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UPPER JURASSIC CRINOIDS IN THE WEST CARPATHIAN KLIPPEN BELT

(Figs. 4, Pls. 8)

A b s t r a c t: Oxfordian marly limestone horizon containing well preserved crinoid fauna has been discovered in Upper Jurassic Czorsztyn nodular limestone succession. It consists of *Phyllocrinus belbekensis* ARENDT, *P. borcicensis* sp. n., *?P. skalensis* sp. n., *P. aff. malbosianus* D'ORBIGNY, *P.* sp., *?Cyrtocrinus stiavnikensis* sp. n., *C.* sp. A., *?C.* sp. B., *Lonchocrinus* sp. and of other fossils. The preservation of all the fossils indicates minimal transport. The data obtained enriched considerably the recent knowledge of West Carpathian Late Jurassic fauna, and enabled refining the sedimentational and paleobiogeographical model of the Czorsztyn Formation.

Р е з ю м е :В работе описывается в первый раз фауна циртокринид словацкой части зоны утесов Карпатского орогена, происходящая из оксфордских известняков местонахождений Велька Скала и Приечница. Остатки криноидей относятся к видом *Phyllocrinus belbekensis* ARENDT, *P. borcicensis* n. sp., *?P. skalensis* n. sp., *P. aff. malbosianus* D'ORBIGNY, P. sp., *?Cyrtocrinus stiavnikensis* sp. n., *?C.* sp. A., *?C.* sp. B., *Lonchocrinus* sp. В материале чашечек высоко преобладает *P. belbekensis*. Многочисленные изолированные элементы также присутствуют. Полученные результаты расширяют в значительной мере знания о видовом составе и географическом распространении верхнеюрских тетидных фаун.

Introduction

Alpine Upper Jurassic and Lower Cretaceous sediments are well known by their abundant crinoidal fauna (L o r i o l, 1879; P i c t e t, 1863—1868; O o s t e r, 1865; D e s o r, 1845, 1847 etc.). The mentions on Jurassic/Lower Cretaceous crinoid faunas of the Czechoslovak Western Carpathians have been concerned mostly with their outer orogene zones (R e m e š, 1902, 1905, 1912; R e m e š and B a t h e r, 1913; P a l i v e c, 1967; Ž í t t, 1974, 1978 a—d, 1979, 1983 etc.). Klippen Belt crinoidal fauna has been mentioned sporadically only (A n d r u s o v, 1945, 1959; M i š í k, 1979).

Considering the literary data, it could have been concluded that the Central West Carpathian area of Tethys has been inhabited by less diversified benthic communities than were those of the Alpine area. However, the abundance of crinoidal debris in Upper Jurassic/Lower Cretaceous sediments (e. g. in Czorsztyn succession of Klippen Belt) indicate that the Carpathian indigenous crinoidal assemblages have been comparably high diversified. Recent detailed stratigraphical and paleontological investigations brought discoveries of new

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paleontological localities confirming the supposition that the lack of data on West Carpathian crinoidal fauna is caused not by its scarcity but by its insufficient systematical study in this area.

Geographical and geological localization

The Carpathian Klippen Belt forms an expressive tectonically complicate contact zone between Outer and Central Carpathians. It outcrops from Vienna to Poiana Boticei in the Roumanian Eastern Carpathians. Western part of the Klippen Belt rimmed by middle Váh River offers good chance for stratigraphical studies. In their course, slightly marly limestone level containing exceptionally well preserved crinoid cups has been found in several places. The best findings have been obtained in localities Veľká Skala-rock in Borčice valley near Horné Srnie about 7 km NW from Dubnica nad Váhom, and Priečnica-hill near Štiavnik northern from Brvnište, 12 km N from Považská Bystrica. Both the localities are separated by about 35 km distance (Fig. 1.).

The Klippen Belt sequences originated in several different paleogeographical elements (cordillera-like elevations separated by depression, cf. Andrusov, 1959; Mahel' et al., 1967). Czorsztyn succession represents the products of marginal shallow water sedimentation rimming the Jurassic-Cretaceous Vahic (Penninic) ocean (non-volcanic insular arc-like cordillera?). The oldest members preserved consist of Lower Jurassic shally and clastic sediments. They are followed by thick crinoidal limestone sequence with quartz detrite (Smolegowa- and Krupianka Limestone Formations according to Birkenmajer's (1977) lithostratigraphical classification). Upper Jurassic sedimentation is represented by Czorsztyn Limestone Formation (red nodular limestones). It is represented by "Ammonitico Rosso"-type facies, Callovian to Early Tithonian in age. The nodular limestones in its top part pass into characteristic complex of rosa-, red- and white organogene limestones of Tithonian-Hauterivian Faltones and brachiopod-ammonite shelly limestones (Rogoznik Coquina). Higher Dursztyn Limestone Formations is represented by subpelitic calpionellid limestones and brachiopod-ammonite shelly limestones (Rogożnik Coquina). Higher lying Lysa and Spiš Limestone Formations consist of detrital, crinoidal and brecciated limestones.

Our findings come of yellowish weatherig thin-bedded reddish slightly marly compact limestones occurring in intercalations in nodular limestones. Abundant

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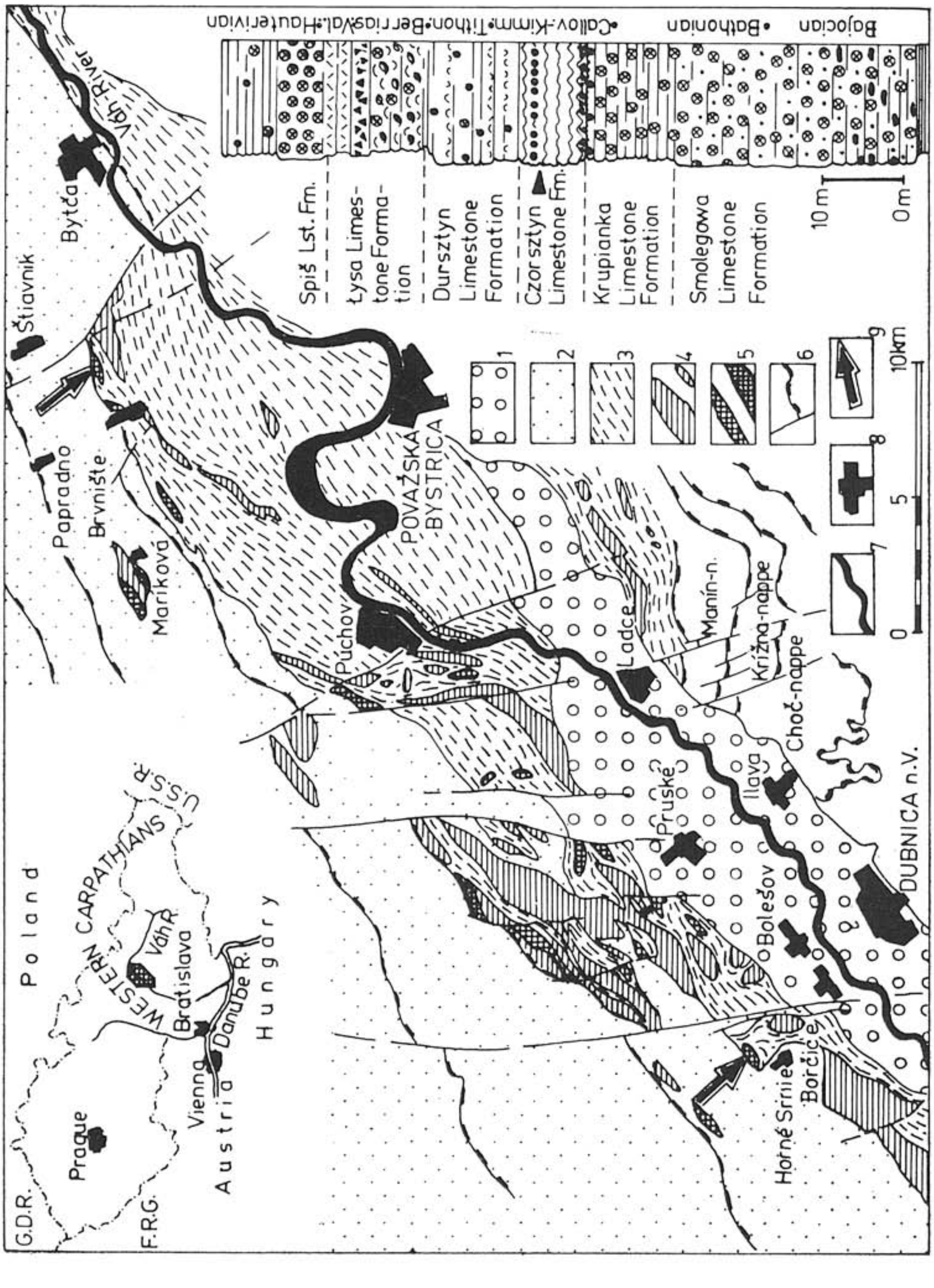
Fig. 1. Localization of Oxfordian crinoid localities in Klippen Belt, Middle Váh River-valley (left upper corner) in geological sketch of this area (in the middle) and in lithostratigraphical column of Czorsztyn succession (right lower corner, see the arrow).

Legend to the geological sketch: 1-Neogene infilling of Ilava Basin, 2 – Paleogene flysch, 3 – Mid- and Upper Cretaceous sequences of the Klippen Belt, 4 – Jurassic and Lower Cretaceous carbonates of the Klippen Belt indistinguished, 5 – Malm limestone bodies, 6 – fault sand overthrusts, 7 – Váh River, 8 – urbanized area of the towns and villages, 9 – localities described.


