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# Tertiary borings in Devonian limestone rockgrounds from Hranice (northern Moravia, Czech Republic)

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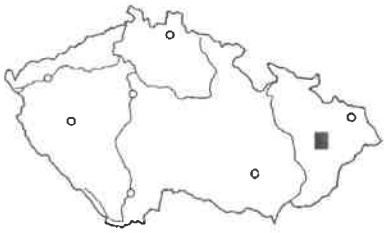
Abstract. Lower Badenian borings *?Circolites kotoucensis* Mikuláš, 1993, *Gastrochaenolites* ichnosp., *Entobia* cf. *ovula* Bromley and D'Alessandro, 1984, *E.* cf. *retiformis* (Stephenson, 1952), *E.* ichnosp. A, *E.* ichnosp. B, *Maeandropolydora sulcans* Voigt, 1965 and *?Trypanites* ichnosp. were ascertained on the limestone rockgrounds near Hranice in northern Moravia.

Abstrakt. Na vápencových rockgroundech u Hranic na severní Moravě byly zjištěny následující spodnobadenské ichnofosilie (stopy po činnosti vrtavých organizmů): *?Circolites kotoucensis* Mikuláš, 1993, *Gastrochaenolites* ichnosp., *Entobia* cf. *ovula* Bromley and D'Alessandro, 1984, *E.* cf. *retiformis* (Stephenson, 1952), *E.* ichnosp. A, *E.* ichnosp. B, *Maeandropolydora sulcans* Voigt, 1965 a *?Trypanites* ichnosp.

Key words: Limestone rockgrounds, borings, epibionts, Badenian, Czech Republic.



## Introduction

Instructive outcrops of the limestone rockgrounds at Hranice have been known for a long time. Their morphological aspect was evaluated by Dvořák (1957) and their morphological peculiarity is the main reason why they are often attended as an excursion locality. The outcrops are described and pictured also in textbooks. Chlupáč in Svoboda et al. (1964) figured ancient cliffs of the Devonian limestones at Hranice and their surface bored by bivalves (Pl. XLI, fig. 1, 2); Buday et al. (1967) figured a rockground with borings from the Černotín locality lying in the Hranice area (Pl. XXXIV). At present, the locality is proposed for a statutory protection.

Nevertheless, the knowledge of palaeontological phenomena is still inadequate. Therefore, the aim of this contribution is to describe the community of borings present in the rockgrounds.

## Geological settings

The locality under study is located in cement plant quarries in the town of Hranice (Northern Moravia). In the so-called "Cement plant block" (Dvořák and Friáková 1978), the Vilémovice Limestones (Upper Givetian - Lower Frasnian) have been exposed. The limestones are massive or thick bedded, light grey or grey, fine-grained, micritic to organodetritomicritic.

In the warm climate of the Upper Cretaceous and especially during the Paleogene, tropical conical karst developed here.

Miocene rocks in the vicinity of Hranice belong to the sedimentary filling of the Carpathian foredeep (Carpatian - Badenian). During the Early Badenian, extensive sea transgression progressed from the SW; in the top phase, the sea extended beyond the Moravian Gateway to the Odra Cuphole and to the Ostrava Basin. Steep slopes, at Hranice formed by karstified Devonian limestones (and by Carboniferous greywackes at the top), became part of an abrasion cliff. The coast showed a typical ria character (Dvořák 1957, Czudek and Dvořák 1989).

At present, the karst cones (=mogotes) at Hranice reach a height up to 10 m. During the transgression of the Lower Badenian sea, the surface of these mogotes was effaced almost perfectly by sea abrasion in a vertical extent of about 10 m (movements of sea level in closed or narrow bays may reach 10 m, cf. Dvořák 1957). The surface of the cones was partly covered by numerous traces of boring activity of shallow-water organisms.

The occurrence of boring activity of littoral Badenian organisms was reported e.g. by Dvořák (1957), Řehoř, Řehořová and Vašíček (1978). However, the above authors have not specifically described these traces from an ichnological point of view. They confined themselves, in these papers, to mere statements of existence of such traces ascribing them to the activity of boring mollusks (pholadids), poriferids and corals (sic!).

In addition, abraded cobbles, boulders and blocks of Devonian or Culmian rocks (limestones, greywackes) occur in the close environs of the karst cones. The size of these clasts reaches 1 m in diameter. On some limestone clasts, borings (*Entobia* and *Gastrochaenolites*) are present, either on one side or all over the surface.

