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EARLY CRETACEOUS PHYLLOCRINIDS (CRINOIDEA, CYRTOCRINIDA) IN THE MANÍN UNIT (MT. BUTKOV, MIDDLE VÁH VALLEY, CENTRAL WEST CARPATHIANS)

(Text - figs. 6, Pls. 2, Tab. 1)



Abstract: The paper deals with the first finds of rare echinoderm fauna from the pelagic Lower Cretaceous (Lower Valanginian—Lower Barremian) strata of the Manín sequence of Mt. Butkov. Four species of crinoids were assigned to the genus *Phyllocrinus*: *Ph. sp.*, *Ph. malbosianus* d'ORBIGNY, *Ph. aff. malbosianus*, *Ph. misiki* sp. n. All species belong to the same morpho-functional phyllocrinid type, distinguished by the elliptical imprints of radial notch bottom and high septum separating it from the ventral cavity. Isolated cups are sparsely dispersed in the micrite limestones. The state of their preservation excludes the possibility of their more significant postmortal transportation.

Резюме: В работе описываются первые находки относительно редкой эхинодермовой фауны из пелагических нижнемеловых отложений Манинской секвенции горы Бутков в западной Словакии. Все четыре вида принадлежат криноидам рода *Phyllocrinus* (*Ph. malbosianus* d'ORBIGNY, *Ph. aff. malbosianus*, *Ph. misiki* sp. n. *Ph. sp.*). По строению чашечек, отличающихся эллиптическими впадинами нижних поверхностей радиальных депрессий между интеррадиальными выростами и их частным отделением от центральной полости, эти виды принадлежат тому же морфофункциональному типу филлокринид. Изолированные чашечки рассеяны в микритовых известняках, но их постмортальную транспортировку, судя по степени их сохранения нельзя считать большой.

Introduction

During the last years the rich crinoid fauna was described from the Slovak West Carpathians by Žitť — Michalík (1984) and by Žitť (1987). The first paper deals with the Oxfordian crinoids from the localities Veľká Skala near Borčice and Priečnica-hill near Štiavnik, in the second one the results of crinoid investigations from the Lower Valanginian locality at Vršatec Castle Klippe are summarized. All three localities are situated in the western part of the Klippen Belt. Relatively near to the preceding localities a new hitherto unknown crinoid fauna was discovered during the detail geologic investigations made by one of us (Michalík) and by other workers in the Butkov area.

The crinoids are here very scarce and their preparation is difficult as the cups disintegrate easily owing to the cleavage of its calcite substance. In spite

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of these unfavourable circumstances, the detailed morphological studies were realized. The results obtained (see below) extend significantly the knowledge of the West Carpathian crinoids and may at least serve for the future studies of this group.

Geological setting

The Manín Unit is one of the most discussed tectonic units of the Central West Carpathians. Its paleotectonic development was very complicated. This originally Central Carpathian unit has become a part of accretionary prism of the front of Central Carpathian block and incorporated itself into the region of the Klippen Belt (Fig. 1). The Manín Unit was deformed anew during the younger phases of the Alpine Orogeny together with the Outer Carpathians. As a consequence, there are striking differences among the single sedimentary megacycles of the bed sequences, which reflected in the completely different approaches of the authors (Andrusov, 1938, 1959; Began, 1969; Gašparíková — Salaj, 1984; Maheľ, 1978, 1980; Rakús 1975 a. o.) to the stratigraphic range, subdividing, paleotectonic interpretation, position and the pertinence of the unit as a whole.

In the quarry of Považské cementárne Ladce (cement works) (geographical setting see Fig. 2) a sequence of the Upper Jurassic and Lower Cretaceous beds of Manín Unit was exposed. The unit may be divided into three different parts. The lowest one, the Czorsztyń Limestone Formation, represents a product of the Callovian—Tithonian pelagic sedimentation of "Ammonitico Rosso" type. The epoch of the Jurassic deep-sea sedimentation of siliceous and radiolarian limestones was thus finished.

The second, Lower Cretaceous complex of pelagic limestones consists of four formations (Borza et al., 1987). Near the base of the lowermost Ladce Limestone Formation ("sublithographical" yellowish-grey, slightly marly, micrite to biomicrite limestones) the beds of limestone breccias are exposed. These rocks document the Beriasian period of disturbed sedimentary regime connected with the erosion of the older, middle to upper Tithonian horizons (Vašíček et al., 1983). Ladce Formation is overlain by the Mrázňica Formation represented by the bathyal grey marly spotted limestones with occasional alloclastic intercalations. The third, Kališče Formation consists of green-grey cherty limestones originated by the even pelagic sedimentation (Fig. 2). The uppermost of the four formations mentioned is Lúckovská Formation formed by yellowish weathering, marly, in places cherty limestones with nodular bedding planes and intercalations of marlstone. This formation shows the stabilization and gradual differentiation of the carbonate ramp. In all the formations of the pelagic complex relatively well preserved micro- and macrofaunal remains and remains of nannoflora occur.