G.D.R.
F.R.G.
Poland
Prague
WESTERN CARPATHIANS
U.S.S.R.
Váh R.
Bratislava
Vienna
Danube R.
Austria
Hungary
Štiavnik
Papradno
Brvnište
Bytča
Váh River
Marikova
POVAŽSKÁ BYSTRICA
Púchov
Ladce
Manín-n.
Križna-nappe
Choč-nappe
Pruské
Ilava
DUBNICA n.V.
Bolešov
Horné Srnie
Borčice
0
5
10km
Spiš Lst. Fm.
Łysa Limestone Formation
Dursztyn Limestone Formation
Czorsztyn Limestone Fm.
Krupianka Limestone Formation
Smolegowa Limestone Formation
10 m
0 m
Bajocian
Bathonian
Callov.-Kimm.
Tithon.
Berrias.
Val.
Hauterivian

echinoderm skeletal fragments become loosened on their bedding planes. Skelets of crinoids, echinoids, foraminifers, ostracods, aptychi, ammonites, brachiopods and bivalves form 25–30 % of the biomicrital rock mass. The rock is only insignificantly affected by stylolitization or tectonization. On the other hand, initial micritization on rims of organic remnants occurs locally. Despite of it, both tiny morphological details and fine inner microstructures of fossils are mostly well preserved. The rock contains microplanctic remnants, determined by Dr. K. Borza (pers. comm.) as *Colomisphaera fibrata*, indicating Oxfordian age of the fossiliferous horizon.

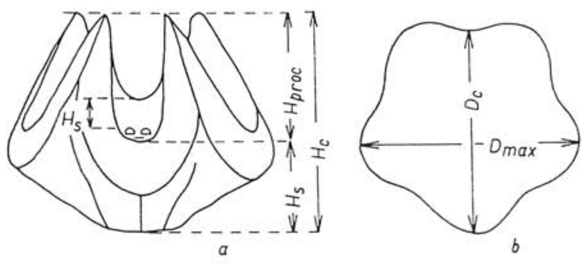


Fig. 2. Cup dimensions of *Phyllocrinus belbekensis*. a – lateral view, b – axial view. H_c – total cup height, H_d – cup height without interradial processes, H_{proc} – interradial processes height, H_s – septum height in radial notch, D_c – cup diameter D_{max} – maximal cup diameter.

Remarks to cups measurement

Measured parameters are schematically illustrated on Text-figure 2, a–b. In agreement with Žítt (1978 a) and Pisera and Dzik (1979), the boundary between dorsal part of the cup and interradial processes is parallelized with the lower margin of radial facetta. All the parameters obtained on cup sides (height) were measured as perpendicular projection as usual. Owing to frequent inapropriate orientation of specimens in the rock, D_{max} parameter (see Text-figure 2–b) has been favourized in measuring of cup diameter. This parameter considerably argumenting the number of measurements could has been obtained on the cups both with vertically- (on dorsal or ventral side) or horizontally oriented sup axis. Dc-value, measured in radial-interradial direction has been obtained in minority of measurements only. All the measurements have been obtained with use of ocular caliber.

Systematic part

Cyrtocrinida SIEVERTS-DORECK
Phyllocrinidae JAEKEL, 1907
Phyllocrinus D'ORBIGNY, 1850

Type species: *Phyllocrinus malbosianus* D'ORBIGNY, 1850. Orgon, France, Lower Cretaceous.

Phyllocrinus belbekensis ARENDT, 1974

Pl. 1., Figs. 1–2; Pl. 2., Figs. 1–2; Pl. 3., Figs. 1–2; Pl. 4., Figs. 1–2; Pl. 5., Figs. 1–2; Pl. 6., Figs. 1–2, 4; Pl. 7., Figs. 1–3.

1974 *Phyllocrinus belbekensis* sp. nov; ARENDT, p. 118–119., Pl. 14., Figs. 1–21., Text-figs. 14 d-k.
1979 *Phyll. belbekensis* ARENDT; Pisera and Dzik, p. 824–825, Pl. 4., Fig. 1., Text-fig. 11 d.
?1979 *Phyll. belbekensis* ARENDT; Pisera and Dzik, Text-fig. 11 c.

Holotype: specimen figured in Arendt, 1974, Pl. 14. Fig. 1.

Type horizon and locality: Upper Hauterivian, right bank of Belbek River 3 km over Kuybyshevo village. Crimea, USSR.

Material: 893 cups and their fragments in various degree sticking out of eight limestone fragments surface from Veľká Skala locality (Borčice valley) and of two fragments from Priečnica-hill locality near Štiavnik (Oxfordian).

Description: Small cups, in dorsal view with expressive radial lobes and interradial depressions, in lateral view with high interradial processes. Cup height (H_c) is $1 - 3.2$ mm ($N = 30$), the interradial processes height (H_{proc}) being $40 - 62.5\,\%$ ($N = 29$) of this value. The processes are widest at their base, distally narrowing to sharpened points, slightly converging with cup axis. Their transversal cross-section is triangular to quadrangular in upper part; the shortes side being oriented centrally. Radial facets are situated subhorizontally near to the radial notch (by its outer rim). A transversal septum (cf. Text-fig. 4) forming ventral cavity wall (cf. Pl. 7., Fig. 2) is situated in it. Septum height (H_s) reaches $29.2 - 57\,\%$ of interradial processes height ($N = 32$) and $26.7 - 66.7\,\%$ cup height without interradial processes (H_d) ($N = 29$). Septum wall proximal to radial notch is inclined steeply to radial facet inner rim. Muscle fossae of radial facet are developed near to the base of septum. Other constructional elements of the facet are inexpressive (see Text-fig. 4), axial canal is small, ligament fossa shallow, transverse ridge low. Ligamentary part of facet is slightly externally convex. A small ridge forms a continuation of intermuscular septum to the axial canal. Radial notch is externally rimmed by flattened horse-shoe-shaped element on each radialium. It is most expressively developed below radial facets, strong narrowing (and exceptionally also disappearing) distally to the points of the processes.

Ventral cavity is rounded, very deep, in interradial processes region rimmed by smooth uniform wall, formed by septa and inner parts of the processes. Radial lobes of the cup are very expressive, dorsally pointed, more rounded to facets. Cup diameter reaches $86.4 - 96.3\,\%$ of D_{max} ($N = 14$) (both the parameters are denoted on Text-fig. 2). Cup diameter is expressively greater than its height. Overal height attains $72.7 - 94.4\,\%$ of D_{max} ($N = 29$), cup height without processes is equal to 27.3 to $59.1\,\%$ of D_{max} ($N = 27$). The dorsal part of the cup becomes expressively narrower to its base. The base proper has mostly pentagonal outline. Dorsal cavity is deep, rounded. The cavity margin is rounded or flattened, rising gradually to outer margin of the cup base. The outline of this rim is usually pentagonal, rounded to sharpened.

Remarks: Comparing the Slovak material with the typical (Crimean) series one must consider great difference in dimension of the collections. Both

Veľká Skala- and Priečnica localities taking together yielded only 60 sufficiently loosed specimens from 893 collected. On the other hand, A r e n d t (1974) who has used Crimean material consisting of 1800 completely loosed well preserved specimens, could had much better possibility of complex intraspecific variability study.

As a whole, it is possible to say that the Slovak material differs from the Crimean one in small details only. The most expressive difference is in the development of dorsal (or basal) part of the cup. A r e n d t (op. cit., p. 118) has noted that the dorsal cavity can be shallow and inexpressively bounded — or lined by a ridge. His figures (Pl. 14) indicate that dorsal cavity area can be widened into extensive shallow funnel-like depression with the dorsal cavity in the centre. In this case, the complex will be seemingly composed of two parts: the dorsal cavity proper with columnal articulation on the bottom, and of the outer peripheral part with less sloped walls. The outer part is limited with sharp edge against cup sides without any rounded passage. The dimensions of dorsal cavity and its funnel-like area of Slovak specimens have much more even distribution; for the average value see the figures. The base boundary is never such a sharp like these of some Crimean specimens. Radial ribbing of cup sides of Slovak specimens is less sharp, too, while the septum height in radial notch seems to be considerably greater in the average. A r e n d t (op. cit.) did not laid stress upon this feature, mentioning the striated convexities only. However, these small grooves have been ascertained by none of the even best preserved Slovak specimens. The other features are similar by both the collections. It is rather hard to estimate the quantity of hexagonal and tetragonal deviations from the pentagonal symmetry of Slovak material, because small part of 893 specimens allows to estimate this parameter only. Thus, the share of pentagonally symmetrical specimens seems be rather underestimated. If compared with the Crimea, where A r e n d t (op. cit.) has found in 1800 specimens sole one with tetragonal symmetry, this deviations occur more frequently in the Slovak localities. Hexagonal symmetry has not been found (on the other hand, 7 specimens have been described in the Crimean collection). Recently, P i s e r a and D z i k (1979) have introduced *P. belbekensis* from Rogoźnik (Polish part of the Carpathian Klippen Belt, Lower--Mid Tithonian Red Rogoźnik Coquina). In 60 specimens studied here, only one specimen has been different from *P. belbekensis* holotype. This specimen (P i s e r a and D z i k, op. cit., p. 824, Fig. 11 c) has unusual situation of muscle fossae of radial facets lying on horse-shoe-shaped area below radial notch. Although similar specimen has been never found on Veľká Skala- and Priečnica-hill localities, our specimens are morphologically identical with the remaining 59 Rogoźnik specimens, if one considered the picture and descriptions. The Valanginian *Phyllocrinus minutus* ŽÍTT, 1978 (non Z a r ę c z n y, 1876) of Stramberg is probably closely related to *P. belbekensis*. The former one differs by very narrow stalk-like basis and by very high and thin septum of radial notch. Despite of these differences, the specific identity of both the mentioned species cannot be excluded.

