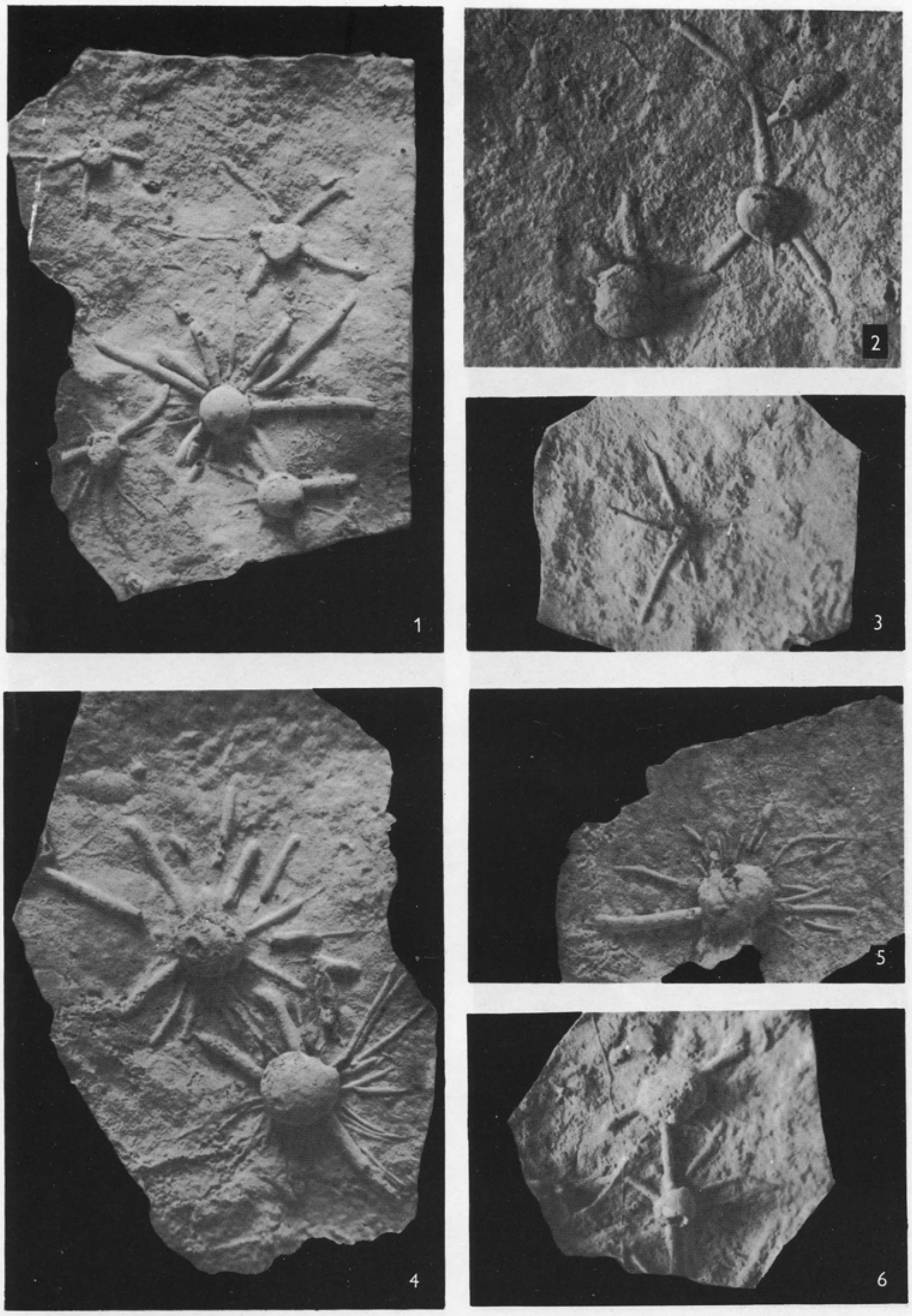
K podrobnějším rozborům patří i článek našeho B. Moldana o geochemii životního prostředí. Autor se soustřeďuje hlavně na problém sběru dat, na přenos materiálů a koncentraci různých součástí v půdách, biosféře i geologických materiálech. Zmiňuje se i o tom, co je jeho doménou, o malých povodích a významu jejich studia. V závěrečné kapitole se zabývá celkovou biologickou produkcí a vlivem člověka na biogeochemický cyklus.

Zajímavá je i následující práce o vztahu mezi geochemií a lidským zdravím. Autor vyvozuje, že geochemické mapování stopových prvků je nezastupitelné, zároveň však varuje před přílišným zjednodušováním vztahu stopové prvky – výskyty nemocí. Práce jednoho z editorů se zabývá exploatací nerudních surovin, jejich zpracováním a následným vlivem na životní prostředí. Nechybí ani rozbor výskytu surovin na mořském šelfu a jejich využití. Vazba na životní prostředí je v tomto článku příliš vykonstruovaná.

