

Rudolf Prokop  
1871.

SBORNÍK  
GEOLOGICKÝCH  
VĚD

• paleontologie

řada P • sv. 9 • 1967

## The Class Hyolitha in the Caradoc of Bohemia

(43 text-figures, 10 plates, Czech summary)

LADISLAV MAREK

Presented September 13, 1966

**Abstract:** This paper describes all hyolithid species known from the Caradoc Series of the Barrandian, from the Libeň to the Bohdalec Formation. One new family, 8 new genera, and 19 new species are established, and a re-description of four previously described species is given. Remarks concerning the morphology, ecology, anatomy, and previous classifications of hyolithids are included, together with my own view on the systematic division of the Class *Hyolitha*.

### Introduction

The Caradoc hyolithids of Bohemia were described first by J. BARRANDE (1847, 1867). Later, in 1891, some observations concerning five of Barrande's species were added by O. Novák.

Three years of systematic field research by the writer have resulted in the discovery of an abundance of new material that contributes not only to our knowledge of the morphology but also to that of the systematics of the Class *Hyolitha*. Caradoc sediments yielded the richest material, which forms the subject of the present publication.

This paper is intended as a basis for the further study of *Hyolitha*. The hyolithids represent an important component of older Paleozoic faunas throughout the world. They are widely distributed mainly in sediments of Cambrian and Ordovician age and might, after further study, prove useful as index fossils. Further, their study and the resulting facts will be significant also for zoopaleontology, giving information on one of the unsuccessful and extinct animal groups.

### History of the research

The bibliography on the Caradoc species of Bohemia is very limited. It is restricted, in fact, only to two monographs by J. Barrande and O. Novák, dealing with all older Paleozoic hyolithids, and including also those few species that derive from the Caradoc.

J. BARRANDE described in 1847 five hyolithid species under the generic name *Pugiunculus* BARR., which became a junior synonym of *Hyolithes* EICHWALD, 1840. Three of these species, *P. elegans* BARR., *P. striatulus* BARR. and *P. undulatus* BARR., are of Caradoc age, whilst the other two are from Silurian and Devonian sediments.

Some years later, in 1854, J. BARRANDE published his discovery of hyolithid opercula (of the genus *Pugiunculus*) in two Caradoc species, *P. elegans* and *P. striatulus*.

In the year 1867 J. BARRANDE published the third volume of his "Système Silurien du Centre de la Bohême", dealing with conulariids, hyolithids and tentaculitids. In this book 33 hyolithid species were described, of which, after Novák's revision, 29 remained in use. Five of these came from the Caradoc (Vinice and Zahořany Formation), and were assigned by J. Barrande to *Hyolithes*: *H. elegans*, *H. magister*, *H. solitarius*, *H. striatulus*, and *H. undulatus*. The corresponding opercula were known in only two species, *H. elegans* and *H. striatulus*.

In his 1891 work on Paleozoic hyolithids of Bohemia, O. NOVÁK created 29 new species, though none were of Caradoc age. At the same time O. Novák published also some important supplements concerning the descriptions, shell structure, and stratigraphic range of four Caradoc species described by J. Barrande (*H. elegans*, *H. solitarius*, *H. striatulus*, and *H. undulatus*).

G. HOLM (1893), who considered Novák's genus *Orthotheca* NOVÁK, 1887, only as a subgenus, listed in his work (p. 25) all the five hyolithid species hitherto known from the Caradoc of Bohemia as representatives of the typical subgenus *Hyolithus* (*Hyolithus*) EICHWALD, 1840.

Since that time no-one has dealt with the Caradoc hyolithids of Bohemia, apart from V. A. SYSOEV (1962), who attributed to the genera established earlier by him some of the Bohemian species, including 4 of Caradoc age. In my opinion, his assignment is not correct, and is dealt with in another part of this paper.

In his paper on the morphology of hyolithids L. MAREK (1963) figured also 4 Caradoc species, *H. elegans*, *H. striatulus*, *H. solitarius*, and *H. n. sp.* (= *Joachimilites novaki* sp. n.), without mentioning their mutual relations.

In 1964 L. MAREK and E. L. YOCHELSON described and figured an extremely well-preserved specimen of *Hyolithes striatulus* (BARR.), showing one of the appendages, protruding between the operculum and the aperture of the conch.

In a short preliminary notice in 1966 L. MAREK created several new higher systematic units within the Class *Hyolitha*. His new genus *Elegantilites* MAREK, 1966 was based on the type species *Hyolithes elegans* (BARR.) from the Caradoc. Another Caradoc species, *H. striatulus* (BARR.), was assigned to the genus *Gompholites* MAREK, 1966.

## Localities and mode of preservation

In his work J. BARRANDE (1867) mentioned several localities in the "bands D<sub>3</sub> and D<sub>4</sub>" (present-day Vinice and Zahořany Formations), and their number was not enlarged even by O. NOVÁK (1891). The majority of Barrande's and Novák's material came from concretions, originally carbonatic, in the upper parts of the Zahořany Formation, in which the fauna is extremely well preserved.

Loděnice, near Beroun, was one of the most important *Hyolithes*-yielding localities, and is mentioned in one of Barrande's diaries, deposited in the Geological Department of the National Museum, Praha. It was situated about 100 m to the N of the foot of the Kněží hora, W of Loděnice. Unfortunately, it was impossible to re-discover this locality, but in the same area we succeeded in finding another locality in the uppermost parts of the Zahořany Formation, containing concretions that differ petrographically as well as faunistically from Barrande's material. In this paper the new locality is designated as Loděnice (2), whereas Barrande's locality is simply Loděnice.

The exact position of another Barrande locality, Strašnice (Stražnitz), is also unknown, but the material was undoubtedly obtained from the so-called Vysočany "ore" horizon at the base of the argillaceous facies of the Zahořany Formation. The fauna from this formation was described by J. ŠULC (1924) from the building site of the tramway depot in Praha-Strašnice, and it is possible that Barrande's locality was somewhere nearby. When collecting material, we looked especially for carbonate concretions, as the preservation in shales is not favourable for detailed study. A large quantity of material was obtained from temporary outcrops in Praha.

According to V. Havlíček and J. Vaněk, the Bohemian Caradoc includes the following formations: Libeň, Vinice, Zahořany, and Bohdalec. This new conception differs from the former one in the assignment to the Caradoc of the Libeň Formation, formerly considered to be of Llandeilo age, the same as the Dobrotivá Formation. Only rare, indeterminable remains of hyolithids have been recorded from the Libeň Formation, but we succeeded in assembling a sufficient quantity of new material.

The new specimens were collected from localities listed below.

### *Libeň Formation*

The facies of the Řevnice quartzites. M. ŠNAJDR (1956, p. 8) mentions *Hyolithus* aff. *pauxillus* NOVÁK and *Hyolithus* n. sp. from Čilina, near Rokycany, and Rumpál. These specimens were not at my disposal, and no new material has been found.

J. VANĚK (1941, p. 47) recorded *Hyolithus* sp. [= *Elegantilites* cf. *elegans* (BARR.)] from the facies of the Libeň shales of Praha-Libeň (Bečka brickyard, Pod bání) and left it to me for study. New material was collected on several localities in the shaly facies of the Libeň Formation:

Praha-Motol – railway-cutting, near Stodůlky railroad station. This is a well-known geological and paleontological locality in the Dobrotivá Formation. It is overlain by the Libeň Formation, which consists of quartzites and shales. The abundant small concretions in the shales yielded a rare but well-preserved fauna, including hyolithids.

Na židu – hills between Drahelčice and Loděnice, an old abandoned quarry. The rare fauna is preserved in dark micaceous shales.

#### *Vinice Formation*

Chrutenice – iron ore mine, the fossiliferous layer being unknown for a long time. The palaeontological material, deriving from the oolitic iron ore at the base of the Vinice Formation, is deposited in the Palaeontological Department of the National Museum, Praha. Recently only one indeterminable specimen was found.

Vráž near Beroun – hillsides between Vráž and Loděnice. In the basal layers of the black silty shales there occur many small concretions with a well-preserved fauna.

Praha-Vysočany – former Pleschner brickyard. This now non-existent locality had yielded concretions, with a relatively rare fauna, at the base of the Vinice Formation.

Zdice – mine “Hrouda”. The iron ore at the base of the Vinice Formation yielded only scarce material.

#### *Zahořany Formation*

Nová Dubeč – field SW of the village. Abundant concretions scattered in the field contain an extremely well-preserved fauna from the upper parts of the Zahořany Formation.

Loděnice (2) – lower part of the southern slope of the ridge that lies N of Kněží hora, along the old path above the field. Grey concretions from the uppermost part of the Zahořany Formation.

Praha-Nový Hloubětín – artificial roadside exposure, one stop before the terminal of the trams No. 19 and 15. Large quantity of concretions in the upper parts of the Zahořany Formation. This locality yielded the majority of the Caradoc hyolithids.

Praha-Libeň – railway-cutting, SE of Palmovka. Soft sandy concretions in the upper parts of the Zahořany Formation.

Štěrboholy – fields on the left side of the road between Strašnice and Dolní Měcholupy, behind the road leading to Dolní Počernice. The soft concretions in the fields derive from the uppermost parts of the Zahořany Formation. It is still possible to collect on this old locality of Barrande.

Staňkovka – small hill at the southwestern limits of Radotín, with small con-



## Stratigraphic occurrence of hyolithids in the Caradoc of Bohemia

Species	Libeň Form.	Letná Form.	Vinice Form.	Zahořany Form.	Bohdalec Form.
<i>Elegantilites elegans</i> (BARR.)	•		•	•	?
<i>Elegantilites?</i> <i>magister</i> (BARR.)				•	?
<i>Elegantilites?</i> aff. <i>magister</i> (BARR.)					•
<i>Elegantilites?</i> <i>tigris</i> sp. n.			•	•	
<i>Joachimilites novaki</i> sp. n.			•	•	
<i>Joachimilites modestus</i> sp. n.				•	
<i>Joachimilites havliceki</i> sp. n.					•
<i>Joachimilites?</i> <i>potator</i> sp. n.				•	
<i>Eumorpholites bouceki</i> sp. n.				•	•
<i>Eumorpholites crudus</i> sp. n.	•				
<i>Eumorpholites?</i> <i>tectus</i> sp. n.			•		
<i>Gompholites striatulus</i> (BARR.)			•	•	•
<i>Carinolites?</i> <i>tantulus</i> sp. n.	•				
<i>Sololites ferrigenus</i> sp. n.			•		
<i>Recilites solitarius</i> (BARR.)			•	•	
<i>Recilites</i> aff. <i>solitarius</i> (BARR.)					•
<i>Recilites?</i> <i>poeta</i> sp. n.				•	•
<i>Leolites cognatus</i> sp. n.			•	•	
<i>Chimerolites temperatus</i> sp. n.				•	
<i>Nephrotheca housina</i> sp. n.					•
<i>Nephrotheca?</i> <i>paupera</i> sp. n.			•		
<i>Nephrotheca?</i> <i>dubecensis</i> sp. n.				•	
<i>Panitheca collector</i> sp. n.				•	•
<i>Brevitheca minimax</i> sp. n.				•	
<i>Quadrotheca?</i> <i>rediviva</i> sp. n.				•	•

cretions in the uppermost parts of the Zahořany Formation. This is the locality of J. V. ŽELÍZKO (1900).

Řevnice – W of Lety, above the path along the river Berounka, SW of the bridge (see P. RÖHLICH 1957, pp. 29–30). Small concretions in the uppermost parts of the Zahořany Formation.

Praha-Vysočany – excavations SE of the Medical Health Centre (Obvodní ústav národního zdraví). This abandoned locality yielded a rich fauna, largely hyolithids, in black argillaceous shales belonging to the argillaceous facies of the Zahořany Formations. Due to pressure deformation, the preservation is mostly unfavourable.

#### *Bohdalec Formation*

Housina – small quarry, 1 km N of Neumětely. The dark grey argillaceous shales contain no concretions and the fauna is deformed by pressure (see P. RÖHLICH 1957, p. 28).

Praha-Michle – diggings for the new railway station. The fauna was found both in pelocarbonate concretions and in dark shales of the upper parts of the Bohdalec Formation.

Bílý Beránek – former brickyard near the road to Plzeň, NE of Bílý Beránek. A rich fauna in pelocarbonates of the so-called *Polyteichus* Horizon, belonging to the uppermost parts of the Bohdalec Formation.

The best preserved hyolithid material was found in concretions. As these are mostly decalcified, the shells have been dissolved and the fossils are preserved as internal and external molds. Consequently it was possible to make latex casts which facilitated a detailed description of the internal structure of the opercula.

In the shales the fossils are mostly preserved as composite molds (L. MCALESTER 1962). This mode of preservation makes the specific, and sometimes even the generic, determination of hyolithid specimens difficult or impossible. In rare cases, when the fossils in the shales are pyritized, they are almost as well preserved as in the concretions.

At some places hyolithids with undissolved shells, replaced by calcium carbonate, have been found, but the original shell structure is almost obliterated by recrystallization. In only a few cases a weak line could be observed on the cross-section of the conch, indicating that the shell was composed at least of two layers.

#### **Techniques of investigation**

For casting, latex in ammoniac solution (Revultex) has been used. Afterwards the specimens were coated with ammonium chloride. For the drawings Abbé's drawing apparatus and binocular have been used. When possible, reconstructions of the outer and inner surface of the opercula, the shell and its cross-section have been made.

Owing to the often incomplete preservation of the fossils, it was necessary in most cases to draw the reconstructions of the opercula and conchs from several specimens. The drawings are always more or less diagrammatic, and some details, especially the ornamentation, simplified.

In some species a reconstruction of the operculum as viewed from its cardinal (posterior) margin is given in order to depict the shape and size of the cardinal processes.

When drawing the opercula and their latex casts, the objects were placed in such a position that the direction of the view formed approximately the same angle with the surfaces of both the cardinal and conical shields. Only the opercula of *Pauxillitidae* were placed so that the direction of viewing, when observing the internal surface, was almost parallel to the surface of the cardinal shield.

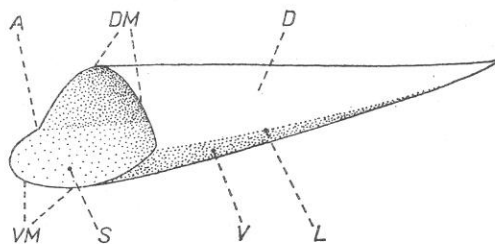
An Exacta-Varex camera with an Agfa 36 mm, 17° din film was used. The photographs have not been retouched.

### Morphology and terminology

The calcium carbonate hyolithid shell is composed of two parts, the oblong, conical, bilaterally symmetrical conch and the operculum that closes the aperture. The morphology of the shell, especially that of the operculum, was dealt with earlier (L. MAREK 1963) and this chapter contains the results of subsequent researches.

The conch. The ventral side is considered to be that which is less convex and forms at the aperture a more or less elongated shelf-like structure, semi-elliptical or semi-circular in form and extending distinctly beyond the dorsal apertural margin. I propose the term ligula instead of the hitherto used "shelf".

It is often difficult to establish the line separating the ventral and dorsal sides. In most representatives of the order *Hyolithida* the cross-section of the conch is roundedly subtriangular, and more or less rounded, sometimes even sharp

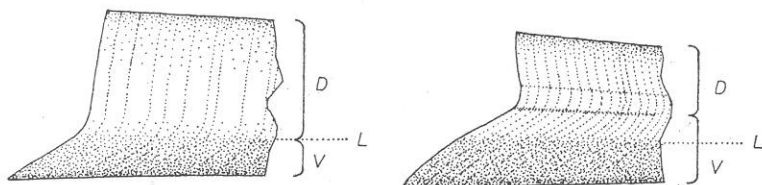


1. Terminology of hyolithid conch

*A* — apertural sinus; *S* — shelf (ligula); *L* — lateral edge; *D* — dorsal side; *V* — ventral side; *DM* — dorsal apertural margin; *VM* — ventral apertural margin

edges are developed on the sides of the conch. These are designated as lateral edges, a term used previously. It is possible to identify these edges also in conchs with an oval cross-section. Thus the boundary between the dorsal and ventral sides points of maximum distance from the plane of symmetry of the conch. However, the lateral edges do not always represent the boundary between the two sides, and in order to establish the latter it is necessary to know the course of the growth-

lines which correspond with the shape of the aperture during the growth of the conch. These growth-lines, when crossing the lateral edges, are arched backwards weakly, corresponding with the slight curves on the lateral sides of the aperture, where the appendages protruded from the shell. These curves are termed lateral sinuses, and their position corresponds with that of the distal ends of the rooflets in an operculum in situ. The boundary between the ventral and dorsal sides of the conch is drawn at a line connecting the lower margins of these growth-lines sinuses, although as already stated, this line does not necessarily coincide with the lateral edge. In some cases (*Hyolithes* EICHW., *Carinolithes* SYSOEV etc.), the boundary is situated above the lateral edge.



2. Lateral views of the apertural regions of the conchs, showing the relations of the lateral edges to the dorsal and ventral side. Left — *Gompholites*, right — *Carinolithes*  
 D — dorsal side; V — ventral side; L — lateral edge

The identification of the ventral and dorsal side is more difficult in representatives of the Order *Orthothecida*, and impossible in genera, whose conch has a rounded or reniform cross-section. The sharp lateral edges in some Devonian orthothecids may be considered as the boundary between both sides of the conch. Nevertheless, in the description of orthothecids from the Cárado Series I use terms ventral and dorsal sides, the boundary between them being the line of the lateral edges, that is the line connecting points on the lateral sides of the conch which attain the maximum distance from the plane of symmetry.

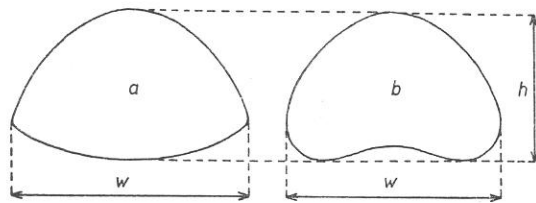
The position of the lateral edges with regard to the height of the conch is considered to be an important specific feature. Usually, the less inflated the ventral side of the conch, the closer to it are the lateral edges. As it is very difficult to define exactly the vault of the ventral side, the position of the lateral edges with regard to the height of the conch is always given in the description, the ventral side serving as the base for this measurement.

The measurement of the apical angle of the hyolithid conch represents another problem. V. A. SYSOEV (1959, p. 397; 1962, p. 5) mentions two angles, the apical and the mean divergence angle, the latter being formed by lines that represent the connection between the lateral margins of the aperture and the apex. For these measurements, however, a conch with a preserved apex is necessary, and as this is rarely found among *Hyolitha*, I measured the angle formed by the lateral edges near the aperture, viewed from the dorsal side. In this view the lateral edges are practically straight in all the described species, and it may be supposed that the

angle agrees approximately with Sysoev's angles. This angle I designate the angle of divergence and unless otherwise stated, it is always measured on the external molds.

To express the width: height relationship of the conch, I use the so-called width-height index (w-h index). As the conchs are always broader than high, the width is divided by the height. The resulting index represents the mean value, obtained from measurements of specimens on internal molds near the aperture but never directly at the aperture, as the molds are usually more expanded here.

The width of the conch is the length between the lateral edges; the height is the maximum distance between the ventral and dorsal sides; and the length is the distance from the anterior margin of the ligula to the apex. The length of the conch in *Orthothecida* is the distance between the apertural margin of the ventral side and the apex. Unless otherwise stated, the dimensions refer to internal molds.



3. Measurement of the conchs, cross-sections  
a — *Hyolithida*, b — *Orthothecida*, w — width; h — height

The length of the operculum is the distance between its cardinal and anterior margins, and is measured in *Hyolithida* in the axis of symmetry, but in *Orthothecida* between the cardinal margin and the ventral extremities. The width of the operculum is measured between the lateral margins, in the axis perpendicular to the axis of symmetry.

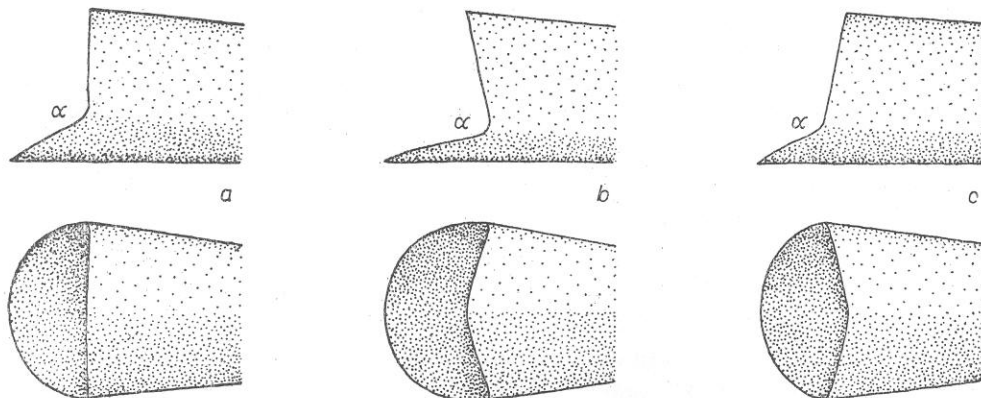
Owing to the existence of the ligula, the aperture in *Hyolithida* never lies in one plane. In lateral view, the dorsal and ventral apertural margins form an angle, designated here as the apertural angle. The more or less rounded vertex of this angle coincides with the apertural sinus.

There are three types of apertures, based on the relationship of the dorsal apertural margin and the apertural sinuses. If the apertural angle is obtuse the dorsal apertural margin is, in most cases, placed somewhat behind the apertural sinuses. This rare type is called an amblygonal aperture, and the operculum is relatively flat, with the cardinal and conical shields forming an obtuse angle (the so-called angular bend of the operculum, see L. MAREK 1963, p. 60). On the other hand, if the apertural angle is sharp the apertural margin lies, for the most part, in front of the apertural sinuses. This type is called an oxygonal aperture, and the angular bend of the operculum is represented by an acute angle. In the third and most frequent case, the dorsal margin lies approximately just above the apertural sinuses. This is an orthogonal aperture.