Text-figure 3 a express the relation between cup height without interradial processes (H_d) and maximal cup diameter (D_{max}) of *P. belbekensis*. The collection of Veľká Skala locality has different size frequence if compared with Rogoźnik material (P i s e r a and D z i k, op. cit., p. 828, Fig. 13 d), containing frequent juvenile specimens. The H_d of partically all the Rogoźnik population does not reach 1 mm (cca 45 specimens), while only 5 specimens of Veľká Skala collection are smaller than 1 mm. However, this disproportion could be caused by impossibility of measuring of Veľká Skala juveniles owing to both their bad preservation and poor determinability. On the other hand, it is evident

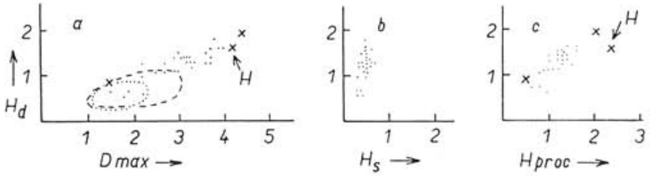


Fig. 3. Relations between H_d and D_{max} (Fig. 3 a), H_d and H_s (Fig. 3 b) and H_d and H_{proc} (Fig. 3 c) by *Phyllocrinus belbekensis*. The area delimited by broken line in Fig. 3 a indicates approximate points dispersion of Rogoźnik collection according to Pisera and Dzik, 1979, Fig. 13 d), the area delimited by dotted line denotes points dispersion of *P. minutus* ŽITT (non ZARĘCZNY) of Štramberk (see Žítt, 1978 a). The Crimean *P. belbekensis* specimens are illustrated by crosses. H is the holotype (according to Arendt, 1974).

that the size interval of H_d over 1 mm is presented sporadically in Rogoźnik collection, but quite currently presented in Veľká Skala locality (not only in the serie measured). Besides of numerical incompatibility of the material derived from both the localities, it is evident that the Veľká Skala- (but also Priečnica-hill) specimens have attained greater size. The interpretation of juvenile mortality effect in these differences needs further quantitative data from the Veľká Skala locality.

Text-figs. 3 b-c demonstrate the relation between radial notch septum height (H_s) and interradial processes height (H_{proc}) to the cup height (H_d). The great dispersion of points on Text-fig. 3 c is given by variable preservation of interradial processes. It is regretable that the Crimean type material has not been evaluated by the same method. Arendt (op. cit.) has measured only four specimens, we supplemented into our diagrams 3 a—3 c for comparison.

Phyllocrinus borcicensis sp. n.

Pl. 1., Fig. 3; Pl. 5, Fig. 2., Pl. 6., Figs. 1—2; Pl.7., Figs. 11—12.

Holotype: The specimen figured on Pl. 7., Fig. 11, deposited in Slovak National Museum in Bratislava under No SNM-Z 18 759/1.

Paratypes: Remaining six figured specimens, deposited together with the holotype.

Other material: two incompletely preserved specimens besides the type serie.

Type horizon and locality: Oxfordian, West Carpathian Klippen Belt, Borčice valley, Veľká Skala locality cca 7 km NW of Dubnica nad Váhom (see Figure 1).

Derivation of name: according to Borčice village.

Description: High, tall, dorsally conical and radially lobate cups with shallow interradial depressions. Transversal cross-section of the cup on facets-level is lobate pentagonal, more proximally attaining more rounded shape. Cup height (H_c) of the paratype No SNM Z-18 759/2 (Pl. 7., Fig. 12) is 3.4 mm, the interradial processes height 1.3 mm (= 38 % of the whole height H_c). Processes have wide base (substantially wider than the radial facets) narrowing rapidly into sharp points, the tops are slightly converging above ventral cavity. Inner parts of the processes are sharped into edges, bearing rows of irregular granulae locally. Granulae are developed also on lateral (adjacent to radial notch) top sides. Mentioned edge lost its expressiveness approximately at the level of radial facets. However, in some specimens it continues as an inexpressive ridge up-to ventral cavity bottom. Transversal cross-section of interradial processes is almost triangular in all its course, the outer side being slightly concave proximally.

Fig. 4. Structure of radial notch with septum and radial facet of *P. belbekensis*. Magnification cca 20 x.

Radial facets are of considerable size, but narrower than the interradial processes base. The facets are located on radial lobes. Muscle fossae are large and deep, axial canal tiny, ligamentary structures indistinct, probably shallow. Transversal edge is inexpressive. Radial notch clearly opened ventrally, its bottom being flat, sinking down to fluent ventral cavity passage immediately behind radial facet. Neither any impressions nor septa are developed.

Cup base is stalk-like narrowed. Dorsal cavity is very deep. (See Pl. 7., Fig. 12). Cup articulated not only on its small and flat bottom, but evidently also on its walls. Articulatory structures are inexpressive. The stem is massive in preserved proximal part, probably consisting of several fused elements (minute swellings and constrictions by holotype). Stem width passes fluently into cup, so that all the complex seems to be formed by single element.

Remarks: *Phyllocrinus borcicensis* sp. n. has an unique cup architecture pattern in all the family range, having large radial facets and relatively low processes (especially by more mature specimens, see the holotype). The structure of radial notch bottom is (in certain aspects) similar to some Apsidocrinus species *(A. cyclamen* (REMEŠ), *A. remesi* BATHER) coming from Stramberg Valanginian deposits. However, the mature Apsidocrinus is characteristic with hypertrophy of interradial processes both up and above ventral cavity. They are connected here together forming an arch (see *A. remesi* JAEKEL in Žítt, 1978 c, *A. moeschi* (ZITTEL) in Pisera and Dzik, 1979, *Phyllocrinus yanini* in Arendt, 1974).

Dorsal cavity development is similar to those of lot of Phyllocrinus and Apsidocrinus species. However, the interpretation of cup and stem joining, appearing by the majority of species, is uncertain. Specimen No SNM Z-18 759/2 of Veľká Skala (see Pl. 7., Fig. 12) shows free dorsal cavity, while an expressive discontinuity between dorsal cavity wall and the stem is visible on broken specimen SNM Z-18 760/1 of the Priečnica-hill (see Pl. 1., Fig. 3). However, no discontinuity has appeared by fragmentation of dorsal cavity region by holotype; the same type of connection has been observed by further two specimens. Thus, we deal with the species with cup fusing tendence – or with some malformations. The former possibility seem to be more probable (e. g. *Proholopus* seems to have the same tendence, see Žítt, 1974; Arendt, 1974; Rasmussen, 1961).

? *Phyllocrinus skalensis* sp. n.
Pl. 8., Figs. 3, 4

Holotype: The specimen figured has number SNM Z-18 756/1, being housed in Slovak National Museum in Bratislava.

Other material: one very incompletely preserved cup fragment.

Type horizon and locality: Oxfordian, West Carpathian Klippen Belt, Borčice valley (Veľká Skala locality), cca 7 km NW of Dubnica nad Váhom (Fig. 1), western Slovakia, Czechoslovakia.

Derivation of name: according to type locality.

Description: Large cup with great dorsal part and short interradial processes. Holotype cup height with interradial processes (H_c) is 4.6 mm, processes height (H_{proc}) 2 mm, thus 48 % of the whole cup height. The processes directed almost perpendiculary upward. Their maximum width is on the proximal end, being rapidly narrowed into sharp points distally. Sharp wedges run obliquely from the point to cup centre; however, they disappear suddenly at half of the process. Thus, the inner part is widened and passes into ventral cavity subvertically. The radial notch rapidly increases in the width upwards. Its bottom is inclined obliquely to ventral cavity margin, the passage on inner interradial processes circle being gradual. Neither any impressions nor septa are developed. Radial facets are large, very wide (2.2 mm by holotype) and relatively short (see Pl. 8., Fig. 3). Muscle fossae are unusually large and deep, filling all the facet width. Axial canal is very minute, ligamentary impressions are expressive but relatively short. Inexpressive small edges project on interradial processes from muscle fossae margins, delimiting inner surface of the processes adjacent to radial notch, from their outer parts. Dorsal cavity is rounded, deep, with smooth bottom, articulatory structures being inexpressive.

Radial lobes of the cup are divided by shallow interradial depressions projecting along interradial processes. D_{max} cca 5 mm (bad preservation).

Remarks: Bottom character and partially also interradial processes of ? *Phyll. skalensis* sp. n. are close to *Phyll. borcicensis* sp. n. However, the cup below interradial processes is not conical, but widely lobed, like *Phyll. malbosianus.* Interestingly, extensive radial facets indicate relatively perfect articulation with PBr_1, characteristic e. g. by *Eugeniacrinites* (see also the flattening of interradial processes margins immediately above facets).

Phyllocrinus aff. *malbosianus* D'ORBIGNY, 1850
Pl. 7., Fig. 4

Horizon and locality: Oxfordian, West Carpathian Klippen Belt, Borčice valley (Veľká Skala locality) cca 7 km NW of Dubnica nad Váhom (Fig. 1.), western Slovakia, Czechoslovakia.

Material: one cup and one cup fragment.

Description: Medium sized cup with strong interradial processes and with wide and lobate lower part. The only measurable cup (see Pl. 7., Fig. 4., No SNM Z-18 756/3) has the whole cup height (H_c) equal to 3 mm, processes height (H_{proc}) is cca 1.5 mm, D_{max} = 3.9 mm, D_c = 3.7 mm. Interradial processes are high, slightly convergent with cup axis distally. The ends are triangular convex facets pointed to cup axis. The pointed ends have lateral rows of irregular granules converging to sharp central edge of the processes. This edge is running down the ventral cavity, disappearing close above radial notch bottom. Transversal cross-section of the processes is triangular in all its course, outer side being slightly concave. Radial facets are expressive, lying on the radial notch margin on radial lobes of the cup lower part. Muscle fossae are large, deep and expressive, separated by thin intermuscular septum. Axial canal is small, ligamentary expressions being wide but shallow, ligamentary point inexpressive (owing to bad preservation ?). Radial notch bottom is slightly concave dropping immediately from muscle fossae to ventral cavity. Neither any impressions nor septum are developed. The transition between radial notch and the ventral cavity is denoted by change in wall inclination. Ventral cavity is rounded, hemispheroidal, deep.

Cup radial lobes are very wide and rounded, being separated by deep interradial depressions, disappearing near cup base and distally on interradial processes. The cup base proper is flattened with central round dorsal cavity: its parameters are not observable.

Remarks: Although the overall morphology of species described is very close to *Phyllocrinus malbosianus,* its details are considerably different: e. g. part of interradial processes adjoining to ventral cavity and radial notch bottom. Interradial processes of *Ph. malbosianus posess* a longitudinal depression in the mentioned part, lined by rows of rough irregular granules on both the sides. This depression becomes wide and deep proximally, while the granules can fuse into diverging ridges or plates, running to the margin of radial notch bottom. They mark the boundary between the radial notch bottom and the ventral cavity, forming low septum. Radial notch bottom is concave, sinking from muscle fossae and sometimes considerably rising again to the septum if compared with ventral cavity. It is divided longitudinally by small ridge with very narrow central furrow. Each of two halves bears an expressive elliptical impression.