Závěrečné články se zabývají organizací výzkumu, některými doporučeními i výchovou, tj. např. postgraduálním studiem předmětu, pro který jsme našli název ekogeologie.

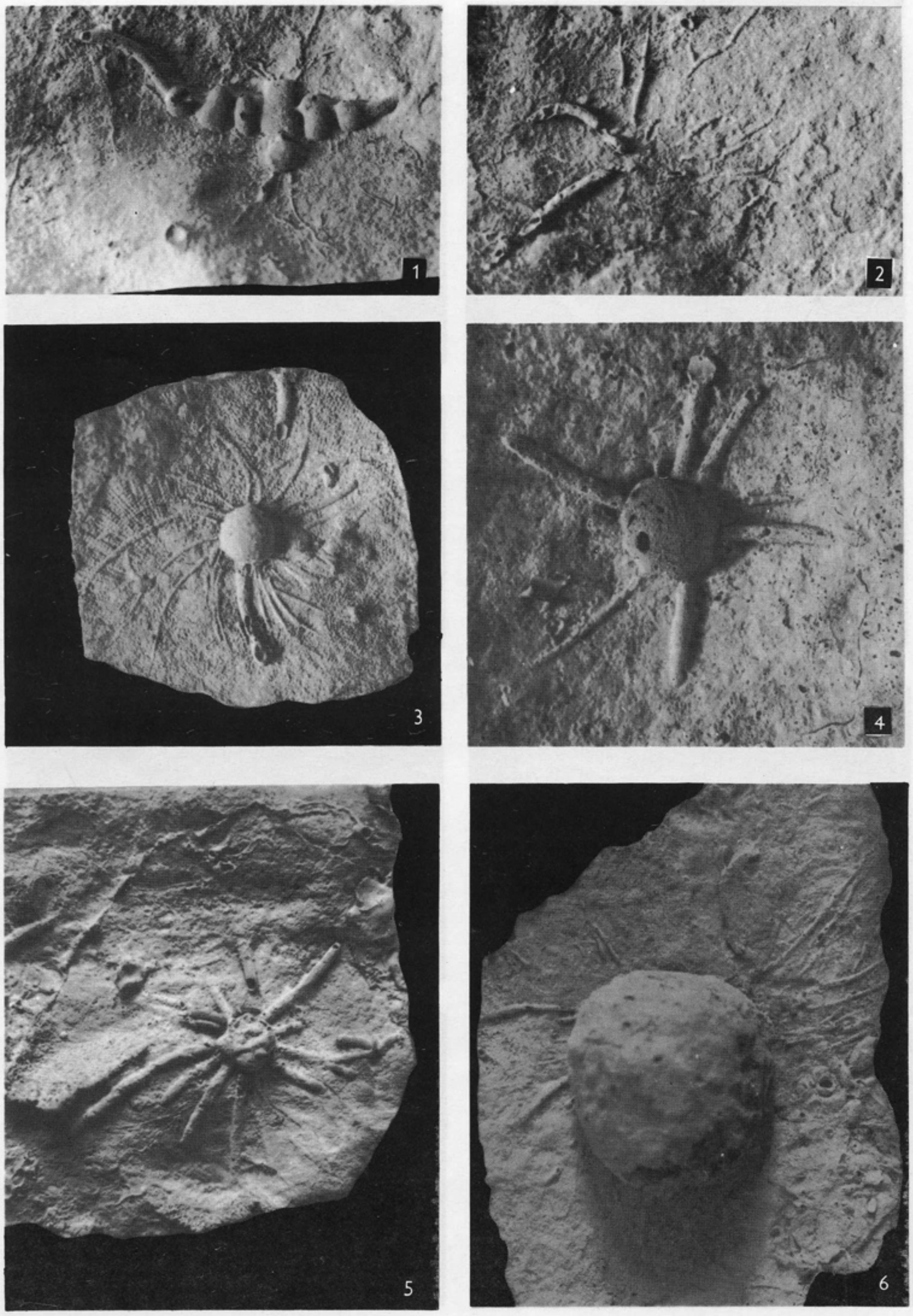
Knížka je velmi sympatická, odborníkům může však vadit příliš mnoho všeobecných konstatování na úkor čísel, dat a faktů. Jsem ale přesto přesvědčen, že patří do knihoven geologických ústavů, univerzit i mnoha dalších institucí, které například u nás působí v resortu ministerstva životního prostředí.

