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THE ORDOVICIAN HYOLITHS OF ANTI-ATLAS (MOROCCO)

INTRODUCTION

This paper contributes to the knowledge of the Ordovician Hyolitha in the Mediterranean Province. From this province only hyoliths from the Bohemian Ordovician are considerably well known (BARRANDE 1867, NOVÁK 1891, ZÁZVORKA 1928 and MAREK 1966, 1967, 1974), whereas those in the other countries have been collected and described only occasionally (BARRANDE 1868, THORAL 1935, MAILLIEUX 1939, SDZUY 1955).

During years of work in the Anti-Atlas of Morocco, J. Destombes gathered an extensive collection of Ordovician fossils and kindly lent me the hyolith material for study. Although this material was not very abundant, it was possible to make a generic assignment of some species (MAREK 1976a). It appeared that the Moroccan hyolith fauna was closely related to that of Bohemia. However, some genera (*Cavernolites*, *Elegantilites*, *Gompholites*, *Pauxillites*) occurred earlier in Morocco.

The results of the study confirmed the present systematic concept of Ordovician Hyolitha, both on the generic and specific levels.

I am much indebted to Dr. Jacques Destombes of the Geological Service of Morocco for enabling me to examine his material.

THE STRATIGRAPHICAL RANGE OF THE HYOLITH GENERA IN MOROCCO

DESTOMBES (1962, 1963, 1968) divided the Moroccan Ordovician into eight stratigraphical units, which can be correlated with the British and Bohemian series respectively from Tremadoc up to Ashgill.

The oldest Moroccan Ordovician hyoliths come from the Lower Fezouata Formation (Upper Tremadoc), in which the genera *Cavernolites* and *Elegantilites* have been recognized.

The Upper Fezouata Formation (Lower Arenig) yielded *Cavernolites*, *Pauxillites* and most probably also *Gamalites* and *Gompholites*. Most of the material from this stratigraphical level is unfavourably preserved.

The nodules from the Tachilla Formation (Llanvirn) contain fairly abundant specimens of *Elegantilites*, *Pauxillites* also appears, but unfrequently.

In the sandstones of the First Bani Group, corresponding to Llandeilo, hyoliths seem to be scarce. Only poorly preserved specimens of *Gompholites* and probably *Elegantilites* have been found in this mostly psamitic series.

The Lower Ktaoua Formation (Caradoc) is rich in hyoliths and the following genera occur: *Neprotheca*, *Panitheca*, *Leolites* and possibly *Elegantilites*, *Sololites* and *Joachimilites*.

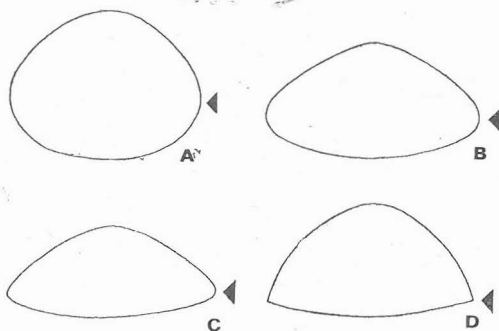
In the Upper Ktaoua Formation (Ashgill) only *Elegantilites* has been identified, but this genus seems to occur frequently at this stratigraphical level.

When comparing the stratigraphical range of single genera from Morocco with those of Bohemia, we notice certain differences. This is the case especially for the time span Arenig-Llanvirn. In the Bohemian Ordovician, hyoliths appear as a significant part of the faunal assemblage for the first time in the Llanvirn, but their occurrence in the Arenig is very limited both in the number of species and specimens. Some genera are known from Bohemia not before the Llanvirn, but appear earlier in Morocco: *Cavernolites* and *Elegantilites* in the Tremadoc, *Neprotheca* and *Pauxillites* in the Arenig.

REMARKS ON MORPHOLOGY AND TERMINOLOGY

The English terminology introduced by MAREK (1963, 1966, 1967) is used in this paper and some terms are new.

The shape of the cross-section of the conch is one of the most important features for distinguishing species, when the material is undeformed. Recently, changes of this shape during ontogeny were demonstrated both in Orthotecida and Hyolithida. The first observation was published by MAREK (1967, p. 70, fig. 9, p. 105, fig. 42) using *Elegantilites elegans* and *Quadrotheca? rediviva*. SYSSOIEV (1972) published in-



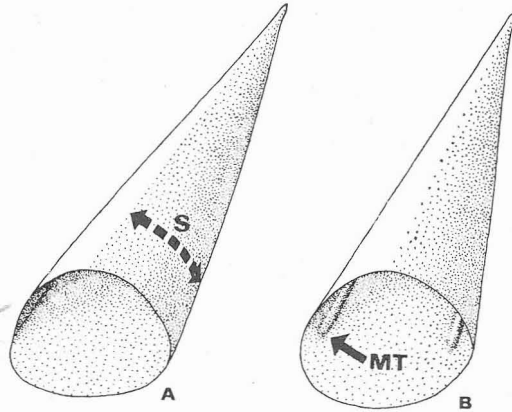
1. Cross-sections of hyolithid conchs showing different shapes of lateral edges. A-strongly rounded, B-rounded, C-roundedly sharp, D-sharp.

structive examples of continuous change in the cross-section in some Lower Cambrian orthothecids. On the current systematic concept of hyoliths, particularly at the specific level, every different growth-stage of the conch could be considered a different species on the basis of its cross-section. To avoid possible confusions, it is recommended to figure at least three cross-sections of every species, one near the apical region, the other in its middle part and the third close to the aperture. It can be presumed, from all hitherto known examples, that the apical part itself had a circular cross-section in all hyoliths [MAREK 1976b, DZIK 1978].

A new term is used to express the outline of the conch in lateral view. Straight conchs are here called orthocone.

To refine the description of the dorsal side of the conch a new term slope is proposed. The slope is the area representing a longitudinal half of the dorsal side, limited by the longitudinal axis (the line connecting the highest points of the dorsum) of the conch on one side and by the lateral edge on the other side.

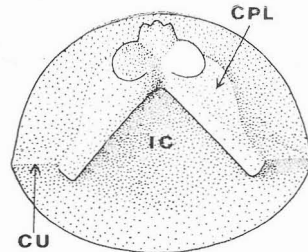
2. Schematized reconstruction of two hyolithid conchs. — A - *Elegantilites*; B - *Pauxillites*. S - slope; MT - ventro-lateral muscle track



In most species of *Pauxillitidae* paired longitudinal ridges are developed on the ventral internal side close to the lateral edges. These ridges are mostly observable only on the internal moulds or steinkerns, where they have the appearance of longitudinal grooves. MAREK and YOCHELSON (1976) interpreted them as places of attachment of body retractor muscles. I feel it justifiable to propose also a special term for these structures, regardless of their real function; the name ventro-lateral muscle tracks is used herein.

New terms are also coined here for some morphological structures on the internal side of the opercula. The first one is proposed for elongated elevations adjacent to the clavicles and separated from the remaining part of the cardinal area by a more or less sharp border edge. Their central parts are usually concave. These structures are called clavicular platforms. They attain their maximum width (exsag.) approximately in the middle of their length; their width decreases from here adaxially (i. e. toward the axis of symmetry of the operculum) and the platforms finally join the bases of the cardinal processes. The border edges approach abaxially the clavicles which they join either about in their middle or as far as at their distal ends.

3. New terms used in the descriptions of the internal morphology of operculum. CU - culmen; IC - interclavicular concavity; CPL - clavicular platform



From here, a short ridge runs toward the lateral margin of operculum. This ridge, called here culmen (pl. culmina), divides the cardinal area from the concave area (interclavicular concavity) which is bordered by the clavicles and the anterior (ventral) margin of the operculum. It corresponds to the main furrow on the external surface of the operculum.

MODE OF PRESERVATION

The Moroccan material is preserved in decalcified nodules, shales and in silty, more or less sandy carbonates. The hyoliths in nodules lack the shell and only internal and external moulds remain, which, however, is advantageous for study. The shell is always preserved in the specimens from carbonatic rocks, while the shales offer only compressed composite moulds which make it impossible to observe the cross-section of the conch and its internal surface.

Local stratigraphy Species	Lower Fezouata	Upper Fezouata	Tachilla	Premier Bani	Lower Ktaoua	Upper Ktaoua
Nephrotheca gaiziana sp. n.					○	
Nephrotheca destombesi sp. n.					○	
Nephrotheca ? sp. n.		○				
Panitheca sp.					○	
Cavernolites senex sp. n.		○				
Cavernolites sp. n.	○					
Elegantilites hejarensis sp. n.			○			
Elegantilites aff. benignensis (Nov.)			○			
Elegantilites ? formosus sp. n.						○
Elegantilites sp. A	○					
Elegantilites sp. B						○
Elegantilites sp. C						○
Elegantilites sp. D					○	
Elegantilites sp. E					○	
Elegantilites ? sp. F				○		
Joachimilites ? orphanus sp. n.					○	
Sololites ? clausus sp. n.					○	
Gamalites ? sp.		○				
Gompholites cf. cinctus (BARR.)			○			
Gompholites sp. A		○				
Gompholites sp. B				○		
Gompholites sp. C					○	
Gompholites sp. D					○	
Gompholites sp. E					○	
Pauxillites pauxillus meridionalis subsp. n.			○			
Pauxillites sp. n.		○				
Leolites sp.					○	
„Hyolithes“ orthothecoides sp. n.					○	
Standard stratigraphy	Tremadoc	Arenig	Llanvirn	Llandello	Caradoc	Ashgill

DESCRIPTIVE PART

Class *Hyolitha* MAREK, 1963
Order *Orthothecida* MAREK, 1966
Orthothecidae SYSSOIEV, 1957
Neprotheca MAREK, 1966

Type species: *Orthotheca sarkaensis* NOVÁK, 1891; Ordovician (Llanvirn, Šárka Formation), Bohemia.

Neprotheca gaiziana sp. n.

Pl. I, figs. 4—7, text-fig. 4

Holotype: Internal mould of a conch, figured here on pl. I, figs. 4, 5. NM-S 2113.

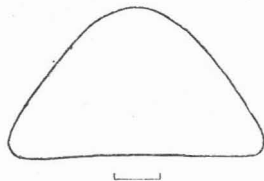
Locus typicus: Jbel Gaiz (N of Alnif).

Stratum typicum: Formation de Ktaoua (Upper Caradoc).

Material: In addition to the holotype, two incomplete external moulds of the ventral side.

Description: The fragmentary holotype shows that the conch was moderately dorsally convex; it is difficult to say, whether this is a specific feature of irregularity of growth. The cross-section is subtriangular, the ventral side is only very slightly concave, strongly inflated dorsal side has moderately convex slopes. Lateral edges are rounded and lie close to the basis of the conch. The w/h index is 1.7. The angle of divergence changes on the internal mould; it attains about 21 degrees close to the aperture, while 3.5 mm from apertural margin it is reduced to only 8 degrees. However, from the course of longitudinal riblets in the other two specimens it can be presumed that the change of the angle reflects only the change of the thickness of the shell-wall in the apertural part.

4. *Neprotheca gaiziana* sp. n., cross-section of conch, external mould. Bar scale 1.0 mm. (Same scale holds for all the other figures)



The external surface of the ventral side is ornamented with fine low longitudinal riblets, which amount 11 per mm near the aperture. Nothing can be told about the sculpture of the dorsal side, the riblets were either much less marked or were absolutely absent.

The operculum has not yet been found.

Dimensions: The width of the internal mould (steinkern) at the aperture — 5,2 mm. The length of a mature conch would certainly exceed 20 mm.

Discussion: Apart from the dorsally convex bending of the conch the almost triangular cross-section of this species distinguishes it from all other Ordovician orthothecids. Only the Swedish *Decoritheca excavata* (HOLM, 1893) has a similar cross-section in the median part of the conch, but its surface is almost smooth with very fine growth-lines only. Moreover, this species derives from the Middle Cambrian. I range the

species described to *Nephrotheca* because of the presence of longitudinal sculptation.

Occurrence: *Nephrotheca gaiziana* sp. n. was found in the Lower Ktaoua Formation (Caradoc), Jbel Gaiz, N of Alnif, locality 134.

Nephrotheca ? destombesi sp. n.

Pl. I, figs. 1—3, text-fig. 5 NM-S 2112.

Derivatio nominis: Dedicated to Dr. Jacques Destombes, who deals with the Ordovician trilobites and stratigraphy of Morocco.