The ventral cavity proper contains expressive pouch-like cavities, developed as continuation of longitudinal inner depressions below interradial processes.

Insufficient preservation can weap up the granules lining inner depression of the processes and the septum can be lowered if compared with ventral cavity. However, the characteristic bottom of radial notch and ventral cavity depression always appear under the processes, if the interradial processes are (even partially) preserved. The Veľká Skala-type preservation could have allowed to observe the majority of structures mentioned, if they had been developed. The observations of Valanginian Stramberg collections (Žitt, 1978 b) have proved that intraspecific variability of *Ph. malbosianus* did not affected the radial notch bottom pattern or processes developmet pattern. Both the structural elements, very important functionally, are expressively developed also by Crimean *Ph. malbosianus* (Lower Valanginian) (see Arendt, 1974, Pl. 13., Figs. 9—10). Despite of small size of Veľká Skala collection it seems be high probable that it represents a different species, although closely related to *Ph. malbosianus*. This taxon can be better defined after new field collecting.

Phyllocrinus sp.
Pl. 7., Figs. 7—8.

Horizon and locality: Oxfordian, West Carpathian Klippen Belt, Borčice valley (Veľká Skala locality), cca 7 km NW of Dubnica nad Váhom, (Fig. 1), western Slovakia, Czechoslovakia.

Material: one cup.

Description: Tiny, sharply lobated and thin-walled cup, aproximately of the same size like the adult *Ph. belbekensis* of the same locality. Whole cup height (H_c) 2 mm, interradial processes height (H_{proc}) 0.5 mm, cup D_{max} is 2.7 mm. Cup conically narrows dorsally. Interradial depresions separating radial lobes become very shallow distally along the processes. Radial lobes are pointed dorsally, being rounded in proximity of radial facets. The interradial processes are very low, with wide base, strongly narrowing distally. In consequence, the radial notch is widely opened ventrally. Its bottom is sloped steeply from radial facets to the ventral cavity. The radial facets are small, muscle fossae tiny, but deep, axial canals minute. Transversal edge and ligamentary structures did not preserved. Ventral cavity is extensive, passing gradually into radial notches, reaching slightly under interradial processes. Basal part of the cup is pentagonal, dorsal articulations with the stem are inexpressive.

Remarks: The morphology of our specimen differs clearly from fore-mentioned species. Single findings does not allow to decide if it belongs to juvenile phyllocrinids or to quite new microcrinid species. Cup fragility, fineness and gracility testify rather for the former possibility. However, this question could be solved after obtaining of a new material containing several growth stages, because the juvenile phyllocrinids have considerable morphological uniformity (see Žítt, 1978 a-b).

Hemicrinidae RASMUSSEN, 1961
Cyrtocrinus JAEKEL, 1891

Type-species: *Eugeniacrinites nutans* GOLDFUSS, 1829, Late Jurassic, Germany.

? *Cyrtocrinus stiavnikensis* sp. n.
Pl. 8., Figs. 1–2.

Holotype: The figured specimen (No. SNM Z-18 761/1) is housed in Slovak National Museum in Bratislava.

Type horizon and locality: Oxfordian, West Carpathian Klippen Belt, Štiavnik (Priečnica-hill locality), cca 12 km N of Považská Bystrica (Fig. 1), western Slovakia, Czechoslovakia.

Material: A cup fragment besides the holotype specimen from the same locality.

Derivation of name: according to village near to the locality.

Description: Small, distally bowl-like widening cup (see Pl. 8., Fig. 1). Interradial processes are not preserved, their base being wider than the radial facets. Processes are not strengthened, but form flat continuation of relatively thin cup wall. Radial facets are showed out on expressive narrow radial lobes. Muscle fossae minute, ligamentary impressions shallow, transversal edge inexpressive. Ventral grooves descent from radial facets area to ventral cavity bottom (see Pl. 8., Fig. 2). They are very deep and wide below facets, narrowing and shallowing ventrally. Ventral cavity is extensive, pentagonal, dominating over whole cup ventral side.

Cup sides between mentioned radial lobes are inexpressively developed. Interradial depression is not developed, slightly concave wall is visible just between the lobes only. Cup base is narrowed dorsally, rounded, dorsal stem articulation is inexpressive.

Remarks: New species could be only provisionally attributed to *Cyrtocrinus* at present. The development of narrow radial lobes bearing tiny radial facets make this species similar to *Hemicrinus digitatus* (REMEŠ, 1905) of Stramberg Valanginian deposits (Žítt, 1983) or to *Cyrtocrinus nutans* JAEKEL (Jaekel, 1981). The cup base of this taxon passes gradually into stem, distally becoming unusually thin (a malformation?). The ventral side also expressively differs by shallow ventral cavity and large rounded facets with great muscle fossae from our specimens (the other structural elements are also more expressive). The similarity between facets development in all these three taxa is probably pure homeomorphic phenomenon. *Hemicrinus digitatus* of Stramberg is a typical representative of his genus, denoted by extensive modification of proximal parts of both stem and cup, forming a common spoon-like element (Žítt, 1983).

?*Cyrtocrinus* sp. *A*.
Pl. 3., Fig. 1.

Horizon and locality: Oxfordian, West Carpathian Klippen Belt, Borčice valley (Veľká Skala locality), cca 7 km NW of Dubnica nad Váhom (Fig. 1), western Slovakia, Czechoslovakia.

Material: one cup weathered out on limestone fragment surface No. SNM Z-18 758.

Description: Medium-sized cup, average D_{max} 4.6 mm. Outline of the only visible little vaulted cup dorsal side is pentagonal. Distribution of radial elements, situation and shape of dorsal cavity are clearly bilaterally symmetrical. One of RR is the largest, the opposite pair being the smallest. Rough tubercles are developed on cup margin below radial facets area. The sutures between RR are expressed by grooves. Extensive dorsal cavity is asymmetrically situated, enlarged in cup bilateral symmetry (see Pl. 3., Fig. 1.). It is divided into two parts: the inner one having steep walls, and the outer one is moderately inclined, especially in course of cavity elongation. Articulatory structures are like irregular nodules in inner part, but similar to inexpressively and scarcely distributed granules to wrinkles in the outer parts. Sutures between RR in the inner parts are lined by irregular ridges.

Remarks: Observable cup parts considerably resemble Mid-Oxfordian *Cyrtocrinus nutans* of Bimensdorf (Switzerland) — chiefly the specimen figured in Loriol (see Loriol, 1879, Pl. 18., Fig. 39; Žítt, 1983, Pl. 5., Figs. 10—12). However, the granulation of the Loriol's specimen is much finer one.

?*Cyrtocrinus* sp. *B*
Pl. 2., Fig. 2.; Pl. 3., Fig. 2.

Horizon and locality: the same as by fore-mentioned species.

Material: two cups on limestone fragment surface No. SNM Z-18 753 and 18 756.

Description: Medium-sized cups (average D_{max} is 4.2 mm) rounded in axial view. Radial facets are extensive, but relatively inexpressive. Muscle fossae small and deep, intermuscular septum is thin. Axial canal minute, transversal ridge long but inexpressive morphologically. Ligamentary impression extensive but shallow, ligamentary point deep. Interradial processes are poorly developed; they have form of rounded edges between radial facets. They overtop slightly the upper facet level above muscle fossae. Ventral cavity is extensive, pentagonal in outline, narrowing conically to its bottom.

The cup narrows rapidly dorsally below facet level. Sutures between RR are slightly expressed by very narrow depressions. The dorsal side is unknown.

Remarks: The cup has expressive sclerocrinid facets, the ventral cavity size is beyond range of this genus. It is ascribed usually to Hettangian-Kimmeridgian (see Arendt, 1974). However, the taxonomic delimitation is very uncertain; the definition of phylogenetic relations to *Sclerocrinus* could bot be considered as definitive, as well.

Eugeniacrinidae ZITTEL, 1879
Lonchocrinus JAEKEL, 1907

Type species: *Eugeniacrinites remesi* BIESE, 1937. Valanginian, Stramberg. ČSSR.

Lonchocrinus sp.
Pl. 2., Fig. 1.

Horizon and locality: Oxfordian, West Carpathian Klippen Belt, Štiavnik (Priečnica Hill), 12 km N of Považská Bystrica (Fig. 1), western Slovakia, Czechoslovakia.

Material: one axillarium on surface of limestone block No. SNM Z-18 761.

Description: incomplete axillare. Middle part of the element is very expressive, long, strong, convex outerwards. Facet morphology (SBrBr and PBr articulation) is uncertain owing to incomplete preservation.

Remarks: Poor preservation hinder the closer systematic determination. However, the determination of better preserved specimens would also demand greated collection, as well. Spear-shaped processes, articulatory facets, auxillarium lateraly wings, etc. have always very high variability (e. g. Pisera and Dzik, 1979, Fig. 8 b–e, *Lonchocrinus staszici*).

Other crinoidal remnants

Besides of the cups and isolater RR, the dominant number of fossil remnants in the collection consists of crinoid brachialia. They are very small and, moreover, damaged by weathering processes: thus, their morphology is very indistinct. Several types of them is figured on Pls. 7, 8. All these elements are greater, probably non-phyllocrinid. Very long bodies with minute terminal facets and very deep ventral groove (see Pl. 7., Fig. 10) belong to pinnular elements, probably isocrinid in origin (?). The axillare figured from its dorsal side only on Pl. 8., Fig. 12 is cylindrical, relatively massively developed. It could has belong to isocrinids, again. The axillary element figured on Pl. 8, Figs. 10–11 is very interesting. It is very gracile and high, ventral grooves being very weak and shallow, leteral wings being lined by granules. The middle pillow is slightly strenghtened to ventrally directed round nodule form. All the founded elements of this type reach the same minute size. Their systematical affinity remains unsolved. On the other hand, the considerably greater element (SBr?), illustrated on Pl. 8., Fig. 14 is probably cyrtocrinid and could belong to "?*Cyrtocrinus* sp. A" or "*C.* sp. B". The axillary element on Pl. 8., Fig. 7. belongs probably to unknown juvenile cyrtocrinid (theirs width being 1 mm).