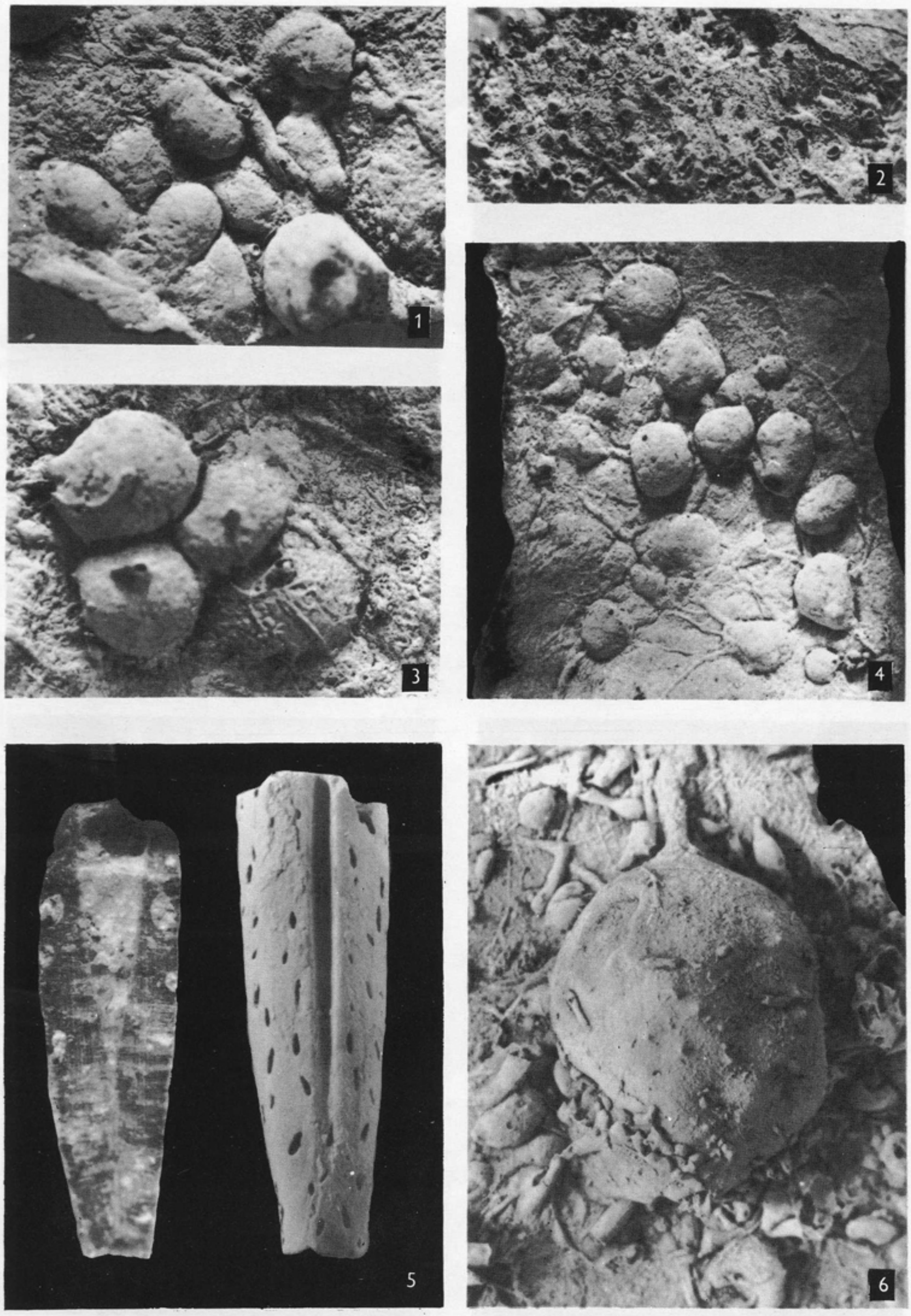
Zdeněk Kukal



For explanation see p. 310

R. Mikuláš: Early Cretaceous borings from Štramberk (Pl. II)