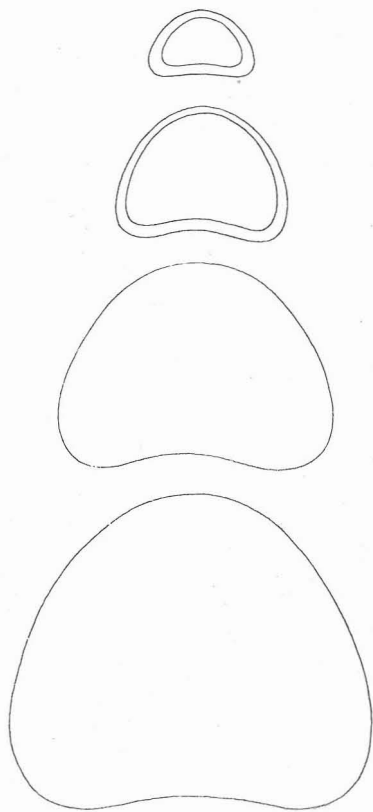
Holotype: Incomplete conch with preserved aperture, figured on pl. 1, figs. 1—3.

Locus typicus: Jbel Gaiz, N of Alnif.

Stratum typicum: Lower Ktaoua Formation (Upper Caradoc).

Material: Including the holotype, 6 incomplete conchs, well preserved and undeformed in pelocarbonate.

Description: The conch is orthocone, relatively high; the dorsal side is strongly inflated, ventral side is distinctly concave. Lateral edges are strongly rounded. The shape of the cross-section changed during the ontogeny and the height of the conch gradually increased toward the aperture (see text-fig. 5). The w/h index is 1.5—1.6 near the apex, 1.35 in the median part of the conch and 1.1. close to the aperture. The conch



5. *Nephrotheca ? destombesi* sp. n., cross-sections showing the changes of the conch during the ontogeny, external mould

is here almost as high as broad. In the lateral view a funnel-like expansion of the dorsal part of the aperture is well visible. The lateral apertural margins are inclined downwards and slightly forwards and gently abapically arcuate. The ventral margin of the aperture is slightly posteriorly arcuate. The angle of divergence amounts to 10—14 degrees. On one steinkern two inexpressive ridges run parallel with ventral apertural margin. The shell wall attains its maximum thickness on the ventral side.

The surface of the conch bears only fine growth-lines.

The operculum is unknown.

Dimensions: Length of the holotype — 19.7 mm, width of the aperture — 7.8 mm, height of the aperture — 7.0. The length of adult conch exceeded 28 mm.

Discussion: The species described resembles *Neprotheca? paupera* MAREK, 1967 by the cross-section and size of its conch. The surface of the Bohemian species, however, is ornamented with fine longitudinal riblets, which are missing in *N.? destombesi* sp. n. The ventral side of the Moroccan species is more concave. A certain resemblance exists to *Semielliptotheca rosmara* (HOLM, 1893), the aperture of which, however, is inclined downwards and backwards. Because the type species of *Neprotheca*, *N. sarkaensis* (NOVÁK, 1891) is ornamented with longitudinal elements, the new species lacking this ornamentation is matched here with *Neprotheca* with certain doubts. The find of an operculum would clarify the problem.

Occurrence: *Neprotheca? destombesi* sp. n. was ascertained in the Lower Ktaoua Formation (Upper Caradoc), Jbel Gaiz, N of Alnif, locality 134.

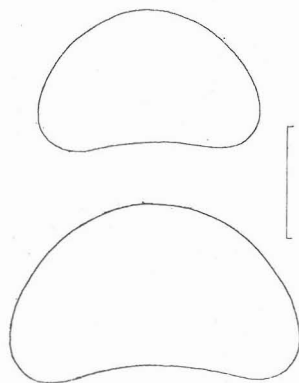
Neprotheca? sp. n.

Pl. I, figs. 8, 9, text-fig. 6

Material: A dozen of mostly incomplete external moulds and 2 incomplete internal moulds, preserved more or less undeformed in nodules.

Description: The conchs are straight with the dorsal side regularly inflated, the ventral side is distinctly concave. The dept of the concavity amounts to one ninth to one tenth height of the conch. The cross-

6. *Neprotheca? sp. n.*, two cross sections of conch, internal mould



-section did not remain the same during the growth, the concavity becomes more shallow toward the apex. In about one third length of the conch, the depth of the concave depression amounts only to one fifteenth height of the shell. The w/h index is about 1.8, the lateral edges are strongly rounded and line at about one fourth height of the conch. The angle of divergence attains 13—16 degrees. The shape of the aperture is imperfectly known except of the ventral apertural margin, which is straight.

The surface of the conch is smooth, without any visible riblets or growth-lines.

The operculum is unknown.

Dimensions: The length of adult specimen is estimated for over 10 mm.

Discussion: All known species of *Nephrotheca* from the Bohemian Ordovician bear longitudinal riblets which are not developed in the described species, which is therefore attributed to *Nephrotheca* with certain doubts.

Occurrence: *Nephrotheca*? sp. n. occurs in the Lower Fezouata Formation (Lower Arenig) at Jbel el-Khannfra, locality 983.

Panitheca MAREK, 1967

Type species: *Panitheca collector* MAREK, 1967; Ordovician (Berounian, Zahořany Formation), Bohemia.

Panitheca sp.

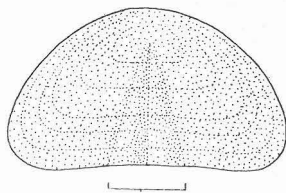
Pl. I, figs. 10—12, text-fig. 7

Material: 3 fragments of the internal moulds, 3 fragments of the external moulds of the conch and a part of the external mould of an operculum.

Description: The material is too fragmentary and does not enable to give a detailed description. We do not know whether the conch is orthocone or dorso-ventrally curved. Its cross-section is roundedly subtriangular, w/h index = 1.7. The ventral side is flat or only very slightly concave, the dorsal side is strongly regularly inflated. The lateral edges are rounded. The shape of the aperture is imperfectly known. The ventral apertural margin is slightly adapically arcuate. The angle of divergence could be measured only on one poorly preserved specimen and it attains approx. 13 degrees.

The surface is ornamented on both sides with thin, comparatively high and undulated longitudinal costellae, numbering 13—15 per mm. Transverse sculpture consists of indistinct growth-lines.

The incomplete operculum is reconstructed on the text-figure 7. The



7. *Panitheca* sp., reconstruction of operculum

plicae are narrow; the furrow separating one plica from the other is clearly visible; on the other hand, the plicae are indistinctly separated from the remaining surface of the operculum. Its outline is almost identical with the shape of the cross-section of the conch.

The surface of the operculum bears only densely spaced unsharp growth-lines.

Dimensions: The width of the operculum was estimated for 4.2—4.4 mm. The minimum length of the conch — about 21 mm was also estimated from the fragmentary material.

Discussion: The specimens described can only be compared with the type species of *Panitheca*, *P. collector* MAREK, 1967. It is clear, in spite of unfavourable preservation of the Moroccan species, that the two species are not identical. *P. collector* has distinctly less densely spaced costellae (about 10 per mm), its ventral side is apparently concave and the plicae on the operculum are much more broader. Nevertheless, I do not feel justified in naming it formally as such until better preserved material is found.

Occurrence: *Panitheca* sp. is known from the Ktaoua Formation (Upper Caradoc), Jbel Ahchach, locality 1813.

Order *Hyolithida* SYSSOIEV, 1957
Hyolithidae NICHOLSON, 1872

Cavernolites MAREK, 1974

Type species: *Hyolithes giganteus* NOVÁK, 1891; Ordovician (Llanvirn), Bohemia.
Cavernolites senex sp. n.

Pl. II, figs 1—6

Holotype: The conch figured on pl. II, fig. 1. NM-S 2117.

Locus typicus: Zagora bou-Dhir.

Stratum typicum: Upper Fezouata Formation (lower part), (Lower Arenig).

Material: In addition to the holotype, 4 incomplete conchs and 4 opercula, one of which is preserved as internal mould, the other as composite moulds.

Description: The conchs attain a large size. Owing to the pressure deformation it was possible to estimate the shape of their cross-section only from the outline of the operculum and from one undeformed external mould of the ventral side of the conch. According to it, the cross-section of the conch was suboval with the ventral side less inflated than the dorsal one. The lateral edges are strongly rounded and diverge at an angle of about 14 degrees. The conch was probably slightly dorsally concave in lateral view. The ligula attains the length a little smaller than the half width of the aperture; it forms an almost regular arc. The aperture was probably orthogonal.

The external sculpture is poorly preserved and is known only on the ventral side and along the lateral edges. The sculpture consists of distinct, closely spaced growth-lines and irregularly spaced imbrications.

The opercula undoubtedly belonging to this species, show characteristic features of the type species of *Cavernolites*, *C. giganteus* (NOVÁK, 1981). Their size corresponds with the dimensions of the aperture and their outline is broadly oval. The tectula are clearly defined by shallow

main and tectular furrows. Their axes contain an angle of 170—180 degrees. The internal side of the operculum is characterized by one pair of hollow clavicles, open on their distal ends. The exact form and length of the cardinal processes are unknown. Only short supporting lamellae projecting laterally from their bases, can be observed. The central process has the form of a rhombic area, inflated along its longitudinal axis and terminating in a sharp point close to the dorsal opercular margin.

The surface sculpture of the operculum consists of concentric growth-lines.

Dimensions: It was estimated that the conchs of adult specimens could amount to a minimum length of 90 m with the apertural width approaching 24 mm.

Discussion: *Cavernolites senex* sp. n. differs from closely related *C. giganteus* (NOVÁK, 1891) in the shape of the ventral apertural margin — ligula. The ligula is markedly shorter in *C. giganteus* [likewise in *C. klouceki* (ZÁZVORKA, 1928)] and the median part of its margin is straight, while in *C. senex* it is arched. The internal morphology of the opercula cannot be compared owing to the imperfect preservation of Moroccan material. The main difference on the external surface of the operculum is in the angle subtended by the axes of the tectula. These axes meet in the apex at 17—180 degrees in *C. senex*, while in *C. giganteus* at 130—140 degrees.

Occurrence: *C. senex* sp. n. was ascertained in the Upper Fezouata Formation (Lower Arenig), Zagora bou-Dhir, locality 1687 and 1689.

Cavernolites sp. n.

Pl. II, figs. 7—9

Material: A single fragment of the cardinal part of operculum, preserved as internal and external moulds in the nodule.

Discussion: The operculum has a very narrow (sag., exsag.) cardinal shield which distinguishes this species from the other species of *Cavernolites*. Rhombic central process, characteristic of the genus, is developed in our species. This process is terminated by a sharp point reaching to the dorsal margin of the operculum. Only one tectulum is preserved on the fragment; it is separated from the cardinal shield by a shallow and comparatively broad tectular furrow. The main furrow is slightly marked.

The single fragment available does not suffice to establish a new species, although we may be concerned with a new, hitherto oldest known representative of *Cavernolites*.

Occurrence: *Cavernolites* sp. n. was found in the Lower Fezouata Formation (Upper Tremadoc) SW of Jbel Tijakhet locality 1540.

Elegantilites MAREK, 1966

Type species: *Pugiunculus elegans* BARRANDE, 1847; Ordovician, (Berounian, Zahořany Formation), Bohemia.

Elegantilites hejarensis sp. n.

Pl. III, figs. 5—11, text-figs. 8, 9

Holotype: Incomplete conch (steinkern), figured here on pl. III, fig. 7. NM-S 2125.

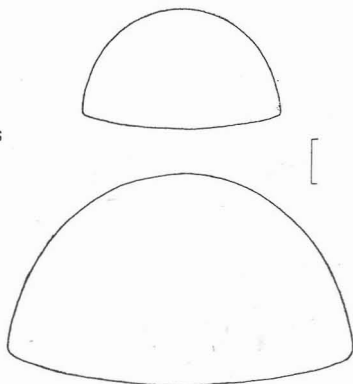
Locus typicus: Rabt el-Hejar.

Stratum typicum: Tachilla Formation (Llanvirn).

Material: In addition to the holotype, 3 more steinkerns, four fragmentary external moulds and 2 opercula; all material preserved in nodules.

Description: The conch is almost straight, only very slightly dorsally concave. Its cross-section has roughly a semicircular outline. The dorsal side is strongly inflated forming a regular arc, the ventral side is only slightly convex. The lateral edges are sharp and lie at about one fifth height of the conch. The w/h index equals 1.7. The angle of divergence, measured on five steinkerns varies from 12 to 17 degrees. The anterior margin of the ligula is moderately arcuate; the length of ligula equals approx. one third apertural width. No muscle scars have been ascertained on the internal surface of the conch. Its apical part is camerate. The number of septa is not known, but they were not numerous.

8. *Elegantilites hejarensis* sp. n., two cross-sections of conch, internal mould



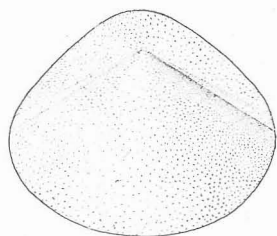
The sculpture of the surface consists by fine but distinct transverse riblets arranged into longitudinal bands of differing width. The riblets in single bands are arched toward the aperture. Only very fine growth-lines have been observed on the ventral side, subparallel to the margin of ligula.