Two strange, regularly granulated elements, resembling some asterioid elements, are figured on Pl. 3., Fig. 3. and on Pl. 6., Fig. 4. However, no sufficiently distinct articulary structures have been observed in any of specimens studied. They belong probably to cyrtocrinid brachialia, too.

The columnal elements are much more rare than the brachialia; the specimen illustrated on Pl. 8., Fig. 6 is very minute, having expressively bisquit shape, the transversal cross-section being circular. The facet morphology is not distinct.

It could be a cyrtocrinid, most probably phyllocrinid element. Three columnalia from Priečnica-Hill by Štiavnik illustrated on Pl. 8., Figs. 8—9 have similar character, being even more concave and shorter. Two of them have been even found in original junction (Fig. 8). Alas, articulatory facets are not observable. They could belong to the elements of identical or related species, as described before (see Fig. 6 of the same plate). Several cylindrical elements with stright latera, having the height non exceeding the diameter and narrow circle crenularium with big and sparse crenullae. Its articulation is on Pl. 8., Fig. 5. *Eugeniacrinus fallax* LORIOL, 1882 of French Oxfordian sediments (Var, Arréche; lectotype ana paralectotype cf. Loriol, 1882—1884) and Štramberk Valanginian are known having similar elements. Several considerably great cylindrical columnalia with concave and terminally rounded latera have been found in Veľká Skala locality, too. Their length is variable, but greater than the diameter (see Pl. 5., Fig. 1). The facets were (partially) observed in two specimens, crenularium is circular, narrow, having dense culmina. All the elements are probably cyrtocrinid.

The Veľká Skala locality yielded only sporadic isocrinid columnalia. Articulatory facet with typical pentalobate symplexy is visible on Pl. 6., Fig. 3. The element has pentagonal outline, the latera having inexpressive central ridge. Ciral facet preserved in one specimen on nodal element is slightly elliptical. However, the incomplete preservation makes the taxonomic determination difficult. Three elements attributed to crinoid holdfasts have been ascertained (two of them being figured on Pl. 1., Fig. 1., Pl. 8., Fig. 15). The attaching facet is always discoidal, flat, indicating the atachment to firm substrate.

Partial damage of the holdfast figured on Pl. 8., Fig. 15 shows deep and great axial canal along with circular sparse crenularium. Distal part of the holdfast with articulation is always of cylindric shape. Similar holdfasts were found in cyrtocrinid association of Štramberk; however, they never have such expressive axial canal.

The specimen figured on Pl. 8., Fig. 13 is probably also holdfast despite of atypical articulation character with three wide culmina. Distal widening of the element is also strange. Alas, the only found tiny specimen (height 1 mm) does not allow more exact systematical attribution (directly attached specimen with reduced radial facets?). All the specimens seems to be monocrystallic one.

Echinoidea

The skeletal remnants of other echinoderms are limited to long very sharp cylindrical echinoid spines. However, they have been broken frequently. Figured spine (Pl. 7., Fig. 9) is finely striated longitudinally, the crests between striae are frequently articulated into lineary arranged, almost fused granules rows (however, this diversification could have been sometimes caused by weathering). Spine base is smooth, slightly convex, acetabulum being deep. The spine has been attached to non-crenulated tubercle. A spine of other type is illustrated on Pl. 2., Fig. 1. Its lower part is very finely and densely striated longitudinally, in the higher parts some rough, approximately lineary arranged granules are developed. Spine base has not been preserved.

Other groups

Two imperfectly preserved juvenile ammonite remnants have been found at Veľká Skala locality (about 1 mm in diameter) along with small aptychi fragments (*Lamellaptychus* sp., cf. Pl. 3., Fig. 1 right below *Cyrtocrinus* sp. A cup). In general, remnants of non-echinoderm fauna occur only scarcely.

The characteristics of crinoid association

Crinoid fauna of Veľká Skala- and Priečnica-Hill localities is highly dominated by cyrtocrinids. The isocrinids, as another reliably determined order, are sporadically presented in Veľká Skala locality fauna (several isolated elements only, as yet).

The family *Phyllocrinidae* forms the substantial part of the cyrtocrinid association. Other groups (*Hemicrinidae* and *Eugeniacrinitidae*) are very rare, being represented by several specimens only (see the systematic part). *P. belbekensis* highly dominates in the phyllocrinids, being represented by four or five species. *P. borcicensis* sp. n. has the second place in abundance. *P.* aff. *malbosianus*, probably juvenile *P.* sp. and problematical ?*P. skalensis* sp. n. are equally rare as other cyrtocrinids and isocrinids. Crinoid association of Veľká Skala- and Priečnica localities are thus characterized by total dominance of *Ph. belbekensis*. Occurrence density on weathered rock surface is about 0.9 cm^2 in the Veľká Skala locality (total surface being 892 cm^2) and 0.2 cm^2 in the Priečnica locality (total surface cca 325 cm^2).

All the crinoids are represented by their dissociated skeletal elements and by cups (only *P. borcicensis* sp. n. could form certain exception – see the description). However, even the cups could disintegrate into individual RR. The preservation of all the disarticulated elements in the rock is perfect including all the finest points of interradial processes (in contrast with out--weathered specimens, which are partially damaged – including all the measured specimens). Thus, the postmortal transport of disarticulated elements must has been very short. Two joined columnalia of Priečnica locality (see Pl. 8., Fig. 8) prove for in situ deposition (if they were not primary growed together).

The isolated, but perfectly preserved RR must have been also minimally transported. The desintegration could not has been violent, but spontanneous one immediately after death, being caused by weaker connection of the individual RR. The cause of this, by cyrtocrinid rare effect is unknown.

The lack of columnals in isolated element accumulation is surprising. On the other hand, the brachialia are very abundant (see higher). Individual elements of probably very fine stems have been probably lost in the mass of indeterminable damaged fine fraction elements. However, the low number of greater columnalia of other species could correlate with rare occurrence of these species at all.

The phyllocrinids are represented by great scale of ontogenetic stages. Some specimens with cup diameter 0.7 mm have been found, even the presence of even younger specimens (0.5 mm) have been indicated in fine fraction. However, their bad preservation hindered measurement and more exact determination.

The indications of septa in radial notches prove the attribution of juvenile cups majority to the dominating *P. belbekensis*. However, the relative high juvenile mortality described in Rogożnik (P i s e r a and D z i k, 1979) has been not confirmed in our association.

Phyllocrinid paleoautecology is very poorly known. A r e n d t (1970) interpreted the position and the type of arm-apparatus in radial notch and stem type by *Ph. sabaudianus* (Lower Barremian of Crimea, Biassala). According him, interradial processes have had both protectory function and function of "water current regulators" above cup ventral side. Ž i t t (1978 d) accepted this interpretation by Valanginian *Ph. malbosianus* of Štramberk. However, this interpretation leading with connection with more rigid stem to active rheophoby assumption by phyllocrinids, is possible in representatives with free radial notches only. This interpretation is improbable in representatives with high transversal septum, filling great part of radial notch (Ž i t t, 1978 a). The function of septa by such a species (*P. minutus* ŽÍTT, *P. belbekensis*) remains uncertain. Despite of it, the structure of *P. belbekensis* cup indicates quiet shallow environment, rich in nutrients. On the other hand, ?*Cyrtocrinus* sp. A., and *C.* sp. B have demanded moderate one-way current (as prove the development of bilateral symmetry in both orientation and morphology of the cup).

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Translated by J. Vitko.

Plate 1

Fig. 1. *Phyllocrinus belbekensis* (be), Nos. SNM Z-18 760/4 (left) and SNM Z-18 760/5 (right specimen); indetermined holdfast (h), SNM Z-18 760/3. Priečnica Hill by Štiavnik Magn. 7.5 x.
Fig. 2. *Phyllocrinus belbekensis* (be), Nos. SNM Z-18 760/6 (great specimen) and SNM Z-18 760/7 (juvenile specimen). The same locality, magnif. x 10.
Fig. 3. *Phyllocrinus borcicensis* sp. n., paratype No. SNM Z-18 760/1. The same locality, magn. x 12.8.
Whitened by ammonium chloride, photo by J. Brožek, Geol. Geotechn. Institute, Czechoslovak Acad. Sci., Prague. All the specimens deposited in collections of Slovak National Museum in Bratislava (rock fragments with the fossils on the surfaces are denoted with numbers SNM Z-18 752 to 18 761).

Plate 2

Fig. 1. *Lonchocrinus* sp. (L), No. SNM Z-18 761/2; *Phyllocrinus belbekensis* (be), Nos. SNM Z-18 761/6 (more to left), SNM Z-18 761/7 (down); echinoid spine (S), No. SNM Z-18 761/5. Priečnica Hill by Štiavnik. Magn. x 3.2.
Fig. 2. ?*Cyrtocrinus* sp. B.–CB/, No. SNM Z-18 756/2; *Phyllocrinus belbekensis,* Nos. SNM Z-18 756/6 (be$_a$), 18 756/7 (be$_b$), 18 756/8 (be$_c$), 18 756/9 (be$_d$), 18 756/10 (be$_e$). Borčice valley, Veľká Skala locality. Magn. x 3.6.
Photo and remarks as Pl. 1.

Plate 3

Fig. 1. ?*Cyrtocrinus* sp. A. (CA), No. SNM Z-18 758/1; *Phyllocrinus belbekensis* (be), No. SNM Z-18 758/5. Borčice valley, Veľká Skala locality. Magn. x 4.5.
Fig. 2. *Phyllocrinus belbekensis* (be), No. SNM Z-18 753/7; ?Cyrtocrinus sp. B (CB), No. SNM Z-18 753/1. Same locality, x 4.8.
Fig. 3. Probable cyrtocrinid brachial element, No. SNM Z-18 758/3. Same locality, x 2.2. Photo and remarks as Pl. 1.