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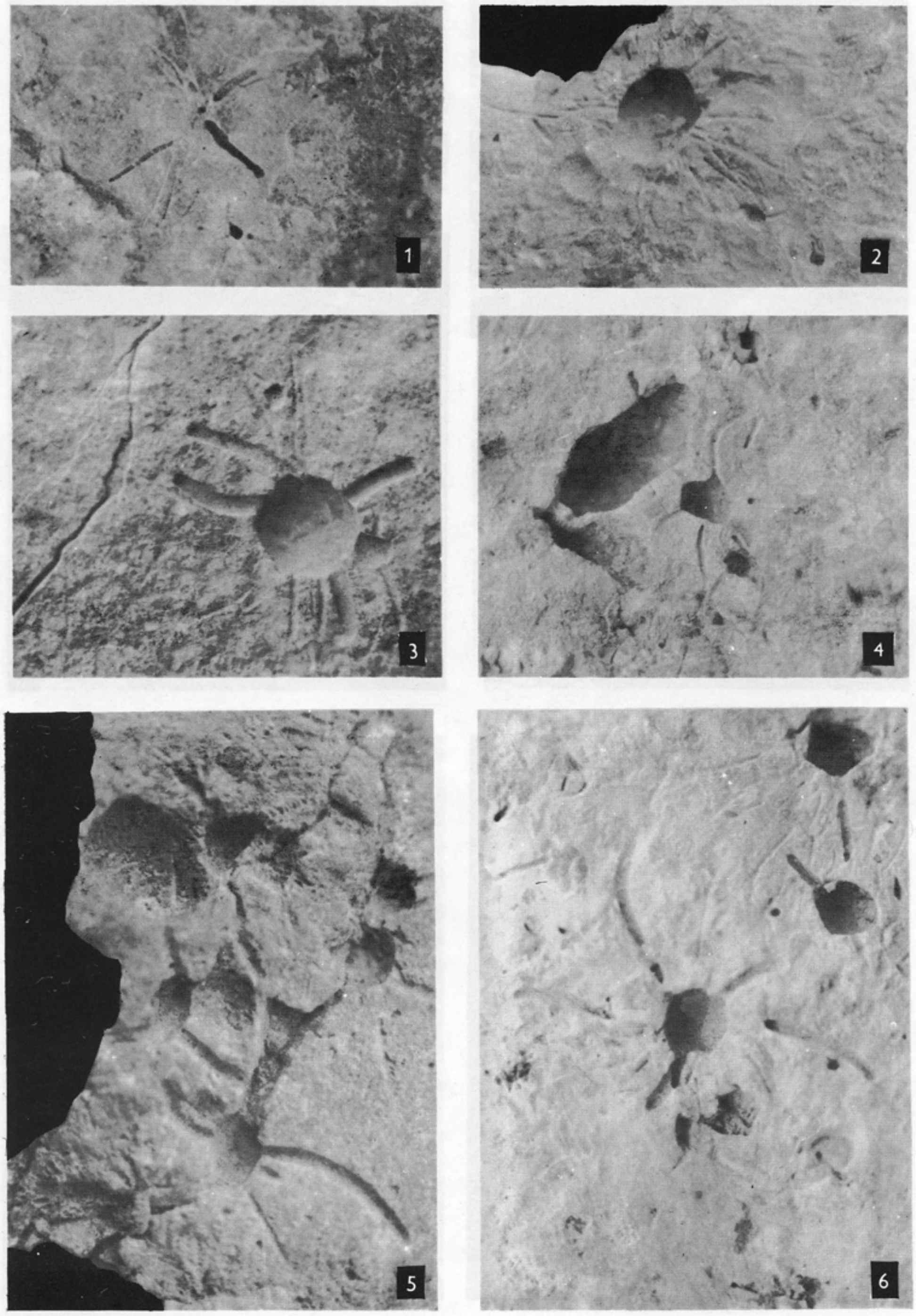
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