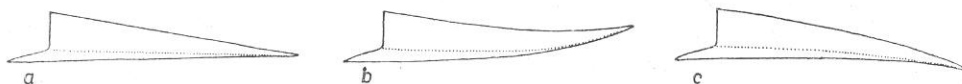
In the description of the conch the length of the ligula is also mentioned, and is the distance between the anterior margin of the ligula and the apertural sinuses.

This distance is expressed in relation to the width of the aperture between the apertural sinuses.

The conchs of hyolithids are not always straight, and a straight conch is considered to be one with a dorsally and laterally almost straight longitudinal axis. Very often more or less curved conchs occur with the apical part bent upwards.

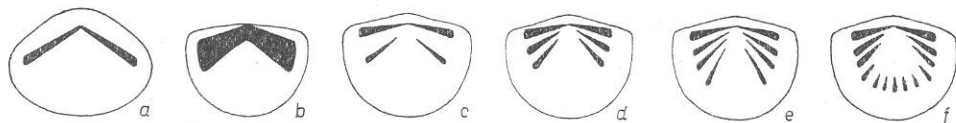


4. The types of aperture in Hyolithida, schematized: above — lateral views, below — dorsal views  
*a* — orthogonal aperture; *b* — oxygonal a.; *c* — amblygonal a.;  $\alpha$  — apertural angle



5. Lateral views of *hyolithid* conchs

*a* — straight; *b* — dorsally concave; *c* — dorsally convex conch



6. Types of opercula, strongly schematized

*a* — monoclavicate operculum; *b* — platyclavicate o.; *c* — biclavicate o.; *d* — triclavicate; *e* — tetraclavicate; *f* — polyclavicate

This type is called a dorsally concave conch. In some species the conch is slightly bent in the opposite direction, and these are dorsally convex conchs. This character usually indicates individual variability of some species with straight conchs.

In some cases the ornamentation of the conch consists only of growth-lines, but most hyolithids have a more expressive sculpture, consisting of transverse or longitudinal ribs or riblets. As a rule the ornamentation is more accentuated on the dorsal side, and can be absent ventrally, even if the dorsal side bears prominent ribs. The spaces between the ribs are designated as interspaces.



Operculum. The conspicuous paired processes on the internal side of hyolithid opercula are called clavicles (L. MAREK 1963, p. 58). In that paper I mentioned the most common type with one pair of clavicles, as well as opercula with two or three pairs. Since that time opercula have been found with a greater number of clavicles, not always even. In the Silurian Wenlock species "*Pauxillites*" *obvius* (BARR.) up to 25 clavicles were observed. It is now possible to distinguish 6 types of opercula in *Hyolithida*:

1. Monoclavicate opercula – with one pair of clavicles with a keel-shaped or rounded, but always relatively narrow cross-section. The clavicles either are completely hollow or have perhaps a greater number of thin, longitudinal channels. Opercula of this type occur from the Lower Cambrian to the Carboniferous.

2. Biclavicate opercula – with two pairs of clavicles. In opercula with more than one pair of clavicles, those of the biggest pair in the close proximity of the cardinal margin are designated as the main clavicles. It is not known whether clavicles of this type are hollow. Stratigraphical range: from Upper Ordovician (Ashgill) to Lower Devonian.

3. Triclavicate opercula – with three pairs of clavicles. This is probably the type from which the bi-, tetra- and some of the polyclavicate types developed. Examples are known only from the Ordovician (Arenig—Caradoc).

4. Tetraclavicate opercula – with four pairs of clavicles. This type has so far been found only in two Ashgill species, one in Great Britain ("*H.*" *armadillensis* REED, 1911), the other in Bohemia.

5. Polyclavicate opercula – with more than four pairs of clavicles. The main clavicles as well as the conspicuous large clavicles of the second and third pairs can always be distinguished. The other clavicles are smaller and shorter, and their number, often odd, varies within the same species. Polyclavicate opercula occur from Middle Ordovician to Lower Silurian (Caradoc—Wenlock) and are probably of polyphyletic origin.

6. Platyclavicate opercula – with one pair of broad, flat clavicles, enclosing a greater number of small channels that taper towards the central part of the operculum. This type can be traced from Middle Cambrian to Middle Ordovician (Lower Caradoc).

In the Caradoc of Bohemia mono-, tri-, poly- and platyclavicate opercula have so far been confirmed, but the biological significance of the clavicles is yet unknown.

In some genera of the Order *Hyolithida*, in addition to the cardinal processes (L. MAREK 1963, p. 58), the so-called central process is developed on the internal side of the cardinal shield of the operculum. Originally I described this outgrowth as a process of T-like cross-section lying between the cardinal processes, but more types of central processes have now been discovered. The most simple type, found in *Joachimilites* gen. n., is represented by an elongated ridge-like process, situated in the axis of the operculum and tapering towards the cardinal

margin. Another type of central process (*Eumorpholites* gen. n.) is a broad (tr.), mostly trilobate flat process, also protruding in a narrow ridge in the longitudinal axis. It is difficult to find a relationship between these central processes and the so-called "secondary" lobes of the cardinal processes. The latter term was used (L. MAREK 1963, p. 58) in the description of the second, shorter branch of the cardinal processes that are characteristic of the genus *Elegantilites* MAREK, 1966. By analogy these branches might correspond with the lateral lobes of the central process in *Eumorpholites*.

The teeth are elongated, mostly drop-shaped outgrowths, arranged radially on the internal surface of the cardinal shield. They have nothing in common with the cardinal teeth of brachiopods and lamellibranchs as there are no corresponding pits on the conch. Perhaps they served for the attachment of muscles or for better affixation of the operculum to the anterior part of the soft body. This suggestion is supported by the variable arrangement of the teeth and by their varying number and prominence within the single species. The teeth are arranged in one, two or even more rows, but the number of rows varies within a single species. In some Ordovician representatives of the family *Pauxillitidae* fam. n. teeth are developed also on the particularly shaped central process. It was also found that species with well-developed teeth or no teeth at all may exist within one genus.

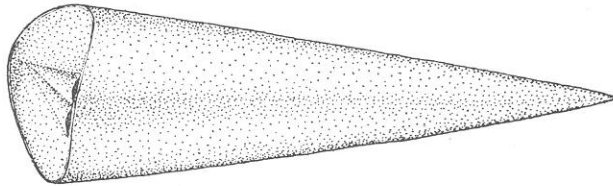
In the Order *Orthothecida* the operculum is different. As the apertural margins of these hyolithids lie approximately in one plane, the margin of the operculum also lies in one plane, and corresponds exactly with the internal surface of the conch. Consequently, orthothecid opercula are often found within the conch (? pushed inside). These basic differences between the opercula of *Hyolithida* and *Orthothecida* suggest their different control and function in both groups, a suggestion supported by the fact that the paired appendages have not yet been found in representatives of the Order *Orthothecida*. Furthermore, adductor muscle scars have not been seen in any orthothecid opercula. From this it may be deduced that the operculum was opened differently from that of the *Hyolithida* where, probably, the central part of the cardinal margin remained almost stationary and the anterior margin of the operculum was raised (conical shield). In *Orthothecida*, the operculum moved vertically (L. MAREK 1966, p. 91, text-fig.)

One typical feature of orthothecid opercula consists of two more or less inflated vaults, diverging from the excentrically situated centre of the operculum to the anterior (ventral) margin. Corresponding furrows are found on the internal side of the operculum. These features resemble the rooflets (tectula) in *Hyolithida*, but are better developed and probably unrelated. If we figure the operculum of an orthothecid in situ in the aperture of the conch, the ventral view shows, between the ventral apertural margin of the conch and the operculum, two transversally elongated slots formed by the vaults. These slots, perhaps enabling the communication of the living chamber with the outside, even with the operculum closed, must have had some biological significance (text-fig. 7). Originally I designated the

vaults as "vaultings" (L. MAREK 1963, p. 61) but now I suggest the term plicae (folds). The corresponding furrows on the internal side of the operculum are called sulci.

Certain changes are necessary also in the remaining terminology of orthothecid opercula. The point at which the plicae converge is the apex, often situated under the level of the opercular margin, with the cardinal part of the operculum bent obliquely upwards, as is the cardinal shield in *Hyalolithida*. In some cases it is very difficult to define the cardinal shield in *Orthothecida* due to the indistinct boundary with the other parts of the operculum. This shield is not developed when the apex does not lie below the level of the opercular margin. For terminology see text-fig. 43 and also L. MAREK 1963. Instead of cardinal shield and main shield I now use the terms dorsal and ventral part of operculum.

On the inner surface of orthothecid opercula the most striking features are the diverging cardinal processes which are relatively large, broad (exsag.), and flat. Their anterior margin usually forms two tips directed towards the anterior margin of the operculum, and in some species the processes almost reach the lateral margins of the operculum. In most opercula, a pair of broad, keel-shaped, fairly prominent ridges, in symmetry with the axis of the operculum, runs from the cardinal processes obliquely towards its anterior margin. In some cases these ridges are continuous and run along the entire margin of the operculum. It is not clear whether these ridges compare with the clavicles in *Hyalolithida*, but this is apparently not the case.



7. Reconstruction of an *orthothecid* conch with operculum in situ, showing a pair of slots between the operculum and the ventral apertural margin of the conch

In some genera of the Order *Hyalolithida*, paired appendages which extend from the shell between the conch and the operculum have been found. Probably all representatives of this order were equipped with similar appendages, which were solid, probably of the same composition as the conch and the operculum. Their cross-section was usually flat, elliptical or lenticular. The question of the appendages was dealt with earlier (L. MAREK 1963, pp. 62-65).

In the description of conchs and opercula I use the abbreviations tr., sag., and exsag. in the same sense as in descriptions of trilobites, the saggital axis being the longitudinal axis of the conch.

## Remarks on the systematics

It can hardly be supposed that investigations of only Caradoc species in a limited area could change substantially the existing system of *Hyolitha*. Neither was it possible, nor was it the object of this paper, to deal with the validity of all hitherto created hyolithid genera, mainly described by older authors such as Salter and Matthew, for which it would be necessary to study the original type material.

Until recently, the systematic units were very widely conceived. Within the Family *Hyolithidae* no more than four genera were recognized: *Hyolithes* EICHWALD, 1840; *Orthotheca* NOVÁK, 1887; *Bactrotheca* NOVÁK, 1891, and *Cerathotheca* NOVÁK, 1891. The majority of authors dealing with hyolithids recognized only two genera, *Hyolithes* and *Orthotheca*, the latter often only as a subgenus of *Hyolithes* (see G. W. SINCLAIR 1946).

Recently, this situation was altered by V. A. SYSOEV (1957, 1958, 1959, 1960, 1961, 1962), who proposed a new classification of the group. He divided the hyolithids into four orders and regarded them as a superorder within the Class *Comiconchia* LJASHENKO, 1955. However, several authors have pointed out that the Class *Comiconchia* is an artificial unit, comprising different groups of organisms – mainly *Hyolithes* and *Tentaculites* – without any phyletic relations and with only an elongated conical conch in common. Consequently D. W. FISHER (1962, in Moore) created a new mollusc class – *Calyptoptomatida* FISHER – for hyolithids only, regarding the *Tentaculites* as another new class. One year later I established for hyolithids the Class *Hyolitha* MAREK, 1963, and included in this class the order *Hyolithida* with the families *Orthothecidae* SYSOEV, *Hyolithidae* NICHOLSON, and *Pterygothecidae* SYSOEV, as well as the orders *Diplothecida* SYSOEV, *Camerothecida* SYSOEV and, with some doubts, *Globorilida* SYSOEV. On the other hand, D. W. Fisher included in his Class *Calyptoptomatida* other systematic groups, whose members cannot be considered as related to hyolithids (see L. MAREK and E. L. YOCHELSON 1964, p. 2).

V. A. SYSOEV (1957) placed in his Superorder *Hyolithoidea* the Orders *Diplothecida* SYSOEV, 1957, *Camerothecida* SYSOEV, 1957, *Globorilida* SYSOEV, 1957, and *Hyolithellida* SYSOEV, 1957 as well as the *Hyolithida*. D. W. FISHER (1962) made some changes, and included in his Class *Calyptoptomatida* only the Order *Hyolithida*, with the suborders *Hyolithina* MATTHEW, 1899 and *Mathevina* FISHER, 1962, *Globorilida* and *Camerothecida*, with the suborders *Camerothecina* and *Diplothecina*. D. W. Fisher excluded from the *Calyptoptomatida* the Order *Hyolithellida* and established the new, more restricted Order *Hyolithelminthes* FISHER, 1962. Since then V. POULSEN (1963) has transferred the Order *Hyolithellida* SYSOEV to the Class *Pogonophora* JOHANNSSON, 1937.

L. MAREK and E. L. YOCHELSON (1964) confirmed Marek's conclusions of 1963 and included the families *Orthothecidae*, *Hyolithidae* and *Pterygothecidae* in the

Class *Hyolitha*. The status of the Orders (or Suborders) *Diplotheccida*, *Camerotherccida*, and *Globorilida* remains doubtful.

Sysoev based these higher systematic units only on the study of literature, mostly more than 50 years old, without having studied the type material, and his classification must now be examined critically.

The Order *Diplotheccida* was based on the genus *Diplothecca* MATTHEW, 1885, with type species *D. hyattiana* MATTHEW, 1885 (p. 294) from the Middle Cambrian of Canada (the type species of this genus cited by Fisher is *D. acadica* (WALCOTT, 1884). In Matthew's illustrations, both *D. hyattiana* and *D. acadica* have structures along the sides of the conch which, in his opinion, were the remains of a distinct chambered cavity within the conch. In one specimen of *D. hyattiana caudata* MATTHEW, 1885, a peculiar oblong, tube-like structure has been seen, attached to the apex of the conch, and deflected slightly from its longitudinal axis. This is regarded as the embryonal chamber. If new studies reveal that both features are not due to unfavourable preservation or inaccurate observation, it will be possible to consider the *Diplotheccida* a separate order. However, the opercula figured by Matthew as belonging to *D. hyattiana* do not differ substantially from those of representatives of the *Hyolithida*.

R. HORNÝ (1964) proved that the genus *Phragmothecca* BARR., 1867, assigned by A. V. SYSOEV to the Order *Diplotheccida*, is part of the shell of a goniophorid lamelli-branch, although Fisher had placed it in the group of uncertain affinities within his Class *Calyptomatida*.

*Hyolithes gracilis* MATTHEW, 1885, is the type species of Matthew's subgenus *Camerothercca*, on which A. V. Sysoev based the Order *Camerotherccida*. O. NOVÁK (1886, p. 7) mentioned that the presence or absence of transverse septa in the apical part of the hyolithid conch cannot be considered a generic feature. According to Matthew's diagnosis of the subgenus *Camerothercca*, the conchs are terminated by a narrow little tube which is "divided by transverse diaphragms (?) at regular intervals and is more or less flexible" (1886, p. 48). Matthew's pictures (1886, pl. VI, fig. 1-3) do not show pronounced narrowing of the apical part, mentioned in the description, and the drawing of the apex was apparently a restoration, especially in the case of the type species *Camerothercca gracilis*. In another picture of this species G. F. MATTHEW (1901) showed a narrow conch, tapering gradually towards the apex. D. W. FISHER (1962, p. 129, fig. 2) figured as representative of *Camerothercca* the species *C. daniana* MATTHEW. The picture seems to be drawn after Matthew's illustration (1886, pl. VI, fig. 1a) but the apical part of the conch is distinctly narrower than in the original drawing. Matthew's drawing probably also served as a model to A. V. SYSOEV (1958), who figured on p. 187, fig. 8 the cross-section of *Camerothercca* with a considerably narrowed, tube-like projection, open at the end. D. W. FISHER, who accepted the drawing by A. V. SYSOEV, showed this tube-like part considerably broader (1962, p. 122, fig. 66). In the Bohemian Middle Cambrian one species closely related to "*Camerothercca*" *daniana*, though without



the camerate apical portion and with the conch gradually tapering, has been discovered. This Bohemian species is a typical representative of the order *Hyolithida*.

The order *Globorilida* was based by V. A. SYSOEV on the family *Globorilidae* SYSOEV, 1958, and in turn on the monotypic genus *Globorilus* SYSOEV, 1958. The spherical protoconch on which this order was based is preserved only in the holotype. In one Bohemian specimen of *Eumorpholites bouceki* sp. n., which undoubtedly belongs to the Family *Hyolithidae*, a similar globular structure found on the apex probably represents the internal mold of the conical protoconch. In one specimen of *Carinolites ? tantulus* sp. n. (Order *Hyolithida*) an oval, slightly pointed protoconch, distinctly separated from the rest of the conch, was found. The ontogeny of hyolithids will be dealt with in a separate paper.

Thus it follows that many problems remain concerning the morphology of the species on which the high systematic units of the Class *Hyolitha* have been based. It is also evident that the creation of such taxa without detailed studies is undesirable.

Sysoev established 12 genera of hyolithids which, with two exceptions, were based on Swedish species described by G. HOLM (1893). A. V. Sysoev used, in part, Holm's morphological groups, based mainly on cross-sections of the conch and its ornamentation. Consequently in some cases type species are based on a poorly preserved specimen, or the type species is missing. An example is *Quadrotheca* SYSOEV, 1958, whose type species *Q. quadrangularis* (HOLM, 1883), was known from only two specimens. I did not succeed in finding them in Holm's collection in Stockholm and they must be considered lost.

During the study of Bohemian hyolithids I came to the conclusion that the establishment of taxa (with exception of taxa in the species group), based only on the morphology of the conch, does not comply with the demands of modern systematics. As shown earlier (L. MAREK 1963, p. 70), for the classification of hyolithids and the study of their phylogeny the operculum, especially its internal surface, is very important. In the conch we meet with only a few fundamental forms and types of ornamentation from the Cambrian to the Devonian (Carboniferous and Permian material being poorly known), but in the operculum certain changes are apparent throughout the geological periods. Apart from the longitudinal ridges on the inner surface of the ventral side in some species, and of muscle scars near the aperture in some rare cases, there are no other features on the conch directly related to the soft body. On the other hand the inner surface of the operculum is provided with a varying number of outgrowths or scars. Even though their function is not known, they probably served as places for the attachment of the soft parts of the body or organs. Consequently they reflect changes and differences in the organization of the body.

Although I consider the operculum the most important structure for hyolithid systematics, I am also aware that a system based on only a single feature need not be – and seldom is – suitable and does not correspond with the phylogenetic



relations if other characteristics are not taken into account. Therefore I do not consider the hyolithid operculum the only basis for the systematics of *Hyolitha*, but one must also take into consideration the features of the conch. From the palaeozoological point of view it would be best if every hyolithid species could be described and defined from its conch as well as its operculum. Unfortunately it is rare to find both parts of the shell, and the assignment of the operculum to the corresponding conch is often difficult. As opercula are mostly overlooked, they have been presumed to be scarce, and it has been necessary, from a practical point of view, to use the conch for the classification of hyolithids, but such an approach to systematics has great disadvantages. Claims that the hyolithids cannot be used for stratigraphical purposes can be easily disproved by the fact that it is possible to distinguish hyolithid species by the features of the conch. If species are insufficiently known it would be better to avoid assigning them to known or new genera.

In the Order *Hyolithida* I regard as generically important the following features: a – the number and shape of the clavicles on the operculum; b – the shape of the cardinal processes and the central process; c – the angular bend of the operculum and the ornamentation of its surface. On the conch the following are important: a – its shape and cross-section; b – the shape of the lateral edges; c – the type of ornamentation of the dorsal and ventral side; d – the presence or lack of ridges on the inner ventral surface; e – shape of the aperture, and f – the relative size of the conch.

Specific features of the operculum are represented by differences in divergence of the cardinal processes and clavicles, by the shape of the cardinal shield, by the ratio of its length to the conical shield, and by the presence and size of teeth, etc. On the conch, specific differences are manifested especially by the width: height index, by the density and prominence of the ribs, and by the angle of divergence.

For the generic assignment in *Orthothecida*, the cross-section of the conch and the type of its ornamentation as well as the shape of the cardinal processes are very important.

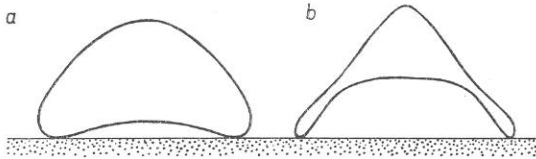
### Ecology

I have already published remarks on the ecology of the hyolithids (L. MAREK 1963). In my opinion the representatives of the Order *Hyolithida*, all of them probably equipped with paired appendages, were specialized as vagrant benthos, using the appendages for stabilization of the shell or for slow movement on the sea bottom, with the ventral side down. As far as we are aware, the representatives of the Order *Orthothecida* were not provided with these appendages, but the species with smooth, or almost smooth, conchs probably belonged also to the benthos.

D. W. FISHER (1962, p. 119) expressed the justifiable opinion that the ligula (shelf) on the ventral side of the conch in *Hyolithida* "inhibited influx of sediment into the living chamber". In most smooth or almost smooth representatives of the

Family *Orthothecidae*, however, the influx of the sediment into the living chamber could be inhibited by the concave ventral side of the conch. When resting horizontally on the sea bottom the greater part of the lower apertural margin did not touch the sediment, and in these species this could well replace the protective function of the ligula (text-fig. 8). Locomotive organs of these animals might have been represented by projections of the soft body.

In the Palaeozoic of Central Bohemia finds of hyolithids in sandy and coarse-grained sediments are very rare. On the contrary, the hyolithids form an important



8. Cross-sections of two *orthothecid* conchs demonstrating their possible position on the sea bottom  
*a* — *Panitheca collector* sp. n.; *b* — “*Orthotheca*” sp. n. (undescribed species from the Middle Cambrian of Bohemia)

component of the thanatocoenosis of the clayey and shaly beds. In sediments of reef origin hyolithids are absent or very rare, and although they occur, as a rule, with gastropods, they are very rare in rocks with abundant gastropods associated with bryozoans. This can easily be explained by the fact that

overgrowths of sessil organisms prevented the movement of hyolithids equipped with long appendages. D. W. FISHER (1962, p. 117) came to the same conclusion and mentioned that hyolithids are most common in argillaceous rocks, although they occur in all types of marine sediments with the exception of hypersaline and dolomitic beds and those of reef origin. In his opinion, they are also very rare in greywackes and in micaceous siltstones, whilst in rare cases they are associated with corals and bryozoans.