The third carbonate complex is "Urgonian" complex of biotrititic and biogenic limestones of the Upper Barremian—Lower Albian shallow-sea carbonate platform, which gradually covered the basin deposits of the region. In the Butkov area, the major part of these carbonates is developed as the facies of the platform slope (Michalík — Vašíček, 1987). After the Mid —

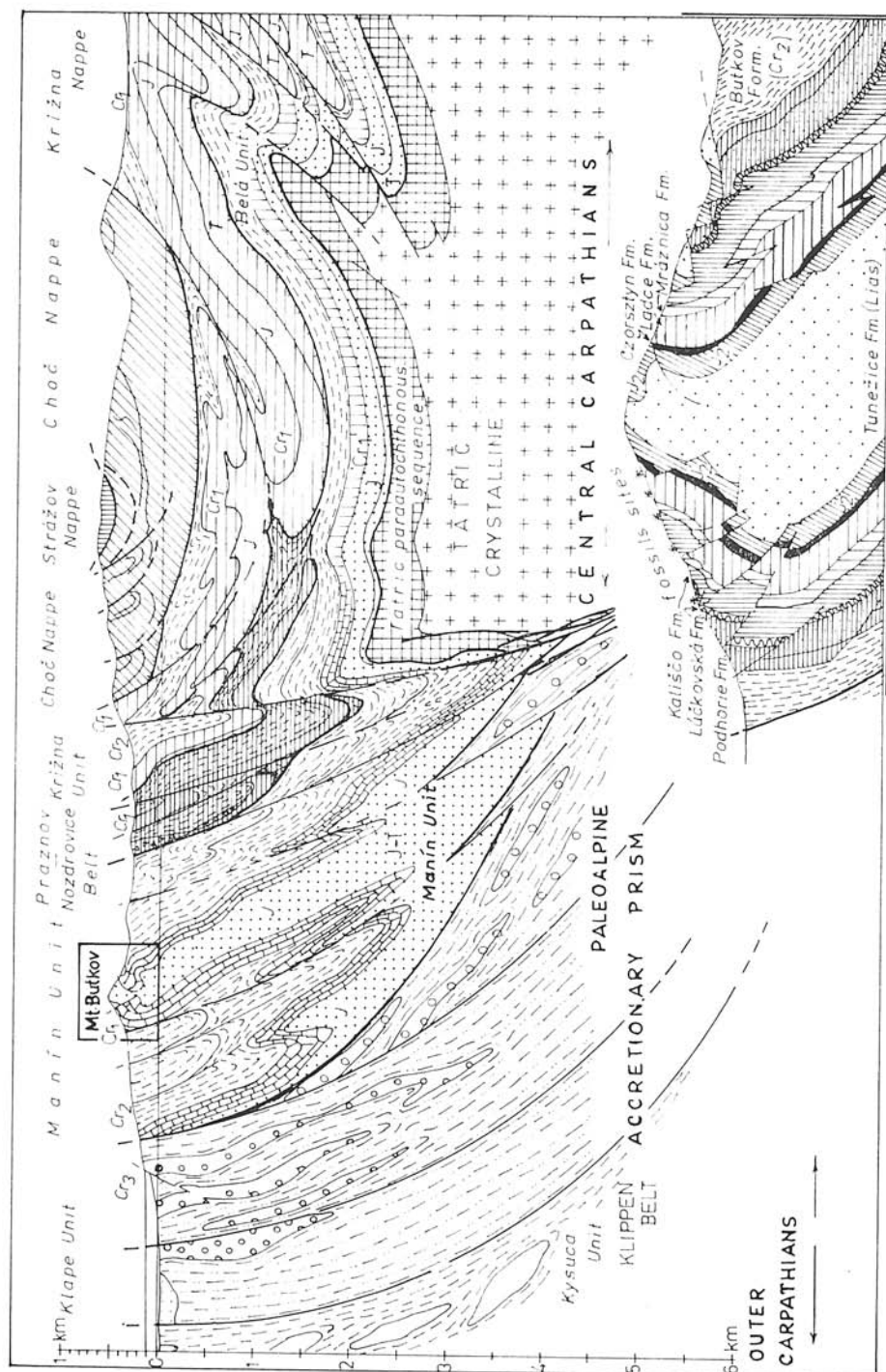


Fig. 1. Geological section of the margin of Central West Carpathians built by the Manín and Kostelec Units (see Rakús, 1975, 1977; Maheř, 1978, 1980; Gašparíková—Salaj, 1984; Michalík—Vašíček, 1987). Orig. J. Michalík.