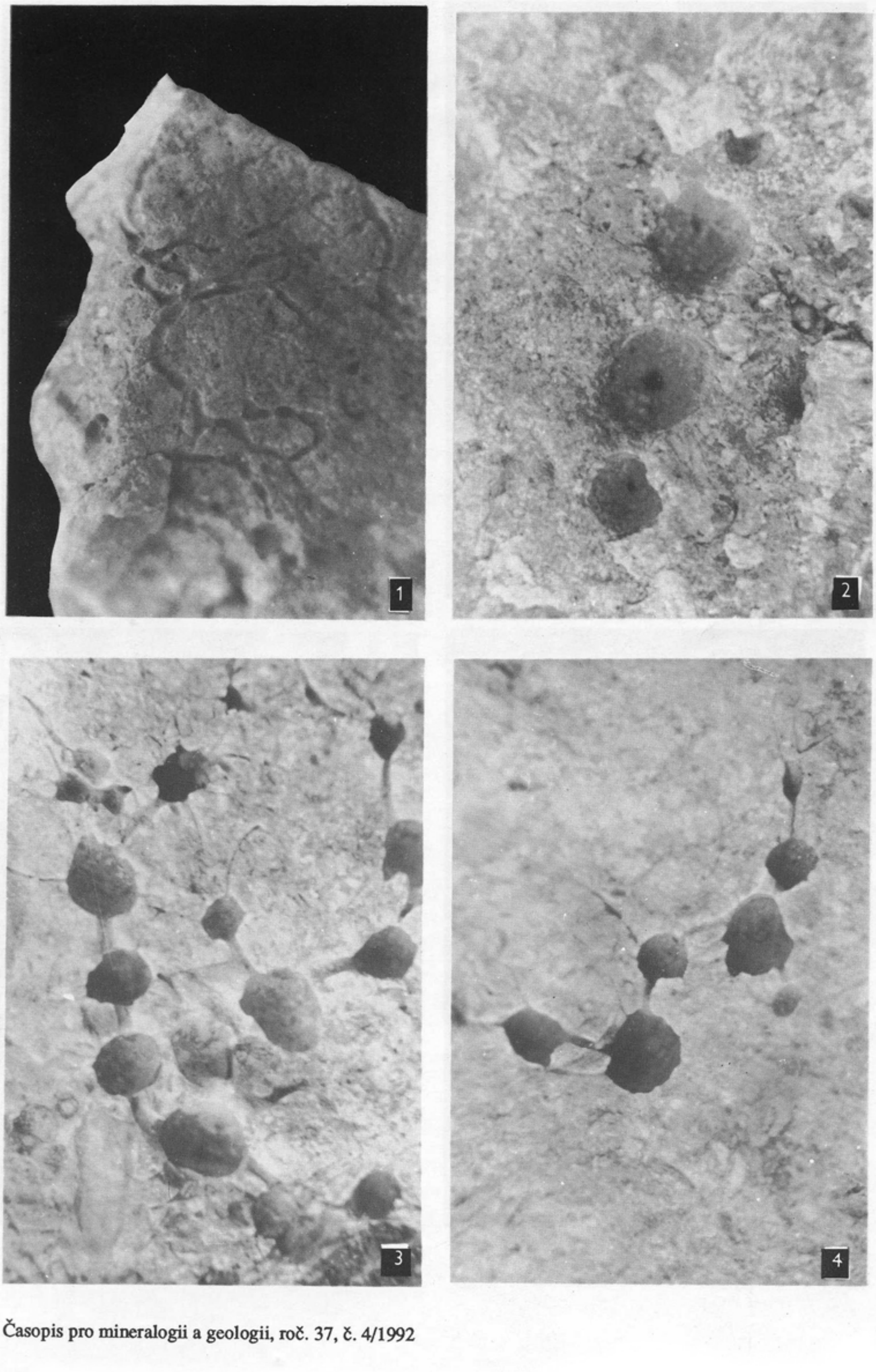
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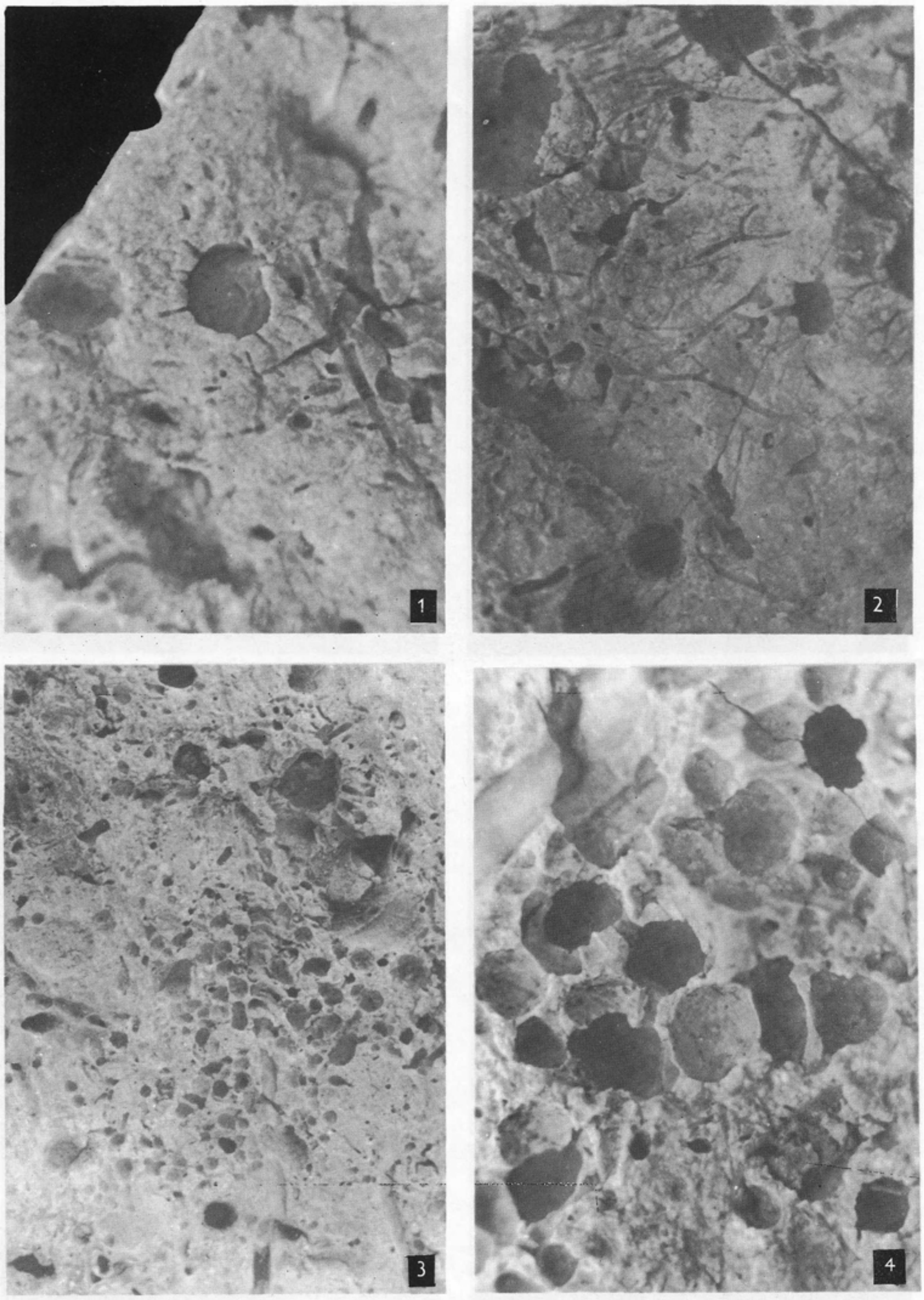