To solve the complex problem of hyolithid ecology it will be necessary to study in detail the environmental conditions of their occurrence throughout the world.

### Anatomy

Of the arrangement and structure of the soft hyolithid body almost nothing is known. From the presence of the outgrowths and muscle scars on the operculum and near the apertural margin of the conch, the existence of several muscles serving for the attachment and closing of the operculum may be inferred, whilst the paired appendages also had to be held in position or operated by the muscles. If we regard the hyolithids as molluscs, we may assume also the presence of a mantle and of a mantle cavity, into which led the sexual and excretory organs. The mouth and the anus must have been placed on the anterior part of the body. In some polyclavicate types of opercula, muscle scars of adductors have been found which would be hardly understandable if the accessory clavicles served as an attachment for muscles controlling the closing of the operculum, for which such a number of muscles would not be necessary. The varying number of these small clavicles

within one species is also striking and suggests that if these clavicles were related to various organs, the latter would not be too important, and their number irrelevant.

M. THORAL (1935, p. 155, pl. 14, fig. 1) described and figured an interesting structure of the species *Nephrotheca* ? *guiraudi* (THORAL) from the Tremadoc and Arenig of the Montagne Noire. Within the internal mold of two specimens Thorall found a narrow, flattened tube filled with sediment, running along the longitudinal axis of the conch and close to its ventral side. Below this tube, which Thorall considered a digestive tube, lies a much folded band interpreted by him provisionally as infillings of sexual glands.

One fragment of a similar structure was found in a Bohemian species *Panitheca collector* sp. n. from the Zahořany Formation (Caradoc Series). Unfortunately, this fragment was broken soon after collection and only part of the folded band remains, so the description of this structure can be given only as I remember it before its destruction. The whole "organ" was flat and lay close to the ventral side. Along the longitudinal axis of the conch two horizontally flattened tubes run, close together. From the lower tube closely-spaced and vertically flattened bands run to both sides, directed perpendicularly with reference to the axis of the conch. Their connection with the longitudinal tube could not be proved and their distal ends are insufficiently preserved, so it could not be observed if every two adjoining bands have been connected in the way as in *N?* *guiraudi*, or if they were separate tubes, terminating blindly.

Thorall's opinion that the median tube represents the digestive tube is acceptable. This tube (see also Thorall's description, 1935, p. 155) probably ran from the mouth through the lower part of the body into its posterior part, where it bent through 180° and, lying on its lower part, continued towards the aperture. Its lower part was provided with folded, relatively long, tube-like processes which probably represent the digestive glands.

### Systematic part

Class *Hyolitha* MAREK, 1963

Order *Hyolithida* SYSOEV 1957

Family *Hyolithidae* NICHOLSON, 1872

Hyolithids with conchs ornamented usually by transverse ribs or riblets. Although the operculum of *Hyolithes acutus* EICHWALD, 1840 (the type species of *Hyolithes*) is unknown, I suppose that it possessed one pair of clavicles. Stratigraphical range: Cambrian-Carboniferous.

*Elegantilites* MAREK, 1966

Type species: *Pugiunculus elegans* BARRANDE, 1847, by original designation of L. MAREK (1966, p. 89), Middle Ordovician (Caradoc, Zahořany Formation), Bohemia.

*Elegantilites elegans* (BARRANDE, 1847)

Pl. 7, figs. 1–5, text-figs. 9, 10

1847 *Pugiunculus elegans* BARR.; J. BARRANDE, p. 557, fig. 3.

1867 *Hyolithes elegans* BARR.; J. BARRANDE, p. 81, pl. 11, figs. 14–20, 22–25 (non fig. 21 = *Joachimilites novaki* sp. n.); pl. 12, fig. 42–46 [non fig. 47–49 = *Gompholites striatulus* (BARR.), non fig. 50 = *Eumorpholites bouceki* sp. n.].

1891 *Hyolithus elegans* BARR.; O. NOVÁK, p. 17, pl. 6, fig. 22–23.

1893 *Hyolithus* (*H.*) *elegans* BARR.; G. HOLM, p. 25.

1962 *Ambrolinevitus elegans* (BARRANDE); V. A. SYSOEV, p. 44.

1963 *Hyolithes elegans* BARR.; L. MAREK, pl. 4, fig. 2 (non pl. 3, fig. 3 = *Joachimilites novaki* sp. n.).

1966 *Elegantilites elegans* (BARRANDE); L. MAREK, p. 89, text-fig.

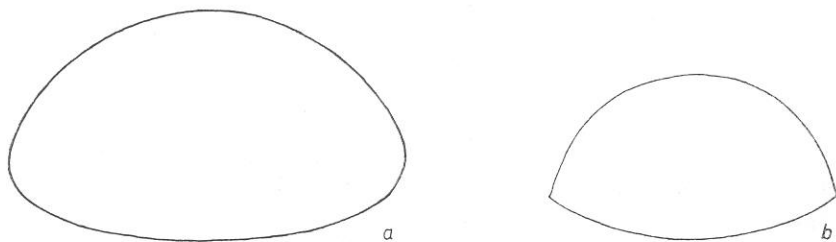
Lectotype: The specimen figured by J. BARRANDE (1867) on pl. 11, figs. 14–19 (NM ČD 1009).

Locus typicus: Loděnice near Beroun.

Stratum typicum: Zahořany Formation.

Material: In addition to the lectotype 35 internal and external molds of the conchs and 38 opercula, preserved in the same way with the exception of two composite molds. These two opercula are preserved in the argillaceous shales, all remaining material comes from concretions.

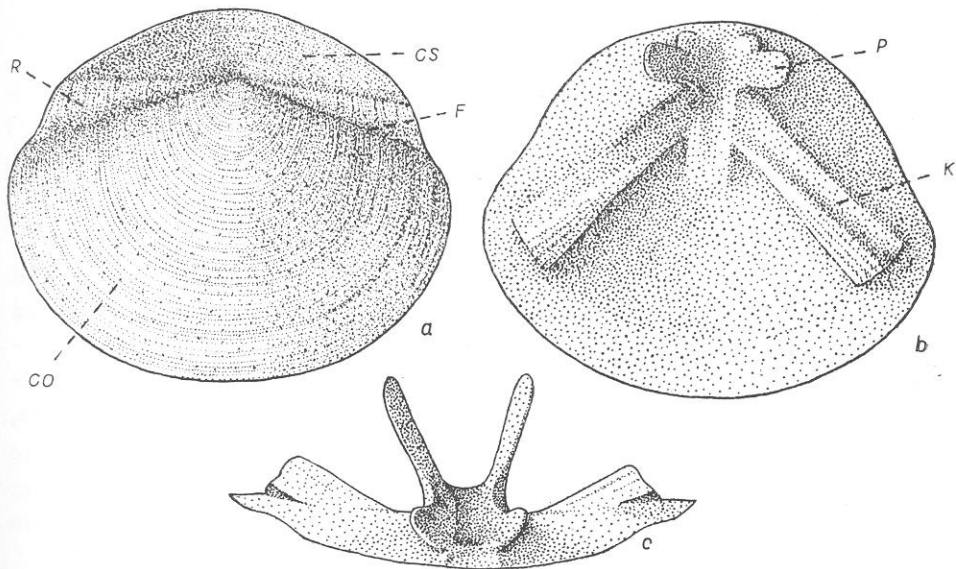
**Description:** The conch is straight, only rarely slightly dorsally convex; its cross-section is subtrigonal, with the ventral side gently convex. W-h index = 1.55 (1.46–1.65). The lateral edges are sharp almost along the whole length of the conch; they are rounded only near the aperture. The angle of divergence about 10°. Ligula is moderately convex, its length equals approx. three-eighths of the width of the aperture. On the internal molds we can observe sparsely spaced transverse rounded ridges of inequal prominence, following the shape of the aperture on both sides. There was probably one strongly elongated (tr.) adductor muscle scar on the ventral interior of the conch. On well preserved internal molds, extremely fine, slightly undulated transverse riblets (20–25 per mm) are visible by use of strong magnification. The apical portion of the conch is often septate. In two specimens I discovered concentric circular growth lines on the surface of these septa; this points most probably to a circular cross section of the protoconch of this species.



9. *Elegantilites elegans* (BARR.), cross-sections of conch

a — cross-section near the aperture; b — cross-section of older part of conch. External molds

The ornamentation of the surface consists of fine transverse riblets (10–12 per mm) with interspaces of the same width (sag.). These riblets cover both the dorsal and ventral side and are often interrupted by longitudinal hairlines, more frequent on the ventral side. The riblets are divided by these lines into short (tr.), little arcs, arched slightly forwards.



10. *Elegantiites elegans* (BARR.), operculum

*a* — external surface; *b* — internal surface; *c* — posterior view; *CS* — cardinal shield; *CO* — conical shield; *R* — rooflet (tectulum); *F* — main furrow; *P* — cardinal process; *K* — clavicle (clavícula)

The operculum is relatively flat, the angle of its bend equals approx.  $120^\circ$ ; the length: width ratio = 1:1.25. The length (sag.) of the cardinal shield in proportion to the length of the conical shield = 1:3.5. The main furrows are distinct, diverging at an angle of about  $130^\circ$ . The surface is ornamented by very fine, closely spaced concentric riblets, rarely interrupted by radial hairlines.

The interior of the operculum is characterized by a pair of keel-like clavicles and long blade-like cardinal processes, diverging at an acute angle of about  $30^\circ$  to each other. The cardinal processes are bilobate, the lobes near the cardinal margin being considerable shorter. The length of the main lobes equals almost  $1/3$  of the width of operculum. The central pit is small, subtriangular. In the axial line of the operculum, close to the proximal parts of the clavicles there is a distinct, flat and short (sag.) ridge, appearing on the internal mold as a groove with subparallel or slightly diverging margins. The teeth on the cardinal margin absent except of two very delicate teeth at the level of the cardinal processes. In some specimens, even these teeth are not developed.

Subparallel to the anterior margin of the internal molds there is a shallow furrow,

which becomes deeper and more distinct in gerontic specimens. This furrow probably corresponds to the pallial line of bivalvia or brachiopoda. The muscle scars of adductors indistinct; their position is indicated in rare cases by the presence of two pairs of lines, arranged radially on the inside of the conical shield. On the internal molds of well preserved opercula an extremely fine structure like this on conchs is perceivable. The hair-like riblets are arranged radially.

Dimensions: The estimated length of the longest conch is more than 120 mm.

Dimensions of some opercula (the measurements are always given in mm):

Width	22.6	13.4	14.4
Length	18.5	10.7	11.3

Discussion: *Elegantilites elegans* differs from the other Bohemian species of *Elegantilites* in the cross section and ornamentation of the conch and in the shape and inner morphology of the operculum. The differences are relatively small.

Occurrence: This species is known from the Libeň, Vinice, Zahořany and probably also Bohdalec Formations. Libeň Formation: Praha-Libeň (Bečka Brickyard), Praha-Motol. Vinice Formation: Praha-Vysočany (Pleschner Brickyard). Zahořany Formation: Praha-Libeň, Praha-Nový Hloubětín, Dubeč, Loděnice, Řevnice etc. Bohdalec Formation: Bílý Beránek. A fairly common species, especially in the Zahořany Formation.

*Elegantilites ? magister* (BARRANDE, 1867)

Pl. I. figs. 6, 7, text-fig. 11

1867 *Hyolithes magister* BARR.; J. BARRANDE, p. 84, pl. 15, figs. 37-39.

1891 *Hyolithus magister* BARR.; O. NOVÁK, p. 4.

1893 *Hyolithus (H.) magister* BARR.; G. HOLM, p. 25.

Lectotype: The specimen figured by J. BARRANDE (1867) on pl. 15, figs. 37-39 (NM ČD 1011).

Locus typicus: Praha-Strašnice.

Stratum typicum: Zahořany Formation.

Material: With the exception of the lectotype, two more incomplete internal molds of the conchs preserved in concretions.

Description: The conchs are relatively very big, slightly dorsally concave or straight. The cross section is subtrigonal, lateral edges sharp also on the internal mold. The dorsal side is strongly, the ventral side very moderately convex. W-h index = 1.5 (1.44-1.57), the lateral edges lie approx. in one-fifth of the height of the conch. The angle of divergence amount to 13-14°. Orthogonal aperture with ligula attaining the length of one-third of the width of the aperture.

The ornamentation consists of fine transverse riblets of different prominence, similar to those in *E. elegans*, but comparably less closely spaced. They number 7-9 per mm on the ventral side, about 7 per mm on the dorsal side. The riblets multiply toward the lateral edges. On the internal molds, there are several sparsely spaced transverse grooves, which are shallow, broad and indistinct.

The operculum is unknown.



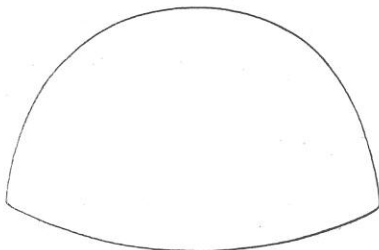
Dimensions of the lectotype: The length of the incomplete internal mold – 57.7 mm, max. width – cca 26.0 mm. The total length of the conch of an adult specimen attained at least 100 mm.

Discussion: *Elegantilites ? magister* (BARR.) is a poorly known species, differing from the related species *E. elegans* in the cross section and in the thickness of the ornamentation. As the operculum is unknown, it is difficult to attribute this species to the genus *Elegantilites* with certainty.

Occurrence: *E. ? magister* (BARR.) is a rare species in the upper parts of the Zahořany Formations in the eastern part of Praha (Strašnice, Nový Hloubětín). It occurs probably also in the Bohdalec Formation in Praha-Michle.

*Elegantilites ? aff. magister* (BARRANDE, 1867)

Pl. I, fig. 8



11. *Elegantilites ? magister* (BARR.), cross-section of conch, external mold

Seven specimens found in the uppermost parts of the Bohdalec Formation at one locality, differ from *E. ? magister* (BARR.) in the size of the conch and in the ornamentation.

The conch which is smaller than in the species mentioned, is slightly dorsally concave, the aperture being orthogonal. Lateral edges sharp both on the external and internal molds. W-h index equals approximately that of *E. ? magister*, the ventral side is still more convex. The angle of divergence amounts to 12–13°.

The ornamentation consists of fine transverse riblets, which on the dorsal side number 6–7 per mm. They are sharp and narrow, the interspaces being approx. twice as broad (sag.) as the riblets themselves. Distinct, closely spaced riblets on the ventral side number about 10 per mm.

The operculum is unknown.

Discussion: The material available is too poorly preserved and insufficient for establishing a new taxon.

Occurrence: All specimens come from the abandoned brickyard at “Bílý Beřánek”, W. of Praha-Motol, where the uppermost layers of the Bohdalec Formation have been exposed few years ago.

*Elegantilites ? tigris* sp. n.

Pl. II, figs. 7, 8, text-fig. 12

Holotype: External mold of a conch, figured here on pl. II, figs. 7, 8; LM 13.

Locus typicus: Loděnice (2) near Beroun.

Stratum typicum: Zahořany Formation.

Material: In addition to the holotype, 16 incomplete external molds and 9 internal molds. All specimens are preserved in concretions, unaffected by compression.

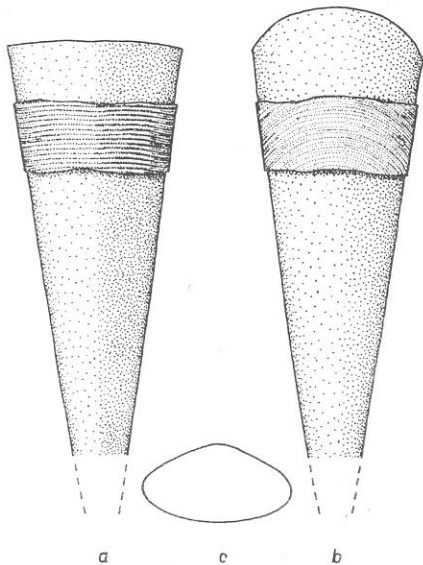
Description: The conch is straight, of roundedly subtrigonal cross-section. The lateral edges are rounded on the internal molds, sharp on the external molds. W-h index = 1.6, the lateral edges lie at three-seventh of the height of the conch. The aperture is orthogonal, ligula relatively short, attaining the length which equals one-third of the apertural breadth.

The ornamentation consists of transverse elements. Dorsal side with relatively coarse, rounded riblets, numbering 8–10 per mm, with the interspaces of the same breadth as that of the riblets. The riblets are often slightly rippled, and in the posterior part of the conch they are interrupted in their course by delicate longitudinal lines. The riblets usually multiply towards the lateral edges, where their number increases. The ventral surface is covered with fine growth-lines of unequal prominence.

The operculum is unknown.

Discussion: It is impossible to attribute this species with certainty to the genus *Elegantilites*, until the operculum is found. However, the type of ornamentation and the presence of sharp lateral edges indicate that it belongs to this genus. This species differs from all known representatives of *Elegantilites* in the ornamentation of the conch.

Occurrence: *Elegantilites ? tigris* sp. n. is a rare species in the Vinice Formation, where it was found in its basal layer in Praha-Vysočany (abandoned Pleschner's brickyard) and in the uppermost parts of the Zahořany Formation in Loděnice (2) near Beroun.



12. *Elegantilites ? tigris* sp. n., conch  
a — dorsal side; b — ventral side; c — cross-section of external mold

#### *Joachimilites* gen. n.

Type species: *Joachimilites novaki* sp. n., Middle Ordovician (Caradoc, Zahořany Formations), Bohemia.

Diagnosis: Conchs straight or slightly dorsally concave; cross-section subtrigonal. Lateral edges sharp, aperture orthogonal. Ornamentation consisting of fine transverse riblets on both sides. Riblets often discontinuous, divided into small arc-like parts. In some cases the surface only with growth-lines.

Operculum with one pair of long, simple cardinal processes, diverging at an acute angle. Central process ridge-like,

narrow; cardinal teeth present. Surface with concentric riblets and growth-lines.

Discussion: *Joachimilites* gen. n. is closely related with *Elegantilites*. The main difference is in the presence of the narrow central process in *Joachimilites*. The cardinal processes of this genus are simple, while in *Elegantilites* they are bilobate.

Occurrence: Ordovician (Caradoc—Ashgill), known hitherto only from Bohemia.

Species: *J. novaki* sp. n., *J. modestus* sp. n., *J. havliceki* sp. n., *J. ? potator* sp. n.

*Joachimilites novaki* sp. n.

Pl. II, figs. 1–6, text-figs. 13, 14

1867 *Hyolithes elegans* BARR.; J. BARRANDE (partim), pl. 11, figs. 20, 21.

1963 *Hyolithes* sp. n.; L. MAREK, pl. 4, fig. 6, text-fig. 12.

1963 *Hyolithes elegans* BARR.; L. MAREK, pl. 3, fig. 3.

Derivatio nominis: The species is named in honour of O. P. Novák (1851–1892), who dealt with the Bohemian hyolithids.

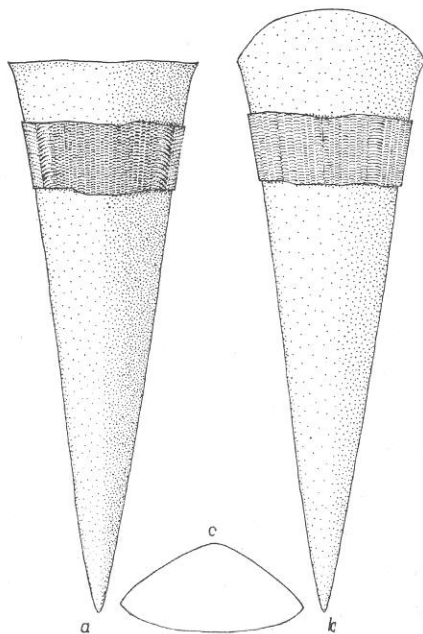
Holotype: The external mold of the specimen figured here on pl. II, figs. 5, 6, LM 17. Figured paratypes: LM 10, LM 11, LM 12, LM 18.

Locus typicus: Dubeč near Praha.

Stratum typicum: Zahořany Formation.

Material: In addition to the holotype, 39 internal molds of the conchs and a somewhat smaller number of external molds; 41 opercula, internal or external molds; material preserved in concretions, mostly underformed by compression.

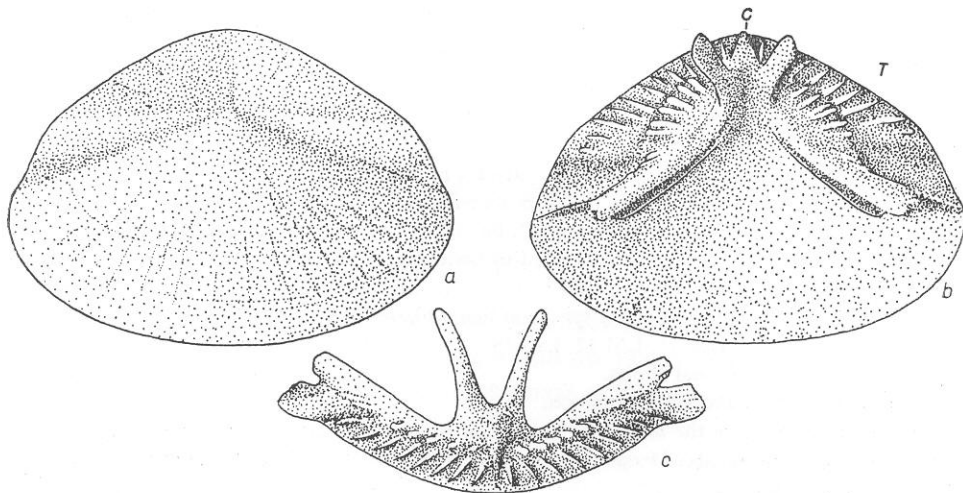
Description: The conchs are usually very slightly dorsally concave, their cross-section is subtriangulate, with all three sides moderately convex. The ventral side is almost flat in its median area. W-h index = 1.7. The lateral edges are sharp on the external molds of the posterior part of the conch: they are rounded near the aperture and lie approx. at one-third of the height of the conch. The aperture is orthogonal, the angle of divergence equals 8–10°. The length of ligula attains approximately one-third to two-eighths of the breadth of the aperture. Along each lateral margin of the dorsal side a shallow longitudinal furrow is visible on the external molds; these furrows can be traced only near the aperture on the internal molds.