The opercula occurring together with the conch have bilobate cardinal processes characteristic of *Elegantilites*. The clavicles are thin, overlapping the interclavicular concavity of the operculum. The tectula are narrow and only the main furrows are distinct and diverge at an angle of about 120 degrees. The conical shield is moderately convex and the cardinal shield is almost flat and its length (sag.) attains one fourth to one fifth the length of the conical shield. The internal surface of the cardinal shield bears radially arranged denticles counting 9 to 14.

The surface of the operculum is almost smooth, with few indistinct growth-lines only.

Dimensions: Estimated length of mature conch exceeded 30 mm. In two specimens measurable close to the aperture, the width of the steinkern was 8.1 mm, (6.6 mm) the height 5.3 mm (4.2 mm).

Discussion: The species described belongs undoubtedly to *Elegantilites* according to the shape and ornamentation of the conch and the



9. *Elegantilites hejarensis* sp. n., reconstruction of operculum, outer surface

morphology of the operculum. *Elegantilites hejarensis* sp. n. is similar to *E. euglyphus* (NOVÁK, 1886) from which it differs in more sparsely spaced and more prominent transverse ornamentation, which resembles *Joachimilites modestus* MAREK, 1967 (pl. 3, fig. 1). *E. euglyphus* can be distinguished by one more feature: a flattened narrow band cuts the top of the dorsal side in its longitudinal axis; this band is absent in the new species.

Occurrence: *Elegantilites hejarensis* sp. n. occurs in the Tachilla Formation (Llanvirn), Rabt el-Hejar, locality 1320, and possibly in Ouedel-Jdaid, locality 1528.

Elegantilites aff. *benignensis* (NOVÁK, 1891)

Pl. IV, figs. 1—3

Material: Only one compressed conch preserved in the nodule as external mould.

Description: The conch is flattened by pressure and its cross-section is therefore unknown; it is also impossible to ascertain whether the conch is orthocone or curved. The angle of divergence is about 14 degrees, the lateral edges are sharp. The ligula is considerably short, attaining the length a little smaller than two sevenths apertural width. The dorsal apertural margin is slightly arcuate anteriorly.

The sculpture of the dorsal side consists of fine transverse riblets counting 12—14 per mm. in the axial part of the conch close to its aperture. The riblets anastomose and their number increases laterally approx. by one fifth. Their ridges are rounded and the interspaces are a little narrower than the riblets themselves. The ventral side bears fine indistinct growth-lines. Few transverse riblets occur close to the ventral apertural margin but they are more closely spaced than those on the dorsum.

The operculum is unknown.

Dimensions: The length of the conch is 22.4 mm, the width at the aperture attains about 7.5 mm.

Discussion: The shape of ligula is typical of *Elegantilites* and the character of the sculpture resembles much that of *E. benignensis* (NOVÁK, 1891). It consists also of continuous transverse riblets, only the density is different. The riblets count about 10—11 per mm in *E. benignensis*. This difference may well be caused by different sizes of specimens compared. All Bohemian specimens with preserved sculpture attain a larger size than the Moroccan individual.

Occurrence: Tachilla Formation (Llanvirn), Oued Nejark, locality 1363.

Elegantilites ? formosus sp. n.

Pl. III, figs. 1—4, text-fig. 10

Holotype: Anterior part of the conch, figured on pl. III, figs. 3, 4. NM-S 2123.

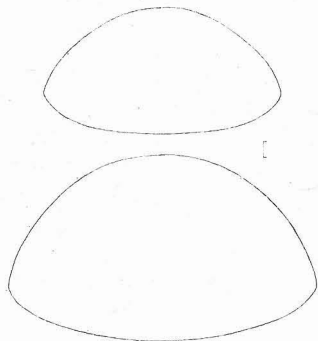
Locus typicus: Jbel bou-Degane.

Stratum typicum: Upper Ktaoua Formation (Ashgill).

Material: Two incomplete conchs with partly preserved shell.

Description: The conch was large and probably straight. The ventral side is moderately convex, dorsal side much more inflated, forming a regular arc — a part of a circle. The w/h index measured on slightly compressed holotype is 1.9, the other specimen which seems to be quite undeformed is higher and its index is 1.6. The angle of divergence amounts to 12—13 degrees, the aperture is orthogonal and the dorsal apertural margin is straight in the dorsal view. The ligula forms a low arc, somewhat flattened in its mid part; it is 3.5 times as wide as long. The lateral edges are sharp.

10. *Elegantilites ? formosus* sp. n., two cross-sections of conch, external mould



The surface bears marked irregularly spaced transverse grooves both on ventral and dorsal sides. The sculpture consists of very fine and very closely spaced growth-lines.

The operculum is unknown.

Dimensions: The width and height of the conch, holotype: 23.1 mm, 12.0 mm, the same of the other specimen: 20.1 mm, 11.8 mm.

Discussion: The new species is attributed to *Elegantilites* because of its resemblance to the type species, *E. elegans* (BARR.). However the latter is smaller, its angle of divergence is more acute (about 10 degrees) and the ligula comparatively shorter. *E. magister* (BARR.) is generally similar to *E. ? formosus* sp. n., but its dorsal side is more inflated than in the species compared.

Occurrence: *Elegantilites ? formosus* sp. n. derives from the Upper Ktaoua Formation (Ashgill), Jbel bou-Degane, locality 901.

Elegantilites sp. A

Pl. IV, figs. 6—9

Material: External mould of a conch and a fragment of the operculum, both preserved in sandy siltstone.

Description: The conch is straight and its cross-section is roundedly subtrigonal. The dorsal side is strongly inflated, the highest point

of the slope is situated a little above its midline, the ventral side is moderately convex. The lateral edges are rounded and lie at about two sevenths height of the conch. W/h index = 1.5. The angle of divergence is unmeasurable. The surface of the conch is smooth, without any trace of sculpture.

The operculum, most probably belonging to the conch has a slightly convex conical shield. The cardinal shield is flat and narrow and its length (sag.) in proportion to the length of the conical shield is 1 : 4.5. Both the main and tectular furrows are very indistinct, partially due to the imperfect preservation. The surface lacks any sculpture.

Only one clavicle is preserved on the internal mould. It is thin and has an L-shaped cross-section characteristic of *Elegantilites*, Cardinal processes are unknown.

Dimensions: The length of the cardinal shield: 1.0 mm; the length of the conical shield: 4.5 mm. The length of the conch must have exceeded 25 mm.

Discussion: The shape of the conch and the morphology of the operculum, above all that of the clavicles allow to attribute this species to *Elegantilites*. The material, however, is insufficient for establishing a new species. The absence of the surface sculpture, which would be the most important differentiating feature (all known species of *Elegantilites* bear transverse riblets), can be caused by imperfect preservation. Anyway, it is the oldest known representative of *Elegantilites*.

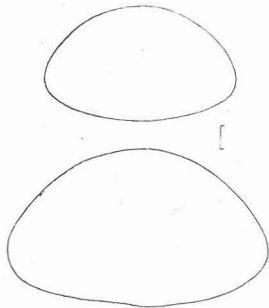
Occurrence: *Elegantilites* sp. A was found in the Lower Fezouata Formation (Upper Tremadoc), SW of Jbel Tijakhet, locality 1540.

Elegantilites sp. B

Pl. IV, figs. 4, 5, text-fig. 11

Material: One partly corroded steinkern of the conch with internal mould of the operculum in life position.

Description: The conch is orthocone, however, its ventral side is moderately convex in the lateral view. The cross-section is roundedly subtrigonal, the dorsal side forms a parabolic arc close to the aperture; the older part of the conch is more regularly arched, the curve resembles a semicircle. The ventral side is moderately convex, but is slightly concave in its middle part. This shallow depression does not lie in the longitudinal axis of the conch and it is probably caused by deformation. W/h index 1.6, the angle of divergence approaches 16 degrees. The aper-



11. *Elegantilites* sp. B, two cross-sections of conch, internal mould

ture is orthogonal, its dorsal margin is almost straight, the ligula is incomplete. The lateral sinuses are broad (tr.) Very weakly marked transverse waultings are visible on the dorsal side of the internal mould.

The sculpture of the conch is unknown.

The operculum is very poorly preserved, but it shows clear features typical of *Elegantilites*. The cardinal processes are bilobate but nothing can be said about their length. The clavicles are thin, L-shaped in the cross-section and diverge at an angle of about 105 degrees.

Dimensions: The height of the aperture: 8.4 mm, its width: 14.0 mm; the estimated length of the conch is almost 40 mm.

Discussion: Owing to the lack of the sculpture of the conch, which is one of the most important specific features, this species is not particularly named only on the basis of a slightly different cross-section of the conch; in this respect our specimen cannot be matched with other known species of *Elegantilites*.

Occurrence: Upper Ktaoua Formation (Ashgill), the anticline of Jbel Mimount, Sud Maider, locality 1125.

Elegantilites ? sp. C

Pl. IV, figs. 10, 11, text-fig. 2

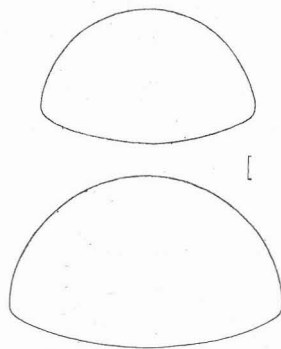
Material: One incomplete internal mould of the conch with the operculum pushed inside. The operculum is preserved as internal and external moulds.

Description: Orthocone conch of subsemicircular cross-section. The dorsal side forms an almost regular half-circle, the ventral side is only moderately convex. The convexity decreases slightly toward the aperture. The lateral edges of the internal mould are rounded and lie at two sevenths to two eighths height of the conch. The w/h index = 1.6, the angle of divergence amounts to 12 degrees.

The aperture is orthogonal, regularly arched ligula attains the length of about two fifths apertural width.

The surface of the conch is not preserved.

12. *Elegantilites* sp. C, two cross-sections of conch, internal mould



The operculum is typical of *Elegantilites*. The conical shield is moderately convex, the main furrows are distinct, but the tectular furrows are shallow and broad. The sculpture consists of concentric growth-lines of unequal prominence.

The internal surface bears one pair of narrow clavicles, which are L-shaped in cross-section. They diverge at an angle of about 100 degrees. The cardinal processes are bilobate but their length is unknown. The cardinal area is smooth, without any trace of dentation.

D i m e n s i o n s : The width of the operculum attains approx. 14 mm, the estimated length of the conch is minimum 50 mm.

D i s c u s s i o n : This species can be compared with the other Moroccan representatives of *Elegantilites* only on the basis of the cross-section of the conch. The dorsal side of *E. sp. C* forms an almost regular semi-circle, that distinguishes it distinctly from the other species of *Elegantilites* in which the slopes are less inflated. The only exception is *E. hejarensis sp. n.*, which, on the other side, has a less inflated ventral side and comes from considerably older beds (Llanvirn).

There is no visible difference between the operculum of *Elegantilites sp. C* and that of *E. sp. B*. The operculum of *E. hejarensis sp. n.* has a more trigonal cardinal shield and its cardinal area is denticulate. The cardinal shield of *E. sp. C* has a subsemicircular outline and lacks the teeth on its internal surface.

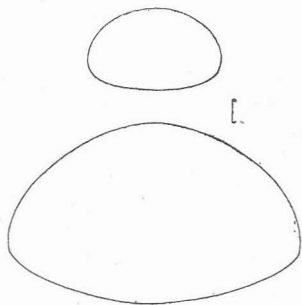
O c c u r r e n c e : *Elegantilites sp. C* comes from the Upper Ktaoua Formation (Ashgill) at Alkhikh, locality 1791.

Elegantilites ? sp. D

Pl. V, figs. 6, 7, text-fig. 13

M a t e r i a l : One incomplete broken internal mould with partly preserved external mould.

D e s c r i p t i o n : Othocone conch of roundedly subtrigonal cross-section, which is subelliptical in the most posterior part of the specimen. The w/h index is 1.6—1.7. The dorsal side is strongly inflated, the slopes attain their maximum height a little below their midline. The lateral edges of the steinkern are rounded and lie a little lower than at one third height of the conch. The angle of divergence amounts to 13 degrees. The ligula is not preserved, the dorsal apertural margin was most probably straight in the dorsal view. On the dorsal side of the steinkern, several unobscured longitudinal edges are visible in the appropriate side-light. They are symmetrically arranged according to the longitudinal axis. The edges are not developed on the external surface.



13. *Elegantilites ? sp. D*, two cross-sections of conch, internal mould

The surface both of the dorsal and ventral sides bears only very indistinct growth-lines and coarsely spaced transverse undulations.