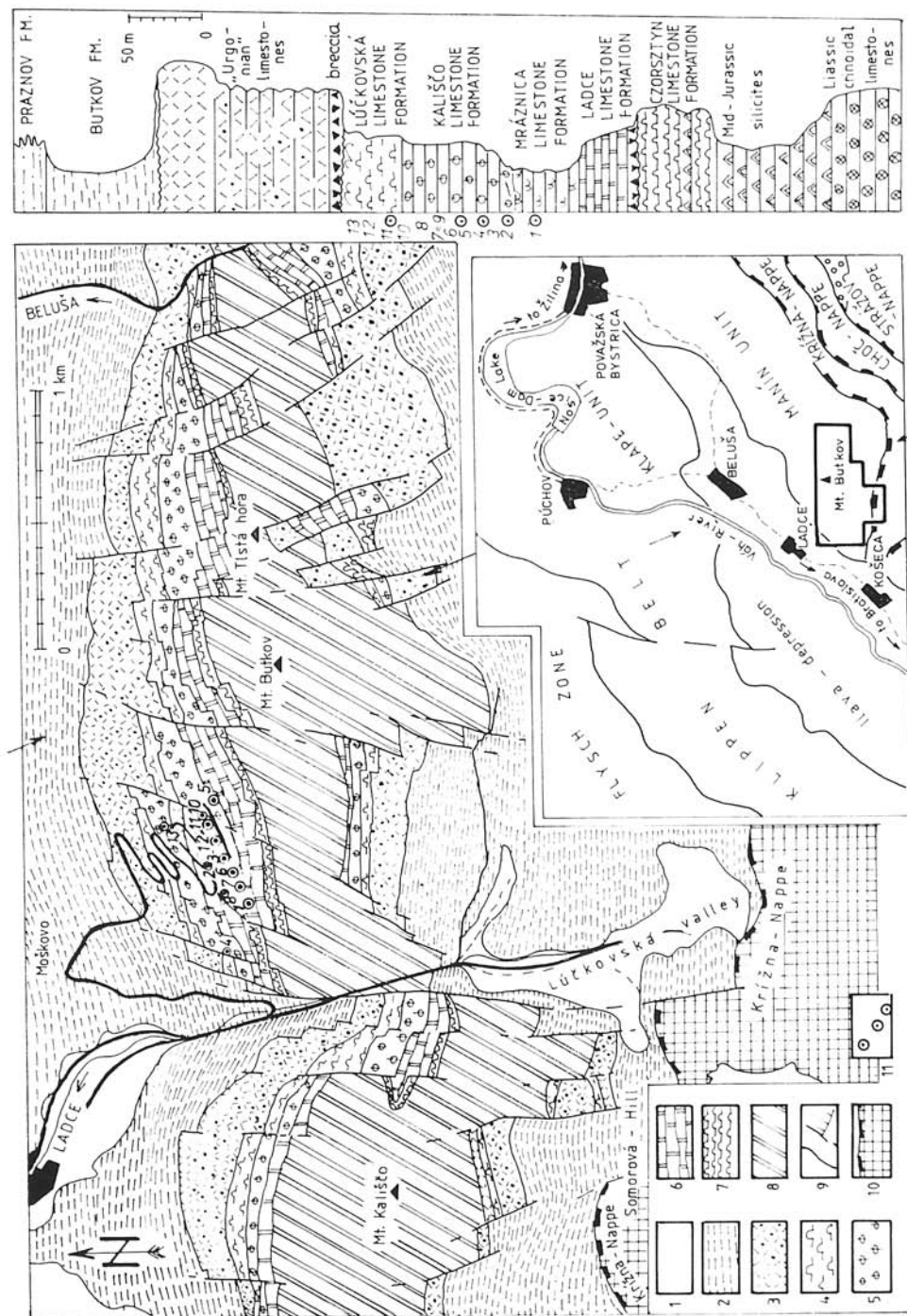


Fig. 2. Geological sketch of the Butkov Klippe and the lithostratigraphical scheme of the Jurassic and Lower Cretaceous sequences exposed in the Butkov quarry. *Legend:* 1. — Quaternary; 2. — Middle Cretaceous flyschoid complexes (Pražnov and Butkov Formations); 3. — "Urgonian" limestone complex; 4. — Luckovská Limestone Formation; 5. — Kališčo Limestone Formation; 6. — Mrázňica and Ladce Limestone Formations; 7. — Czorsztyń Limestone Formation; 8. — Lower and Middle Jurassic beds; 9. — dislocations and thrust faults; 10. — complexes of Krizna Nappe; 11. — crinoid localities.

Albian) sedimentary gap marked by the condensed horizon (hard ground) the thick marlstones of Butkov Formation follow.