13. *Joachimilites novaki* sp. n., conch

a — dorsal side; b — ventral side; c — cross-section of external mold

The ornamentation consists of very fine, but conspicuous transverse riblets divided into very short (tr.) parts, arranged into narrow longitudinal bands. This gives a reticulate appearance to the ornamentation, especially in the median part of the dorsal side. The riblets number about 10 per mm on the dorsal, 12 per mm on the ventral side. The number of the longitudinal bands can amount to 10 per mm on the dorsum.



14. *Joachimilites novaki* sp. n., operculum

a — external surface; b — internal surface; c — posterior view; C — central process; T — teeth

The operculum is broadly elliptical, relatively flat. Its angular bend equals approx.  $140^\circ$ , the length: width ratio = 1:1.5. The ratio of the length the of cardinal shield to the length of the conical shield equals 1:2.7. The rooflets are distinct, the main furrows diverge at an obtuse angle of about  $140^\circ$ . The surface is ornamented with concentric riblets and growth-lines of inequal prominence, combined with sparsely spaced hair-like radial grooves.

The inner side of the operculum carries one pair of long cardinal processes of flatly elliptical cross-section. They diverge at about  $50^\circ$ . The central process is long (sag.) and narrow, reaching mostly to the cardinal margin. There is pair of narrow, ridge-like clavicles on the operculum. Their inner margins are bordered with longitudinal furrows. The extremities of the clavicles are connected with the lateral margins of the operculum by narrow (exsag.) and high ridges. There are usually two rows of long and narrow teeth arranged radially on the cardinal shield. In rare cases we meet with three rows of teeth. On the inner surface of the conical shield there are few (4–6) indistinct radial grooves representing most probably the traces of adductor muscles of unknown shape and location. On the anterior margin of the operculum there is usually a row of short, rounded radial ribs and furrows.

Dimensions: The length of some almost complete conchs: 25.0; 34.2; 36.9; 39.8.

Dimensions of opercula:

Width	7.3	8.4	9.2	9.5	10.0	10.2
Length	5.0	5.7	6.2	6.0	6.9	6.4

Occurrence: *Joachimilites novaki* sp. n. is abundant in the Zahorany Formation, almost at all localities: Praha, Dubeč, Loděnice (1, 2), Řevnice, Staňkovka etc. It is a fairly common species, which used to be confused with *Elegantilites elegans* (BARR.). One specimen was also found in the Vinice Formation at Vráž near Beroun.

*Joachimilites modestus* sp. n.

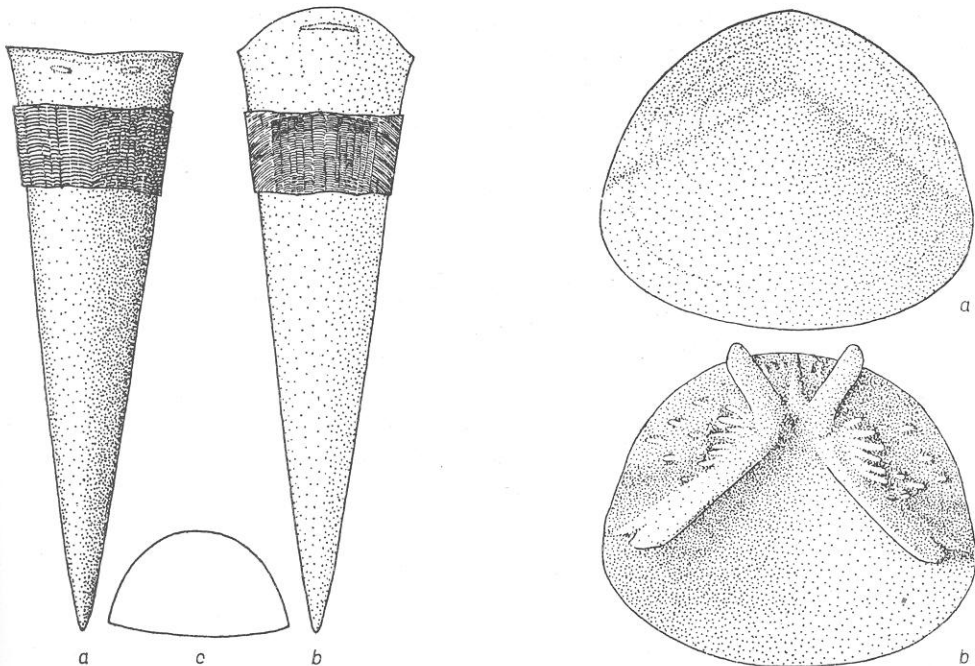
Pl. III, figs. 1-7, text-figs. 15, 16

Holotype: The internal mold, figured here on pl. III, figs. 1-3. LM 14. Figured paratypes: LM 15, LM 16, LM 19.

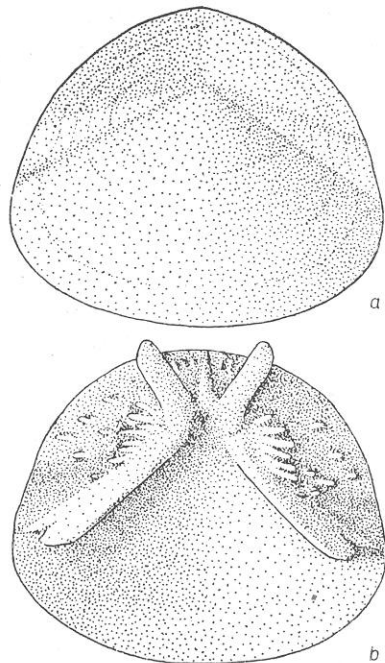
Locus typicus: Praha-Nový Hloubětín.

Stratum typicum: Zahorany Formation.

Material: In addition to the holotype, 25 more or less complete fragments of internal molds of conchs are preserved, usually with corresponding external molds, and 4 opercula. All material preserved in concretions, mostly underformed by compression.



15. *Joachimilites modestus* sp. n., conch  
a — dorsal side; b — ventral side; c — cross-section of external mold



16. *Joachimilites modestus* sp. n., operculum  
a — external surface; b — internal surface

**Description:** The conchs are almost straight, only very slightly dorsally concave. The cross-section is subtrigonal, with the dorsal side highly convex and the ventral side almost flat in the axial portion. W-h index = 1.65. The lateral edges are sharp on the external mold and sharply rounded on the internal mold. They lie approx. at one-ninth of the height of the conch. The aperture is practically orthogonal; the dorsal apertural margin is slightly arched backwards in its median part. The angle of divergence equals  $13^\circ$ . The ligula is short, attaining the length about two-sevenths of the apertural breadth.

On the internal molds of well preserved specimens one pair of elongated (tr.) muscle scars near the dorsal margin of the aperture is visible. Two longitudinal lines on the ventral side indicate the presence of the ventral muscle scar, which was also ascertained in one specimen. This scar was single, elongated (tr.) attaining about one-third of the width of the conch. The surface of the internal mold is covered with extremely fine transverse "riblets" (18–20 per mm).

The ornamentation consists of prominent transverse riblets, arranged in longitudinal bands of unequal breadth (tr.). The riblets in the single bands are arched moderately forwards. The ventral side is ornamented with less prominent riblets of the same type and the longitudinal bands are narrower (tr.). The riblets number about 8–10 per mm on the dorsal side, 15–20 per mm on the ventral one.

The operculum is very similar to that of *J. novaki* sp. n. Above all it differs in its shape, which is more rounded. The lateral parts of the cardinal shield are broader (exsag.), the teeth are smaller and more sparsely spaced in the outer row. They are grouped mainly around the bases of the cardinal processes.

The surface is covered with fine concentric growth-lines.

**Dimensions:** The maximal estimated length of the conch attained more than 26 mm. The width of two opercula: 6.8 mm, 6.0 mm.

**Discussion:** This species undoubtedly belongs to *Joachimilites* regarding the presence of a narrow and sharp central process. From the other species of this genus it differs in the characteristic ornamentation of the dorsal side and in the shape of the cross-section. The operculum differs in the shape of the cardinal shield and in the dentation distinctly from the operculum of *J. novaki* sp. n. The difference between the opercula of *J. modestus* sp. n. and *J. havliceki* sp. n. is practically unascertainable owing to the paucity of the material.

**Occurrence:** *Joachimilites modestus* sp. n. was found only in the Zahořany Formation of Praha-Nový Hloubětín and Praha-Libeň.

*Joachimilites havliceki* sp. n.

Pl. III, figs. 8–12, text-fig. 17

**Derivatio nominis:** The species was named in honour of V. Havlíček, who deals with the paleontology and stratigraphy of the Lower Paleozoic of Bohemia.

**Holotype:** The specimen (fragmentary internal mold with partly preserved shell), figured here on pl. III, figs. 8, 9. LM 22. **Figured paratypes:** LM 21, LM 22.



Locus typicus: Praha-Michle.

Stratum typicum: Bohdalec Formation.

Material: The holotype and 36 fragmentary internal and external molds, preserved mainly in concretions; 6 incomplete opercula.

Description: The conch is very slightly dorsally concave. Its cross-section is subtrigonal, with a very slightly convex, almost flat ventral side and strongly convex dorsal side. W-h index = 1.5. The lateral edges are sharp, lying at about one-eighth of the height of the conch. The ligula is short, attaining the length equaling about three-tenths of the apertural width. The aperture is orthogonal, the angle of divergence equals 11–13°. The muscle scars are not developed.



17. *Joachimilites havliceki* sp. n., cross-section of conch, external mold

The conch is mostly smooth. In the holotype and in another well preserved specimen the ornamentation is visible. It consists of faint, relatively sparsely spaced, discontinuous transverse riblets of unequal prominence. The conchs preserved in the shale does not show any traces of the ornamentation.

The operculum has one pair of long cardinal processes and one sharp, narrow central process. It resembles in all features the operculum of *J. modestus* sp. n.

Dimensions: The maximal length of the conch could have reached up to 22 mm, the width of the aperture being 6 mm.

Discussion: The material available does not allow to find out any difference between the operculum of *J. havliceki* and that of *J. modestus*. However, the differentiating features of the conchs of both species are sufficient for establishing a new species.

Occurrence: *Joachimilites havliceki* sp. n. occurs in the Bohdalec Formation of Praha-Michle, Praha-Spořilov and Velká Chuchle. It appears probably also in the upper argillaceous parts of the Zahořany Formation in Praha-Vysočany.

*Joachimilites ? potator* sp. n.

Pl. IV, figs. 1–3, text-fig. 18

Holotype: The specimen figured here on pl. IV, figs. 1–3. LM 23.

Locus typicus: Loděnice (2) near Beroun.

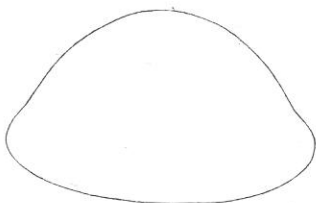
Stratum typicum: Zahořany Formation.

Material: In addition to the holotype, 3 more or less complete fragments of internal molds of the conch with 5 fragments of external molds. All specimen are practically undeformed in concretions.

Description: The conchs are slightly dorsally concave, of roundedly subtrigonal cross-section. In one specimen a distinct lateral bend of the conch is visible. Along each lateral edge of the dorsal side runs a shallow and broad longitudinal

furrow, which is most conspicuous in the anterior part of the conch. W-h index = 1.55. Slightly rounded lateral edges lie approx. at one-third to one-fourth of the height of the conch. The aperture is orthogonal; the angle of divergence of the internal mold equals 12–13°. The ligula is relatively short, attaining about three-eighths of the apertural width.

The ornamentation consists of slightly marked transverse riblets of unequal prominence, which are more closely spaced on the ventral side. They numbers 5–6 per mm on the dorsal side and 7–9 per mm on the ventral side. The riblets are rounded and approximately of the same width (sag.) as are the interspaces. Close to the lateral edges, the riblets of the dorsal side are interrupted by fine longitudinal lines.



18. *Joachimilites* ? *potator* sp. n., cross-section of conch, internal mold

The operculum is unknown.

Dimension of the holotype: Length (incomplete) – 27.2 mm, width at the aperture – 7.3 mm, height – 5.0 mm.

Discussion: I refer this species provisionally to the genus *Joachimilites* because of the presence of two longitudinal shallow furrows along the lateral margins of the dorsal side, which are also developed in the type species *J. nova-ki* sp. n.

Occurrence: *Joachimilites* ? *potator* sp. n. was found in the uppermost parts of the Zahořany Formations in Loděnice (2) near Beroun.

### *Eumorpholites* gen. n.

Type species: *Eumorpholites bouceki* sp. n. Middle Ordovician (Caradoc, Zahořany Formation), Bohemia.

Diagnosis: Conchs of medium size (about 20 mm) ornamented by transverse continuous riblets. Lateral edges rounded on the external molds. Inner side of operculum with one pair of broad clavicles; cardinal processes widely divergent, short (tr.) and broad (exsag.). Central process developed, broad (tr.), flat and usually trilobate; its median lobe protruding into a narrow process. Teeth, if present, faintly marked and closely spaced.

Occurrence: Ordovician (Caradoc), Bohemia.

Species: *E. bouceki* sp. n., *E. crudus* sp. n.

### *Eumorpholites bouceki* sp. n.

Pl. IV, figs. 4–8, text-figs. 19, 20

1867 *Hyolithes elegans* BARR.; J. BARRANDE, pl. 12, fig. 50.

Derivatio nominis: Named in honour of B. Bouček, an outstanding Czech paleontologist.

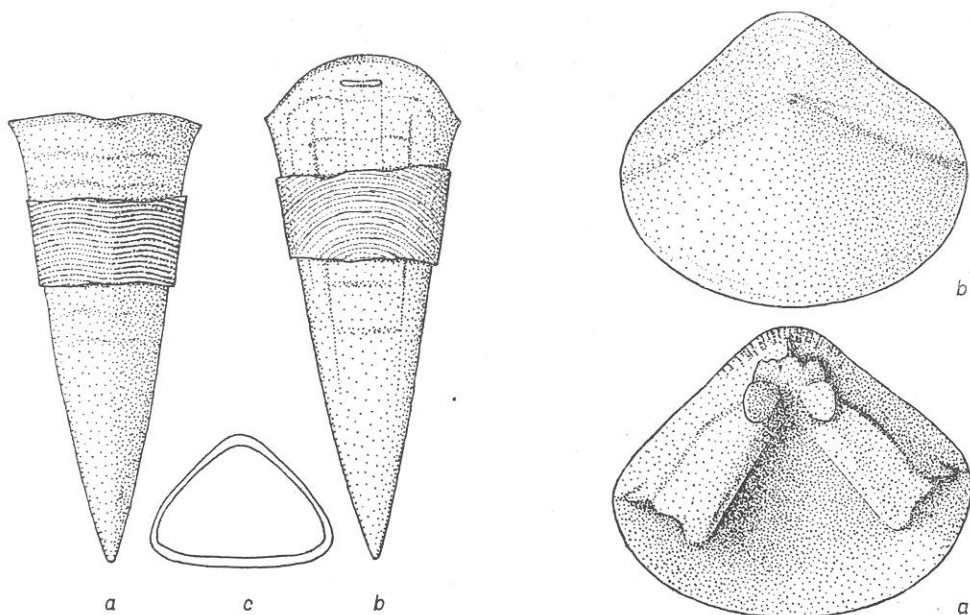
Holotype: The specimen, figured here on pl. IV, fig. 5. LM 27. Figured paratypes: LM 25, LM 24, LM 26.

Locus typicus: Praha-Nový Hloubětín.

Stratum typicum: Zahořany Formation.

Material: In addition to the holotype, 80 more internal molds of the conchs and about the same number of their external molds; 54 internal and 19 external molds of opercula. All material preserved in concretions, mostly undeformed by compression.

Description: The conchs are straight or slightly dorsally convex; their cross-section is subtriangular, the median part of the ventral side is almost flat. The lateral



19. *Eumorpholites bouceki* sp. n., conch

a — dorsal side; b — ventral side; c — cross-section

20. *Eumorpholites bouceki* sp. n., operculum

a — external surface; b — internal surface

parts of the dorsal side join on the dorsum at a rounded angle of about  $90^\circ$ . W-h index = 1.55. The aperture is orthogonal, the median part of its dorsal margin is arched backwards. The ligula is relatively long — its length equals approx. one-third of the apertural width. The angle of divergence attains  $17-20^\circ$ . On the dorsal side of the internal molds several transverse, shallow furrows, supparallel to the dorsal apertural margin are visible. On the ventral side of the internal molds one single elongated (tr.) muscle scar can be traced, close to the apertural margin. Along each lateral margin of the ventral side run two pairs of narrow and shallow longitudinal furrows.

The ornamentation consists of transverse rounded riblets, numbering 8–14 per mm on the dorsal, 13–18 per mm on the ventral side. These riblets multiply on the axial part of the dorsal side and near its lateral edges.

The operculum is characterized by the small angle of its bend and by an elon-

gated (sag.) middle part of the cardinal shield. The length of this shield in relation to the length of the conical shield = 1:3. The main furrows diverge at about 120°, the rooflets are narrow. The ornamentation consists of fine, slightly marked concentric riblets and growth-lines.

The operculum is uniclavicate, the clavicles being thick and subelliptical in cross-section. They are separated from the cardinal part of the operculum by prominent furrows. The cardinal processes are short and broad (exsag.). The trilobate central process is broad (tr.) and flat. From its middle lobe runs out a narrow ridge almost to the cardinal margin. Thin and short, closely spaced teeth are developed on the cardinal margin in adult, well preserved specimens. Between the distal ends of the clavicles and the lateral margins of the operculum lie distinct and sharp ridges, perpendicular to the axial line.

Dimensions: The maximal length of the conch reached up to 18 mm. The measurements of some opercula in mm:

Width	5.4	5.5	5.8	5.6
Length	4.4	4.2	4.6	4.3

Occurrence: *Eumorpholites bouceki* sp. n. is abundant in the Zahořany Formation almost at all localities. This species has been obtained also from the Bohdalec Formation of Praha-Michle, where it occurs rarely.

*Eumorpholites crudus* sp. n.

Pl. IV, fig. 9, text-fig. 21

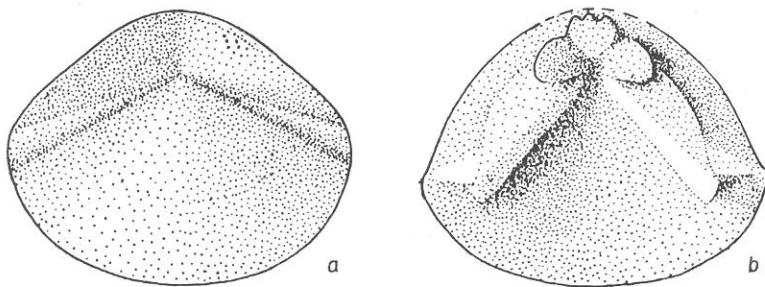
Holotype: The specimen (operculum), figured here on pl. IV, fig. 9, text-fig. 21. LM 36.

Locus typicus: Praha-Motol.

Stratum typicum: Libeň Formation.

Material: In addition to the holotype another fragment of operculum and possibly also 3 fragmentary external molds of the conchs. All specimens are preserved in concretions and are undeformed by compression.

Description: The conchs, which probably belong to this species are straight and their cross-section is asymmetrically subelliptical. The ventral side is mod-



21. *Eumorpholites crudus* sp. n., operculum  
a — external surface; b — internal surface

erately, the dorsal considerably convex. W-h index = about 1.6. The lateral edges are rounded, the angle of divergence is unmeasurable.

The surface is ornamented with inconspicuous transverse growthlines.

The operculum resembles considerably the operculum of *E. bouceki* sp. n. The outline of its cardinal shield is more rounded and the shield itself is relatively shorter (sag.). The other differences consist in the conspicuously narrower (tr.) central process and a different course of the furrows separating the clavicles from the cardinal shield.

The surface of the operculum is covered with faintly marked concentric growthlines.

Dimensions of the operculum (holotype): The specimen is incomplete, its estimated width is about 2.8 mm.

Occurrence: *Eumorpholites crudus* sp. n. is a rare species in the shale facies of the Libeň Formation of Praha-Motol.

*Eumorpholites ? tectus* sp. n.

Pl. V, figs. 1, 2, text-fig. 22

Holotype: The specimen, figured here on pl. V, fig. 1. LM 28. Figured paratype: LM 29.

Locus typicus: Praha-Vysočany.

Stratum typicum: Vinice Formation.

Material: In addition to the holotype, another internal mold and 2 external molds; all specimens preserved in concretions, undeformed by compression.

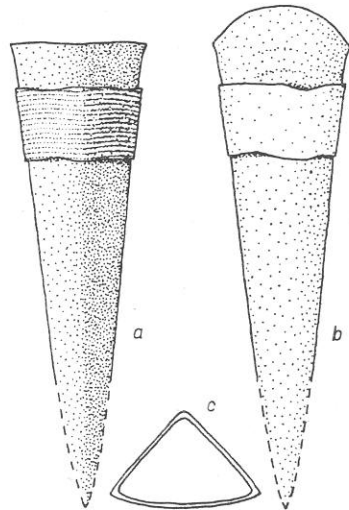
Description: The conchs are small, straight and of trigonal cross-section. The lateral edges are sharp, the ventral side is slightly convex. Lateral parts of the dorsal side are almost flat, joining in the axial line at about 90°. The dorsal edge is roundedly sharp. W-h index = 1.48. The angle of divergence equals 16°. The lateral edges lie at two-thirteenths of the height of the conch. The ligula is moderately arched; its length attains two-sevenths of the apertural breadth. The aperture is orthogonal.

The ornamentation consists of continuous transverse, faintly marked riblets spaced 7-9 per mm.

The operculum is unknown.

Dimensions of the holotype: Length (incomplete) - 6.0 mm, breadth of the aperture - 2.6 mm, height - 1.5 mm.

Discussion: The systematic position of this



22. *Eumorpholites ? tectus* sp. n., conch

a — dorsal side; b — ventral side; c — cross-section

species is questionable. Owing to its ornamentation, I assign this species provisionally to *Eumorpholites*.