In the Lower Badenian in the grey to ochre clays deposited in the depressions between karst cones, relatively rich fauna is found which hasn't been systematically evaluated yet - solitary hexacorals (div. sp.), spines and fragments of echinoids (*Brissopsis* sp.), bivalves (*Crassostrea crassicostata* /Sowerby/, *Ostrea lamellosa* Brocchi, *Ostrea gingensis* Schlotheim, *Pycnodonta hoernesi* /Reuss/) - see Dvořák (1957), Řehoř et al. (1978).

## Epibionts

Dvořák (1957) reported cemented oysters and corals on the rockground; Řehoř et al. (1978) mentioned the oysters only.

The present-day state of the locality enabled us to observe, in addition to oysters (Pl. IV, fig. 8) and bases of corals (Pl. IV, fig. 3), also the following epibionts: sessile foraminifers (Pl. II, fig. 4) and bases of straight or meandering carbonate tubes (possibly the polychaete tubes; Pl. IV, fig. 9, 10). The phenomenon needs a separate study.

## Systematic ichnology

*Circolites* Mikuláš, 1993

*? Circolites kotoucensis* Mikuláš, 1993

Pl. II, fig. 3

Material: About 10 specimens observed in situ, more or less damaged by abrasion.

Description: Relatively shallow (about 10 mm), circular to oval pits on inclined parts of the rockground. Usual diameter about 20 mm. Surface smooth.

Remarks: These ichnofossils seem to be conformable to *C. kotoucensis* and other formerly (but informally) described borings, whose presumed tracemakers are echinoids (cf. Mikuláš 1993). In our case, however, all the pits of corresponding shapes and dimensions are considerably eroded and therefore cannot be identified with certainty. It seems possible that large, truncated borings *Gastrochaenolites* ichnosp. should show the same morphology.

*Gastrochaenolites* Leymerie, 1842

*Gastrochaenolites* ichnosp.

Pl. II, fig. 1-4; pl. III, fig. 5, 6

Material: Thousands of borings present on the rockground of the described locality, mostly on steeply inclined parts. Several dozens of borings documented photographically, five specimens by latex casting. Five limestone boulders with strongly eroded traces.

Description: Morphologically continuous spectrum of forms, starting from minute, shallow circular pits (about 3 mm in diameter), and ending with quite deep (20 mm) chambers of cylindrical or ovoidal shape, whose openings are more narrow than their central parts.

Remarks: The present morphology is mostly highly influenced by abrasion processes. Perfectly preserved borings are not present. This is the reason why we must keep the ichnogeneric level only. For the description of the ichnogenus and its numerous representatives see the work of Kelly and Bromely (1984).

*Entobia* Bronn, 1837

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

Pl. III, fig. 4

Material: Three finds observed on overhanging parts of the rockground; one of them documented by latex casting.

Description: Camerate systems of entobians formed by dense clusters of 3 - 10 chambers of spheroidal or ovoidal shape, with minute uneveness of the surface. Diameter of chambers is 2 - 7 mm. Exploratory threads of various directions are uncommonly present near the chamber clusters; their diameter is 0.05 - 0.1 mm. All the studied finds are broadly opened to the present-day surface. The borings do not show influence of abrasion.

Remarks: In general, the representatives of *Entobia* are classifiable on the ichnospecific level with considerable difficulties, owing to large changes of morphology during the growth, stenomorphism, and various transitional forms (see papers of Bromley and D'Alessandro, 1984, 1987, 1989). At the Hranice locality, the situation is complicated by a small number of specimens and by limited possibilities of study (in the field only). The small number of finds does not enable us to reconstruct the growth phases of the individual distinguishable forms.

We presume that the specimen figured on Pl. III, fig. 4 (and two similar examined in situ) corresponds to the growth phase D of *E. ovula* (or some very similar camerate ichnospecies), as described by Bromley and D'Alessandro (1984) from the Miocene, Pliocene and Pleistocene of southern Italy.

*Entobia* cf. *retiformis* (Stephenson, 1952)

Pl. III, fig. 2, 3, 7; Pl. IV, fig. 1, 4

Material: About 20 specimens observed in situ on vertical or overhanging parts of the rockground. Most of them documented photographically, three finds by latex casting. Two poorly preserved specimens situated inside *Gastrochaenolites* ichnosp. assemblage on the surface of limestone boulder.