Notes to the occurrence and preservation

Isolated crinoid cups in association with the ammonite shells, aptychi, rhyncholites, belemnite rostra, brachiopods, sporadic fish teeth and ichnofossils (*Zoophycos* sp., *Rhabdoglyphus* sp., see Michalík, 1987) are most frequent in the Mráznic, Kališčo and Lúčkovská Limestone Formations. The crinoids are not distinctly worn (above all in the younger formations). Their cups are very sparsely dispersed on the bedding planes of the rock. On the contrary, faunal remains concentrated near the intercalations of the allodapic limestones are mostly more worn. The oldest find of crinoids (*Phyllocrinus* sp.) in the rock closely overlying the biodetritic allodapic limestone intercalation within the Mráznic Formation makes an exception. The specimen is very slightly worn from which its transportation by only weak currents results. The age of this find (loc. No. 1, see Fig. 2) was determined on the basis of *Lamellaptychus aplanatus retroflexus* TRAUTH and *Kilianella* sp. as the upper part of Lower Valanginian.

Specimens of *Phyllocrinus malbosianus* from the Kališčo Limestone Formation (loc. Nos. 2—9, see Fig. 2) are, on the other hand, well preserved probably immediately on or very close to their life site. They are in association with the rich fauna (*Lamellaptychus didayi* (COQ.), *L. angulocostatus* (PICT. et LOR.) a. o., see Vašíček — Michalík, 1986) indicating the Lower Hauterivian age of this species.

The species *Phyllocrinus misiki* sp. n. was found in the limestones of Lúčkovská Limestone Formation (loc. Nos. 10—13, see Fig. 2). A good preservation of the specimen gives the evidence of the minimum transport as in the preceding species. *Phyllocrinus misiki* sp. n. forms a part of faunal association (brachiopods, belemnites, ammonite species *Barremites* (B.) *subdifficilis* Kar., a. o., see Michalík — Vašíček 1987) indicating the Uppermost Hauterivian — Lower Barremian age.

Systematic part

Cyrtocrinida SIEVERTS-DORECK

Phyllocrinidae JAEKEL, 1907

Phyllocrinus d'ORBIGNY, 1850

Type species: *Phyllocrinus malbosianus* d'ORBIGNY, 1850,

Phyllocrinus malbosianus d'ORBIGNY, 1850;

Pl. 1, Figs. 1—6, Text-fig. 3

Material: 7 cups from the Lower Hauterivian Kališčo Limestone Formation of Butkov quarry (Tab. 1).

Remarks: Specimens from Butkov vary morphologically in a great range. Some of them (Pl. 1, Figs. 1—6) are similar to the specimens from the Štram-

Table 1

Location of crinoid finds in the quarry of Považské cementárne Ladce (cement works) on the NW slope of the Mt. Butkov.
 Symbols: L. F. — Limestone Formation

Collection number	Species	Number of specimens	Locality	Formation	Age
SNM Z-18 763	<i>Phyllocrinus</i> sp.	1	1.: groove Nr. 8/4	Mrázňica L. F.	u. Lower Valanginian
SNM Z-18 764/1	<i>Ph. malbosianus</i>	1	2.: road-cut between 6-th and 7-th level	Kališčo L. F.	u. Lower Hauterivian
SNM Z-18 764/2	<i>Ph. malbosianus</i>	1	3.: 8-th level, 410 m	Kališčo L. F.	L. Hauterivian
SNM Z-18 764/3	<i>Ph. malbosianus</i>	1	4.: 6-th level, 100m	Kališčo L. F.	L. Hauterivian
SNM Z-18 764/4	<i>Ph. malbosianus</i>	1	5.: groove Nr. 20 above 8-th level	Kališčo L. F.	L. Hauterivian
SNM Z-18 764/5	<i>Ph. malbosianus</i>	1	6.: 8-th level, 420 m	Kališčo L. F.	L. Hauterivian
SNM Z-18 764/6	<i>Ph. malbosianus</i>	1	7.: 8-th level, 470 m	Kališčo L. F.	Lowermost Hauterivian
SNM Z-18 764/7	<i>Ph. malbosianus</i>	1	8.: 7-th level, 550 m	Kališčo L. F.	Lowermost Hauterivian
SNM Z-18 765	<i>Ph. aff. malbosianus</i>	1	9.: 8-th level, 470 m	Kališčo L. F.	Lowermost Hauterivian
SNM Z-18 766/1	<i>Ph. misiki</i> sp. n.	1	10.: 8-th level, 140 m	Lúčkovská L. F.	Uppermost Hauterivian-Lower Barremian
SNM Z-18 766/2	<i>Ph. misiki</i> sp. n.	1	11.: 8-th level, 300 m	Lúčkovská L. F.	Uppermost Hauterivian-Lower Barremian
SNM Z-18 766/3	<i>Ph. misiki</i> sp. n.	1	12.: 8-th level, 325 m	Lúčkovská L. F.	Uppermost Hauterivian-Lower Barremian
SNM Z-18 766/4	<i>Ph. misiki</i> sp. n.	1	13.: 6-th level, -50 m	Lúčkovská L. F.	Uppermost Hauterivian-Lower Barremian

berk Upper Valanginian (see Žitt, 1978a). Distally tapering interrarial processes end by a saddle. Inner parts of processes bear longitudinal furrows which widen proximally and pass into the ventral cavity.