Dimensions: The length of the conch certainly exceeded 50 mm.

Discussion: This species differs from the other known species of *Elegantilites* in the cross-section of the conch, especially in the vaulting of the slopes, which resemble a ballistic curve. However, this is too little for establishing a new taxon.

Occurrence: *Elegantilites* sp. D was found in the Lower Ktaoua Formation, (Lower Caradoc) in the region of Jbel-bou-Isidane, locality 1822.

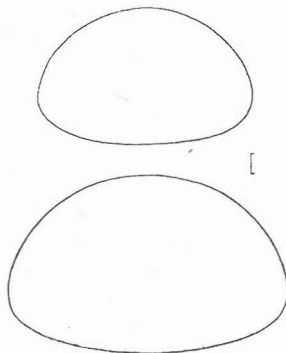
Elegantilites ? sp. E

Pl. IV, fig. 12, text-fig. 14

Material: A fragment of the anterior part of the conch (steinkern) .

Description: The cross-section of the steinkern is subsemicircular. The dorsal side is strongly inflated, the slopes are symmetrically arched, with their highest points approximately in their midlines. The w/h index = 1.55 — 1.57. Rounded lateral edges lie between two fifths to two sixths height of the conch. The ventral side is moderately convex. The lingula is not preserved, the dorsal apertural margin is straight in the dorsal view. Close to the anterior margin of the fragment runs a distinct transverse step-like edge. Behind it, a pair of transversely elongated, slightly raised muscle scars is developed.

14. *Elegantilites* ? sp. E, two cross-sections of conch, internal mould



Dimensions: The length of the conch is estimated for 55 — 60 mm.

Discussion: The unusual widening of the internal mould at the aperture, caused by the step-like edge and the presence of the dorsal apertural muscle scars is characteristic of this species. However, the fragmentary specimen is not suitable for establishing a new species.

Occurrence: This species derives from the Lower Ktaoua Formation (Caradoc) at Alkhikh, locality 1785.

Elegantilites ? sp. F

Unfigured incomplete compressed and deformed internal mould comes from the Llandeilo of Jbel Bani (locality 20).

The cross-section of the conch could originally be suboval or subtriangular with rounded lateral edges. The dorsal side is more inflated than the ventral one.

The specimen is too poorly preserved and it can be attributed to *Elegantilites* with doubts only. It is mentioned here since it is the only Moroccan hyolith preserved in sandstone.

Joachimilites MAREK, 1967

Type species: *Joachimilites novaki* MAREK, 1967; Ordovician (Berounian, Zahofany Formation), Bohemia.

Joachimilites ? orphanus sp. n.

Pl. V, figs. 9, 10, text-fig. 15

Holotype: The conch figured on pl. V, figs. 9, 10. NM-S 2137.

Locus typicus: Jbel Gaiz (N of Alnif).

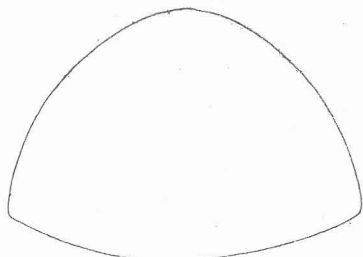
Stratum typicum: Ktaoua Formation, Upper Caradoc.

Material: Only one specimen (holotype), the conch with partly preserved shell.

Description: The conch is orthocone, the angle of divergence about 18 degrees. The dorsal side is strongly inflated, ventral side is only slightly convex. Sharp lateral edges lie at about one-fifth height of the conch. W/h index about 1.5. The lingula is short, attaining the length of only one-fifth apertural width. The ventral apertural margin is therefore only slightly arched forwards. The dorsal margin of the orthogonal aperture is almost straight in dorsal view. Preserved shell prevents to ascertain if ventral and/or dorsal apertural muscle scars were developed on the internal mould.

The external surface bears only inexpressive and irregularly spaced growth-lines. Close along the lateral edge runs on ventral surface a narrow but distinct little groove. In the longitudinal axis of the dorsal side lies a very fine, hair-thin sharp edge which is visible only in appropriate light.

The operculum is unknown.



15. *Joachimilites ? orphanus* sp. n., cross-section of conch, external mould

Discussion: It is not easy to attribute our species to some existing genus without knowing its operculum. The shape of the conch resembles the genera *Elegantilites* or *Joachimilites*. All hitherto known species of *Elegantilites* have transverse surface sculpture above all on the dorsal side. This sculpture consists of more or less fine continuous or interrupted riblets, which, however are not developed in *J. ? orphanus*. In this

respect, our species shows certain similarity to *Joachimilites havliceki* MAREK, 1967 from the Upper Berounian of Bohemia. This feature alone, of course, is only of specific importance and so I range the species mentioned only provisionally to *Joachimilites*. I would like only to mention that no other known representative of this genus has such a short ligula, which can be compared only with even shorter ligula in „*Hyolithes orthothecoides* sp. n. Both species may be related but it is impossible to throw some light on their precise systematic position until the opercula are found.

Occurrence: *J. ? orphanus* sp. n. was found in the Lower Ktaoua Formation, Jbel Gaiz, N of Alnif, locality 134.

Sololites MAREK, 1967

Type species: *Sololites ferrigenus* MAREK, 1967; Ordovician (Berounian, Zahořany Formation), Bohemia.

Sololites ? clausus sp. n.

Pl. V, figs. 1—5, text-fig. 16

Holotype: Steinkern with internal mould of incomplete operculum, undeformed by pressure, figured on pl. V, figs. 1—5. NM-S 2138.

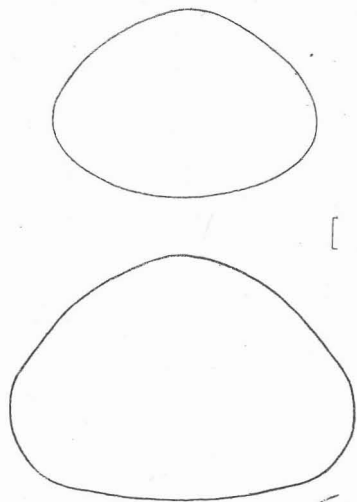
Locus typicus: Isk-n-Ifroukht.

Stratum typicum: Ktaoua Formation (Caradoc).

Material: Only the holotype.

Description: The conch is almost straight in its anterior part (apical part is missing). The dorsal side is straight in lateral view, ventral side is slightly longitudinally convex. The greater part of the ventral side is slightly convex, but its lateral parts are bent upwards in regular arcs. The w/h index is about 1.4. The lateral edges are strongly rounded and lie at about two-fifths height of the steinkern. The lingula is regularly anteriorly arched, almost semicircular. Its length attains almost half a width of the aperture. Above each lateral edge runs a shallow and broad longitudinal groove. Close to the ventral margin of the aperture a single

16. *Sololites ? clausus* sp. n., cross-section of conch, internal mould



transversely elongated muscle scar is developed. A weakly elevated and very indistinct longitudinal band of the same width (tr.) as that of the scar runs along the longitudinal axis, tapering backwards; it is a muscle track indicating the forward movement of the ventral apertural muscles.

The sculpture of the conch is unknown.

The operculum is platyclavicate; the clavicles are transversely (exsag.) moderately convex and bear a shallow but distinct radial groove. Their anterior margins slope toward the interclavicular concavity and join its surface at a blunt angle. The distal ends of the clavicles are straight, with few shallow pits on their terminal faces and overhang a little the internal surface of the operculum. The cardinal area is separated from the clavicles by fairly sharp ridges which join the external, laterally facing sides of the cardinal processes. These processes are robust and almost parallel to one another; their cross-section is suboval, elongated, about three times as long (exsag.) as wide.

The external surface of the operculum is unknown.

Dimensions: The width of the steinkern is 10.4 mm, the height 7.5 mm near the aperture. The length of the conch is estimated as approaching or even slightly exceeding 40 mm.

Discussion: The position of the apertural sinuses which lie close above the lateral edges indicates certain similarity to *Sololites* MAREK. So does the cross-section in which the indistinct longitudinal grooves on the lateral parts of the slopes appear as shallow depressions above the lateral edges. MAREK (1967, p. 88) regarded *Sololites* as related to *Carinolithes* SYSOIEV, 1958. Recently it was ascertained that the operculum of *Carinolithes* is of platyclavicate type (unpublished). If the opinion of the relationship between the two genera discussed is correct, *Sololites* should have platyclavicate operculum. *Sololites* ? *clausus* sp. n. has this type of operculum, yet, it is not a bit a clear evidence of its generic appurtenance.

Occurrence: *Sololites* ? *clausus* sp. n. was found in the Ktaoua Formation (Caradoc), Isk-n-Ifroukht, locality 1266.

Gamalites MAREK, 1974

1974 *Eumorpholites* (*Gamalites*) gen. n., L. MAREK, p. 290.

Type species: *Gamalites hanusi* (ZÁZVORKA, 1928); Ordovician (Dobrotivian, Dobrotivá Formation), Bohemia.

Discussion: *Gamalites* was originally described as the monotypic subgenus of *Eumorpholites* MAREK, 1967. Recently some ascertainments were made which are important for the refinement of the systematics of Hyolithida at generic level. It appeared, for instance, that the differences in the internal morphology of the opercula are considerably small within the genus. It concerns both the shape of the clavicles and cardinal processes. The best evidence for it gives the genus *Elegantilites* MAREK, 1966. The type species of this genus, *E. elegans* (BARRANDE, 1847) has the operculum with bilobate cardinal processes. The lobes closer to the dorsal margin are substantially shorter than the other two (see MAREK 1967, text-fig. 10). The clavicles are comparatively narrow in this genus, their cross-section is L-shaped.

Recently, the opercula were ascertained in seven other species of *Elegantilites* and it appeared that all of them have the same type of cardinal processes and clavicles as mentioned above. The similar situation is in *Gompholites* MAREK, 1966 of which we know the opercula in four species; all are very closely morphologically related. In regard to this fact, it was necessary to review the systematic value of the subgenus *Gamalites*, which in my opinion deserves to be treated not as a subgenus but as an independent genus closely related to *Eumorpholites* MAREK, 1967. *Gamalites* differs from *Eumorpholites* in the absence of the trilobate central process and in longitudinally elongated, slightly bilobate cardinal processes. These processes are distinctly shorter (exsag.) and unilobate in *Eumorpholites*.

Occurrence: *Gamalites* is known to date only from the Bohemian Dobrotivian and probably from the Arenig of Morocco.

Gamalites ? sp.

Pl. IV, fig. 14

Material: 3 opercula poorly preserved in the shale as composite moulds.

Discussion: Owing to unfavourable preservation it is enough problematic to attribute these opercula to *Gamalites*. However, only this genus comes into consideration from all hitherto known genera of Hyolithida with the operculum described.

The imprints of clavicles resemble their shape in the type species in which, however, the opercula are well preserved in the nodules. The configuration of cardinal processes is unfortunately very indistinct on the material studied. The cardinal area bears obscure radial elements which may indicate the presence of radially arranged indentations, developed in the type species.

Several very poorly preserved and strongly compressed conchs derive from the same locality, which yielded the operculum figured; they can hardly be attributed to any other genus. They are smooth, whereas the conchs both of *Gamalites* and *Eumorpholites* are transversely ribbed.

Dimensions: The only measurable operculum (pl. 4, fig. 14) is approx. 3.4 mm wide, its length attains about 2.6 mm.

Occurrence: *Gamalites* ? sp. was found in the Lower Fezouata Formation (Arenig), Zagora bou-Dhir, locality 1691, 1988 and 1692.

Gompholites MAREK, 1966

Type species: *Hyolithes cinctus* BARRANDE, 1867; Ordovician (Llanvirn), Bohemia.

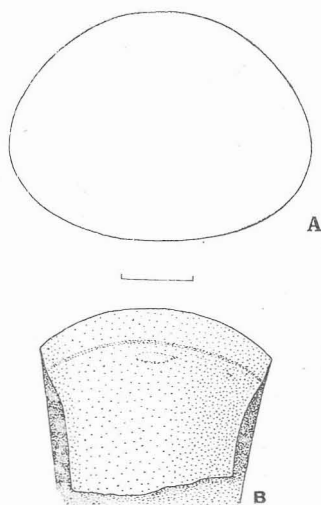
Gompholites cf. *cinctus* (BARRANDE, 1867)

Text fig. 17

Material: A fragment of the anterior part of the conch (internal mould) and incomplete external mould of the dorsal side.

Description: The conch has a subelliptical cross-section with strongly rounded lateral edges which lie approx. at about two fifths height of the conch (close to the aperture). This means that the ventral side is less convex than the dorsal one. The w/h index amounts to 1.3. The ligula is short, broadly arched; its length attains about two sevenths apertural width. The ventral apertural margin is bordered by a distinct

step-like edge which most probably corresponds with the line, where the margin of the soft body (mantle) was attached to the internal surface of the conch. A somewhat assymetrical, transversely elongated elevation is situated in the middle part of the internal mould of lingula. It is most probably the ventral apertural muscle scar. A considerably thick shell-wall looses abruptly its thickness near the aperture; this gives the internal mould a funnel-shaped appearance.