Description: System of borings formed by chain-like arranged chambers. The "chains" are straight to

moderately curved, usually 10 - 40 mm long, formed by 5 - 30 spheroidal chambers 1.5 to 3 mm in diameter. In places, the "chains" gradually change into cylindrical galleries. Exploratory threads were not observed.

Remarks: Chain-like camerate borings resemble the growth phase C of *E. retiformis*, as described by Bromley and D'Alessandro from the Pliocene-Pleistocene of southern Italy. Other remarks correspond to those to *E.* cf. *ovula.*

*Entobia* ichnosp. A

Pl. III, fig. 1

Material: A sole find in a vertical part of the rockground, documented by a latex cast.

Description: System composed of moderately branching network of thin exploratory threads (about 0.2 mm) and wider canals (0.6 - 1.0 mm). Four initial forms of roughly triangular chambers are developed in branchings of canals.

Remarks: A sole find cannot be classified in ichnospecific level. It seems to be comparable to *E. laquea* described by Bromley and D'Alessandro (1984).

*Entobia* ichnosp. B

Pl. IV, fig. 5-7

Material: Five specimens on vertical to overhanging parts of the rockground, documented by photographs.

Description: Cylindrical galleries 2 - 3 mm in diameter, curved or S-shaped, showing several branchings in each system. The galleries bear regular constrictions in some parts, documenting their development from rows of chambers. Overall length of individual galleries up to 50 mm. Exploratory threads were not observed.

Remarks: Because the individual growth phases of this boring are not known, the ichnospecific classification would be very speculative.

*Maeandropolydora* Voigt, 1965

*Maeandropolydora sulcans* Voigt, 1965

Pl. III, fig. 8

Material: An oyster shell fallen off the rockground, containing one or more, probably 2 - 3 systems of *Maeandropolydora.*

Description: Cylindrical galleries, exceptional branching, meandering irregularly in the divisional plane in the shell. Diameter of galleries 0.2 - 0.8 mm.

Remarks: Classification of this boring follows the criteria given in the papers of Bromley and D'Alessandro (1983, 1987), Žítt and Mikuláš (1994). Polychaete worms are probable tracemakers.

*Trypanites* Magdefrau, 1932

*? Trypanites* ichnosp.

Pl. IV, fig. 2, 8

Material: More than 10 seemingly or factually isolated openings of simple tubes in the rockground. They are developed in limestone and also in shells of cemented oysters.

Description: Simple circular openings of vertical or inclined tunnels, present solitary or in small groups. Usual diameter about 2 mm.

Remarks: Because the vertical dimension and possible subsurface parts cannot be studied, it is impossible to determine whether openings of simple tunnels (*Trypanites*) are concerned in all the cases, or if openings of complex borings (as *Entobia*) are also represented.

## Conclusions

There are two qualitatively different types of preservation of borings on the described rockground. The first (*Gastrochaenolites, ? Circolites*) represents very abraded borings, in places fully covering the surface. Borings of the second group (entobians, *? Trypanites* ichnosp.) usually do not show abrasion damage; they occur solitarily or in small clusters.

It is very probable that *Gastrochaenolites* and *?Circolites* originated sooner than entobians and *? Trypanites.* They represent a simple assemblage of boring mollusks and echinoids, adapted to extremely high energy settings, possibly in the intertidal zone. The change of borers was, in our opinion, probably caused by the deepening of the sea in connection with the progress of transgression accompanied by the reduction of physical energy. The second assemblage - boring sponges, polychaete worms, and epibionts cemented to rockgrounds (foraminifers, oysters, corals) represent probably a shallow subtidal zone.

During the Lower Badenian sedimentation, all rockgrounds were relatively quickly covered by clay layers (cf. comparative data in Bubnoff /1948/, Schwarzacher /1975/). Fossil relief was thus protected against post-Badenian erosion and exhumed by Quaternary processes and anthropogenic activity only recently.

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Explanation of plates
All photos by R. Mikuláš

Pl. I. ⇨

1, 2: Fossil karst cones (mogotes) on the grounds of the cement plant at Hranice.