The majority of specimens is not preserved well enough to allow the measurements. Some of them are also slightly deformed. For that reason a new material is necessary for better understanding of species variation.

Phyllocrinus aff. *malbosianus* d'ORBIGNY, 1850

Pl. 1, Figs. 7—9, Text-fig. 4

Material: 1 specimen from the lower part of the Lower Hauterivian, Kališčo Formation, near the boundary with underlying Mráznica Formation.

Description: Cup of medium size. Dorsal part very low and wide, radially lobate beyond the radial facets. Lobes very prominent, rounded. Interrarial processes massive, low and wide, externally with slight lateral wings, in the cross-section externally concave. Processes only slightly distally tapering with their endings formed by a saddle, from which very wide planes sink centrally down to the level of the ventral cavity margin. The planes are roughly granulated, without any central furrow. Radial notch between the processes narrower than the process proper. On its bottom there are two longitudinal fossae directed to the cup center and separated from each other by their raised neighbouring margins (Text-fig. 3) forming a ridge. The position of fossae is very oblique. They rise from the radial facet to the margin of ventral cavity separated from it by a septum. This septum is formed by the lateral inner parts of interrarial processes. The upper level of the septum reaches up to two thirds processes height. Radial facets are very small and bear relatively great muscle fossae. Other features are not preserved. Ventral cavity is of pentagonal outline down to its bottom. Circular dorsal cavity consists of external rim only slightly inclined to the cup axis, and of a very deep central part, on the bottom of which an articular stem facet is situated. Articular elements for stem joining are not visible.

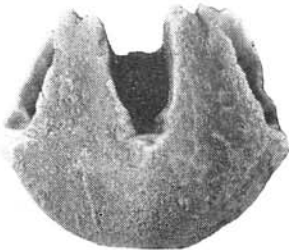
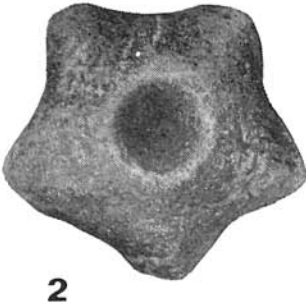
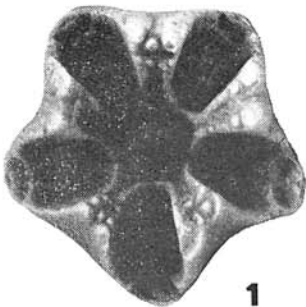
Remarks and relations: No phyllocrinid species as far described has the central portions of interrarial processes so wide and flat and no medium sized *Phyllocrinus* has so high septa between the radial notch and ventral cavity. The external and the uppermost parts of processes, which are very wide and equipped with a saddle are, on the other hand, known in more species. They all are probably mutually related (*Ph. malbosianus* d'ORBIGNY, *Ph. chalupai* ŽÍTT, *Ph. hykeli* ŽÍTT a. o.).

Phyllocrinus misiki sp. n.

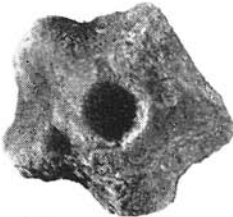
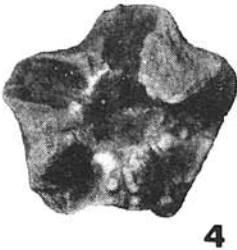
Pl. 2, Figs. 1—6, Text-fig. 5

Holotype: Specimen figured here on Pl. 2, Figs. 1—3, deposited in the collections of the Slovak National Museum in Bratislava under the No. SNM Z-18 764/1. Dimensions: $H_c = 8.2$ mm, $H_{proc} = 3.6$ mm, $W_{proc} = c. 3.2$ mm, $D_c = 7.7$ mm, $D_d = 2.9$ mm (= cup height, process height, process width, cup diameter, dorsal cavity diameter).