Occurrence: *Eumorpholites* ? *tectus* sp. n. was found only in the basal layers of the Vinice Formation in the abandoned Pleschnei Brickyard, Praha-Vysočany.

### *Gompholites* MAREK, 1966

Type species: *Hyolithes cinctus* BARRANDE, 1867, by original designation of L. MAREK (1966, p. 90), Middle Ordovician (Llanvirn, Šárka Formation), Bohemia.

### *Gompholites striatulus* (BARRANDE, 1847)

Pl. V, figs. 3–8, text-figs. 23, 24

- 1847 *Pugiunculus striatulus* BARR.; J. BARRANDE, p. 557, fig. 2.  
1847 *Pugiunculus undulatus* BARR.; J. BARRANDE, p. 558, fig. 4.  
1867 *Hyolithes striatulus* BARR.; J. BARRANDE, p. 92, pl. 12, figs. 47–49 [non fig. 42–46, 50 = *Elegantilites elegans* (BARR.)].  
1867 *Hyolithes undulatus* BARR.; J. BARRANDE, p. 94, pl. 11, figs. 29, 30.  
1891 *Hyolithus striatulus* BARR.; O. NOVÁK, p. 25, pl. 6, figs. 24–36.  
1891 *Hyolithus undulatus* BARR.; O. NOVÁK, p. 27, pl. 4, fig. 31.  
1893 *Hyolithus* (*H.*) *striatulus* BARR.; G. HOLM, p. 25.  
1893 *Hyolithus* (*H.*) *undulatus* BARR.; G. HOLM, p. 25.  
1962 *Lineovitus striatulus* (BARRANDE); V. A. SYSOEV, p. 23.  
1962 *Dorsolinevitus* ? *undulatus* (BARRANDE); V. A. SYSOEV, p. 40.  
1963 *Hyolithes striatulus* BARR.; L. MAREK, text-fig. 6; pl. 3, fig. 2; pl. 4, fig. 1, 5.  
1964 *Hyolithes striatulus* (BARRANDE); L. MAREK, E. L. YOCHELSON, figs. 1, 2.  
1966 *Gompholites striatulus* (BARR.); L. MAREK, p. 90.

Lectotype: The specimen, figured by J. Barrande (1867) on pl. 12, fig. 47. NM ČD 1002.

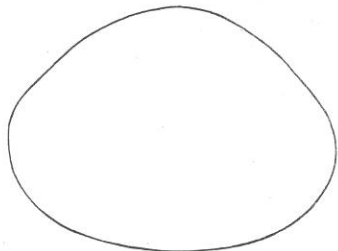
Locus typicus: Loděnice near Beroun.

Stratum typicum: Zahořany Formation.

Material: In addition to the lectotype, a larger amount of internal and external molds and 28 more or less complete opercula; of these, two are preserved in situ, one specimen was obtained with appendages in natural position. All material comes from concretions and is mostly undeformed by compression.

Description: The conch is straight, its cross-section being asymmetrically subelliptical. W-h index = 1.44. The apertural angles are strongly rounded; the aperture is orthogonal. The lateral edges are considerably rounded and lie approx. at one-half of the height of the conch. The angle of divergence equals 9–11°.

The ligula is relatively long, attaining about two-fifths of the apertural breadth. On the ventral side of the internal mold are two longitudinal lines along the longitudinal axis; they represent the traces of the ventral muscle scar, which has been shifted

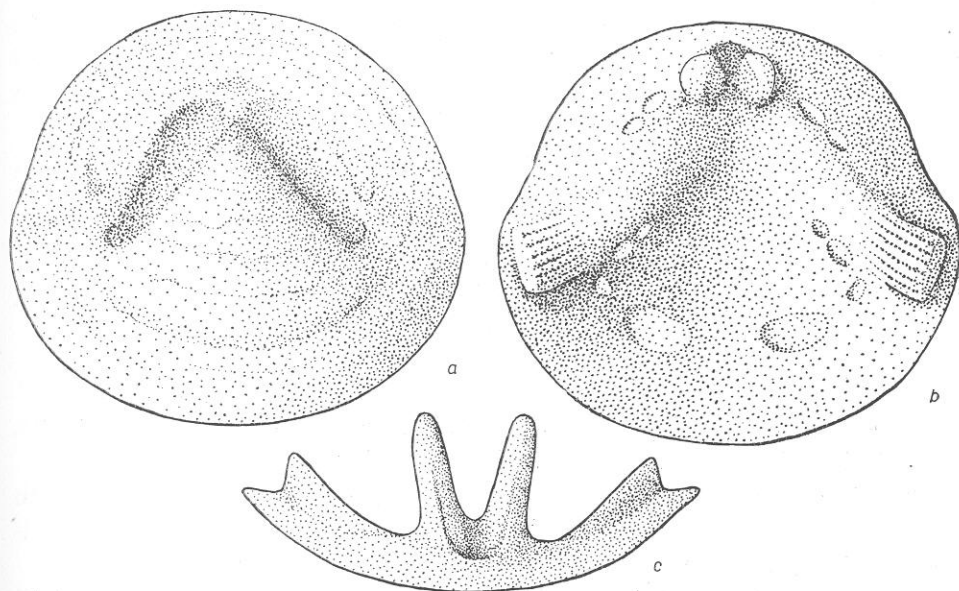


23. *Gompholites striatulus* (BARR.), cross-section of conch, external mold



forwards during the growth of the shell. In rare cases these elongated (tr.) narrow scars are visible. In the apical part of some specimens, a single, mostly asymmetrically inflated septum was detected.

The surface is ornamented with relatively coarse transverse riblets, numbering about 10–15 per mm on both sides. Besides the riblets, the ornamentation is characterized by transverse, irregularly and sparsely spaced distinct furrows.



24. *Gompholites striatulus* (BARR.), operculum

a — external surface; b — internal surface; c — posterior view

The operculum is considerably flat and almost subcircular in outline. Its angular bend equals about  $145^\circ$ . The main furrows and rooflets are indistinct and can be detected only near the lateral margins of the operculum. Two deeply impressed conspicuous furrows run from the summit, diverging at  $90^\circ$ ; they do not reach the margins of the operculum. The surface is ornamented with irregular concentric riblets and furrows.

The inner side of the operculum is characterized by one pair of clavicles, suboval in cross-section, and one pair of relatively long cardinal processes, diverging at  $25^\circ$ ; their cross-section is subtrigonal. The clavicles bear a larger number of distinct longitudinal furrows. The central pit of subcircular shape is developed on the cardinal shield. Near the anterior margin two distinct bean-shaped muscle impressions of adductors can be detected. These scars represent, as always in *Hyolithidae*, places with a reduced thickness of the shell. Besides these adductor scars, there are several more pairs of small muscle impressions on the inner side of the

operculum; two pairs lie on the lateral portions of the interior of the conical shield, two other on the extended proximal parts of the clavicles.

Dimensions: The length of the longest conch known to me, attained at least 50 mm. The dimensions of some opercula in mm:

Width	7.5	7.8	8.3	
Length	7.0	7.0	7.5	9.8

Discussion: *Gompholites striatulus* (BARR.) can be compared with the related species *G. cinctus* (BARR.) from the Šárka and Dobrotivá Formations, the type species of *Gompholites*. The latter species differs in a smaller size of the conch and a different ornamentation. The diverging furrows on the exterior of the operculum in *G. cinctus* are comparably shorter.

*Hyolithes undulatus* (BARR.), a poorly known species from the Vinice Formation, turned out to be the synonym of *G. striatulus* (BARR.). There are no differences in the ornamentation of the two species.

Occurrence: *Gompholites striatulus* (BARR.) is a rare species in the Vinice Formation; it occurs fairly abundantly in the Zahořany and Bohdalec Formations.

#### *Carinolites* SYSOEV, 1958

Type species: *Hyolithus pennatulus* HOLM, 1893, by original designation of V. A. SYSOEV (1958, p. 188), Middle Cambrian — Middle Ordovician, Sweden, Bohemia.

Discussion: This genus was established by V. A. Sysoev for the species with conchs characterized by three longitudinal keels on the dorsal side, which is considerably smaller than the ventral one.

Unfortunately, the operculum of the type species *Carinolites pennatulus* (HOLM) is poorly known; G. HOLM (1893) figured only its external surface. I had the opportunity to study two unfigured opercula of the species mentioned in the collections of the Naturhistoriska Riksmuseet in Stockholm and found that the operculum of *Carinolites* is of platyclavicate type. However, the latex cast did not come out very well, so that the shape of the cardinal processes could not be detected. They were probably short and broad. In another undescribed species of *Carinolites* from the Middle Cambrian of Bohemia the operculum shows one pair of broadly diverging, short and broad cardinal processes.

Occurrence: M. Cambrian — M. Ordovician, Sweden, Bohemia.

#### *Carinolites* ? *tantulus* sp. n.

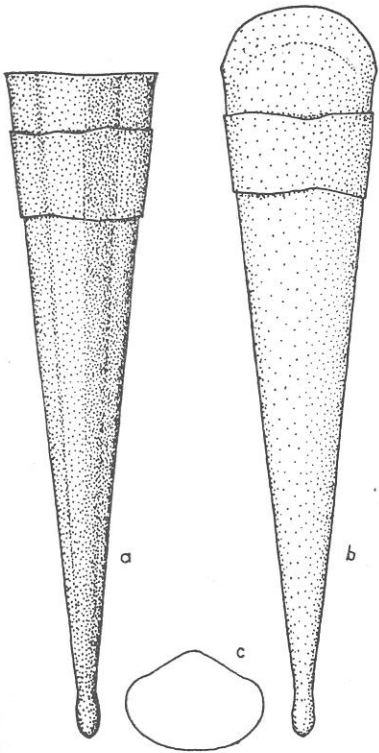
Pl. V, figs. 9–11, text-figs. 25, 26

Holotype: The specimen figured here on pl. V, figs. 9, 10. LM 32. Figured paratype: LM 35. Locus typicus: Praha-Motol.

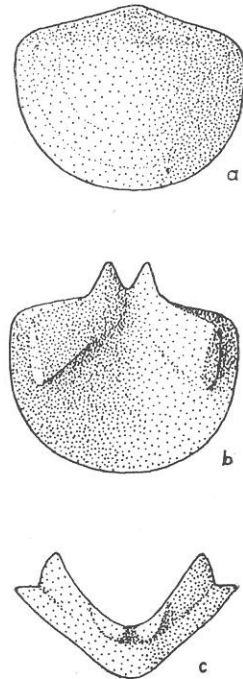
Stratum typicum: Libeň Formation.

Material: In addition to the holotype, another internal and external mold of the conch and one poorly preserved operculum.

Description: The minute conchs are dorsally convex, of subtrigonal cross-section. The ventral side is broadly convex, the dorsal roundedly keeled. The angle of divergence equals  $10^\circ$ . Strongly rounded lateral edges are not identical with the bounds between the ventral and dorsal side, which are placed much higher. The edges lie almost at one-half of the height of the conch. Both sides are divided



25. *Carinolites ? tantulus* sp. n., conch  
a — dorsal side; b — ventral side; c —  
cross-section, external mold



26. *Carinolites ? tantulus* sp.  
n., operculum  
a — external surface; b —  
internal surface; c — poste-  
rior view

by longitudinal rounded keels. The areas between these keels and the median keel are very moderately concave. W-h index = 1.35. The ligula is relatively long and attains about two-fifths of the apertural breadth. The aperture is orthogonal.

The apical part of one specimen (pl. V, fig. 11) has a preserved protoconch, which is elongated, oval and slightly pointed; its length is 0.25–0.3 mm.

The surface is smooth on both sides.

The operculum is highly convex, with a relatively narrow (sag., exsag.) subtrigonal cardinal shield, The angular bend is unmeasurable. Broad (exsag.) and flattened clavicles have an elongately drop-shaped cross-section. The cardinal

processes have broad bases and taper very rapidly towards their extremities. They do not diverge, their axis being almost parallel; the cross-section is drop-shaped.

The surface is ornamented with faint concentric growth-lines.

Dimensions of the holotype: Length of almost complete conch - 3.7 mm, apertural breadth - 1.0 mm.

Discussion: The species described differs from the Cambrian representatives of *Carinolites* in the shape and arrangement of the cardinal processes. In my opinion, *C. ? tantulus* sp. n. could be attributed to a new separate genus closely related to *Carinolites*. The creating of such a genus, however, would necessitate a new well-preserved material and a more detailed study of the type species of *Carinolites*. I refer the new species provisionally to *Carinolites*.

Occurrence: *Carinolites ? tantulus* sp. n. was obtained from the shale facies of the Libeň Formation, Praha-Motol.

↓  
*Sololites* gen. n.

Type species: *Sololites ferrigenus* sp. n. Middle Ordovician, Bohemia.

Diagnosis: Shell straight, subpentagonal in cross-section. Lateral edges strongly rounded. Dorsal side considerably smaller than ventral side. Apertural sinuses lie on the dorsal part of the conch, above the lateral edges. Ligula relatively long. Middle part of dorsal apertural margin arched distinctly backwards.

Ornamentation of the dorsal side consists of coarse rounded, longitudinal ribs, the most prominent lying on the margins of dorsal side. Their position corresponds to that of the apertural sinuses. Ventral side ornamented with fine transverse riblets that pass onto dorsal side.

Discussion: *Sololites* gen. n. is related to *Carinolites* SYSOEV. The most prominent lateral ribs of *Sololites* correspond to the lateral keels in the latter genus. The apertural sinuses in both genera are located above the lateral edges of the conch. The main differentiating feature is the presence of longitudinal ribs in *Sololites*.

The seemingly related genus *Dorsolinevitus* SYSOEV, 1958 differs in having sharp lateral edges identical with the limits between the dorsal and ventral side and in a different longitudinal ribbing. V. A. Sysoev attributed to *Dorsolinevitus* among others the species *H. textilis* HOLM, 1893 and *H. vomer* HOLM, 1893, which differ from the type species *Dorsolinevitus dispar* (HOLM, 1893) distinctly in having broad (tr.) and flat longitudinal bands along the lateral margins of the dorsal side. These species may probably belong to a separate genus.

Occurrence: Ordovician (Caradoc), Bohemia.

Species: *S. ferrigenus* sp. n.

*Sololites ferrigenus* sp. n.

Pl. VI, fig. 1-3, text-fig. 27

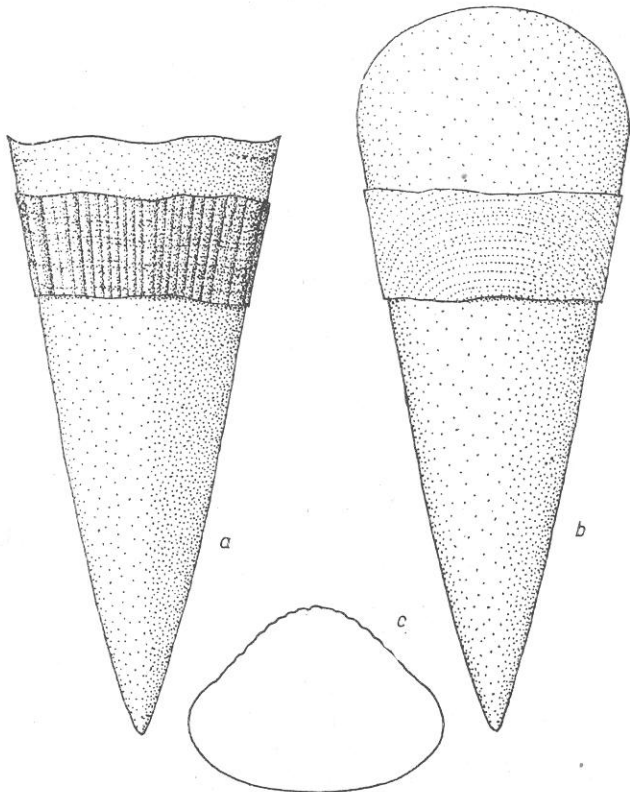
Holotype: The specimen figured here on pl. VI, fig. 1-3, text-fig. 27. NM 6850.

Locus typicus: Chrustenice.

Stratum typicum: Vinice Formation.

Material: In addition to the holotype, another internal mold of the conch; both specimens preserved in iron ore, undeformed by compression.

Description: The conch is straight, of roundedly subpentagonal cross-section, the lateral edges strongly rounded. They are not identical with the limits between the ventral and dorsal side which are located on the dorsal part of the conch. The bend of the transversal ribs corresponds with the position of the lateral sinuses that are located on the two prominent longitudinal rounded ribs which run on the margins of the dorsal side. The dorsal side is considerably smaller than the ventral side. W-h index = 1.5. The angle of divergence equals  $18^\circ$ . The aperture is orthogonal. The ligula is relatively long, its length equalling almost one-half of the apertural breadth. The middle part of the dorsal apertural margin is distinctly arched backward, the lateral parts are arched forwards.



27. *Sololites ferrigenus* sp. n., conch

a — dorsal side; b — ventral side; c — cross-section, external mold

The ornamentation of the dorsal side consists of longitudinal rounded ribs which, apart from the two most prominent marginal ribs, amount to 20 in the holotype. The interspaces are considerably narrower than the ribs. On the dorsal side the longitudinal ribs are combined with fine, indistinct transverse riblets, subparallel to the dorsal apertural margin. The ventral side is ornamented only with fine transverse riblets and growth-lines.

The operculum is unknown.

Dimensions of the holotype: Length of almost complete conch - 20 mm, breadth - 8.7 mm, height - 5.7 mm.

Occurrence: *Sololites ferrigenus* sp. n. is a very rare species in the iron ore deposit on the base of the Vinice Formation in Chrutenice near Beroun.

#### Family *Pauxillitidae* fam. n.

Type genus: *Pauxillites* MAREK, 1966. Middle Ordovician, Bohemia. Synonymum: *Barrela* HENGSTRÖM, 1930, junior synonymum of *Barrella* HIRST, 1910, an arachnid.

Hyalolithids characterized by straight conchs ornamented with longitudinal riblets mostly only on dorsal side, in some cases on both sides. Lateral edges sharp, rarely also moderately rounded. Internal surface of ventral side often bears two longitudinal ridges (furrows on the internal mold) along its lateral margins. Aperture oxygonal.

Operculum with more than one pair of clavicles; cardinal processes short and broad, central process broad and dentate. Ornamentation, if present, consisting of radial riblets.

Occurrence: Ordovician—Devonian.

#### *Recilites* gen. n.

Type species: *Hyalithes solitarius* BARRANDE, 1867. Middle Ordovician (Caradoc, Zahofany Formation), Bohemia.

Diagnosis: Conchs almost straight of low subtrigonal cross-section. Lateral edges rounded. Longitudinal lateral furrows on internal mold of ventral side absent. Ligula fairly long, aperture oxygonal. Ornamentation consisting of longitudinal ribs on both sides of conch.

Operculum triclavicate, strongly bent along its main furrows. Cardinal processes broad (exsag.) and short (tr.); central process broad (tr.) and dentate. Ornamentation predominantly of fine radial riblets.

Discussion: This genus is closely related to *Pauxillites* MAREK, 1966. While the ornamentation in the latter genus is reduced on the dorsal side only, the conch of *Recilites* bears the longitudinal ribs on both sides. In *Pauxillites* we meet always two longitudinal furrows, each located along the lateral margin of the internal mold of the ventral side; these are absent in *Recilites*.

The internal structure of the operculum is the same in both genera. The only important difference is the radial ornamentation in *Recilites*.

Occurrence: Ordovician (Caradoc), Bohemia.

Species: *R. solitarius* (BARRANDE, 1867), *R. aff. solitarius* (BARRANDE, 1867), *R. ? poeta* sp. n.



*Recilites solitarius* (BARRANDE, 1867)

Pl. VI, figs. 4-10, pl. VII, fig. 17, text-figs. 28, 29

1867 *Hyolithes solitarius* BARR.; J. BARRANDE, p. 92, pl. 13, figs. 34, 35.

1891 *Hyolithus solitarius* BARR.; O. NOVÁK, p. 24.

1893 *Hyolithus* (*H.*) *solitarius* BARR.; G. HOLM, p. 25.

1962 *Ambrolinevitus* ? *solitarius* (BARRANDE); V. A. SYSOEV, p. 44.

1963 *Hyolithes solitarius* BARR.; L. MAREK, p. 63, pl. 2.

Holotype: By monotypy, the specimen figured by J. BARRANDE (1867) on pl. 13, figs. 34, 35.  
NM ČD 1010.

Locus typicus: Zahořany near Králův Dvůr.

Stratum typicum: Zahořany Formation.

Material: In addition to the holotype, 18 mostly fragmentary internal molds of the conchs and about the same number of external molds; 21 internal and external molds of the operculum, one of them preserved in situ. One specimen preserved with displaced operculum and both appendages - this specimen is preserved in flattened condition in the shale, other material is undeformed in concretions.

Description: The conchs are slightly dorsally concave; their cross-section is low subtrigonal. W-h index = 2.0. Rounded lateral edges lie at about two-sixths of the height of the conch. The angle of divergence equals 11-14°. The aperture is slightly oxygonal; the ligula is moderately arched, attaining the length of about five-thirteenths of the apertural breadth. On the dorsal and ventral apertural margins of the internal mold, short (sag., exsag.) indentations are visible. Their total number corresponds with the number of ribs on the conch. On the ventral side, near the aperture is an elongated (tr.) muscle impression, composed probably of two fused shorter impressions.

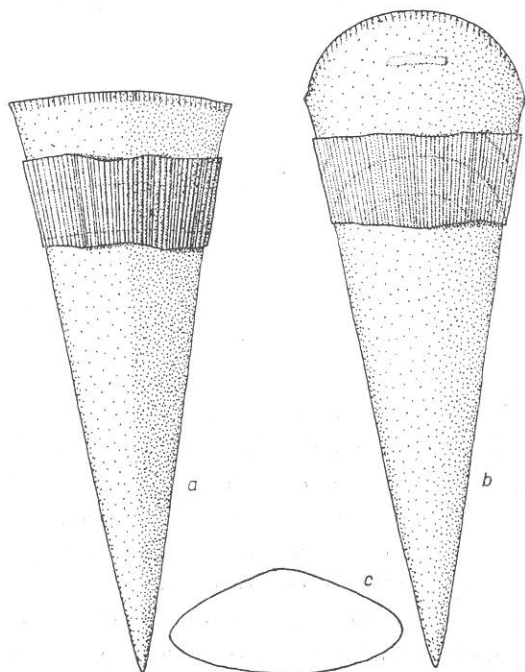
The dorsal and ventral side is ornamented with distinct rounded longitudinal ribs. They are more closely spaced on the ventral side, where they number about 16 per mm; their number on the dorsal side is about 11. The longitudinal ribs are combined with fine transverse furrows, subparallel to the apertural margin. Most of these furrows are inconspicuous, only few are more prominent.