Pl. II. ⇨⇨

1: Southern side of a karst cone, showing overhanging and inclined parts of rockground with numerous borings (mostly *Gastrochaenolites*). 2: Detail of the obliquely inclined part of the rockground; *Gastrochaenolites* and bases of probable polychaete tubes are present. 3: *? Circolites kotoucensis* Mikuláš, 1992 (arrowed) and *Gastrochaenolites* ichnosp. 4: Surface of rockground with borings *Gastrochaenolites* ichnosp. and sessile foraminifers; x 2.0. Grounds of the cement plant at Hranice.

Pl. III. ⇨⇨⇨

1: *Entobia* ichnosp. A; latex cast; x 2.0. 2, 3, 7: *Entobia* cf. *retiformis* (Stephenson, 1952); latex casts; x 2.3; x 2.7; x 2.7. 4: *Entobia* cf. *ovula* B. & D'A., 1984; latex cast; x 1.8. 5, 6: *Gastrochaenolites* ichnosp.; latex casts; x 3.0; x 2.6. 8: *Maeandropolydora sulcans* Voigt, 1965 in oyster shell; x 4.0. Cement plant at Hranice.

Pl. IV. ⇨⇨⇨⇨

1, 4: *Entobia* cf. *retiformis* (Stephenson, 1952). 2: *? Trypanites* ichnosp. 3: Bases of corals. 5-7: *Entobia* ichnosp. B; all x 0.8. 8: *? Trypanites* ichnosp. in oyster shell cemented on the rockground; x 0.7. 9, 10: Bases of carbonate tubes (probably the polychaete tubes). All photos in the field, cement plant at Hranice.

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*RECENZE*

Ch. Pelant: *Horniny a minerály.* - Spolupráce H. Pellantová, fotografie H. Taylor. 256 s. Osveta, Martin 1994.

Moderně pojatou příručku atlasového typu vydalo v češtině na sklonku minulého roku nakladatelství Osveta v Martině. Jde o překlad anglického originálu (Rock and Minerals), vydaného v roce 1992 londýnským nakladatelstvím Dorling Kindersley Ltd. v edici Pouhým okem.

Knížka je určena nejen začínajícím sběratelům, ale i dalším zájemcům o minerály a horniny. Po úvodních informacích pro mladé sběratele a metodických pokynech, jak pracovat s touto příručkou, následuje přehled obecné mineralogie a petrologie (vznik, složení vlastnosti nerostů a hornin) s jednoduchými určovacími klíči, bohatě ilustrovanými fotografiemi, obrázky, tabulkami, značkami atd.

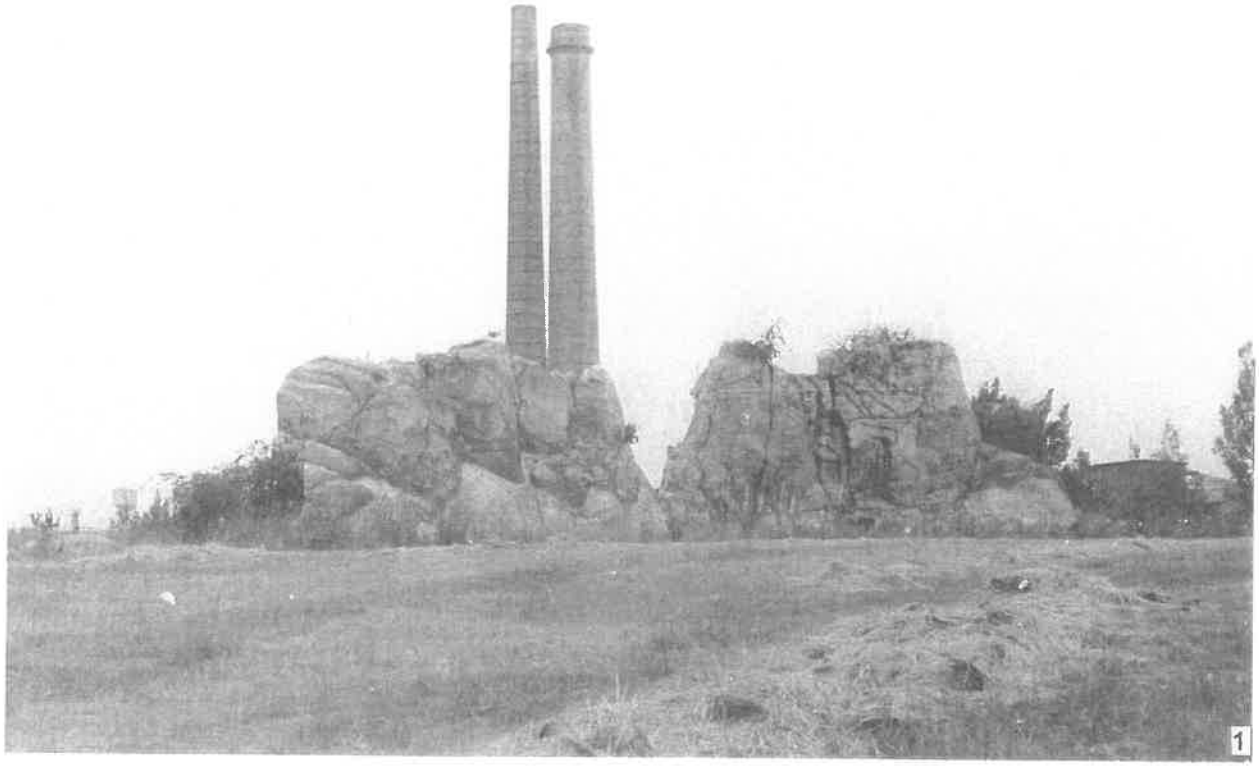
Stěžejní část publikace je pak přehledem (atlasem) minerálů a hornin dle vžitého systému (nerosty dle chemického složení, horniny podle způsobu vzniku). Heslo každé přírodniny je provázeno fotografií vzorku (většinou ze sbírek Přírodovědného muzea v Londýně), stručným popisem charakteristických rysů, schematickým obrázkem krystalické soustavy a barevnými kódovými pruhy se základními informacemi - u nerostů chemická skupina a vzorec (značka), tvrdost, hustota, štěpnost a lom, u hornin genetická skupina, původ, velikost zrn, omezení krystalů, klasifikace dle chemismu, výskyt a barva. Celkem je uvedeno na 280 mineralogických a přes 150 petrologických hesel.