Plate 4

Fig. 1. *Phyllocrinus belbekensis* (be), No. SNM Z-18 757/10. Borčice valley, Veľká Skala locality, magn. x 4.8.
Fig. 2. Association of *Phyllocrinus belbekensis* cups on the surface of rock fragment No. SNM Z-18 753. The same locality, x 2.9.
Photo and remarks as Pl. 1.

Plate 5

Fig. 1. *Phyllocrinus belbekensis* (be), Nos. SNM Z-18 756/6 (above) and 18 756/7 (right of the columnalium); cyrtocrinid columnalium with concave latera (c), No. SNM 756/4. Borčice valley, Veľká Skala locality, x 5.2.
Fig. 2. *Phyllocrinus belbekensis,* Nos. SNM Z-18 757/6 (be$_a$), 18 757/7 (be$_b$), 18 757/8, (be$_c$), 18 757/9 (be$_d$); *Phyllocrinus borcicensis* sp. n. (bo), paratype, No SNM Z-18 757/1. Same locality, magn. x 4.1.
Photo and remarks as Pl. 1.

Plate 6

Fig. 1. *Phyllocrinus borcicensis* sp. n. (bo) paratype, No. SNM Z-18 752/1; *Phyllocrinus belbekensis* (be), No. SNM Z-18 752/2. Borčice valley, Veľká Skala locality. Magn. x 6.8.

Fig. 2. The same in other view. (x 7.6).
Fig. 3. Isocrinid columnalium, No. SNM Z-18 758/4. The same locality, magn. x 4.2.
Fig. 4. *Phyllocrinus belbekensis* (be), No. SNM Z-18 756/8; probable crinoidal brachialium (br.), No. SNM Z-18 756/5. Same locality, magn. 2.8.
Photo and remarks as Pl. 1.

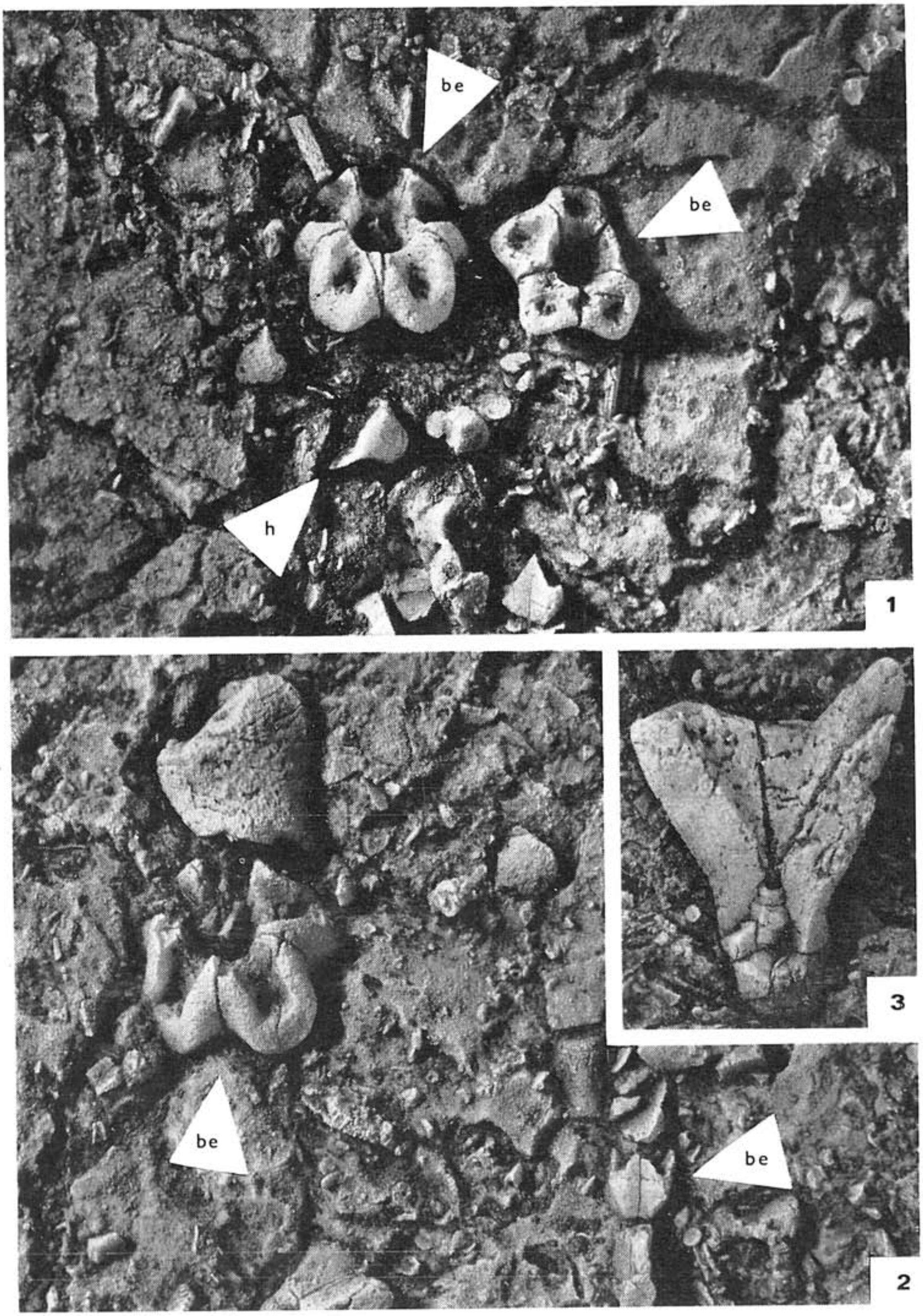
Plate 7

Fig. 1. *Phyllocrinus belbekensis*, No. SNM Z-18 753/2, lateral view. Posterior interradial process covered by rock. Borčice valley. Veľká Skala locality, magn. 10 x.
Fig. 2. The same, No. SNM Z-18 753/3, lateral view. Two anterior RR missing. The same locality. Magn. x 10.
Fig. 3. The same, No. SNM Z-18 759/3, dorsal view. Same locality, magn. x 12.5.
Fig. 4. *Phyllocrinus* aff. *malbosianus*, No. SNM Z-18 756/3, ventrolateral view. Adjacent *P. belbekensis* cup denoted by outline left above. Same locality, magn. x 13.
Fig. 5. *P. belbekensis*, No. SNM Z-18 757/2, lateral view on juvenile specimen. Same locality, magn. x 10.
Fig. 6. The same, No. SNM Z-18 757/3, lateral view. Same locality, magn. x 8.5.
Figs. 7—8. Lateral and ventral view on *Phyllocrinus* sp., No. SNM Z-18 759/5. Same locality, magn. x 13.
Fig. 9. Echinoid spine No. SNM Z-18 758/2. Same locality, magn. x 10.
Fig. 10. Pinular element No. SNM Z-18 753/4. Same locality, magn. x 10.
Fig. 11. *Phyllocrinus borcicensis* sp. n., holotype, No. SNM Z-18 759/1. The same locality, magn. x 10.
Fig. 12. The same, paratype No. SNM Z-18 759/2. Anterior RR are missing. The same locality, magn. x 10. Drawings J. Žítt.

Plate 8

Figs. 1.—2. ?*Cyrtocrinus stiavnikensis* sp. n., lateral and ventral view on the holotyp, No. SNM Z-18 761/1. Priečnica Hill by Štiavnik. Magn. x 10.
Figs. 3.—4. ?*Phyllocrinus skalensis* sp. n., ventrolateral and lateral view on holotype, No. SNM Z-18 756/1. Borčice valley, Veľká Skala locality. Magn. x 9.2.
Fig. 5. Articulatory facet of the columnalium No. SNM Z-18 757/4. The same locality, magn. x 10.
Fig. 6. Columnalium No SNM Z-18 757/5, same locality, x 7.5.
Fig. 7. Axillare, No. SNM Z-18 755/1, ventroproximal view. The same locality; Magn. x 8.
Fig. 8. Two connected columnalia No. SNM Z-18 761/3. Priečnica Hill by Štiavnik. Magn. x 6.5.
Fig. 9. Columnalia of the same type, No. SNM Z-18 761/4, the same locality, magn. x 6.5.
Figs. 10—11. Axillare in ventral and distal view. No. SNM Z-18 762 (separated element). Borčice valley, Veľká Skala locality, magn. x 9.
Fig. 12. Axillare, No. SNM Z-18 753/5, dorsal view. The same locality, magn. x 7.5.
Fig. 13. Probale holdfast, No. SNM Z-18 759/4. The same locality, magn. x 10.
Fig. 14. Brachiale No. SNM Z-18 753/6. The same locality; Magn. x 12.
Fig. 15. Holdfast No. SNM Z-18 760/2. Priečnica Hill by Štiavnik. Magn. x 10. Drawings by J. Žítt. Other explanations the same as Pl. 1.