The operculum is strongly bent along its main furrows; the angle of this bend is about 90°. The rooflets are indistinct. The cardinal shield is shorter (sag.) than the conical shield approximately at a ratio 1:4.

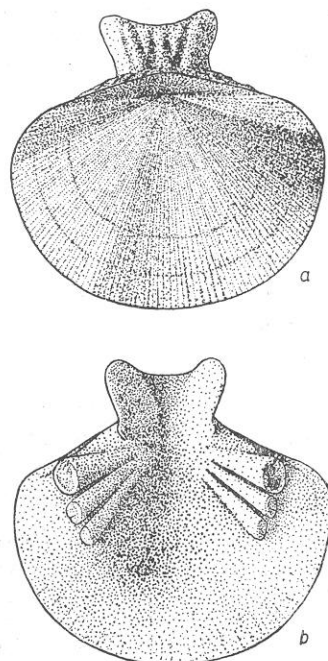
The ornamentation consists of fine radial riblets numbering about 15 per mm on the anterior margin.

The inner side of the operculum is characterized by three pairs of clavicles of suboval cross-section. The first pair is of the largest breadth while the other two pairs attain only half of it. The cardinal processes are ear-shaped and relatively broad (exsag.). They are fused posteriorly (towards the cardinal margin) so that they form one single formation with concave median part. The central process is broad (tr.) and low and has a shape of a trapezium with distinct and elongated (sag.) teeth. Prominent teeth are developed also on the cardinal shield. No traces of the muscle scars have been ascertained.

Dimensions of the holotype: Length – 20 mm, breadth of the aperture (compressed specimen) – 5.0 mm. This is also the maximal length of the conch yet known.



28. *Recilites solitarius* (BARR.), conch  
a — dorsal side; b — ventral side; c — cross-section, external mold



29. *Recilites solitarius* (BARR.), operculum  
a — external surface; b — internal surface

**Occurrence:** *Recilites solitarius* occurs sporadically in the Vinice Formation at the lonely house Vinice near Beroun, Knížkovice near Zdice etc. In the Zahořany formation this species is known from Zahořany, Loděnice (2), Praha-Libeň, Praha-Nový Hloubětín etc.

*Recilites* aff. *solitarius* (BARRANDE, 1867)  
Pl. VII, figs. 1–4

**Discussion:** In the uppermost parts of the Bohdalec Formation one specimen of the genus *Recilites* has been found, which shows close affinities with *R. solitarius* (BARR.). The younger specimen differs from this species in a smaller number of ribs on the ventral side. They number about 10–11 while in *R. solitarius* they are about 16 for the same length. The number of the ribs on the dorsal side is approximately the same in both species. In addition to this, the conch of *R. aff. solitarius* seems to be a little higher than that of *R. solitarius*.

Until other finds are made I consider the specimen under discussion as being closely related with *R. solitarius* but I hesitate to erect a separate species.

Occurrence: *Recilites* aff. *solitarius* (BARR.) is a rare species in the upper part of the Bohdalec Formation of Praha-Michle.

*Recilites? poeta* sp. n.

Pl. VII, figs. 5-9, text-fig. 30

Holotype: The specimen, figured here on pl. VII, fig. 6. LM. 44. Figured paratypes: LM 43, LM 45, LM 46, LM 47.

Locus typicus: Praha-Vysočany.

Stratum typicum: Zahořany Formation (argillaceous facies).

Material: In addition to the holotype, preserved as a pyritized internal mold, 8 more conchs and 4 opercula preserved as compressed composite molds in argillaceous shales.

Description: The conchs are straight of subtrigonal cross-section. The ventral side is only moderately convex; the lateral parts of the strongly inflated dorsal side join in the axial line forming an inexpressive yet conspicuous keel. W-h index = 1.47. The lateral edges are sharp, lying at about one-sixth of the height of the conch. The angle of divergence is 17-18°; the aperture is slightly oxygonal. The ligula is very short attaining about one-fourth of the apertural breadth. Several transverse rounded ridges, subparallel to the apertural margins are visible on the internal mold.

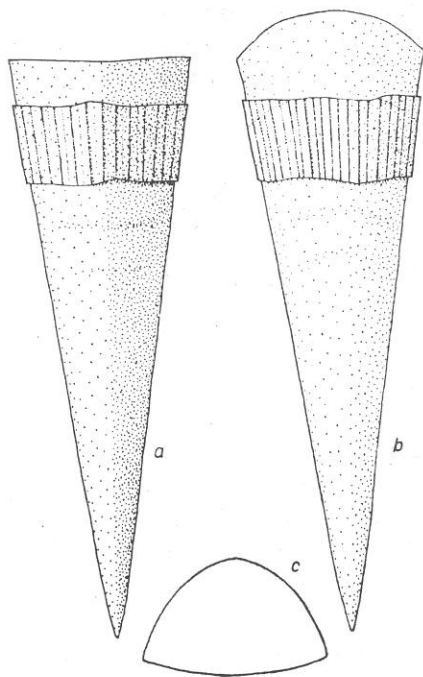
The ornamentation consists of longitudinal fine and inequidistant sharp ribs, spaced more closely on the ventral side; here they number about 5-8 per mm, on the dorsal side they are spaced 4-6 per mm.

The operculum which is broadly suboval, is known only after its outer surface. The number of clavicles is unknown - the mode of preservation allows only to surmise that they were several pairs, but not more than three.

The operculum is ornamented with radial riblets numbering about 9 per mm on its anterior margin.

Dimensions: The length of the conch attained at least 18 mm in the adult specimens.

Discussion: The radial ornamentation



30. *Recilites? poeta* sp. n., conch

a — dorsal side; b — ventral side; c — cross-section, internal mold

of the conch and of the operculum is one of the important features of the genus *Recilites* gen. n. Nevertheless, the knowledge of the internal structure of the operculum would be necessary for approving this opinion. This species differs from *R. solitarius* in having less numerous and narrower riblets. "*Hyolithes*" *subcrispatus* REED, 1911 is probably a related species differing in having equidistant ribs.

Occurrence: *Recilites* ? *poeta* sp. n. was ascertained in the upper argillaceous parts of the Zahořany Formation in Praha-Vysočany and in the Bohdalec Formation at Housina and Velká Chuchle.

### *Leolites* gen. n.

Type species: *Leolites cognatus* sp. n. Middle Ordovician (Caradoc, Zahořany Formation), Bohemia.

Diagnosis: Conchs small and straight, of low subtrigonal cross-section. Ventral side of internal mold with one pair of longitudinal furrows along its lateral margins. Ligula long, aperture oxygonal. Ornamentation of longitudinal ribs on dorsal side; ventral side with inconspicuous growth-lines.

Operculum with 12–15 radially arranged clavicles and narrow (sag.) cardinal shield. Ornamentation of coarsely spaced radial ribs.

Discussion: This new genus differs from *Pauxillites* MAREK and *Recilites* gen. n. in a larger number of clavicles. The ventral side of *Recilites* bears the longitudinal riblets while that of *Leolites* is almost smooth. The operculum of *Pauxillites* is ornamented with faint growth-lines only.

Occurrence: Ordovician (Caradoc—Ashgill), Bohemia.

Species: *L. cognatus* sp. n., *L. sp. n.* (undescribed species from the Králův Dvůr formation.

### *Leolites cognatus* sp. n.

Pl. VII, figs. 10–16, pl. VIII, figs. 1–3, text-fig. 31–34

Holotype: The specimen figured here on pl. VII, figs. 13, 14. LM 48. Figured paratypes: LM 49, LM 50, LM 51, LM 53, LM 57, LM 58.

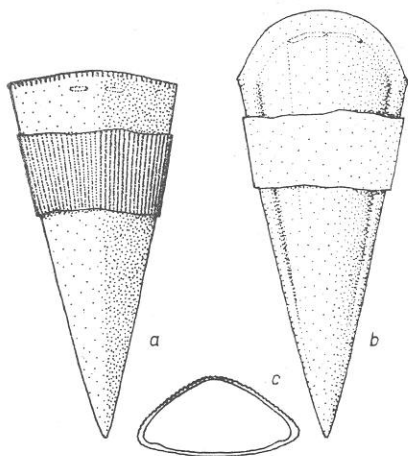
Locus typicus: Praha-Nový Hloubětín.

Stratum typicum: Zahořany Formation.

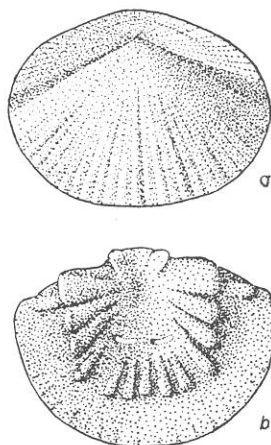
Material: In addition to the holotype, 34 incomplete internal, 23 external molds of the conch; 23 internal and external molds of the operculum, two of them in situ and one lying near the aperture with preserved displaced appendages. All specimens derived from concretions excepting three of them, preserved in argillaceous shales.

Description: The conchs are small and straight, of low-subtrigonal cross-section. The angle of divergence = 25–27°. The lateral edges, which are rounded, lie at about one-fourth of the height of the conch. The ventral side is moderately convex as well as the lateral parts of the dorsal side. The ligula is long, attaining more than one-half of the apertural breadth. The aperture is orthogonal, with its

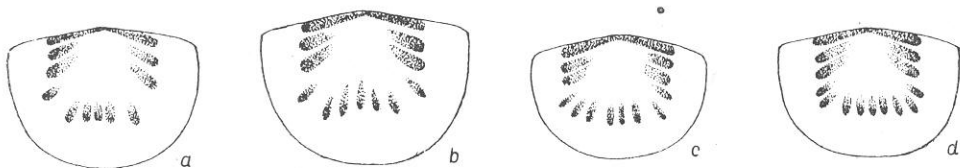
dorsal margin arched slightly forwards. Along the lateral margins of the ventral side of the internal mold run two distinct furrows, each on one side. Towards the aperture, these furrows bend inwards in a moderate arc and became shallower. Near the ventral apertural margin on well-preserved internal molds the arch-



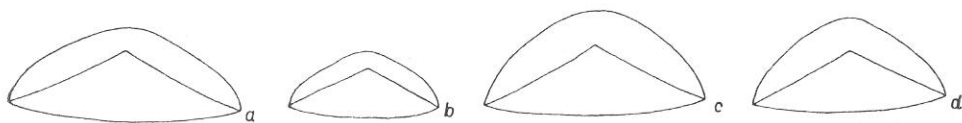
31. *Leolites cognatus* sp. n., conch  
a — dorsal side; b — ventral side; c — cross-section



32. *Leolites cognatus* sp. n., operculum  
a — external surface; b — internal surface



33. *Leolites cognatus* sp. n., variability in the number of additional clavicles on the operculum  
a — has six; b — seven; c — eight; d — nine clavicles



34. *Leolites cognatus* sp. n., two slightly different "forms", anterior views of the conchs with opercula in situ  
a, b — Praha - Nový Hloubětín; c, d — Loděnice (2) near Beroun

shaped narrow (sag.) and elongated (tr.) muscle scar is visible; evidently, it is composed of two fused scars. From the lateral margins of the scar towards the apex run two longitudinal lines representing the traces of the shift of this scar during the ontogeny. W-h index = 2.1. Along the dorsal apertural margin a row of short (sag.) indentations numbering 9–10 per mm is developed.

The dorsal side of the conch is ornamented with longitudinal, prominent rounded ribs of unequal breadth; they number 7–9 per mm. The interspaces are usually narrower than the ribs. The ventral side is smooth.

The operculum is polyclavicate. Three pairs of larger clavicles are always developed on its inner surface. In addition to them, 6–9 additional, smaller, radially arranged clavicles can be detected. The first pair (closest to the cardinal margin) is carinate and reaches almost to the lateral margins of the operculum. The cardinal processes are small; the central process is low and narrow (tr.) and carries 2–3 teeth. One pair of sickle-shaped adductor muscle scars can be detected on well-preserved opercula.

The ornamentation consists of relatively sparsely spaced rounded ribs arranged radially and of unequal prominence.

**Dimensions:** The largest known specimen attained at least 16.0 mm. The dimensions of one complete operculum: Breadth – 3.0 mm, length of the cardinal shield – 0.4 mm, length of the conical shield – 1.8 mm.

**Discussion:** In the upper parts of the Zahořany Formation at Loděnice (2) occur specimens differing slightly from those at other localities. Their conch is higher, w-h index equals 1.8. The cardinal shield of the operculum is longer and the additional clavicles are longer and narrower than those of other specimens. In my opinion, these differences are a token of a special environment and the specimens can not be taken for a separate species.

**Occurrence:** *Leolites cognatus* sp. n. is known from the Vinice Formation of Vráž near Beroun, and Praha-Vysočany. This species is fairly common in the Zahořany Formation: Praha-Nový Hloubětín, Praha-Libeň, Štěrboholy, Dubeč, Loděnice (2), Staňkovka near Radotín etc.

## Family uncertain

### *Chimerolites* gen. n.

Type species: *Chimerolites temperatus* sp. n. Middle Ordovician (Caradoc, Zahořany Formation), Bohemia.

**Diagnosis:** Conch of asymmetrically subelliptical cross-section; ornamentation of obscure growth-lines. Lateral edges rounded.

Polyclavicate operculum characterized by a large angle of angular bend. One pair of main broad (exsag.) clavicles, each composed of three fused clavicles, and two pairs of smaller accessory clavicles in the central part of operculum. Cardinal processes of flattened subelliptical cross-section; central process unknown. Surface with faint concentric growth-lines.

**Discussion:** By its polyclavicate operculum *Chimerolites* gen. n. resembles the representatives of *Pauxilitidae* fam. n., in which, however, fused clavicles have not been detected. The other features exclude this genus undoubtedly from the



family mentioned. The subelliptical cross-section of the conch and the absence of ornamentation is atypical for *Pauxillitidae*, characterized by the subtrigonal cross-section of the conchs, by the mostly sharp lateral edges and by the ornamentation, consisting of longitudinal ribs either on the dorsal or on both sides. The operculum of *Chimerolites* differs strikingly from the opercula of all known species of *Pauxillitidae* in having the cardinal shield inclined in its middle part at a very blunt angle to the conical shield; this causes necessarily a different type of the aperture. While in all representatives of the *Pauxillitidae* we meet the oxygonal aperture, the aperture of *Chimerolites* is probably amblygonal or at least orthogonal.

In my opinion, all these features would be sufficient for establishing a new family with the type genus *Chimerolites*, but new material and more detailed knowledge on the phylogeny of *Hyolithida*s desirable. Until then I left this genus provisorily within the family *Pauxillitidae*.

Occurrence: Ordovician (Caradoc), Bohemia.

Species: *Ch. temperatus* sp. n.

*Chimerolites temperatus* sp. n.

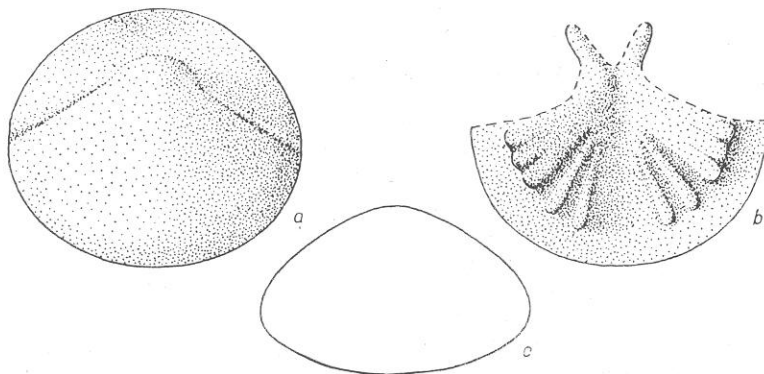
Pl. VIII, figs. 4-7, text-fig. 35

Holotype: The specimen, figured here on pl. VIII, figs. 4-7, text-fig. 35. LM 52.

Locus typicus: Řevnice.

Stratum typicum: Zahořany Formation.

Material: Only the holotype as internal and external molds in concretion is available.



35. *Chimerolites temperatus* sp. n., holotype

*a, b* — operculum: *a* — external surface, *b* — incomplete internal surface; *c* — cross-section of conch (external mold)

Description: The conch is of roundedly subtrigonal cross-section; w-h index = approx. 1.6. The strongly rounded lateral edges lie approx. at two-fifth of the height of the conch. The angle of divergence is unmeasurable owing to the incomplete preservation of the conch; it can only be estimated at 20-25°. The ligula was most probably long, but is not preserved in the holotype.

The surface of the conch bears no traces of ornamentation of growth-lines. The operculum has a strongly convex conical shield. The central part of the cardinal shield is flat, the angular bend is very obtuse. The rooflets are extraordinary narrow, the main furrows diverge at about  $95^\circ$ . The surface carries only obscure concentric growth-lines.

The interior of the operculum is characterized by one pair of broad main trilobate clavicles, each composed evidently of three fused clavicles. Closer to the anterior margin of the operculum lie two pairs of small, elongated accessory clavicles. The shape and the length of the cardinal processes are imperfectly known, their cross-section is somewhat flattened, subelliptical. It was not possible to prove the existence of the central process.

Dimensions of the operculum: breadth – approx. 2.6 mm, length – 2.0 mm.

Occurrence: *Chimerolites temperatus* sp. n. is known from the Zahořany Formation from the locality Řevnice.

Order *Orthothecida* MAREK, 1966

Family *Orthothecidae* SYSOEV, 1957

*Nephrotheca* MAREK, 1966

Type species: *Orthotheca sarkaensis* NOVÁK, 1891. Original designation of L. MAREK (1966, p. 91), Middle Ordovician (Llanvirn, Šárka Formation), Bohemia.

*Nephrotheca housina* sp. n.

Pl. VIII, figs. 8–10, text-fig. 36

Holotype: The specimen figured here on pl. VIII, fig. 9. LM 55. Figured paratype: LM 54.

Locus typicus: Housina near Neumětely.

Stratum typicum: Bohdalec Formation.

Material: Including the holotype, 21 conchs and 9 opercula preserved as flattened composite molds in dark-grey argillaceous shales.

Description: The conch is probably straight, its cross-section can be estimated only from the shape of the operculum. It was probably broadly heart-shaped. The ventral side is concave, w-h index = 1.3. The aperture seems to lie in a plane perpendicular to the longitudinal axis. The angle of divergence =  $13^\circ$  to  $15^\circ$ .

The ornamentation of the ventral side consists of faintly marked longitudinal riblets, numbering approx. 12 per mm. The dorsal side is probably smooth.

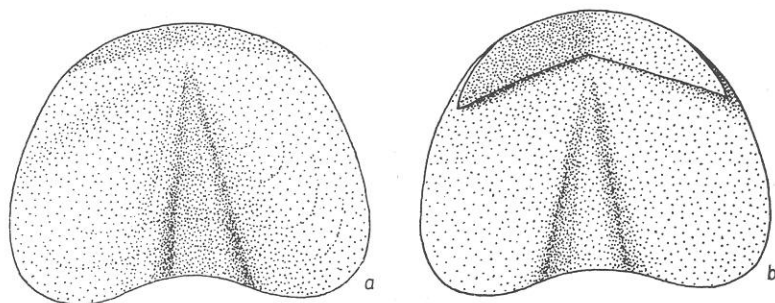
The operculum is heart-shaped, with the apex close to the dorsal margin. The folds diverge at about  $20^\circ$ . The surface is marked with sparsely spaced obscure concentric riblets. The cardinal part, represented by a very elongated (tr.) sub-trigonal area is slightly inclined toward the remaining part of the operculum. The cardinal processes are considerably elongated (tr.), reaching almost to the

lateral margins of the operculum. The anterior margins of the processes are ankylosed to the operculum along their whole length.

Dimensions: The longest known conch measures 24.5 mm.

Dimensions of two complete opercula:

length	3.5	2.9
width	4.6	3.8



36. *Nephrotheca housina* sp. n., operculum  
a — external surface; b — internal surface

Discussion: *Nephrotheca housina* sp. n. differs from the related species *N. sarkaensis* (NOVÁK) in its bigger size, in the w-h index, in the greater number of ribs. The operculum of the new species is longer and differs also in the shape.

Occurrence: *Nephrotheca housina* sp. n. is fairly abundant in the shales of the Bohdalec Formation at Housina.

*Nephrotheca ? paupera* sp. n.

Pl. VIII, figs. 11, 12, text-fig. 37

Holotype: The specimen figured here on pl. VIII, figs. 11, 12, text-fig. 37. LM 56.

Locus typicus: Zdice.

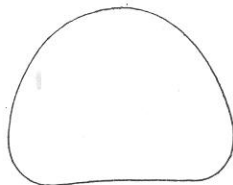
Stratum typicum: Vinice Formation.

Material: Only the holotype, represented by incomplete internal and external molds. The specimen is preserved in iron ore and underformed by pressure.

Description: The conch is straight, its cross-section roundedly sub-trigonal, with a slightly concave ventral side. The broadly rounded lateral edges are situated at about one sixth of the height of the conch. W-h index = 1.4, angle of divergence about 10°. The ventral apertural margin seems to be straight, the shape of the dorsal one is unknown. From the course of the growth-lines it may be assumed that the aperture was slightly oblique, the dorsal margin lying somewhat behind the ventral one.

The ornamentation of the ventral side consists of faintly

37. *Nephrotheca ? paupera* sp. n., holotype, cross-section of conch, internal mold



marked fine longitudinal riblets, inconspicuous and wider-spaced (about 8 per mm) in the axial part, more conspicuous and closer-spaced (about 16 per mm) at the lateral margins. The dorsal side had probably the same ornamentation.