Publikace se vzornou grafickou úpravou (s více než 600 barevnými obrázky) se jistě stane ozdobou každé knihovničky a díky tomu, že byla distribuována před Vánocemi neodradila, snad ani její cena (obvykle za 270,- Kč). Je nepochybné, že u mladých čtenářů může vzbudit trvalý zájem, i když praktické použití obdobných určovacích atlasů a klíčů bývá - jak z vlastní zkušenosti ví asi většina geologů - nesnadné a ošidné. Předností je velmi dobrý překlad (O. Paškové a dr. J. Rubína), který si poradil i s takovými záludnostmi, jakými je např. odlišné chápání pojmů textura a struktura v angloamerické literatuře atd. Svědčí o tom i terminologický slovníček v závěru knihy. Není však zřejmé, proč v atlasové části nebylo užito českých názvů krystalických soustav (s výjimkou krychlové soustavy).

Poněkud "rušivým momentem" je schematické znázornění krystalických soustav u jednotlivých minerálů. Pokud nebylo možné zařazení odpovídajícího (byť zjednodušeného) zobrazení krystalového tvaru, stačilo by zřejmě jen slovní označení nebo zobrazení základního tvaru příslušné soustavy. Použitý způsob může být matoucí kromě toho není vždy důsledný, zejména u polymorfních nerostů (např. u mastku je slovně uvedena krychlová a graficky monoklinická soustava).

Drobných nepřesností, diskutabilních konstatování i vyobrazení (ke kterým patří např. obrázek "přeměněné krajiny" na str. 34, a tvrzení, že z převážně úlomků křemene neexistuje žádný hrubozrnný úlomkovitý sediment na str. 44, opomenutí podílu uhličitanu vápenatého ve spraši na str. 45 aj.) se publikace tohoto typu asi nevyhnou. Naštěstí jich není mnoho a celkově dobrou úroveň textu nesnižují. V možnostech vydavatele českého překladu zřejmě nebylo přizpůsobení textu i obrázků geologickým poměrům naší republiky.