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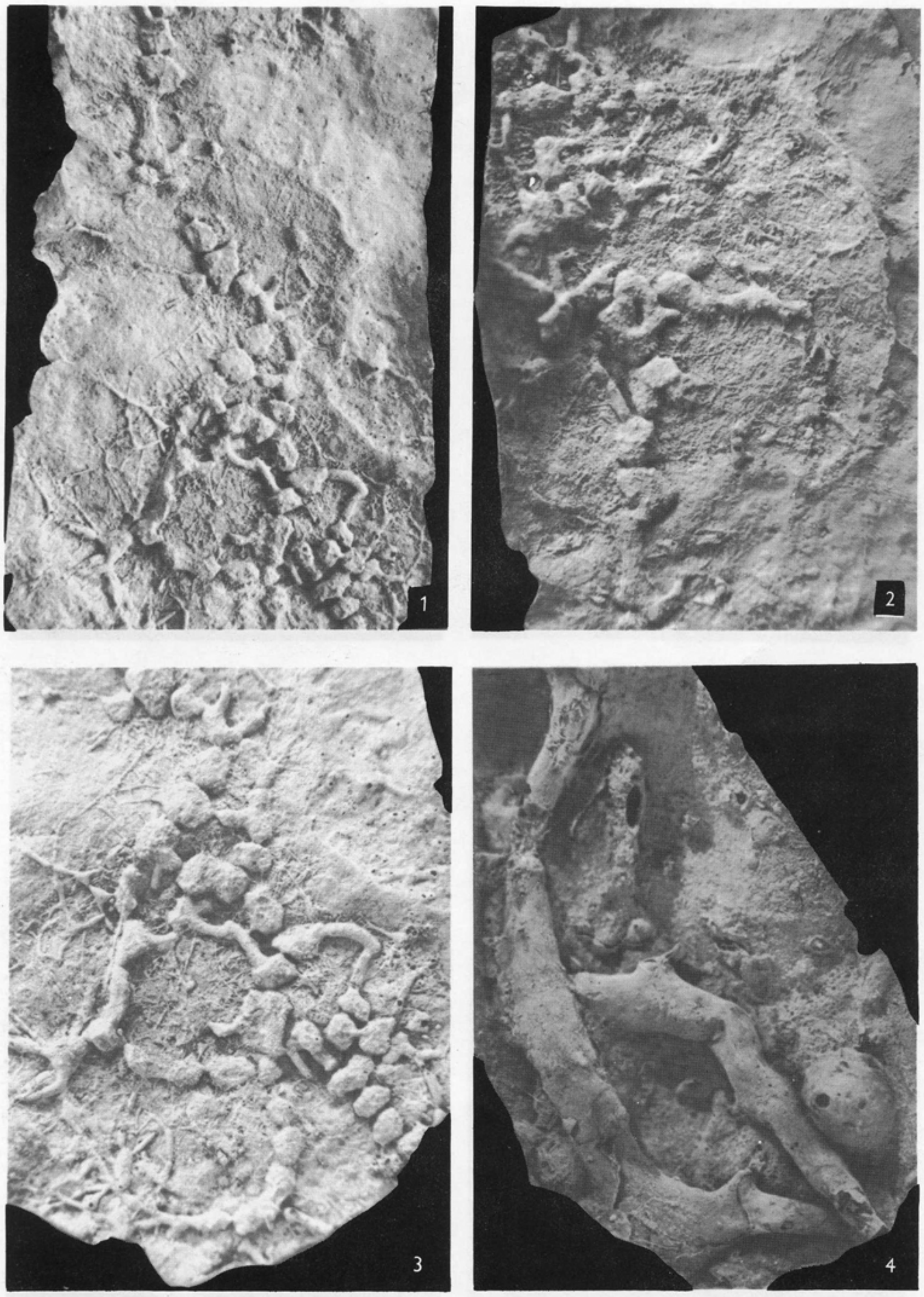
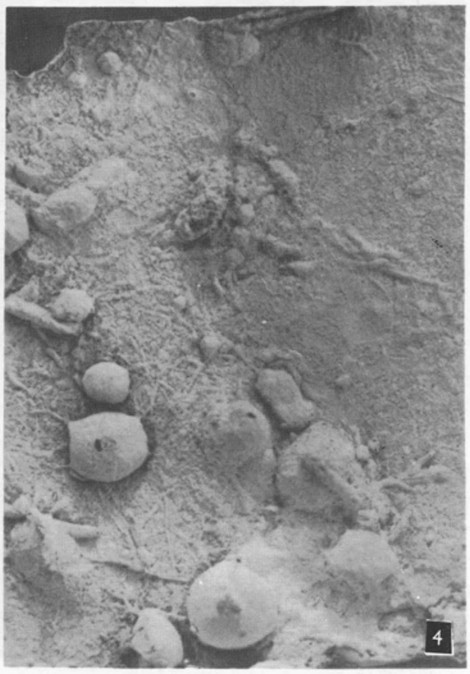