Plate 1



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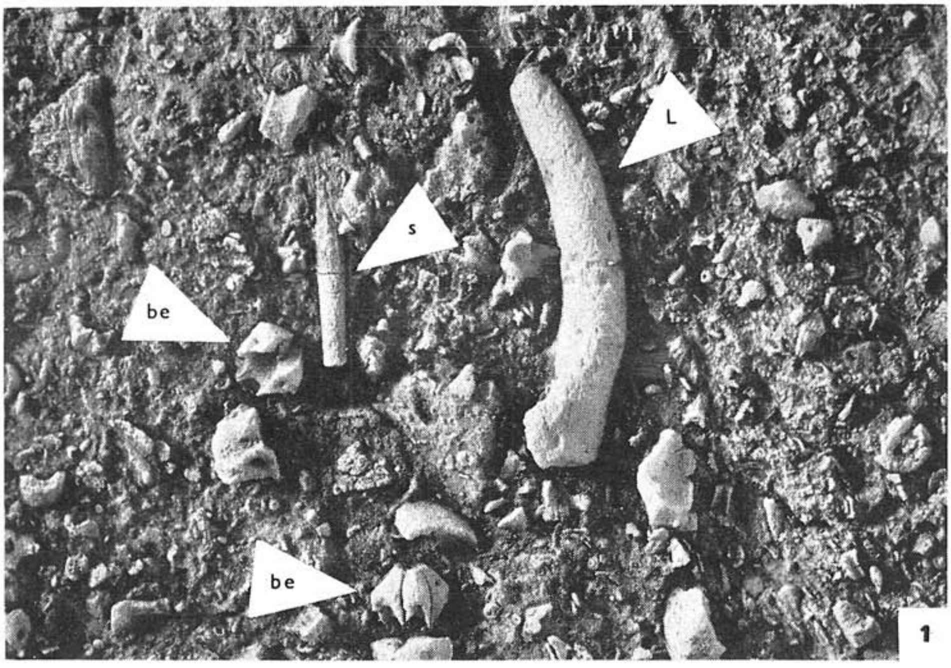

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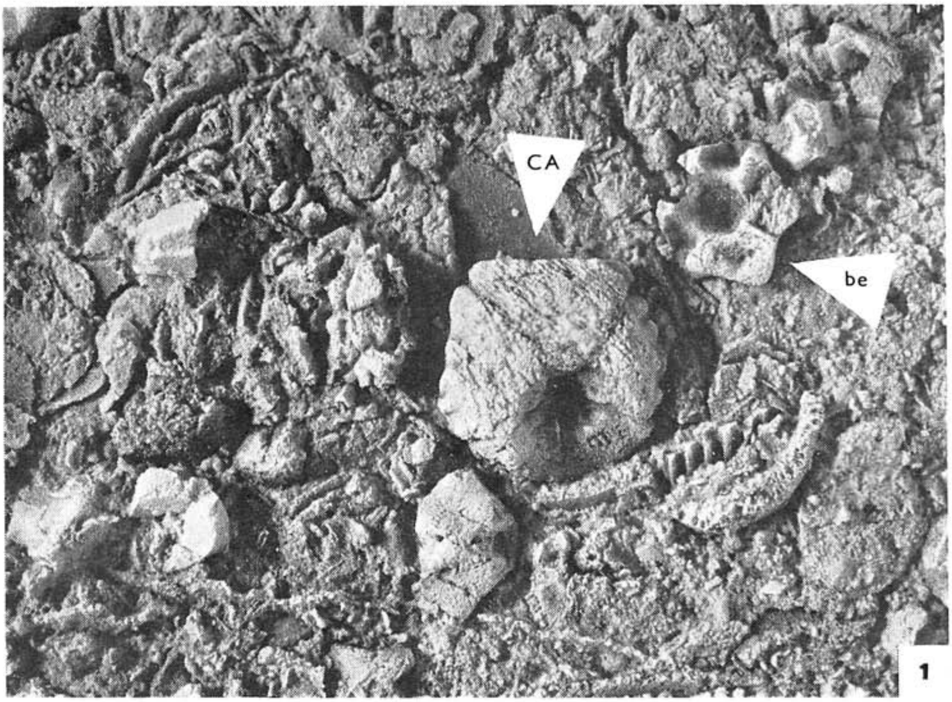

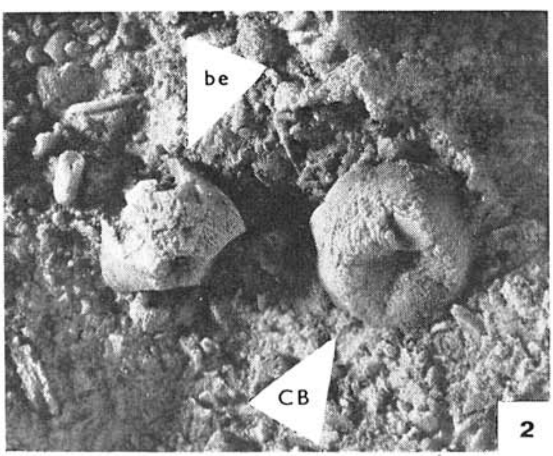

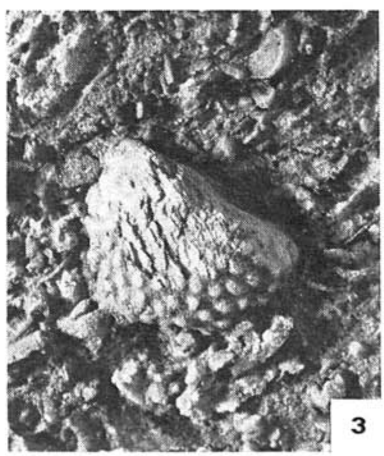

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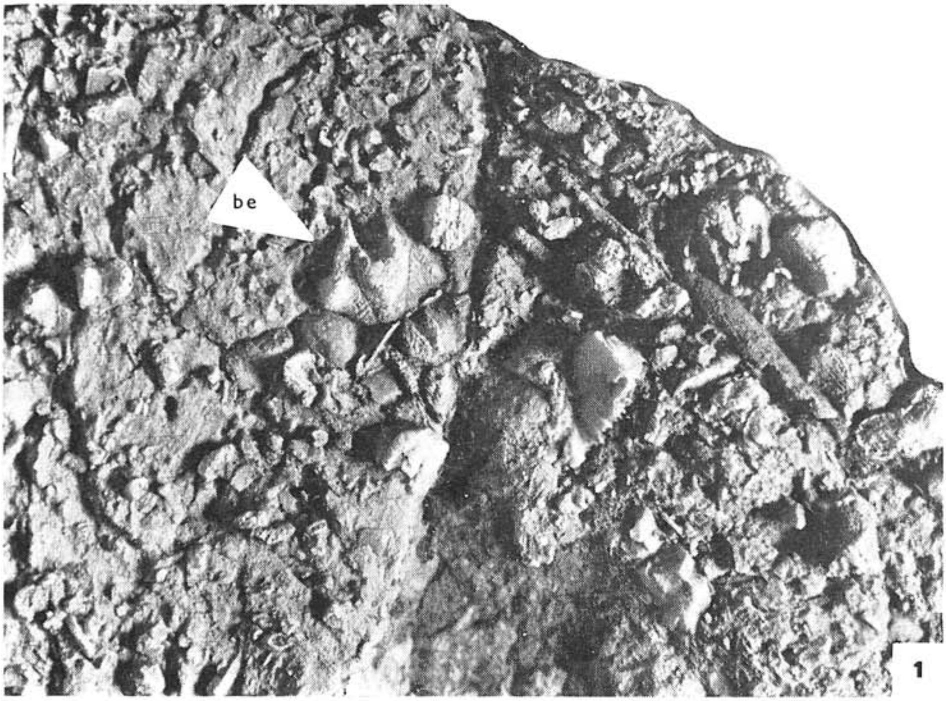

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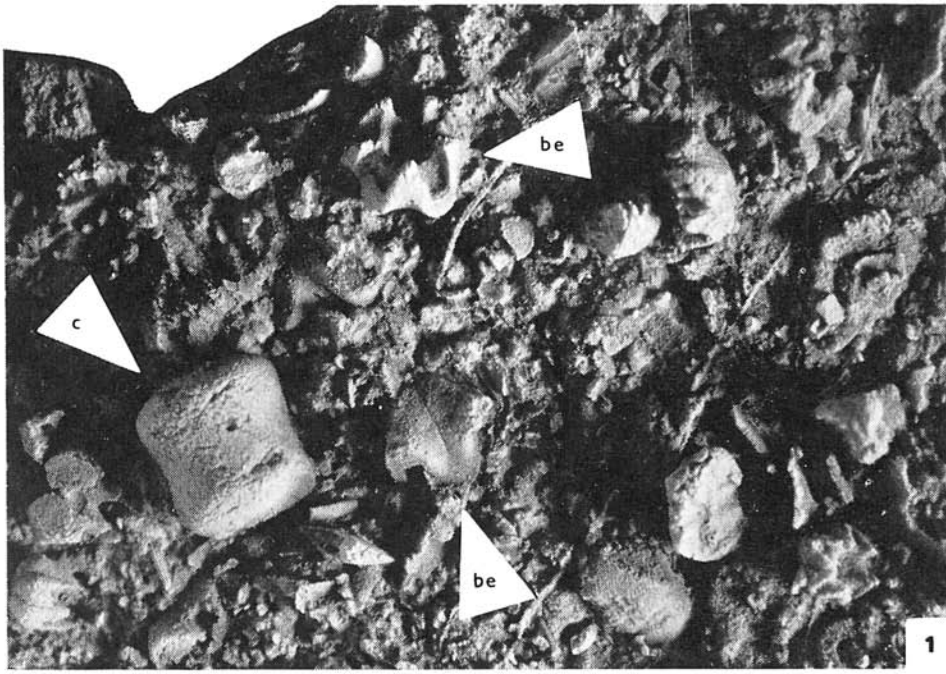
Plate 5