*Jan Vítek*



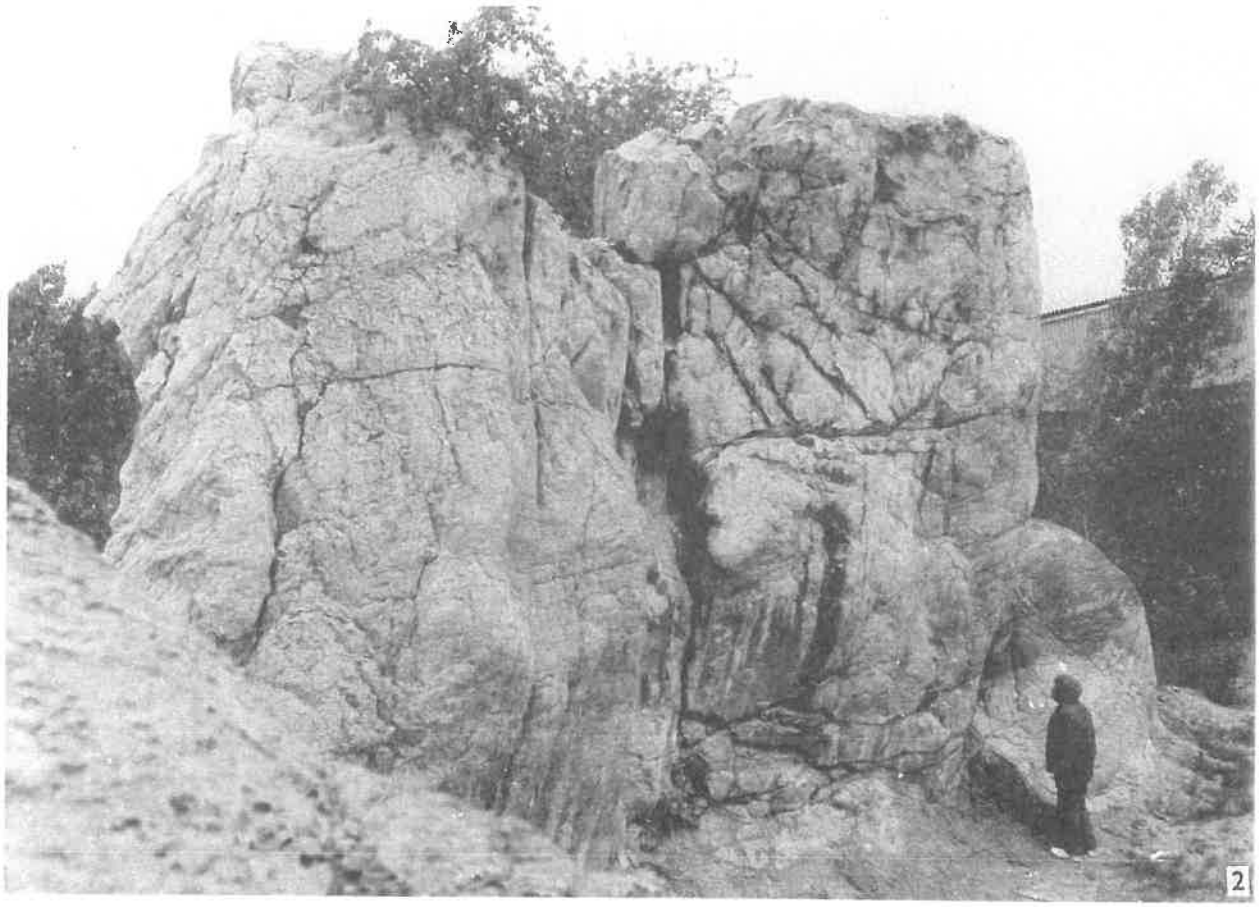


Plate I