17. *Gompholites* cf. *cinctus* (BARR.), A - cross-section of conch, internal mould close to the aperture; B - ventral side of the internal mould showing indistinct muscle scar (?) and tapering of the shell-walls

The surface sculpture is known only on the dorsal side and it is made of fine indistinct growth-lines and several faint imbrications.

Dimensions: The estimated length of the conch is minimum 14 mm, the width of the aperture = 3.5 mm.

Discussion: This species is very similar to the Bohemian *Gompholites cinctus* (BARR.) from the Šárka Formation (Llanvirn). Both species agree in the cross-section of the conch and w/h index, which is also 1.3 in the aforementioned species. The sculpture is more fine in the Moroccan species, but this difference can be caused by imperfect preservation. These two species are probably conspecific.

Occurrence: This species comes from the Tachilla Formation (Llanvirn), Jorf Dahl, locality 1230.

Gompholites sp. A

Material: Two unfigured opercula, very poorly preserved as composite moulds in the shale.

Discussion: Though imperfectly preserved, the specimens show features of *Gompholites*, when they are compared with opercula of this genus preserved in a similar way in the shales of the Bohemian Ordovician. The features are: long peg-shaped cardinal process, narrow, slightly elevated clavicles and subcircular shape of the operculum.

However, new better preserved material is necessary for a 100 per cent evidence of the presence of *Gompholites* in the Arenig, which would be the earliest occurrence of this genus in general.

Occurrence: Upper Fezouata Formation (Lower Arenig), Zagora, Bou-Dhir, locality 1688.

Gompholites sp. B

Pl. IV, fig. 13

Material: One specimen (conch) preserved with the shell in its posterior part.

Description: The conch is orthocone and its angle of divergence is estimated for 13 degrees. The exact outline of the cross-section is unknown, but it certainly is suboval. The ventral side is less inflated than the dorsal one and the lateral edges are strongly rounded. Only the ventral side of the specimen can be observed. The ligula is short and its median part is straight (tr.). A broad (tr.) ventral apertural muscle scar is situated close to its margin. This scar has a straight anterior margin and moderately backwards arcuate posterior margin. Its breadth (tr.) attains a half apertural width. The shell wall is considerably thick and its thickness decreases abruptly toward the apertural margin, which is a typical feature of *Gompholites*.

The sculpture of the ventral surface consists of fine transverse growth-lines, moderately anteriorly arched.

Dimensions: The length of the figured specimen is 20 mm.

Discussion: This specimen is attributed to *Gompholites* and is not specifically named. It resembles much *G. striatulus* (BARR.) from the Berounian of Bohemia but its ventral muscle scar is more distinctly developed in comparison with the aforementioned species.

Occurrence: First Bani Group (Llandeilo), Hassi Brahim, locality 950.

Gompholites sp. C

Pl. V, fig. 8

Material: Internal mould of the conch, undeformed in pelocarbonate.

Description: The conch is orthocone, with few septa (one is preserved) in its apical part. The cross-section is roundedly subtrigonal. The dorsal side is fairly inflated, but the slopes are only moderately convex. The lateral edges are strongly rounded. Almost nothing is known about the aperture, only that it was most probably orthogonal. The angle of divergence amounts to 15 degrees. The most striking feature on the internal mould present distinctly developed paired muscle scars, resembling those figured by MAREK (1963, text-figs. 14, 15, pl. IV, figs. 3, 4). The scars of the Moroccan species are more rounded adaxially.

Dimensions: The length of the preserved conch attains 26.4 mm.

Discussion: The shape of the conch, above all its strongly rounded lateral edges and the presence of serially arranged muscle scars give the evidence for the appurtenance of this species to *Gompholites*. Bohemian Berounian *G. striatulus* (BARR.) is similar but differs in the angle of divergence (9–11 degrees). Moreover, the cross-section of the dorsal side of *Gompholites* sp. C differs from all related species in having the slopes distinctly less inflated.

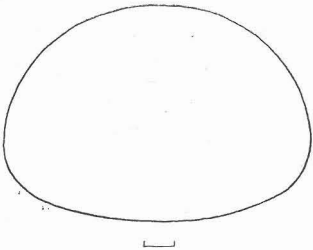
Occurrence: Roud Aissa (Upper Caradoc), Jbel Aroudane, locality 569.

Gompholites sp. D

Pl. VI, fig. 4, text-fig. 18

Material: One conch with preserved apertural region and partly corroded shell.

Description: The conch has a straight dorsal side and a very slightly inflated ventral side in lateral view. The cross-section is sub-oval; the dorsal side forms a regular, almost semicircular arc, the most part of the ventral side is moderately convex. The lateral edges are strongly rounded and lie at about one third height of the conch. The w/h index = 1.4. The aperture is orthogonal, with a short ligula attaining the length of one fourth to one fifth apertural width. The lateral [apertural] sinuses are broad. The angle of divergence varies from 6 to 13 degrees owing to imperfect preservation of the lateral edges.



18. *Gompholites* sp. D, cross-section of conch, partly corroded external mould

The surface is not preserved but the corroded shell suggests that the conch was probably ornamented by transverse riblets and imbrications.

Dimensions: The width of the aperture = 10.4 mm, its height = 7.3 mm. The length of the conch is estimated for 30 to 40 mm.

Discussion: Both the shape of the aperture and the cross-section enable to attribute this species to *Gompholites*. Uninsufficient material does not permit to create a new species, although our specimen differs in the cross-section from other two related Bohemian species: *Gompholites cinctus* (BARR.) and *G. striatulus* (BARR.). The ventral side of the Moroccan species is distinctly less convex, than that in both species mentioned. The other Moroccan *Gompholites*, the cross-section of which is known, *G. sp. E* has more inflated dorsal side.

Occurrence: The specimen comes from the Lower Ktaoua Formation (Middle Caradoc), Jbel Ahchahach, locality 1816.

Gompholites sp. E

Pl. VI, fig. 11, text-fig. 19

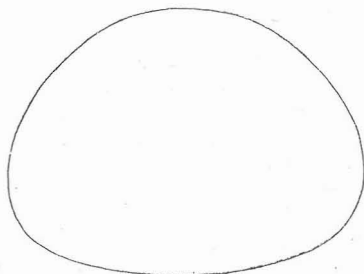
Material: One fragment of internal mould of a conch.

Description: The fragment is too small for ascertaining the shape and length of the conch. Its cross-section is roughly subsemicircular with strongly rounded lateral edges, lying at about two fifths height of the conch. The w/h index of the steinkern is 1.3. The dorsal side bears comparatively closely spaced serially arranged muscle scars, which are

transversely elongated and situated slightly obliquely (adaxially and adaptically) according to the longitudinal axis of the conch.

The external surface is unknown.

19. *Gompholites* sp. E, cross-section of conch, internal mould



Dimensions: The length of the fragment is 15.0 mm, its width in the anterior part amounts to 9.4 mm.

Discussion: Serially arranged muscle scars are known to date only in *Gompholites*. Also the cross-section of the conch agrees with the diagnosis of this genus. Unusual is the oblique position on the scars and their great number. However, this feature cannot be considered specifically important, when it is known only in one specimen.

Occurrence: Lower Ktaoua Formation (Caradoc), Alkhikh, locality 1785.

Pauxillitidae MAREK, 1967

Pauxillites MAREK, 1966

Type species: *Hyolithes pauxillus* NOVÁK, 1891; Ordovician (Llanvirn, Šárka Formation), Bohemia.

Pauxillites pauxillus meridionalis subsp. n.

Pl. VI, figs. 5—7, text-fig. 20

Holotype: The external mould of the conch, figured here on pl. VI, fig. 5. NM-S 2142.

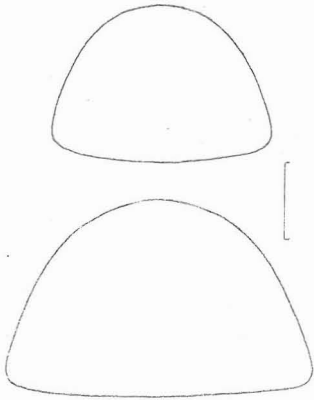
Locus typicus: Arhembou n'Dali

Stratum typicum: Tachilla Formation (Llanvirn)

Material: 8 conchs, mostly preserved as incomplete external mould and 3 opercula (internal moulds); all preserved in nodules.

Description: The conch is straight, the dorsal side is considerably inflated, the ventral one is only weakly convex. Rounded lateral edges lie at less than one fifth height of the conch. The w/h index equals approx. 1.5 in the adult part and approaches 1.7 in the posterior half of the conch. The angle of divergence amounts to 18—20 degrees. The aperture is oxygonal, the length of regularly arched ligula is unknown. A pair of ventrolateral muscle tracks is developed on the ventral side. They appear as distinct, comparatively broad longitudinal furrows on the internal mould.

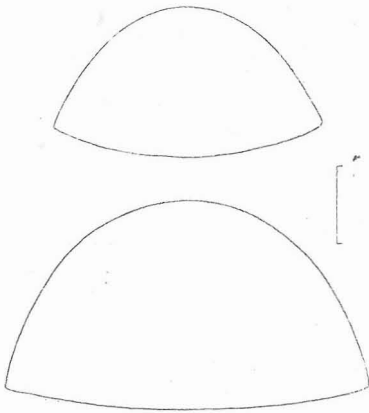
The surface of the dorsal side bears fine longitudinal rounded riblets which are not quite evenly spaced and count about 16 per mm. The ventral side is smooth.



20. *Pauxillites pauxillus meridionalis* subsp. n., cross-section, external mould

The operculum is triclavicate, three pairs of clavicles are arranged radially. The cardinal processes are ear-shaped. The outer surface of the operculum is unknown. It is impossible to distinguish this operculum from that of *Pauxillites pauxillus pauxillus* (NOVÁK, 1891) which was figured by BARRANDE 1867, [pl. 9, fig. 16] and by ZÁZVORKA (1928, pl. 3, figs. 5, 6).

Dimensions: The estimated length of the conch attained minimum 14 mm.



21. *Pauxillites pauxillus pauxillus* (NOVÁK), two cross-sections of conch, external mould

Discussion: This subspecies is very closely related to *Pauxillites pauxillus pauxillus* (NOVÁK, 1891) from the Llanvirn of Bohemia. As already stated, the opercula of both subspecies cannot be distinguished (only internal surface is known in the Moroccan opercula). The conch differ merely in their cross-section. That of the subspecies *meridionalis* is higher and its lateral edges are rounded, while they are sharp in *P. pauxillus pauxillus*. In my opinion, even this only difference is sufficient for establishing a distinct species, but I leave the solving of this taxonomic problem to the next generation of hyolith workers, which should be much wiser than we are now.

Occurrence: Tachilla Formation (Llanvirn), Arhembou n'Dali, locality 1050.

Pauxillites sp. n.

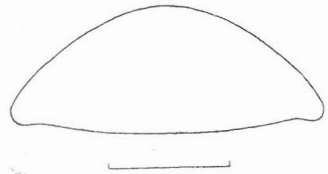
Pl. VI, figs. 8—10, text-fig. 22

Material: Two fragmentary conchs (steinkerns), one with partly preserved external mould and one internal mould of operculum.

Description: Small hyolithid with orthocone conch of low sub-trigonal cross-section. The ventral side is moderately convex as the slopes of the dorsal side. The lateral edges are sharply rounded. The angle of divergence amounts approximately to 25 degrees, the w/h index approaches 2.0. The aperture is oxygonal, the length of ligula attains almost one half apertural width. The ventro-lateral muscle tracks are distinct and reach anteriorly almost to the level of the lateral sinuses.

The dorsal surface bears longitudinal, rounded, not very prominent riblets, the ventral side is smooth.

22. *Pauxillites* sp. n., cross-section of conch, internal mould



Triclavicate operculum is similar to that of the type species *Pauxillites pauxillus* (NOVÁK) from the Šárka Formation of Bohemia. The Moroccan species differs from it in the shape of the cardinal processes, which have almost subparallel outer margins in the type species and in *P. pauxillus meridionalis* subsp. n., whereas they diverge distinctly in *Pauxillites* sp. n. (at angle of about 60 degrees).

The outer surface of the operculum is unknown.

Dimensions: The width of the operculum is approx. 2.2 mm. The estimated length of the conch is 6 — 8 mm.

Discussion: *Pauxillites* sp. n. represents most probably a new species, however, the material is scarce and poorly preserved.