Dimensions: The length of the complete conch attained more than 25 mm. The width of the conch near the aperture – 6.8 mm, the height – 4.8 mm.

Discussion: As the operculum of this species is unknown, I hesitate to place it with certainty in the genus *Nephrotheca*, though the features of the conch are otherwise characteristic of this genus.

The most closely related species is *N. ? housina* sp. n., from which the new species differs in having a less concave ventral side, a smaller angle of divergence, and a different density of riblets.

Occurrence: *Nephrotheca ? paupera* sp. n. was found in the iron ore on the base of the Vinice Formation, in the mine "Hrouda" near Zdice.

*Nephrotheca ? dubecensis* sp. n.

Pl. IX, figs. 1-3, text-fig. 38

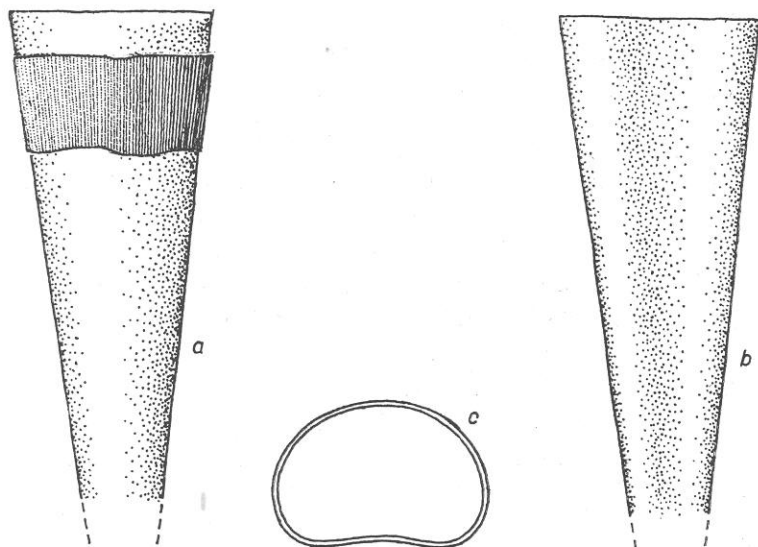
Holotype: The specimen figured here on pl. IX, figs. 1-3, text-fig. 38. LM 60.

Locus typicus: Dubeč near Praha.

Stratum typicum: Zahořany Formation.

Material: Internal and external mold of the conch (holotype), preserved in concretion.

Description: The conch is straight, with an angle of divergence of about 12°. The cross-section is kidney-shaped, the ventral side moderately concave, the dorsal side strongly convex. W-h index = 1.5. The strongly rounded lateral edges are



38. *Nephrotheca ? dubecensis* sp. n., holotype, idealized conch  
a — dorsal side; b — ventral side; c — cross-section

situated at about two-fifths of the height of the conch. The exact shape of the aperture is unknown.

The ornamentation was ascertained only on the dorsal side. It is represented by very fine, almost invisible longitudinal riblets, more than 20 per mm.

Dimensions of the holotype: Length of the fragmentary conch – 8.0 mm, width of the aperture – 3.6 mm, height of the aperture – 2.5 mm.

Discussion: This species differs from the other representatives of Ordovician *Orthothecidae* in its w-h index and the very closely-spaced ornamentation. All the features of the conch agree with those of *Nephrotheca*; nevertheless, as the operculum is missing, the generic assignment of this species has still to be solved.

Occurrence: *Nephrotheca* ? *dubecensis* sp. n. is known from the Zahořany Formation at Dubeč.

### *Panitheca* gen. n.

Type species: *Panitheca collector* sp. n., Middle Ordovician (Caradoc, Zahořany), Bohemia.

Diagnosis: Conch straight, long, roundedly sub-trigonal in cross-section, ventral side concave. Lateral edges low-lying. The ornamentation of both sides consists of thin and high, undulated, closely-spaced riblets.

Operculum roundedly sub-trigonal and broad. One pair of broad (exsag.) cardinal processes with ridge-like extremities.

Discussion: The type of the operculum and the cross-section of the conch resemble the genus *Nephrotheca*. The main differentiating feature is the presence of high undulated costellae in *Panitheca*. This type of ornamentation is common in subquadrate *Orthothecidae*, in Ordovician *Circotheca* (see *Circotheca hofensis* (BARR., 1868), and also in some *Hyolithidae*. The other difference between *Panitheca* and *Nephrotheca* is in the shape of the cardinal processes. While in *Nephrotheca* these processes reach almost the lateral margins of the operculum, they are shorter (tr.) in *Panitheca* and have ridge-like distal ends. In my opinion, both genera compared are closely related.

Occurrence: Ordovician (Caradoc), Bohemia.

Species: *P. collector* sp. n.

### *Panitheca collector* sp. n.

Pl. IX, figs. 4–13, text-figs. 39, 40

Derivatio nominis: Name chosen in honour of the collectors who worked for J. Barrande.

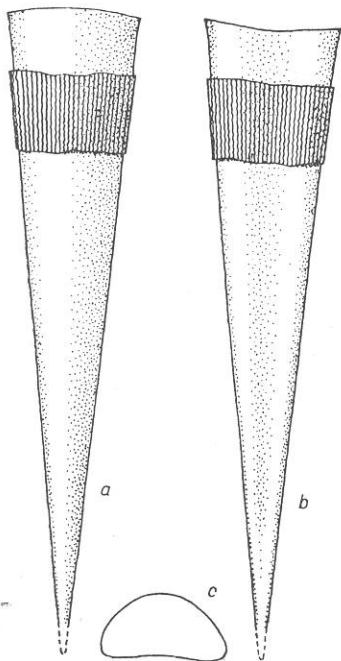
Holotype: The specimen, figured here on pl. IX, figs. 4, 5. LM 65. Figured paratypes: LM 61, LM 62, LM 64, LM 59, LM 72.

Locus typicus: Loděnice (2) near Beroun.

Stratum typicum: Zahořany Formation.

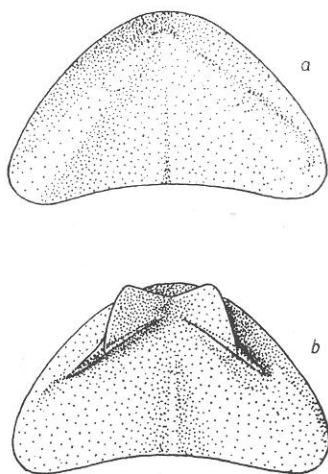
Material: In addition to the holotype, 24 incomplete internal molds and a slightly higher number of external molds of the conch; one internal and four external molds of the operculum. The material is partly undeformed in concretions, partly flattened in argillaceous shales.

Description: The conch is straight, with a roundedly subtrigonal cross-section and a slightly concave ventral side. The lateral edges lie at one-seventh or one-eighth of the height of the conch, w-h index = 1.6. The angle of divergence is about 12°. The dorsal apertural margin is straight, the ventral is distinctly arched backwards. In one specimen a special internal structure has been observed that might have represented the fillings of the digestive tubes and glands (see p. 69 of this paper).



39. *Panitheca collector* sp. n., conch

a — dorsal side; b — ventral side;  
c — cross-section, external mold



40. *Panitheca collector* sp. n., operculum

a — external surface; b — internal surface

The ornamentation on both sides consists of hair-like, high and undulated longitudinal riblets, numbering about 10 per mm at the aperture of adult specimens. The interspaces are flat.

The operculum has a roundedly subtrigonal shape with an inward arched baseline. The cardinal part is very narrow (sag., exsag.) and slightly inclined upwards. The almost inconspicuous folds are very narrow too. The central part of the operculum is moderately convex. There is a pair of distinct vaults running from the apex along the lateral sides of the operculum, diverging at about 90°.

The ornamentation consists of fine concentric not too prominent rounded riblets.



The interior of the operculum is characterized by one pair of broadly diverging cardinal processes, extending rapidly towards their distal ends. The anterior margins of the processes are ankylosed to the operculum. They run out into ridge-like processes, standing perpendicularly to the internal surface of the operculum.

Dimensions: The conch of adult specimens attained at least a length of 25 mm.

Dimensions of the holotype:

width at the aperture — 5.1

height at the aperture — 3.0

Dimensions of two opercula:

width        4.9        4.5

length      2.8        2.3

Occurrence: *Panitheca collector* sp. n. is fairly abundant in the upper argillaceous parts of the Zahořany Formation: Praha-Vysočany and Loděnice (2). One specimen was obtained from the siltstones of the upper part of this formation at Staňkovka near Radotín. This species also occurs in the upper parts of the Bohdalec Formation of Praha-Michle.

### *Brevitheca* gen. n.

Type species: *Brevitheca minimax* sp. n.

Diagnosis: Conch dorsally convex, unusually short for an orthothecid. Dorsal apertural margin overlaps the ventral one. Cross-section kidney-shaped, ventral side slightly concave. The ornamentation consists of distinct transverse rounded riblets.

Operculum unknown.

Discussion: The short and broad conch and the distinct transverse ornamentation distinguishes this genus from the other genera and representatives within the order *Orthothecida*.

Occurrence: Ordovician (Caradoc), Bohemia.

Species: *B. minimax* sp. n.

### *Brevitheca minimax* sp. n.

Holotype: The specimen, figured here on pl. X, figs. 9–11, text-fig. 41. LM 78.

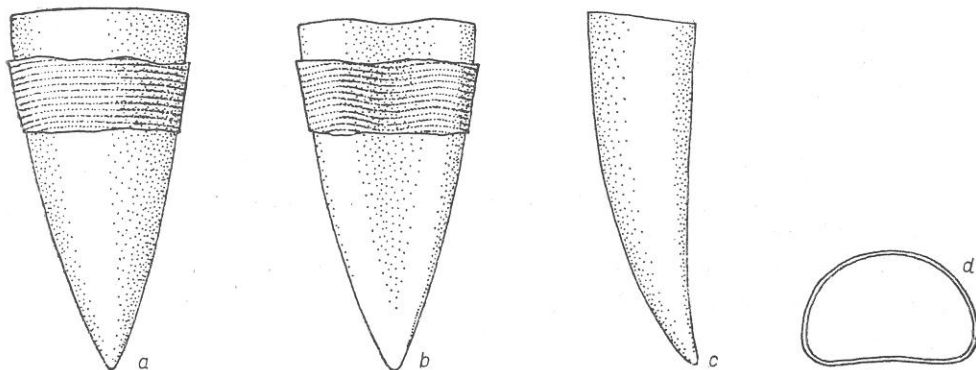
Locus typicus: Štěrboholy near Praha.

Stratum typicum: Zahořany Formation.

Material: Only one conch (holotype), represented in a concretion by an internal and external mold.

Description: The relatively short and broad conch tapers rapidly towards the apex. From the dorsal view, the lateral edges are not straight and the apical angle is larger than the angle of divergence which is 15–20°. The conch is distinctly dorsally convex. It is not sure whether this feature represents just a deviation or

whether it is typical of this species. The cross-section is kidney-shaped, the strongly rounded lateral edges lie at about four-fifth of the height of the conch. W-h index = about 25°. The ventral apertural margin is moderately arched backwards in its medium part; its lateral parts, on the contrary, are slightly arched forwards. The dorsal apertural margin is almost straight, only its lateral parts are bent moderately backwards.



41. *Brevitheca minimax* sp. n., conch  
a — dorsal side; b — ventral side; c — lateral view; d — cross-section

The ornamentation consists of relatively coarse rounded transverse ribs, subparallel to the apertural margin. They number about 11 per mm on both sides. The ribs are broader (sag.) than the interspaces.

Occurrence: *Brevitheca minimax* sp. n. was ascertained in the Zahofany Formation at one locality only: Štěrboholy near Praha.

#### *Quadrotheca* SYSOEV, 1958

Type species: *Hyolithes (Orthotheca) quadrangularis* HOLM, 1893.

Discussion: V. A. Sysoev establishing the diagnosis of his genus *Quadrotheca* used undoubtedly the features of two species: *Q. quadrangularis* (HOLM, 1893) and *Q. clinisepta* SYSOEV, 1960. In my opinion, the second species may be a representative of another genus and the diagnosis of the genus *Quadrotheca* ought to be modified. Unfortunately, both original species of G. Holm are probably lost, and I had no possibility to re-study them. According to Holm's description and figures, this genus is characterized by straight conchs of subrectangular cross-section. In cross-section the walls of the conch are thickened in all four corners. The edges of the internal mold are comparatively more rounded than those of the external mold. The ornamentation consists of prominent longitudinal riblets. The operculum of the type species is unknown.

Finds of new specimens (conch and operculum) are necessary for establishing an accurate diagnosis of the genus *Quadrotheca*.

*Quadrotheca* ? *rediviva* sp. n.

Pl. X, figs. 1-8, text-figs. 42, 43

1957 *Bactrotheca* n. sp.; P. RÖHLICH, p. 00.

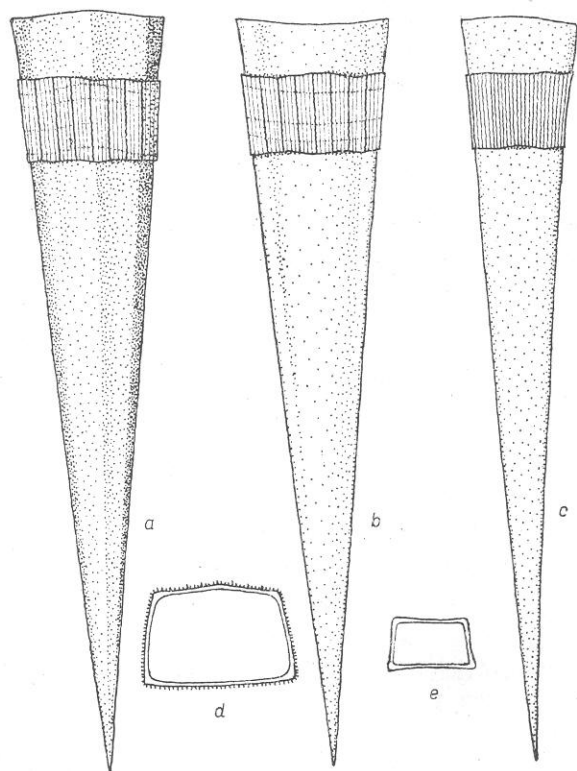
Holotype: The specimen, figured here on pl. X, fig. 1-3. LM 73. Figured paratypes: LM 74, LM 75, LM 76, LM 77.

Locus typicus: Loděnice (2) near Beroun.

Stratum typicum: Zahořany Formation.

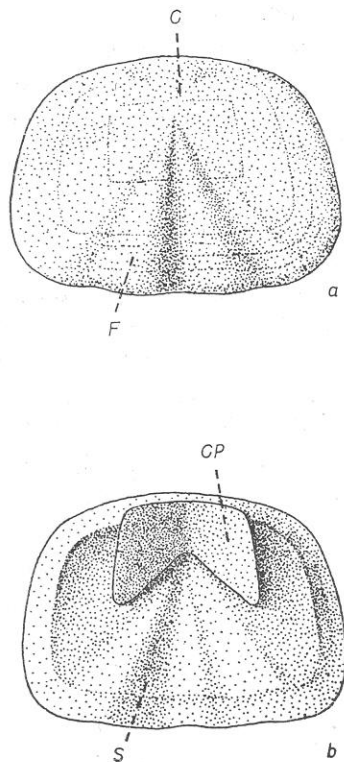
Material: In addition to the holotype, several tens of internal and external molds of conch and 11 internal and 5 external molds of opercula. Material is preserved for the greater part in concretions and is underformed by pressure.

Description: The conch is straight and long; the angle of divergence is about  $12^\circ$ . The ventral and dorsal side, the latter being represented by three planes divided by sharp edges, form a subtrapezohedral cross-section of the conch. All



42. *Quadrotheca* ? *rediviva* sp. n., conch

a — dorsal side; b — ventral side; c — lateral view; d — cross-section near aperture; e — cross-section of young specimen, external mold



43. *Quadrotheca* ? *rediviva* sp. n., operculum

a — external surface; b — internal surface; C — dorsal part; F — fold; S — sulcus; CP — cardinal process

four sides are slightly inflated in the adult part of the conch and slightly concave in its younger portion. The lateral edges lie almost at the level of the ventral side. W-h index = 1.5. The dorsal apertural margin is slightly arched forwards, the ventral one is arched moderately backwards. The lateral view of the conch shows that the lateral apertural margin is arched anteriorly.

The ornamentation of both ventral and dorsal side consists of thin and high undulated costellae, spaced about 11–15 per mm on the dorsal, about 11 per mm on the ventral side. Usually, every fourth costella is higher and obviously thicker than the other. The interspaces are flat.

The shape of the operculum is subtrapezohedral with rounded corners. The folds are distinct and relatively broad (tr.) and the furrows separating them from the other part of the operculum diverge at about 55°.

The ornamentation consists of distinct concentric growth-lines (thin furrows), irregularly spaced.

The interior of the operculum bears one pair of broadly diverging cardinal processes, extending rapidly towards their distal ends and towards the ventral margin of the operculum. Along the opercular margins runs a distinct ridge which is most prominent along the dorsal margin of the operculum.

Dimensions: The maximal length of an adult conch attained at least 35 mm. Dimensions of some opercula:

Width	5.7	5.5	4.2	3.7
Length	4.0	3.9	3.0	2.8

Discussion: From the reason mentioned in the discussion of the genus *Quadrotheca*, the generic assignment of the new species is a little doubtful. The ornamentation of the conch and the type of the operculum resemble those of *Bactrotheca teres* (BARR., 1867) from the Šárka and Dobrotivá Formations (Llanvirn and Llandeilo) of Bohemia. The main differences between these two species are in the cross-section of the conch and the shape of the operculum, which in *B. teres* are distinctly more rounded. The question concerning the relations of *Bactrotheca* and *Quadrotheca* remains still open. It is interesting that Sysoev never mentioned *Bactrotheca* NOVÁK, 1891 in his papers and did not give any reason, why he has put *B. teres*, the type species of *Bactrotheca* to *Orthotheca* NOVÁK, 1886.

Occurrence: *Quadrotheca ? rediviva* sp. n. is a fairly abundant species in the upper argillaceous parts of the Zahořany Formation of Praha-Vysočany and Loděnice (2). One specimen also was obtained from Řevnice. It occurs also in the upper parts of the Bohdalec Formation of Praha-Michle and in the oolitic horizon on the base of this formation at Dolní Počernice (P. RÖHLICH 1957).

K tisku doporučil R. Horný

Geologický ústav ČSAV, Praha

## References

- BARRANDE J. (1847): Pugiunculus, ein fossiles Pteropoden-Geschlecht. — Neues Jb. Mineral. Geogn. Geol., 554–558. Stuttgart.
- (1867): Système Silurien du centre de la Bohême, 3, 1–179. Praha – Paris.
- FISHER D. W. (1962): Small conoidal shells of uncertain affinities. In: Treatise on invertebrate paleontology, part W. — Univ. Kansas Press & Geol. soc. Amer., 98–143. Lawrence–New York.
- HAVLÍČEK V. - VANĚK J. (1966): The Biostratigraphy of the Ordovician of Bohemia. — Sbor. geol. věd, P 8, 7–69. Praha.
- HEDSTRÖM H. (1930): Mobergella versus Discinella; Paterella versus Scapha & Archaeophiala. — Sverig. geol. unders., Årsbok, 23 (1929), 7, Avhandlingar, C, 362, 1–8. Stockholm.
- HOLM G. (1893): Sveriges Kambrisk-Silurska Hyolithidae och Conulariidae. — Sverig. geol. unders., Avhandlingar, C, 112, 1–172. Stockholm.
- HORNÝ R. (1964): Phragmothea Barrande, 1867 is a Pelecypod (Bivalvia). — Čas. Nár. muz., odd. přírodov., 133, 2, 107–108. Praha.
- MAREK L. (1963): New Knowledge on the Morphology of Hyolithes. — Sbor. geol. věd, P 1, 53–73. Praha.
- (1966): New Hyolithid Genera from the Ordovician of Bohemia. — Čas. Nár. muz., odd. přírodov., 135, 2, 89–92. Praha.
- MAREK L. - YOCHELSON E. L. (1964): Paleozoic Mollusk: Hyolithes. — Science, 146, 3652, 1674–1675. Washington.
- MATTHEW G. F. (1886): Illustrations of the fauna of the St. John Group, No. 3, descriptions of new genera and species. — Trans. Roy. soc. Can., 3, 4, 29–84. Ottawa.
- (1901): Hyolithes gracilis and related forms from the Lower Cambrian of the St. John Group. — Trans. Roy. soc. Can., 7, 4, 109–111. Ottawa.
- MCALISTER A. L. (1962): Mode of preservation in early paleozoic Pelecypods and its morphologic and ecologic significance. — J. paleont., 36, 1, 69–73. Menasha.
- NOVÁK O. (1886): Zur Kenntnis der Fauna der Etage F–fl in der paläozoischen Schichtengruppe Böhmens. — S. B. Böhm. Ges. Wiss., 1–27. Praha.
- (1891): Revision der paläozoischen Hyolithiden Böhmens. — Abh. Böhm. Ges. Wiss., 7, 4, 1–48. Praha.
- POULSEN V. (1963): Notes on Hyolithellus Billings, 1871, Class Pogonophora Johansson, 1937. — Biol. Medd. Kong. Dan. Vidensk. Selsk., 23, 12, 1–15. København.
- REED F. R. C. (1911): Lower Palaeozoic Hyolithidae from Girvan. — Trans. Roy. soc. Edinburgh, 47, 2 (1909–10), 203–222. London.
- RÖHLICH P. (1957): Stratigraphy and Facies of the Bodalec Beds (Upper Caradoc of Central Bohemia). — Sbor. Ústř. úst. geol., 23, geol. 2, 373–439. Praha.
- SAITO K. (1936): Older Cambrian Brachiopoda, Gastropoda, etc. from North-western Korea. — J. Fac. sci. univ. Tokyo, 2, 4, 3, 360–367. Tokyo.
- SINCLAIR G. W. (1946): Notes on the Nomenclature of Hyolithes. — J. paleont., 20, 1, 72–85. Menasha.
- SYSOEV V. A. (СЫСОВ В. А.) (1957): K morfologii, sistematicheskomu polozeniyu i sistematike khiolotov. — Dokl. Akad. nauk SSSR, 116, 2, 304–37. Moskva.
- (1958): Superorder Hyolithoidea. In: Osnovy paleontologii, spravochnik dlya paleontologov i geologov SSSR, Molljuskigolovonogie II, 184–190. Moskva.
- (1959a): Ekologija khiolotov. — Dokl. Akad. nauk SSSR, 127, 4, 892–895. Moskva.
- (1959b): Sistematika khiolotov. — Dokl. Akad. nauk SSSR, 125, 2, 397–400. Moskva.
- (1960): Mikrostruktura rakoviny khiolotov i ich sistematicheskoe znachenie. — Dokl. Akad. nauk SSSR, 131, 5, 00–000. Moskva.
- (1962): Khiolity kembrija severnogo sklona Aldanskogo shchita. — Akad. nauk SSSR, 1–64. Moskva.

four sides are slightly inflated in the adult part of the conch and slightly concave in its younger portion. The lateral edges lie almost at the level of the ventral side. W-h index = 1.5. The dorsal apertural margin is slightly arched forwards, the ventral one is arched moderately backwards. The lateral view of the conch shows that the lateral apertural margin is arched anteriorly.