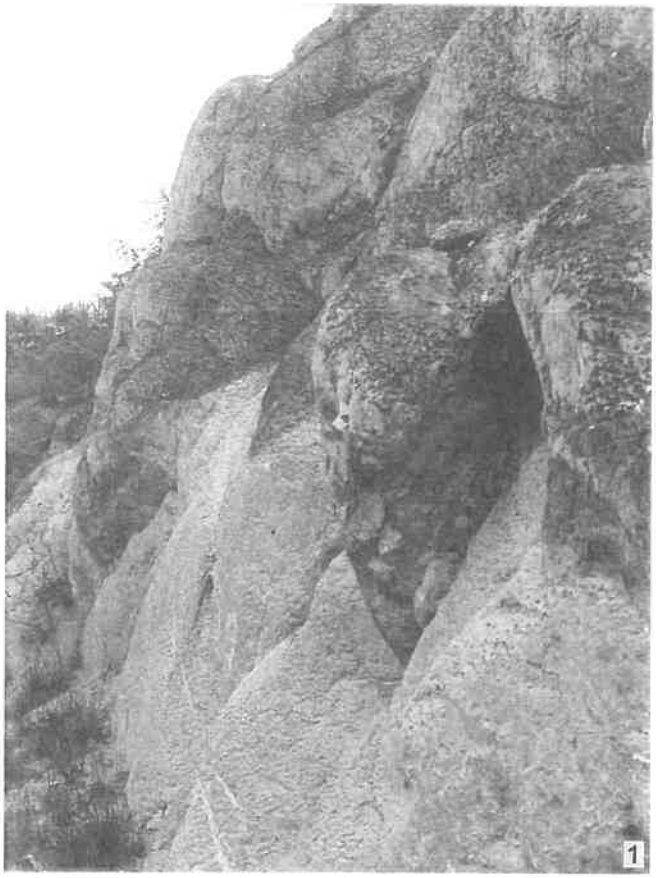












Plate II

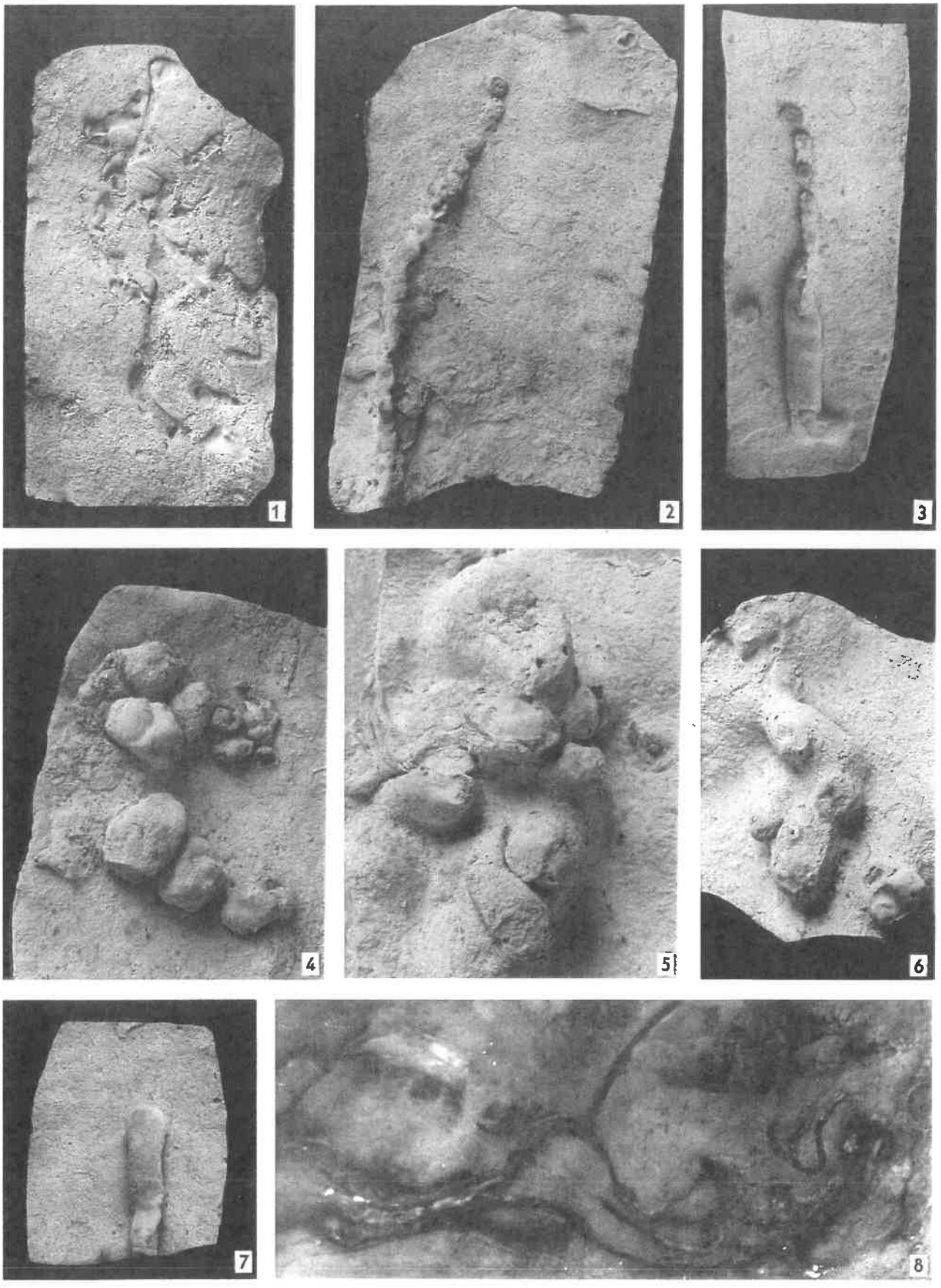