Occurrence: *Pauxillites* sp. n. was found in the Upper Fezouata Formation (Lower Arenig), Jbel el-Khannfra, locality 983.

Leolites MAREK, 1967

Type species: *Leolites cognatus* MAREK, 1967; Ordovician (Berounian, Zahofany Formation), Bohemia.

Leolites sp.

Pl. VI, fig. 12, text-fig. 23

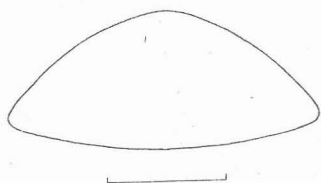
Material: Two incomplete specimens: a fragment of steinkern with a small remain of the shell and a fragment of the ventral internal surface of the shell.

Description: The conch is small, orthocone, of very low triangular cross-section. The ventral side is only gently convex and so are the slopes. The lateral edges are sharply rounded and lie at about one fifth height

of the conch. The w/h index is approx. 2.4, the angle of divergence (measured on the fragment of the steinkern) makes about 23 degrees in the central part of the conch. The aperture is not preserved except for the ligula, which forms a regular arc and attains the length of almost half apertural width. Two shallow but distinct furrows (ventro-lateral muscle tracks) are developed on the internal mould of the ventral side, running along the lateral margins and narrowing and disappearing toward the apex.

The surface of the dorsal side bears marked longitudinal riblets, several of which (2—3) appear also on the ventral side along its lateral margins; the full number of riblets cannot be ascertained.

The operculum is unknown.



23. *Leolites* sp., cross section of conch, internal mould

Dimensions: Width of the ventral side at the aperture = 3.1 mm; width of the steinkern = 2.8 mm, height of the steinkern = 1.2 mm.

Discussion: Although the operculum is unknown, the morphology of the conch almost certainly indicates the appurtenance of this species to *Leolites*. The other genus, to which our species could be attributed, is *Pauxillites*. However, the representatives of this genus have a lower value of the w/h index, smaller angle of divergence, and the longitudinal riblets on the dorsal side are considerably more densely spaced in regard to the size of the conch. Moreover, *Pauxillites* has not been ascertained yet in the beds younger than Llandello.

Leolites was originally described as a monotypic genus, but recently it was found that it comprises probably more species than one and its geographic distribution is fairly wide. The representatives of this genus occur outside Bohemia most probably in Himalaya and in Scotland (MAREK, 1976). Now it is known also from Morocco.

Occurrence: Lower Ktaoua Formation (Caradoc), Jbel Gaiz, locality 134.

„*Hyolithes*“ *orthothecoides* sp. n.

Pl. VI, figs. 1—3, text-fig. 24

Holotype: The conch figured on pl. VI, figs. 1—3. NM-S 2148.

Locus typicus: Jbel Gaiz (N of Alnif).

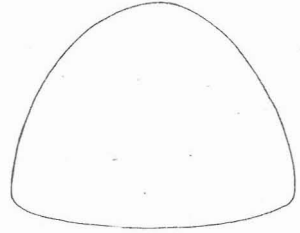
Stratum typicum: Ktaoua Formation, Upper Caradoc.

Material: Only the holotype, undeformed conch with partly preserved shell and broken apical part.

Description: The conch is orthocone, high subtrigonal in cross-section; w/h index about 1.3 (measured close to the aperture), the angle of divergence approx. 16 degrees. The ventral side is very slightly con-

vex and almost flat along the longitudinal axis, the dorsal side is highly inflated with moderately convex slopes. The lateral edges are rounded and lie at about one sixth height of the conch. The aperture is orthogonal, its dorsal margin adapically broadly arcuate. The lingula is very short, a little shorter than one sixth apertural width.

24. „*Hyolithes*“ *orthothecoides* sp. n., cross-section of conch



The surface sculpture consist only of inexpressive and irregular growth-lines, which are probably less prominent on the ventral side.

Dimensions: The length of almost complete conch is about 16.0 mm, the width of the aperture = 6.8 mm, the height of the aperture = cca 5.1 mm.

Discussion: Very high conch of this species is exceptional among all known species of Ordovician Hyolithida. Its cross-section resembles some Devonian orthothecids with slightly convex ventral side (for instance „*Orthotheca*“ *nobilis* BARRANDE, 1867), but the presence of the ligula proves that „*H.*“ *orthothecoides* belongs to hyolithids. It is possible that this species together with *Joachimilites* ? *orphanus* sp. n. represent a new genus, which however, cannot be erected without knowledge of opercula.

Occurrence: Lower Ktaoua Formation (Caradoc), Jbel Gaiz, locality 134.

LIST OF LOCALITIES

Number of locality	Locality, formation and series	Coordinates Lambert	Sheet
20	Bou R'bia, Sidi-Touhama; First Bani Group, Llandeilo	x = 418,15 y = 343,8	Zagora
134	Jbel Gaiz, N of Alnif; Roud Aissa, Upper Caradoc		
310	Foum-Zguid; First Bani Group, probable Upper Llandeilo	x = 358,5 y = 345,4	Alougoum 1/200000
569	Jbel Aroudane, nr. Taouz, south Tafilalt; Roud Aissa, Upper Caradoc		Taouz Est
633	Hassi Brahim; First Bani Group, Llandeilo		
901	Jbel bou-Debgane, Upper Ktaoua, Ashgill	x = 488,8 y = 320,3	Zegdou
950	Hassi Brahim; First Bani Group, Llandeilo		
983	Jbel el-Khannfra, S of Zini massif; Upper Fezouata, Lower Arenig	x = 11°25' y = 27°53'	Ain Semaiers 1/200000
985	Jbel el-Khannfra, S of Zini massif; Upper Fezouata, Lower Arenig	x = 11°24' y = 27°49'	ditto
1050	Arhembou n'Dali, N of Jbel Sarho; Tachilla, Llanvirn	x = 507,2 y = 84,4	Almif
1080	Isk-n'Brahim, E of Tazzarine des Ait-Atta; Upper Ktaoua, Ashgill	x = 499,4 y = 419,9	Tarhbalt
1109	Taggourth-n'Tchegout, anticlinal of Jbel Mimount; Upper Ktaoua, Ashgill	x = 525,3 y = 389,2	ditto
1125	Anticlinal of Jbel Mimount; Upper Ktaoua, Ashgill	x = 525,7 y = 397,5	ditto
1230	Jorf Dahl, western Tafilalt; Tachilla, Llanvirn	x = 585,9 y = 494,1	Tafilalt 1/200000
1236	Jbel bou-Legroun, western Tafilalt; Tachilla, Llanvirn	x = 596 y = 485	ditto
1248	Ouidane Sedar, western Tafilalt; probable Roud Aissa, Upper Caradoc	x = 590,3 y = 460,2	Tafilalt 1/200000
1266	Isk n'Ifroukht, eastern flank, western Tafilalt; Caradoc	x = 588,2 y = 468,4	ditto
1320	E of Rabt-el-Hejar, eastern Tafilalt; Tachilla, Llanvirn	x = 630,0 y = 92,5	Erfoud
1363	Oued Nejark, eastern Tafilalt; Tachilla, Llanvirn	x = 638,4 y = 489,5	Tafilalt 1/200000
1528	Oued el-Idaid, southern Tafilalt; Tachilla, Llanvirn	x = 615,4 y = 429,25	Taouz-Ouest
1540	SW of Jbel Tijakhet; Lower Fezouata, Upper Tremadoc	x = 612,35 y = 424,3	ditto
1649	E of Jbel bou-Debgane; Upper Ktaoua, Ashgill	x = 499,0 y = 331,0	Bou-Haiara-Zegdou 1/200000
1687	Zagora, Bou Dhir; Upper Fezouata, Lower Arenig	x = 474,0 y = 393,4	Tazarine
1688	Zagora, Bou Dhir; Upper Fezouata, Lower Arenig	x = 473,9 y = 393,5	ditto
1689	Zagora, Bou Dhir; Upper Fezouata, Lower Arenig	x = 473,8 y = 393,3	ditto