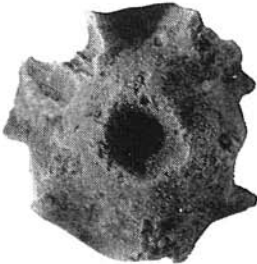
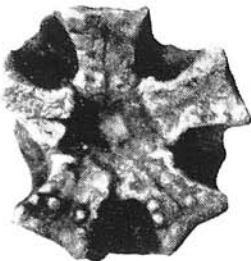
Plate 1



3



6



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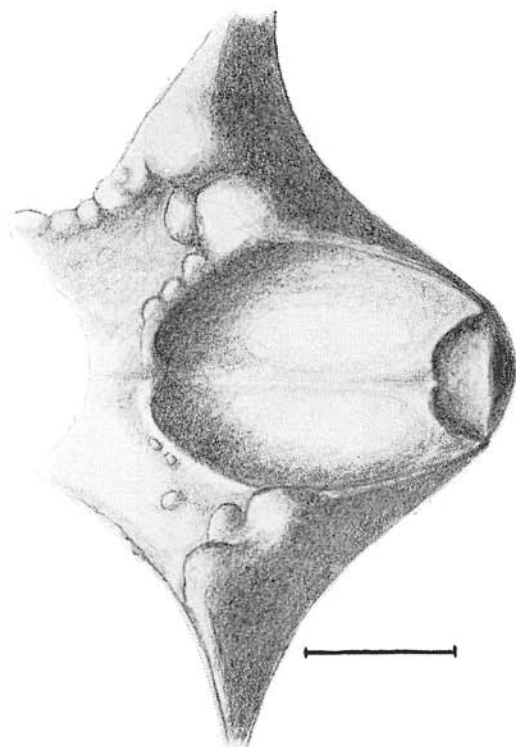


Fig. 3. Radial notch and the neighbouring interrarial processes of *Phyllocrinus malbosianus* d'ORBIGNY (No. SNM Z-18 764/1) in ventral view. Scale bar 1 mm. Orig. J. Žitt.

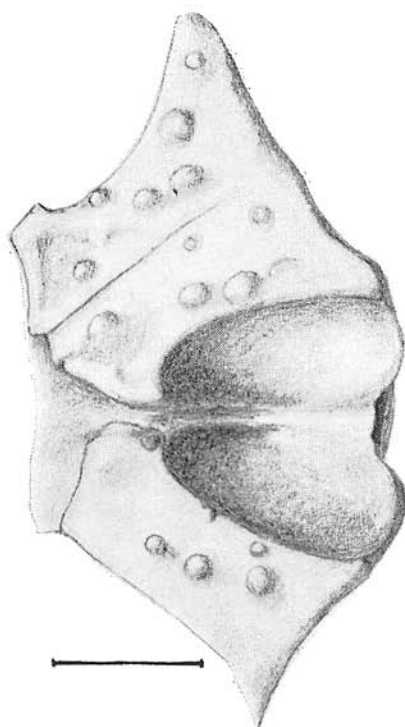


Fig. 4. Radial notch and the neighbouring interrarial processes of *Phyllocrinus* aff. *malbosianus* (No. SNM Z-18 765). Scale bar 1 mm. Orig. J. Žitt.

Paratypes: Specimens Nos. SNM Z-18 766/2 (Pl. 2, Figs. 4—6) to 18 766/4 deposited along with the holotype.

Other material: One badly preserved specimen in the rock.

Type horizon and locality: Lúčkovská Limestone Formation, Upper Hauterivian — Lower Barremian, Butkov quarry near Ladce.

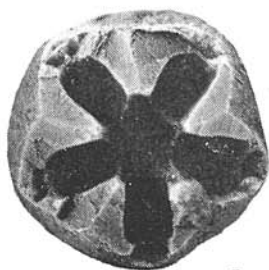
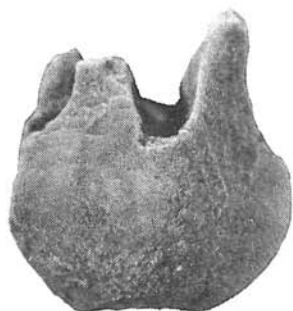
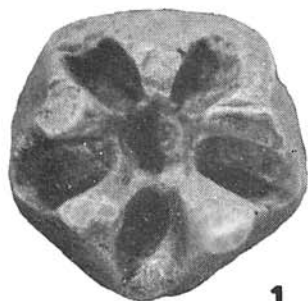
Derivation of name: In honour of an outstanding Czechoslovak geologist, Prof. dr. Milan Mišík, DrSc., Comenius University, Bratislava.

Description: Cups of medium size, roundedly pentagonal to subglo-

Plate 1

Figs. 1—3. *Phyllocrinus malbosianus* d'ORBIGNY, viewed ventrally, dorsally, and laterally. No. SNM Z-18 764/1. Scale bar 1 mm. Figs. 4—6. Dtto. No. SNM Z-18 764/3. Scale bar 1 mm. Figs. 7—9. *Phyllocrinus* aff. *malbosianus* d'ORBIGNY, viewed ventrally, dorsally, and laterally. No. SNM Z-18 765. Scale bar 1 mm.