Plate III

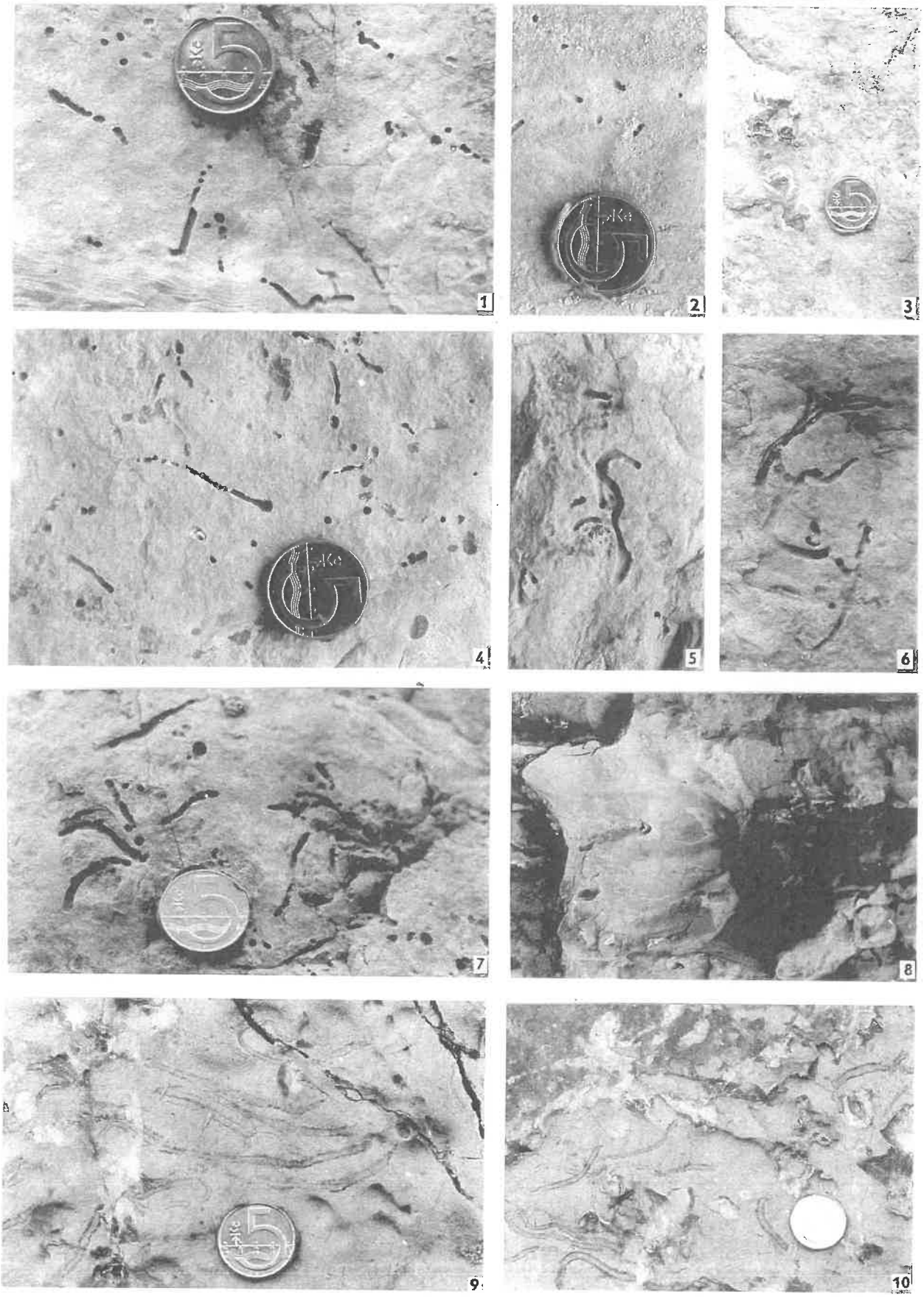



Plate IV