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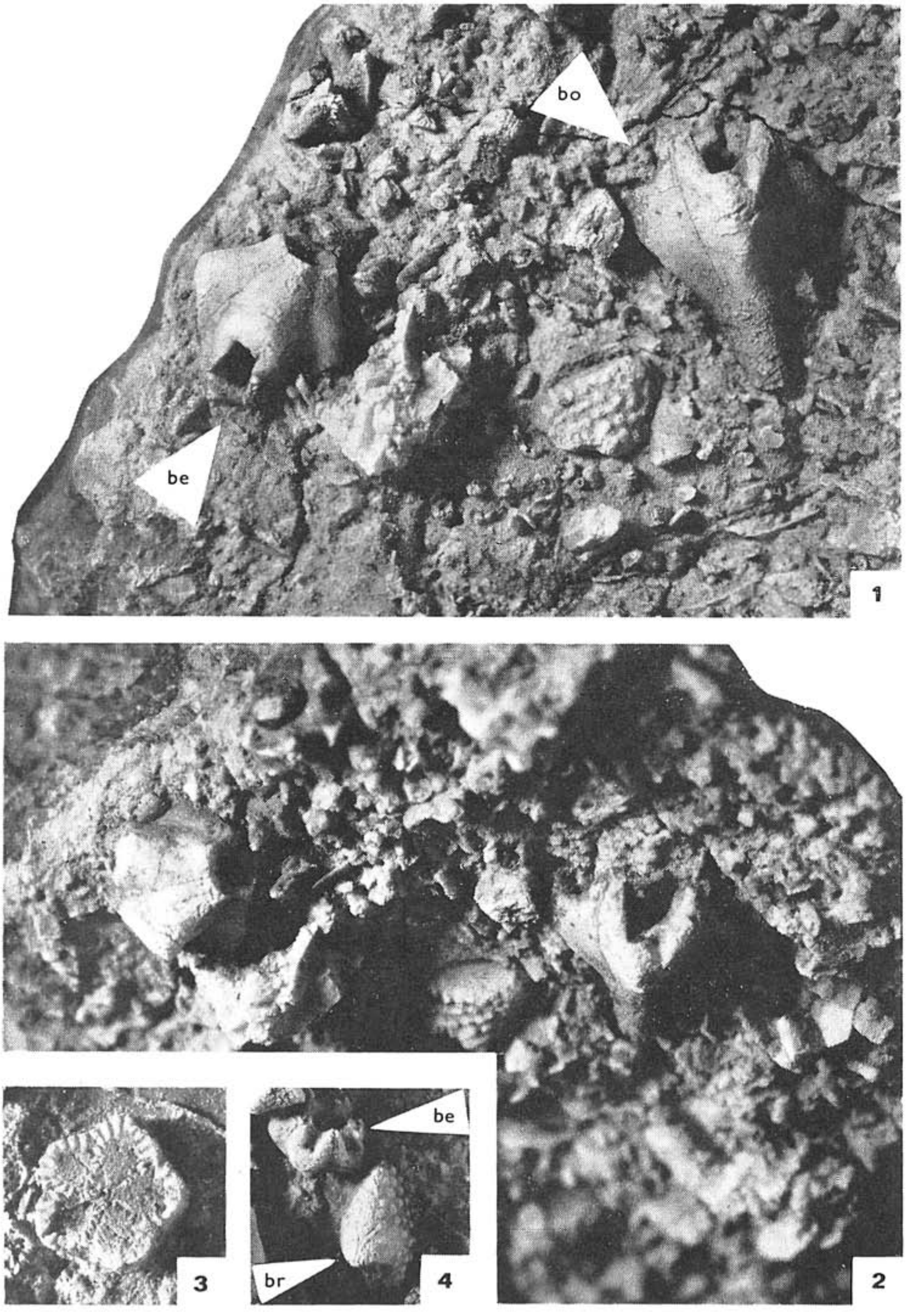

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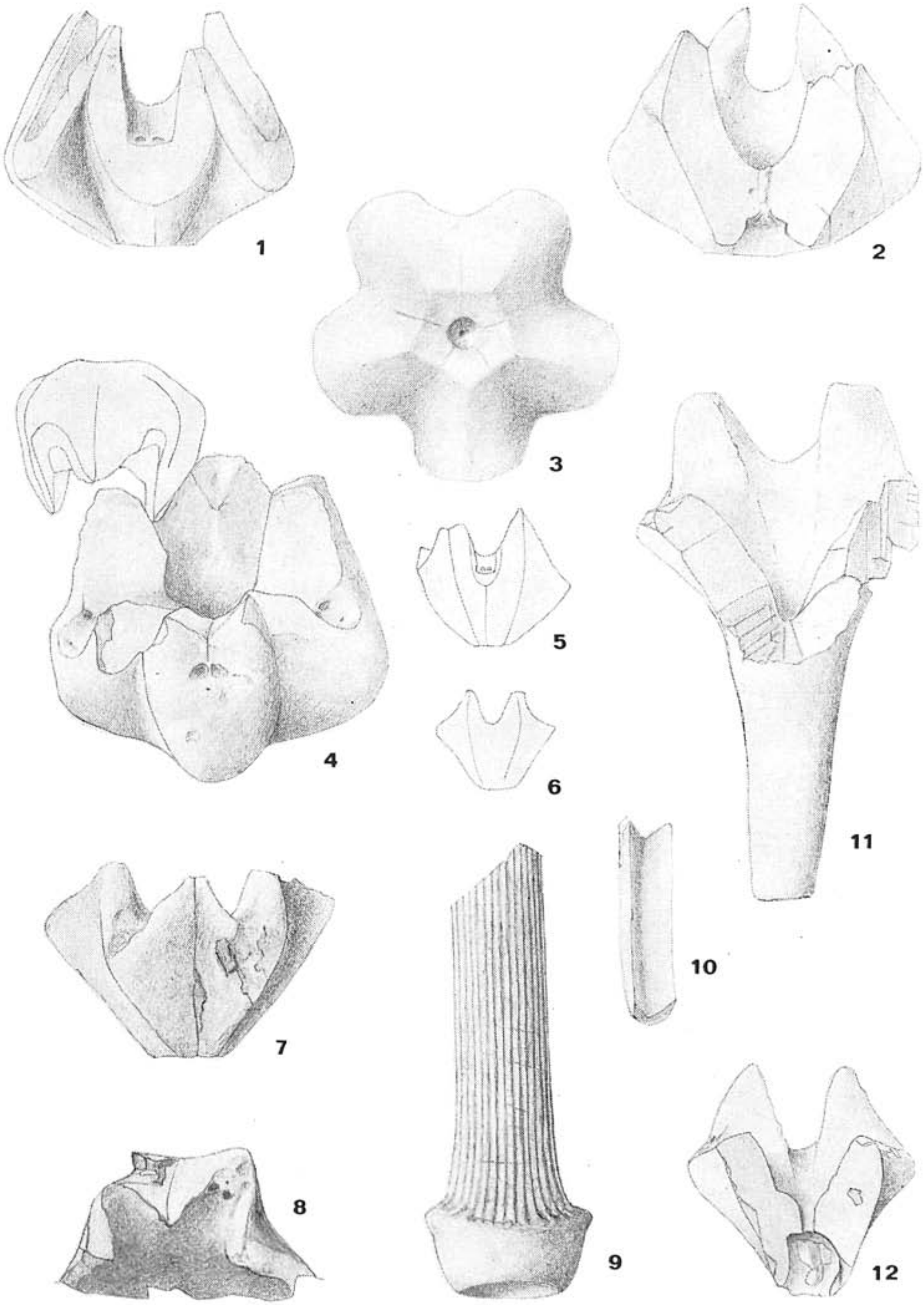
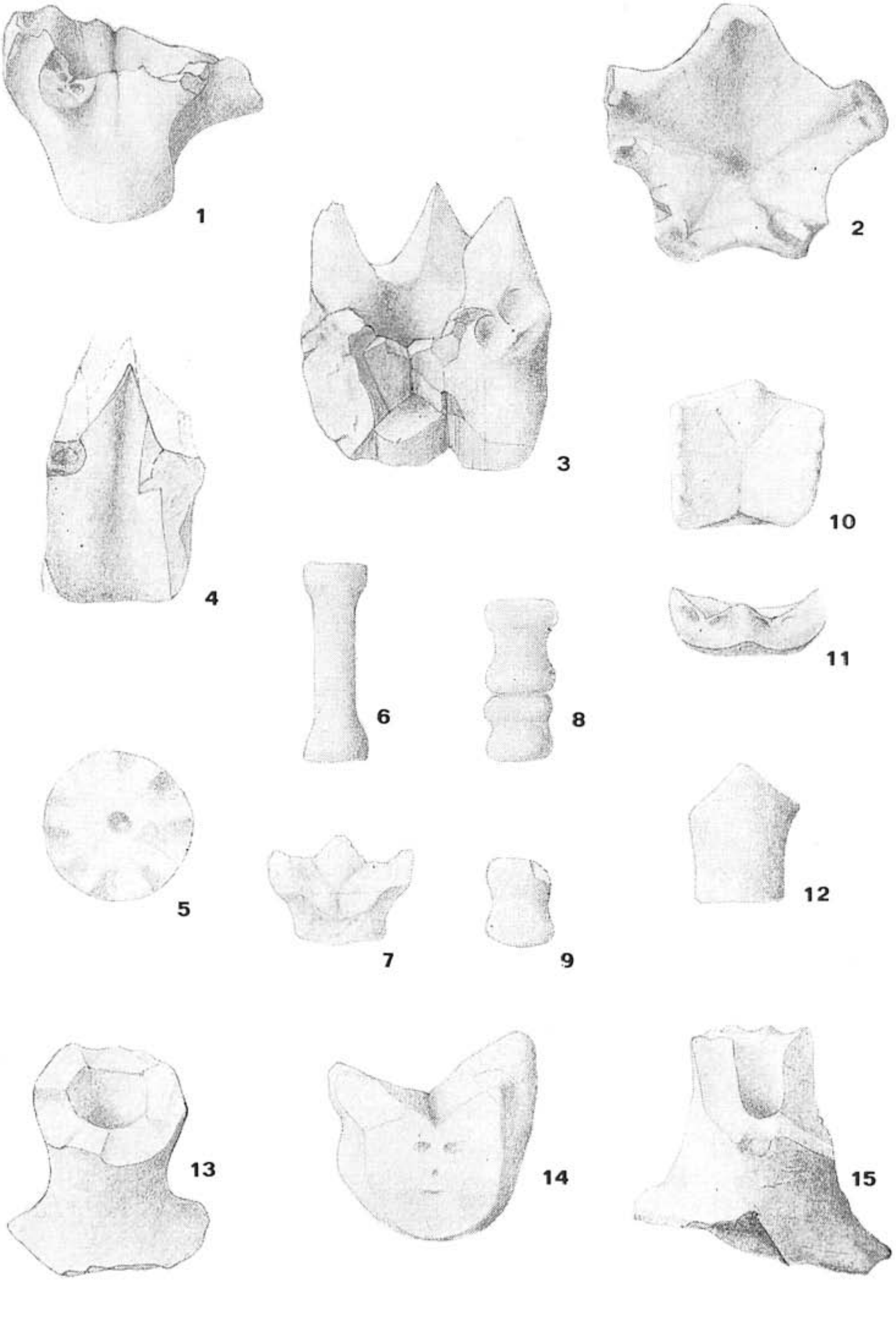


Plate 8



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