Plate 2



bose in dorsal view, very massive. Radial lobes rounded. Interradial processes wide at their bases, rapidly tapering distally where they are sharply pointed. The external parts of processes fall back proximally to the cup axis but c. in one-half their height they turn externally again. However, their tips do not exceed the external outline of the cup. Central parts of processes from the very points are inclined to the ventral cavity. Proximally widening furrows pass into the shallow pocket-like depressions below the processes. Radial notch

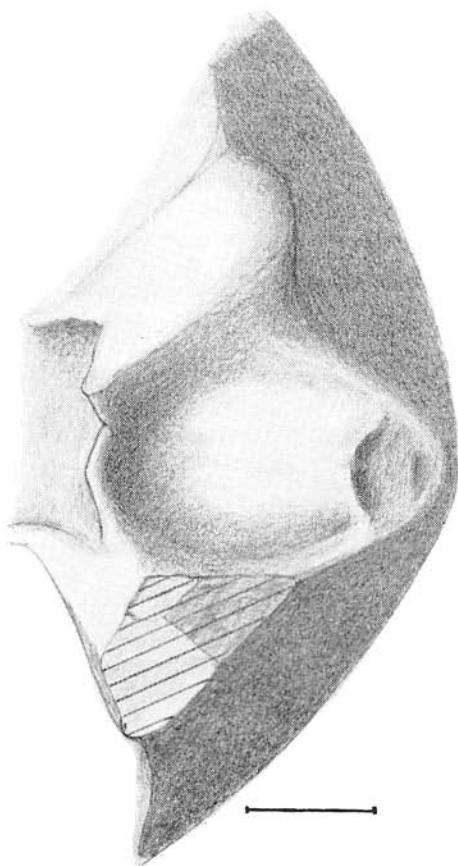


Fig. 5. Radial notch and the neighbouring interradiation processes of *Phyllocrinus misiki* sp. n. (holotype, No. SNM Z-18 766/1) Fragmentation of processes-hatched. Scale bar 1 mm. Orig. J. Žitt.

Plate 2

Figs. 1—3. *Phyllocrinus misiki* sp. n., holotype. Viewed ventrally, dorsally, and laterally. No. SNM Z-18 766/1. Scale bar 1 mm. Figs. 4—6. Dito, paratype. Viewed ventrally, dorsally, and laterally. No. SNM Z-18 766/2. Scale bar 1 mm. Figs. 7, 8 *Phyllocrinus* sp., viewed ventrally and laterally. No. SNM Z-18 763. Scale bar 1 mm.

All photographs by J. Brožek, Institute of Geology and Geotechnics, Czechoslovak Academy of Sciences, Prague. All specimens are deposited in the collections of Slovak National Museum, Bratislava (SNM).

between the processes is proximally narrower and distally more open. Radial notch bottom very deepened immediately from the radial facets. Two fossae and the septum separating the bottom from the ventral cavity are present, similar as in the above described species. Thin septum occupies more than one-third processes height. Radial facets small, muscle fossae large, other structures poorly preserved. Deep ventral cavity distinctly pentagonal. Dorsal cavity of the type described in *Ph. malbosianus* (see above).

Remarks and relations: The species is easy to distinguish from the other known taxa. Its robust dorsal cup part and relatively weak and narrow interrarial processes represent a combination as yet not described. *Phyllocrinus chalupai* ŽÍTT, 1978 from the Upper Valanginian Kopřivnice Formation of Štramberk is dorsally robust but its processes are as well robust and massive (in addition to other differences). Jurassic *Phyllocrinus brunneri* OOSTER, 1865 (Alpes, see Lorient 1882—84) is similar in dorsal view only, its processes and radial notch bottom being completely different.

Some specimens of *Ph. malbosianus* (e.g. from Štramberk Upper Valanginian deposits) show also some morphological similarities to *Ph. misiki* sp. n. Their dorsal cup part is, however, never so globose, their processes are never so long, slender, and externally curved in the distal portions, their bottoms of radial notches are never so deep.

Phyllocrinus sp.

Pl. 2, Figs. 7, 8, Text-fig. 6

Material: The only specimen from the Mráznička Limestone Formation (upper part of the Lower Valanginian), Butkov quarry.

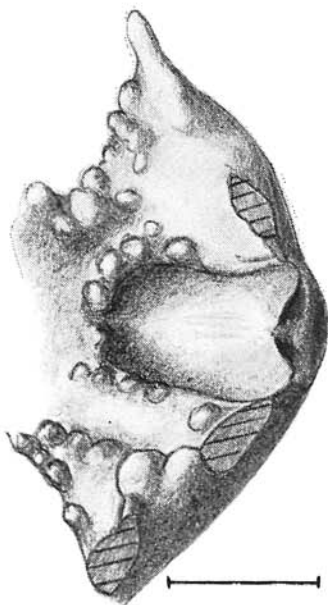


Fig. 6. Radial notch and the neighbouring interrarial processes of *Phyllocrinus* sp. (No. SNM Z-18 763). Fragmentation of processes-hatched. Scale bar 1 mm. Orig. J. Žitt.