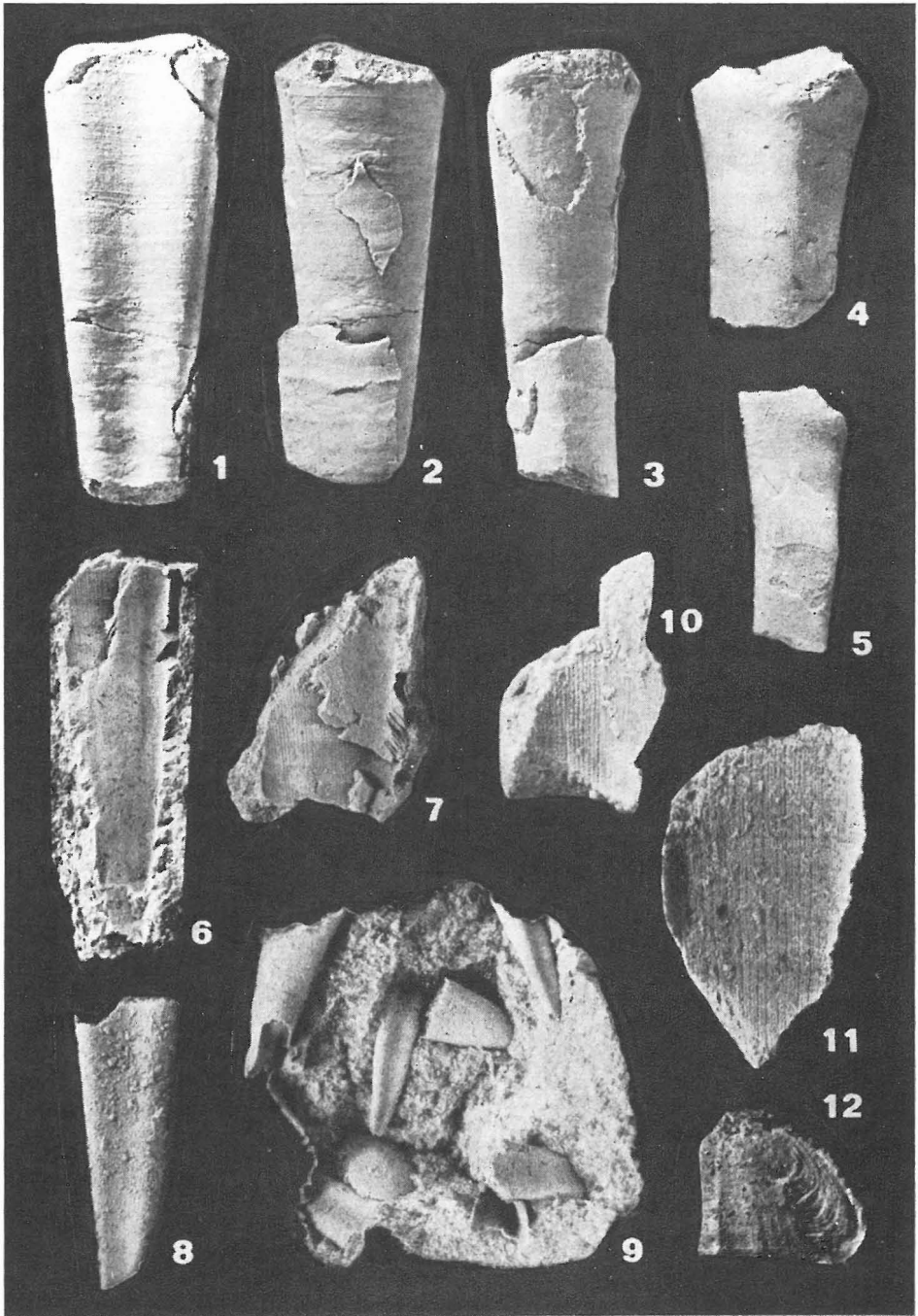
LIST OF LOCALITIES

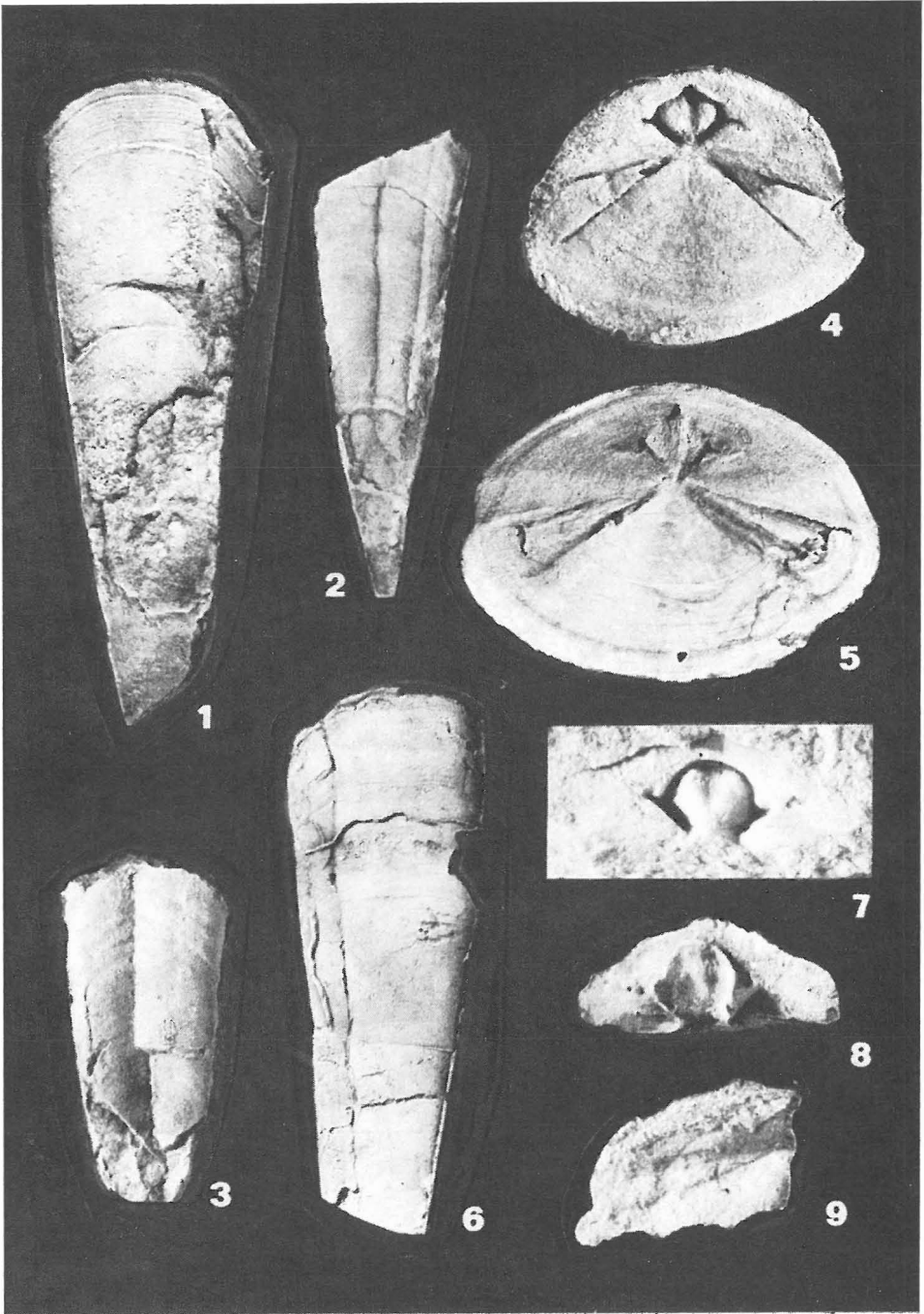
Number of locality	Locality, formation and series	Coordinates Lambert	Sheet
1691	Zagora, Bou Dhir; Upper Fezouata, Lower Arenig	x = 475,7 y = 388,5	Zagora
1692	Zagora, Bou Dhir; Upper Fezouata, Lower Arenig	x = 475,45 y = 388,1	Zagora
1785	Alkhikh-Tazzarine; Lower Ktaoua, Caradoc	x = 493,0 y = 424,85	Tarhbalt
1791	Alkhikh-Tazzarine; Upper Ktaoua, Ashgill	x = 498,3 y = 420,0	Tarhbalt
1813	Jbel Ahchahach (S of Alnif); probable Roud Aissa, Upper Caradoc	x = 528,2 y = 443,1	Maidar
1816	Jbel Ahchahach (S of Alnif); Lower Ktaoua, Middle Caradoc	x = 527,4 y = 442,8	ditto
1822	Jbel bou-Isidane (S of Alnif); Lower Ktaoua, Lower Caradoc	x = 524,2 y = 444,7	ditto
1883	Kheneg Brahim; Upper Fezouata, Lower Arenig	x = 242,1 y = 303,4	Tata 1/200000

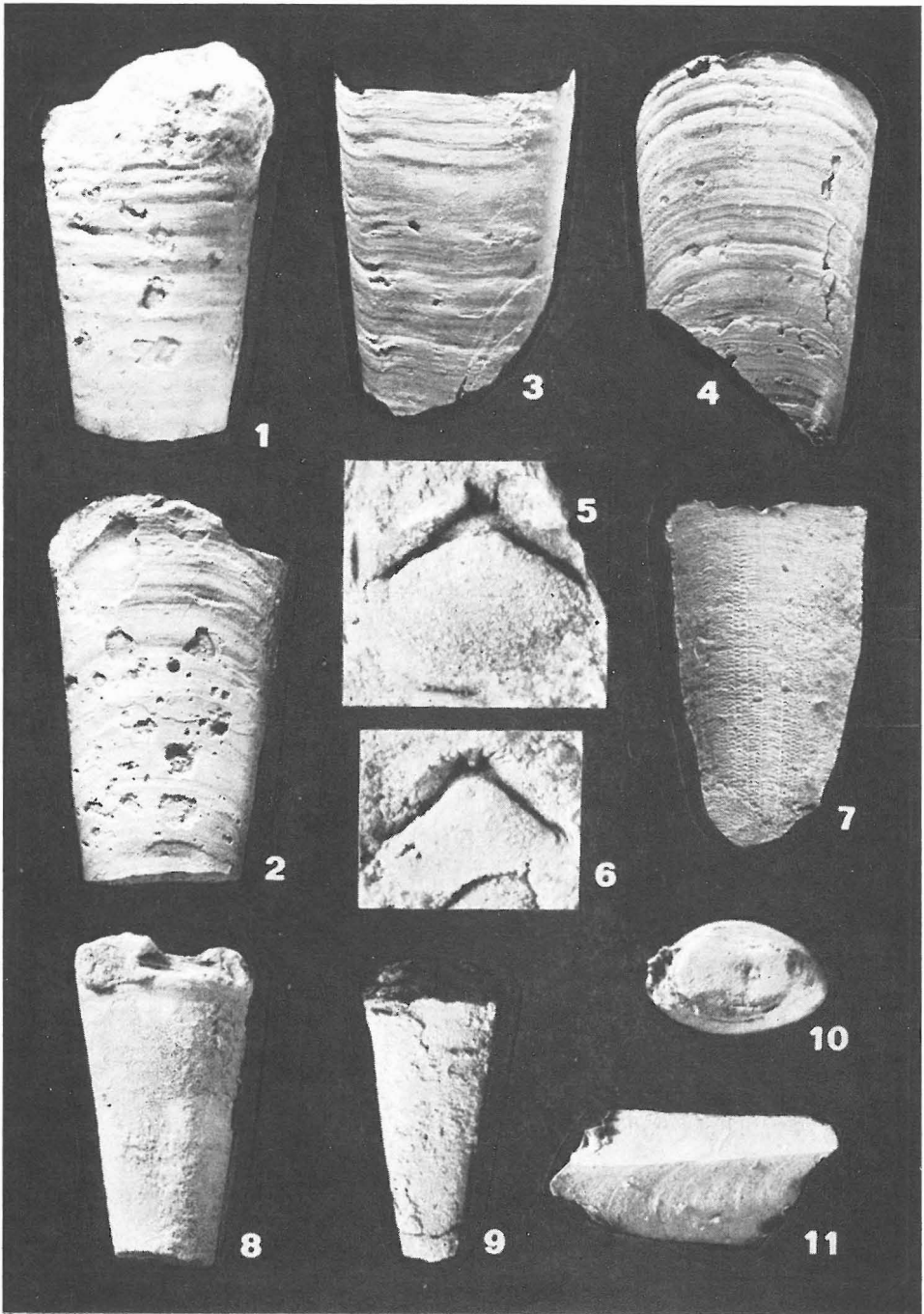
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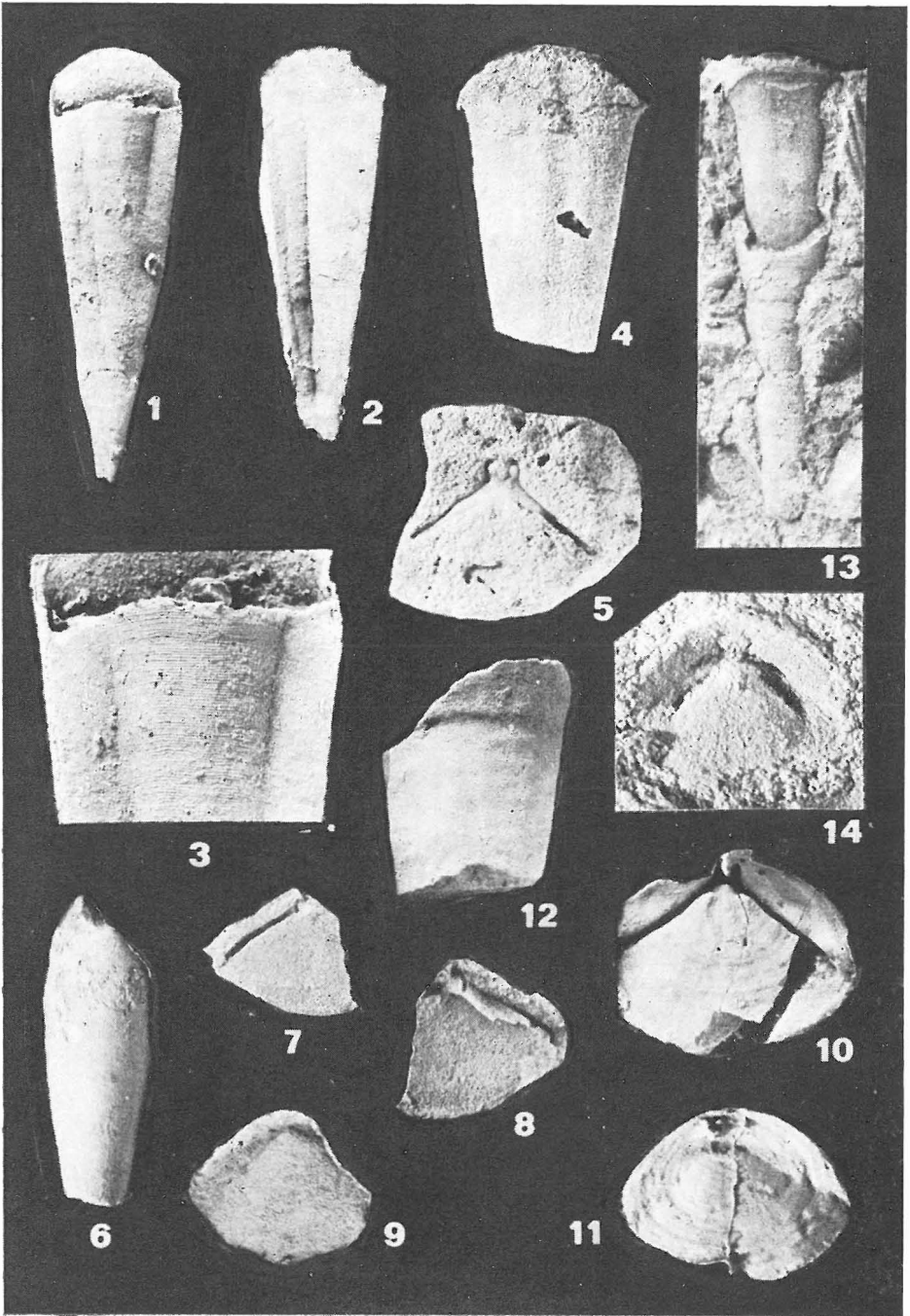
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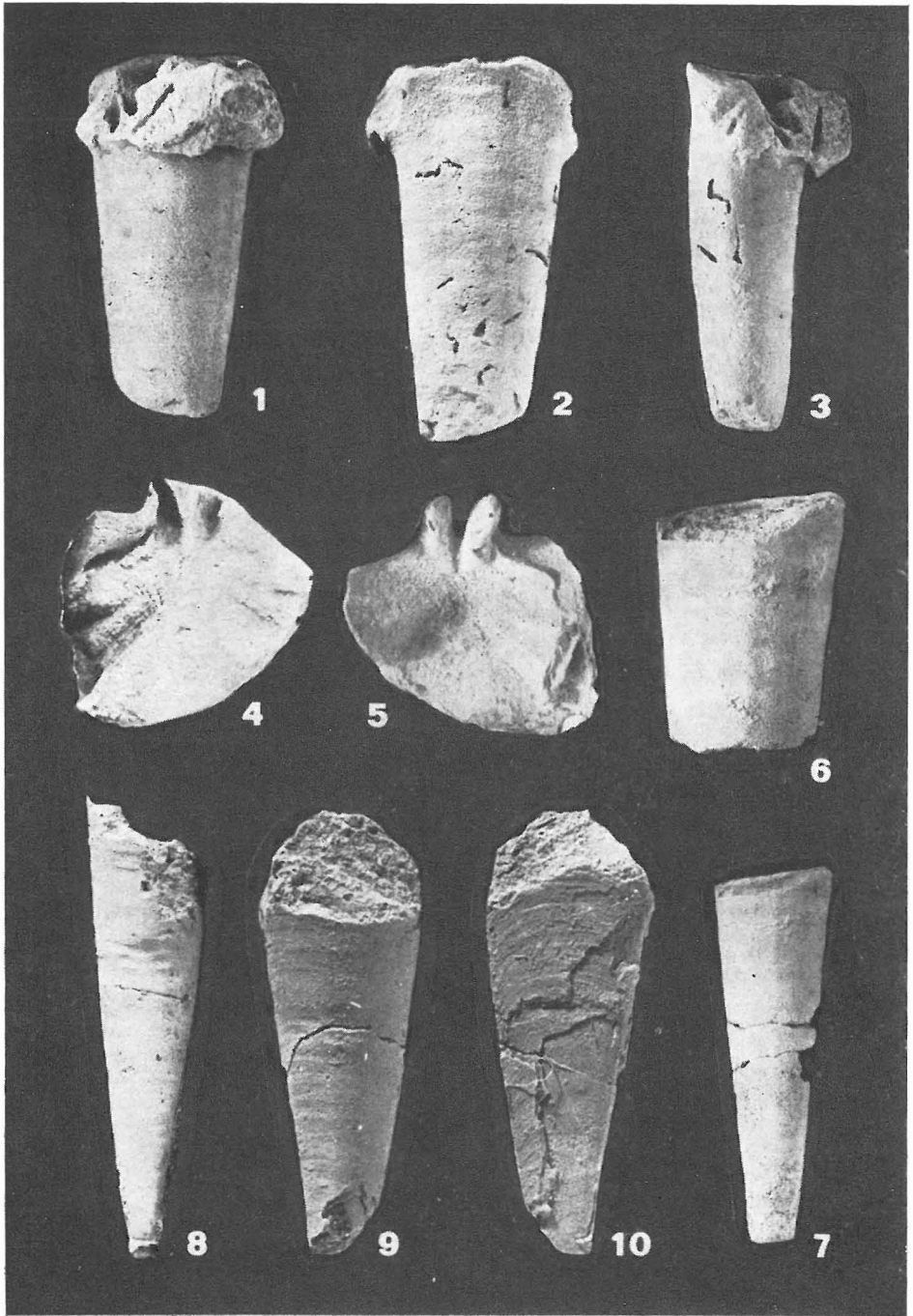
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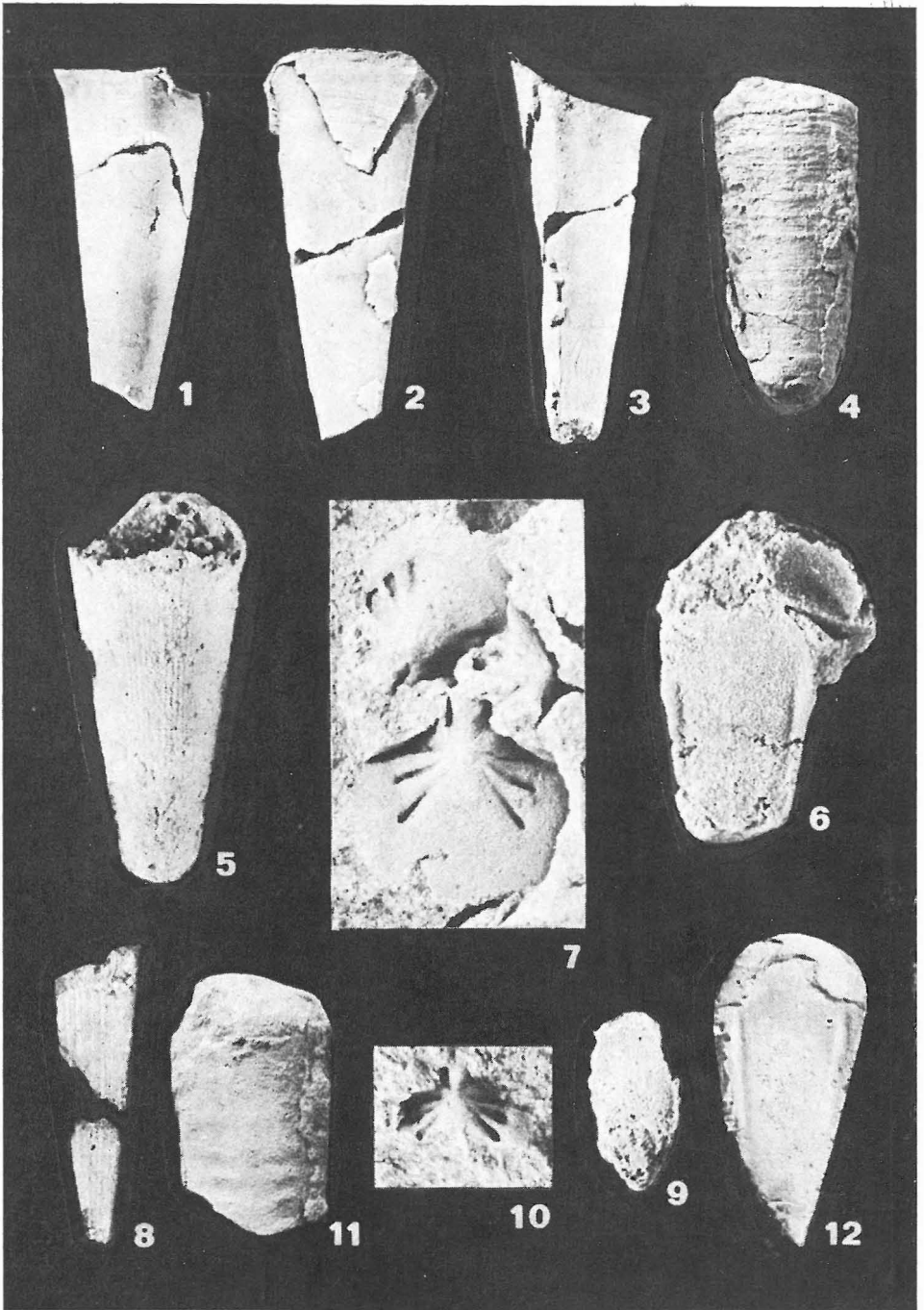