The ornamentation of both ventral and dorsal side consists of thin and high undulated costellae, spaced about 11–15 per mm on the dorsal, about 11 per mm on the ventral side. Usually, every fourth costella is higher and obviously thicker than the other. The interspaces are flat.

The shape of the operculum is subtrapezohedral with rounded corners. The folds are distinct and relatively broad (tr.) and the furrows separating them from the other part of the operculum diverge at about 55°.

The ornamentation consists of distinct concentric growth-lines (thin furrows), irregularly spaced.

The interior of the operculum bears one pair of broadly diverging cardinal processes, extending rapidly towards their distal ends and towards the ventral margin of the operculum. Along the opercular margins runs a distinct ridge which is most prominent along the dorsal margin of the operculum.

**Dimensions:** The maximal length of an adult conch attained at least 35 mm. Dimensions of some opercula:

Width	5.7	5.5	4.2	3.7
Length	4.0	3.9	3.0	2.8

**Discussion:** From the reason mentioned in the discussion of the genus *Quadrotheca*, the generic assignment of the new species is a little doubtful. The ornamentation of the conch and the type of the operculum resemble those of *Bactrotheca teres* (BARR., 1867) from the Šárka and Dobrotivá Formations (Llanvirn and Llandeilo) of Bohemia. The main differences between these two species are in the cross-section of the conch and the shape of the operculum, which in *B. teres* are distinctly more rounded. The question concerning the relations of *Bactrotheca* and *Quadrotheca* remains still open. It is interesting that Sysoev never mentioned *Bactrotheca* NOVÁK, 1891 in his papers and did not give any reason, why he has put *B. teres*, the type species of *Bactrotheca* to *Orthotheca* NOVÁK, 1886.

**Occurrence:** *Quadrotheca ? rediviva* sp. n. is a fairly abundant species in the upper argillaceous parts of the Zahořany Formation of Praha-Vysočany and Loděnice (2). One specimen also was obtained from Řevnice. It occurs also in the upper parts of the Bohdalec Formation of Praha-Michle and in the oolitic horizon on the base of this formation at Dolní Počernice (P. RÖHLICH 1957).

*K tisku doporučil R. Horný*

*Geologický ústav ČSAV, Praha*



## References

- BARRANDE J. (1847): *Pugiunculus*, ein fossiles Pteropoden-Geschlecht. — *Neues Jb. Mineral. Geogn. Geol.*, 554–558. Stuttgart.
- (1867): *Système Silurien du centre de la Bohême*, 3, 1–179. Praha – Paris.
- FISHER D. W. (1962): Small conoidal shells of uncertain affinities. *In: Treatise on invertebrate paleontology*, part W. — Univ. Kansas Press & Geol. soc. Amer., 98–143. Lawrence–New York.
- HAVLÍČEK V. – VANĚK J. (1966): The Biostratigraphy of the Ordovician of Bohemia. — *Sbor. geol. věd*, P 8, 7–69. Praha.
- HEDSTRÖM H. (1930): *Mobergella* versus *Discinella*; *Paterella* versus *Scapha* & *Archaeophiala*. — *Sverig. geol. unders.*, Årsbok, 23 (1929), 7, *Avhandlingar*, C, 362, 1–8. Stockholm.
- HOLM G. (1893): *Sveriges Kambrisk-Silurska Hyolithidae och Conulariidae*. — *Sverig. geol. unders.*, *Avhandlingar*, C, 112, 1–172. Stockholm.
- HORNÝ R. (1964): *Phragmotheca* Barrande, 1867 is a Pelecypod (*Bivalvia*). — *Čas. Nár. muz.*, odd. přírodov., 133, 2, 107–108. Praha.
- MAREK L. (1963): New Knowledge on the Morphology of *Hyolithes*. — *Sbor. geol. věd*, P 1, 53–73. Praha.
- (1966): New *Hyolithid* Genera from the Ordovician of Bohemia. — *Čas. Nár. muz.*, odd. přírodov., 135, 2, 89–92. Praha.
- MAREK L. – YOCHELSON E. L. (1964): Paleozoic Mollusk: *Hyolithes*. — *Science*, 146, 3652, 1674 – 1675. Washington.
- MATTHEW G. F. (1886): Illustrations of the fauna of the St. John Group, No. 3, descriptions of new genera and species. — *Trans. Roy. soc. Can.*, 3, 4, 29–84. Ottawa.
- (1901): *Hyolithes gracilis* and related forms from the Lower Cambrian of the St. John Group. — *Trans. Roy. soc. Can.*, 7, 4, 109–111. Ottawa.
- MCALISTER A. L. (1962): Mode of preservation in early paleozoic Pelecypods and its morphologic and ecologic significance. — *J. paleont.*, 36, 1, 69–73. Menasha.
- NOVÁK O. (1886): Zur Kenntnis der Fauna der Etage F–fl in der paläozoischen Schichtengruppe Böhmens. — *S. B. Böhm. Ges. Wiss.*, 1–27. Praha.
- (1891): Revision der paläozoischen *Hyolithiden* Böhmens. — *Abh. Böhm. Ges. Wiss.*, 7, 4, 1–48. Praha.
- POULSEN V. (1963): Notes on *Hyolithellus* Billings, 1871, Class Pogonophora Johannson, 1937. — *Biol. Medd. Kong. Dan. Vidensk. Selsk.*, 23, 12, 1–15. København.
- REED F. R. C. (1911): Lower Palaeozoic *Hyolithidae* from Girvan. — *Trans. Roy. soc. Edinburgh*, 47, 2 (1909–10), 203–222. London.
- RÖHLICH P. (1957): Stratigraphy and Facies of the Bodalec Beds (Upper Caradoc of Central Bohemia). — *Sbor. Ústř. úst. geol.*, 23, geol. 2, 373–439. Praha.
- SAITO K. (1936): Older Cambrian Brachiopoda, Gastropoda, etc. from North-western Korea. — *J. Fac. sci. univ. Tokyo*, 2, 4, 3, 360–367. Tokyo.
- SINCLAIR G. W. (1946): Notes on the Nomenclature of *Hyolithes*. — *J. paleont.*, 20, 1, 72–85. Menasha.
- SYSOEV V. A. (СЫСОВЕВ В. А.) (1957): K morfologii, sistematicheskomu polozeniyu i sistematike khiolitov. — *Dokl. Akad. nauk SSSR*, 116, 2, 304–37. Moskva.
- (1958): Superorder *Hyolithoidea*. *In: Osnovy paleontologii, spravochnik dlya paleontologov i geologov SSSR, Molluskigolovonogie II*, 184–190. Moskva.
- (1959a): Ekologia khiolitov. — *Dokl. Akad. nauk SSSR*, 127, 4, 892–895. Moskva.
- (1959b): Sistematika khiolitov. — *Dokl. Akad. nauk SSSR*, 125, 2, 397–400. Moskva.
- (1960): Mikrostruktura rakoviny khiolitov i ich sistematicheskoe znachenie. — *Dokl. Akad. nauk SSSR*, 131, 5, 00–000. Moskva.
- (1962): *Khiolity kembrija severnogo sklona Aldanskogo shchita*. — *Akad. nauk SSSR*, 1–64. Moskva.

- ŠNAJDR M. (1956): The Trilobites from the Drabov and Letná Beds of the Ordovician of Bohemia. — Sbor. Ústř. úst. geol., 22, paleont., 447–533. Praha.
- ŠULC J. (1925): Faunistické seznamy z Barrandienu. III. Strašnice–vozovka. — Čas. Nár. muz., 99, 36–38. Praha.
- THORAL M. (1935): Contribution à l'étude paléontologique de l'Ordovician inférieur de la Montagne Noire et révision sommaire de la faune cambrienne de la Montagne Noire. 1–362. Montpellier.
- YOCHELSON E. L. (1961a): The Operculum and the Mode of Life of Hyolithes. — J. paleont., 35, 1, 152–161. Menasha.
- (1961b): Notes on the Class Coniconchia. — J. paleont., 35, 1, 162–167. Menasha.
- ŽELÍZKO J. V. (1900): Ueber einem neuen Fossilienfundort im mittelböhmischem Untersilur. — Verh. Geol. Reichsanst. 3, 85–93. Wien.

### Explanation of plates

All the specimens have been whitened with ammonium chloride. All photographs are by the authors and are unretouched.

LM — collection of the Geological Institute of the Czechoslovakian Academy of Sciences, Praha.

NM — collections of the National Museum (Natural History Museum), Praha.

#### Pl. I

*Elegantilites elegans* (BARRANDE, 1847)

1. operculum of gerontic specimen; internal mold, × 3. Zahořany Formation, Loděnice (2) near Beroun. LM 5.
- 2, 3. operculum; 2 — internal mold, 3 — latex cast of external mold, × 4. Zahořany Formation, Dubeč near Praha. LM 6.
4. ornamentation of shell, lectotype (ad orig. J.BARRANDE, 1867, pl. 11, fig. 14–18), × 4.3. Zahořany Formation, Loděnice near Beroun. NM ČD 1009.
5. septum; external mold showing concentric growth-lines, × 4. Zahořany Formation, Praha-Nový Hloubětín. LM 7.

*Elegantilites ? magister* (BARRANDE, 1867)

6. dorsal side of conch; internal mold with partially preserved shell, × 2.2. Zahořany Formation, Praha-Nový Hloubětín. LM 8.
7. ventral side of conch; same specimen as 6, latex cast of external mold, × 2.2. Zahořany Formation, Praha-Nový Hloubětín. LM 8.

*Elegantilites ? aff. magister* (BARRANDE, 1867)

8. incomplete conch; internal mold of dorsal side, × 1.8. Bohdalec Formation, Praha-Motol, Bílý Beránek. LM 9.

#### Pl. II

*Joachimilites novaki* sp. n.

1. operculum; latex cast of external mold, × 4. Zahořany Formation, Dubeč near Praha. LM 10.
2. operculum; internal mold, × 5. Zahořany Formation, Praha-Nový Hloubětín. LM 11
3. operculum; latex cast of internal mold, × 4. Zahořany Formation, Dubeč near Praha. LM 12.
4. ornamentation of conch; external mold, × 8. Zahořany Formation, Praha-Nový Hloubětín. LM 18.
- 5, 6. holotype, conch, latex casts of external mold; 5 — ventral side; 6 — dorsal side, × 3. Zahořany Formation, Dubeč near Praha. LM 17.

*Elegantilites ? tigris* sp. n.

- 7, 8. holotype, latex casts of conch; 7 — dorsal side of external mold; 8 — ventral side of external mold, × 4. Zahořany Formation, Loděnice (2) near Beroun. LM 13.

P. III

*Joachimilites modestus* sp. n.

- 1–3. holotype, incomplete conch; 1 — ventral side, latex cast of external mold; 2 — dorsal side of internal mold with a pair of muscle scars behind the aperture; 3 — ventral side of internal mold, × 4. Zahořany Formation, Praha-Nový Hloubětín. LM 14.
- 4, 5. operculum; 4 — internal mold; 5 — latex cast of internal mold, × 4. Zahořany Formation, Praha-Nový Hloubětín. LM 15.
6. operculum, the same specimen as 4,5; latex cast of external mold, × 6. Zahořany Formation, Praha-Nový Hloubětín. LM 16.
7. operculum; internal mold, × 6. Zahořany Formation, Praha-Nový Hloubětín. LM 19.
- Joachimilites havlíčeki* sp. n.
- 8, 9. holotype, fragmentary conch with remainder of shell; 8 — dorsal side; 9 — ventral side, × 5. Bohdalec Formation, Praha-Michle. LM 22.
10. incomplete conch; dorsal side of internal mold, × 4.2. Bohdalec Formation, Praha-Michle. LM 21.
- 11, 12. operculum; 11 — latex cast of internal mold; 12 — latex cast of external mold, × 6, × 7. Bohdalec Formation, Praha-Michle. LM 20.

Pl. IV.

*Joachimilites ? potator* sp. n.

- 1–3. holotype, incomplete conch; 1 — dorsal side, latex cast of external mold; 2 — ventral side, ditto; 3 — dorsal side of internal mold, × 4. Zahořany Formation, Loděnice (2) near Beroun. LM 23.

*Eumorpholites boučeki* sp. n.

4. dorsal side of conch; latex cast of external mold, × 4. Zahořany Formation, Praha-Nový Hloubětín. LM 25.
5. holotype, ventral side of conch; internal mold, × 4.1. Zahořany Formation, Praha-Nový Hloubětín. LM 27.
6. incomplete conch with operculum in situ; latex cast of external mold, × 7. Zahořany Formation, Praha-Nový Hloubětín. LM 24.
- 7, 8. operculum; 7 — latex cast of internal mold; 8 — internal mold, × 7. Zahořany Formation, Praha-Libeň. LM 26.

*Eumorpholites crudus* sp. n.

9. holotype, operculum; latex cast of internal mold, × 10. Libeň Formation, Praha-Motol. LM 36.

Pl. V

*Eumorpholites ? tectus* sp. n.

1. holotype, incomplete conch; internal mold of dorsal side, × 8. Vinice Formation, Praha-Vysočany (Pleschner's brickyard). LM 28.
2. conch; latex cast of dorsal side of external mold, × 8. Vinice Formation, Praha-Vysočany. LM 29.

*Gompholites striatulus* (BARRANDE, 1847)

3. ornamentation of conch; latex cast of external mold, × 6. Zahořany Formation, Štěrboholy near Praha. LM 30.
4. operculum; latex cast of external mold, × 5. Zahořany Formation, Praha-Nový Hloubětín. LM 31.

5. incomplete conch with operculum and one appendage in situ; latex cast of external mold (orig. MAREK et YOCHELSON, 1964, fig. 1), × 4. Zahořany Formation, Praha-Nový Hloubětín. LM 32.
6. the same operculum; internal mold, × 4. Zahořany Formation, Praha-Nový Hloubětín. LM 32.
- 7, 8. operculum; 7 — latex cast of internal mold; 8 — internal mold, × 4. Zahořany Formation, Praha-Nový Hloubětín. LM 33.  
*Carinolites ? tantulus* sp. n.
- 9, 10. holotype, conch, latex casts of external mold; 9 — dorsal side; 10 — ventral side, × 9. Libeň Formation, Praha-Motol. LM 34.
11. conch; latex cast of dorsal side of external mold, × 11. Libeň Formation, Praha-Motol. LM 35.

#### Pl. VI

*Sololites ferrigenus* sp. n.

- 1-3. holotype, conch; 1 — dorsal side, latex cast of external mold; 2 — dorsal side of internal mold; 3 — ventral side of the same specimen, × 4. Vinice Formation (iron ore on its basis), Chrusterice. NM 6850.  
*Recilites solitarius* (BARRANDE, 1867)
- 4, 5. conch; latex casts of external mold; 4 — ventral side; 5 — dorsal side, × 4. Zahořany Formation, Loděnice (2) near Beroun. LM 37.
- 6, 7. conch, internal mold; 6 — dorsal side; 7 — ventral side, × 5.4. Zahořany Formation, Loděnice (2) near Beroun. LM 39.
8. operculum; internal mold, × 6.5. Zahořany Formation, Loděnice (2) near Beroun. LM 40.
9. operculum; latex cast of external mold, × 9. Zahořany Formation, Loděnice (2) near Beroun. LM 38.
10. operculum; latex cast of external mold, showing incomplete cardinal processes and central process, × 8. Zahořany Formation, Loděnice (2) near Beroun. LM 41.

#### Pl. VII

*Recilites* aff. *solitarius* (BARRANDE, 1867)

- 1-4. conch; 1 — dorsal side, latex cast of external mold; 2 — ventral side, ditto; 3 — ventral side of internal mold; 4 — dorsal side of internal mold, × 5.5. Bohdalec Formation, Praha-Michle. LM 42.  
*Recilites ? poeta* sp. n.
5. conch; composite mold of dorsal side, × 4.3. Bohdalec Formation, Housina. LM 43.
6. holotype, conch; composite mold of ventral side, × 4.3. Bohdalec Formation, Housina. LM 44.
7. conch; internal mold, dorsal side with partly preserved ornamentation, × 4.6. Zahořany Formation, Praha-Vysočany. LM 45.
8. operculum; composite mold with outer surface predominantly preserved, × 5. Zahořany Formation, Praha-Vysočany. LM 47.
9. operculum; composite mold (latex cast of the negative), × 5. Zahořany Formation, Praha-Vysočany. LM 46.  
*Leolites cognatus* sp. n.
- 10, 11. conch, latex casts of external molds; 10 — dorsal side; 11 — ventral side, × 5.5. Zahořany Formation, Praha-Nový Hloubětín. LM 50.
12. conch; ventral side of internal mold, × 5.3. Zahořany Formation, Praha-Nový Hloubětín. LM 49.

- 13, 14. holotype, conch; 13 — dorsal side of internal mold; 14 — ventral side of internal mold. Zahořany Formation, Praha-Nový Hloubětín. LM 48.
15. operculum; internal mold, × 8. Vinice Formation, Vráž near Beroun. LM 53.
16. operculum; latex cast of external mold showing central process, × 9. Zahořany Formation, Loděnice (2) near Beroun. LM 51.  
*Recilites solitarius* (BARRANDE, 1867)
17. operculum; latex cast of internal mold, × 6.5. Zahořany Formation, Loděnice (2) near Beroun. The same operculum as on pl. VI, fig. 8. LM 40.

#### Pl. VIII

##### *Leolites cognatus* sp. n.

- 1, 2. operculum; 1 — latex cast of internal mold; 2 — internal mold, × 8.2. Zahořany Formation, Praha-Nový Hloubětín. LM 58.
3. operculum; latex cast of internal mold, × 8.5. Zahořany Formation, Loděnice (2) near Beroun. LM 57.

##### *Chimerolites temperatus* sp. n.

4. holotype, conch with somewhat displaced operculum; latex cast of external mold, × 7. Zahořany Formation, Řevnice. LM 52.
- 5-7. operculum of the same specimen; 5 — latex cast of external mold; 6 — latex cast of internal mold; 7 — internal mold, × 11. Zahořany Formation, Řevnice. LM 52.

##### *Nephrotheca housina* sp. n.

8. operculum; composite mold, × 6.5. Bohdalec Formation, Housina. LM 54.
9. holotype, conch; composite mold, × 4. Bohdalec Formation, Housina. LM 55.
10. ditto, showing details of ornamentation, × 10. LM 55.
- 11, 12. holotype, incomplete conch; 11 — dorsal side of internal mold; 12. — ventral side of internal mold, × 4. Vinice Formation, "Hrouda" near Zdice. LM 56.

#### Pl. IX

##### *Nephrotheca ? dubecensis* sp. n.

- 1-3. holotype, conch; 1 — dorsal side of internal mold; 2 — ventral side of internal mold; 3 — dorsal side of external mold, latex cast, × 5.5. Zahořany Formation, Dubeč near Praha. LM 60
- Panitheca collector* sp. n.
- 4, 5. holotype, conch; 4 — dorsal side of internal mold; 5 — ventral side of internal mold, × 4. Zahořany Formation, Loděnice (2) near Beroun. LM 65.
6. incomplete conch with operculum in situ; latex cast of external mold, antero-ventral view, × 8.5. Zahořany Formation, Loděnice (2) near Beroun. LM 61.
7. operculum; external mold, × 7.5. Zahořany Formation, Loděnice (2) near Beroun. LM 63.
8. operculum; external mold, × 7.5. Zahořany Formation, Loděnice (2) near Beroun. LM 62.
9. operculum; latex cast of internal mold, × 7.5. Zahořany Formation, Loděnice (2) near Beroun. LM 64.
- 10-12. conch; 10 — ventral side of internal mold; 11 — external mold of ventral side; 12 — dorsal side of internal mold, × 4. Zahořany Formation, oolitic horizon of Vysočany, Praha-Nový Hloubětín. LM 72.
13. fillings of digestive glands ?, × 8. Zahořany Formation, Loděnice (2) near Beroun. LM 59.

#### Pl. X

##### *Quadrotheca ? rediviva* sp. n.

- 1-3. holotype, conch; 1 — external mold of dorsal side, latex cast; 2 — dorsal side of internal mold; 3 — ditto, lateral view, × 4. Zahořany Formation, Loděnice (2) near Beroun. LM 73.

4. conch; external mold of ventral side, × 4. Zahořany Formation, Loděnice (2) near Beroun. LM 74.
5. operculum in situ; latex cast of external mold, × 6.5. Zahořany Formation, Loděnice (2) near Beroun. LM 75.
6. operculum; external surface with preserved shell, × 6. Zahořany Formation, oolitic horizon of Vysočany, Praha-Nový Hloubětín. LM 76.
- 7, 8. operculum; 7 — latex cast of internal mold; 8 — internal mold, × 7. Zahořany Formation, Loděnice (2) near Beroun. LM 77.  
*Brevitheca minimax* sp. n.
- 9–11. holotype, conch; 9 — latex cast of external mold of dorsal side; 10 — latex cast of external mold of ventral side; 11 — dorsal side of internal mold, × 7.3. Zahořany Formation, Štěrboholy near Praha. LM 78.