Description: Cup of medium size, its $H_c = 3.7$ mm, $H_{proc} = 1.4$ — 1.6 mm, $W_{proc} = 2.2$ — 2.4 mm, $D_c = 3.8$ mm, D_d immesurable (symbols see in preceding species). Cup in dorsal view rounded, only slightly subpentagonal. Radial lobes very weak. Interradial processes massive, rather low and wide, externally convex in the cross-section. Processes slightly distally tapering. Their endings are formed by two slender points directed laterodorsally. The saddle between them is deep and relatively narrow. The points tend to bifurcate. Centrally from the saddle the processes are developed in the form of wide planes sinking down the margins of ventral cavity. The margins of these planes bear great granules. Some granules are also developed on the inner parts of planes (Fig. 6). Radial notch and its bottom are similar to those of the above described species. The fossae of the bottom are, however, more deepened beyond the level of radial facets, and the septum separating them from the ventral cavity is not so high. Radial facets are very small with great muscle fossae. Other articular structures not visible. Ventral cavity more or less circular in upper parts, pentagonal in lower parts. Dorsal cavity with articulation not preserved.

Remarks and relations: The only specimen is very insufficient for the recognition of a new species, even though some features are unique within phyllocrinids. While the bifurcation of distal ends of processes is also known in Upper Valanginian *Ph. hykeli* ŽITT, 1978 from Štramberk (see Žitt, 1978a), the development of central parts of processes is completely different, regardless of some differences in their points. In *Ph. hykeli* a large distal subhorizontal smooth plane of roughly subtrigonal shape lies adaxially from the distal points. In Butkov specimen there is a slope immediately axially from the distal points. While there are subvertical sharp edges present in the most axial portions of *Ph. hykeli* processes, obliquely situated wide granulated planes are developed in our specimen. Even from the features mentioned the closer relations of Butkov specimen to *Ph. hykeli* has to be rejected.

Conclusion

The overall species diversity of crinoids in the Butkov Lower Cretaceous sequence is very low. No highly diversified group (e.g. isocrinids) occurs and all crinoids found are represented by four species of only one phyllocrinid genus. They all are of similar morphological type. No species lacking the fossae and septa in their radial notches is present here. They principally distinguish one from each other only in the shape of their interradian processes. The autecological importance of the structures mentioned was recently studied by Arendt (1974) and Žitt (1978b). Not all the phenomena have been, however, sufficiently evaluated. For that reason, fundamental supplementary studies were initiated by one of us (Žitt). Regardless of the absence of more detail knowledge, the species found in Butkov can be interpreted as the inhabitants of rather calm water (see Žitt, 1978b).

With the exception of the cups no other crinoid skeletal elements were found. The overall superficial wear of cups is very slight and in no case they were found fragmented.

Although the crinoid remains are comparatively scarce in Butkov, the distribution of the species recognized seems to be stratigraphically controlled.

The oldest species, *Phyllocrinus* sp., occurs in the higher part of the Lower Valanginian Mráznica Formation. This species is probably non-autochthonous, but it belongs to the faunal remains redeposited by weakening currents after the turbidite currents (allodapic limestones) had ceased. Both *Phyllocrinus malbosianus* and *Ph.* aff. *malbosianus* occur in the Lower Hauterivian Kališčo Formation where they probably represent a more or less autochthonous part of benthos. The occurrences of *Ph. misiki* sp. n. from the Uppermost Hauterivian to Lower Barremian Lúčkovská Formation are of similar type. Even here, the very slight currents affected the composition of taphocenoses, removing from them the minute skeletal parts (brachials, columnals).

Phyllocrinus malbosianus is a cosmopolitan species of the European Upper Jurassic and Lower Cretaceous seas. Its oldest, Tithonian finds were made in Italy (not revised). The Valanginian specimens of this species are known from the Crimea (Lower Valanginian, Manester locality, see A r e n d t, 1874), Štramberk (Upper Valanginian, see Ž í t t, 1978a, b), and Vršatec (?Upper Valanginian, see Ž í t t, 1987). More later it was found in the Upper Hauterivian strata of the Crimea (Kujbyševo locality, see A r e n d t op. cit.). However, owing to the considerable variability of this species, its present definition does not exclude the taxonomic heterogeneity and a revision of all available European material is needed.

The new data obtained by the study of Butkov Lower Cretaceous crinoids extend the knowledge of species diversity as far known in phyllocrinids. New morphological variants show that this family was one of the most differentiated and probably most successful groups of cyrtocrinids during the Hauterivian and Barremian.

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