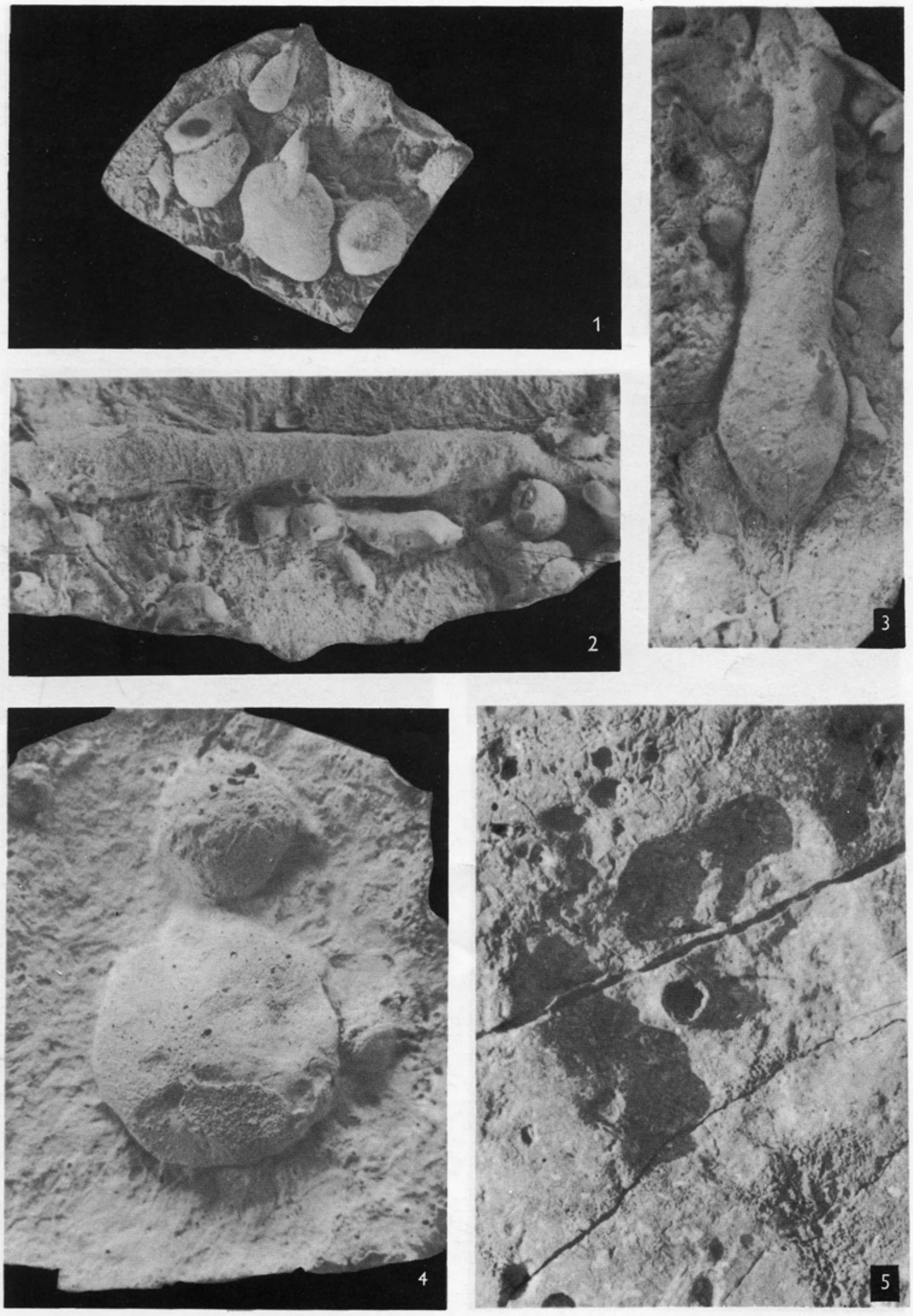


R. Mikuláš: Early Cretaceous borings from Štramberk (Pl. VIII)

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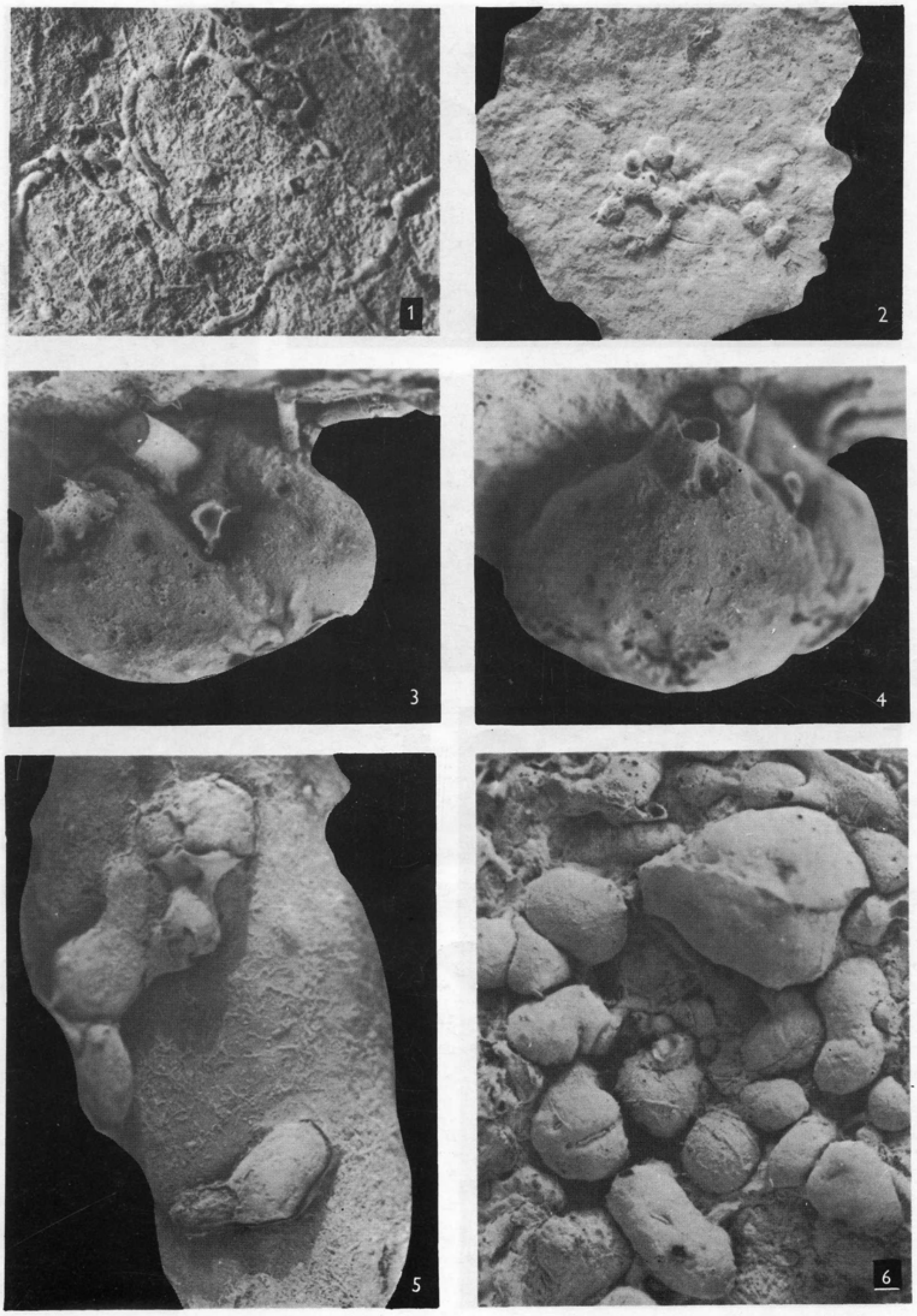
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