EXPLANATION OF PLATES

All the specimens and latex casts have been coated with ammonium chloride before being photographed. The photographs, taken by the author are untouched.

The figured specimens are deposited in the collections of the Geological Service, Rabat. NM denotes the inventory numbers of plaster replicas, deposited in the collections of the National Museum (Natural History), Prague.

Pl. I

Nephrotheca ? destombesi sp. n.

- 1—3. holotype, conch with preserved shell; 1 — ventral side; 2 — dorsal side; 3 — left lateral view, x 3.2. Lower Ktaoua Formation, Jbel Gaiz, loc. 134. NM - S 2112.

Nephrotheca gaiziana sp. n.

- 4, 5. holotype, conch; 4 — dorsal side of internal mould; 5 — left lateral view, x 4.5. Lower Ktaoua Formation, Jbel Gaiz, loc. 134. NM - S 2113.
6. conch; internal surface of ventral side with a part of external mould bearing longitudinal sculpture (upper left). Note the comparatively thick shell-wall, x 4.5. Lower Ktaoua Formation, Jbel Gaiz, loc. 134. NM - S 2114.
7. conch; another fragmentary specimen; external mould with remains of shell, x 4.2. Lower Ktaoua Formation, Jbel Gaiz, loc. 134.

Nephrotheca ? sp. n.

8. conch; ventral side of external mould, latex cast, x 5. Lower Fezouata Formation, Jbel el-Khannfra, loc. 983.
9. slab with conchs; latex cast, x 4.2. Lower Fezouata Formation, Jbel el-Khannfra, loc. 983. NM - S 2115.

Paniteca sp.

10. conch; fragment of external mould (negative), x 7.2. Ktaoua Formation, Jbel Ahchahach, loc. 1813.
11. conch; another fragment showing negatives of fine undulate riblets, x 7.2. Ktaoua Formation, Jbel Ahchahach, loc. 1813.
12. incomplete operculum; negative of external surface, 8.5. Ktaoua Formation, Jbel Ahchahach, loc. 1813. NM - S 2116.

Pl. II

Cavernolites senex sp. n.

1. holotype, conch; ventral side of external mould, x 1.2. Upper Fezouata Formation, Zagora bou-Dhir, loc. 1687. NM - S 2117.
2. conch; ventral side without aperture, x 0.8. Upper Fezouata Formation, Zagora bou-Dhir, loc. 1689. NM - S 2118.
3. conch; ventral side of incomplete specimen, x 1.1. Upper Fezouata Formation, Zagora bou-Dhir, loc. 1687. NM - S 2119.
4. operculum; internal mould, x 1.9. Upper Fezouata Formation, Zagora bou-Dhir, loc. 1687. NM - S 2120.
5. operculum; composite mould, x 2.5. Upper Fezouata Formation, Zagora bou-Dhir, loc. 1689. NM - S 2121.

Cavernolites giganteus (NOVÁK, 1891)

6. conch; latex cast of external mould of ventral side, x 0.8. Šárka Formation, Praha, former Vokovice brickyard. Author's collection.

Cavernolites sp. n.

- 7—9. operculum; 7 — internal mould of cardinal area; 8 — latex cast of this internal mould; 9 — external mould of this specimen, showing left half of cardinal shield, tectulum and part of conical shield, x 5.3. Lower Fezouata Formation, SW of Jbel Tijakhet, loc. 1540. NM - S 2122.

Pl. III

Elegantilites ? formosus sp. n.

- 1, 2. conch; 1 — dorsal side; 2 — ventral side, x 1.4. Upper Ktaoua Formation, Jbel bou-Degane, loc. 901. NM - S 2124.
- 3, 4. holotype, conch; 3 — dorsal side; 4 — ventral side, x 1.4. Upper Ktaoua Formation, Jbel bou-Degane, loc. 901. NM - S 2123.

Elegantilites hejarensis sp. n.

5. operculum; internal mould, x 6.2. Tachilla Formation, Rabt el-Hejar, loc. 1320. NM - S 2126.
6. operculum; internal mould, x 7.0. Tachilla Formation, Rabt el-Hejar, loc. 1320. NM - S 2127.
7. holotype, conch; external mould of dorsal side, x 4. Tachilla Formation, Rabt el-Hejar, loc. 1320. NM - S 2125.
8. conch; dorsal side of internal mould, x 3.5. Tachilla Formation, Rabt el-Hejar, loc. 1320. NM - S 2128.
9. conch; dorsal side of internal mould with one septum in its posterior part, x 4.4. Tachilla Formation, Rabt el-Hejar, loc. 1320.
10. septum; internal mould in posterior view, x 5.5. Tachilla Formation, Rabt el-Hejar, loc. 1320.
11. conch; latex cast in left ventro-lateral view, showing sharp lateral edge, x 4.3. Tachilla Formation, Rabt el-Hejar, loc. 1320. NM - S 2129.

Pl. IV

Elegantilites aff. *benignensis* (NOVÁK, 1891)

- 1—3. conch; 1 — latex cast of dorsal side; 2 — latex cast of ventral side, x 2.3, 3 — detail of apertural region of dorsal side, x 5.7. Tachilla Formation, Oued Nejark, loc. 1363. NM - S 2130.

Elegantilites sp. B

4. conch; ventral side of internal mould, x 1.7. Upper Ktaoua Formation, anticline of Jbel Mimount, loc. 1125. NM - S 2131.
5. operculum; strongly corroded internal mould, x 2.5. Upper Ktaoua Formation, anticline of Jbel Mimount, loc. 1125. NM - S 2131.

Elegantilites sp. A

6. conch; latex cast of dorsal side, x 2.4. Lower Fezouata Formation, SW of Jbel Tijakhet, loc. 1540. NM - S 2132.
- 7—9. operculum; 7 — internal mould, x 3.5; 8 — latex cast of internal mould, x 4.4; 9 — latex cast of external mould, x 4.4. Lower Fezouata Formation, SW of Jbel Tijakhet, loc. 1540. NM — S 2133.

Elegantilites sp. C

- 10, 11. operculum; 10 — internal mould, x 2.5; 11 — latex cast of external mould, x 2.5. Upper Ktaoua Formation, Alkhikh, loc. 1791. NM - S 2134.

Elegantilites ? sp. E

12. conch; dorsal side of internal mould, x 1.7. Lower Ktaoua Formation, Alkhikh, loc. 1785. NM - S 2135.

Gompholites sp. B

13. conch; ventral side with preserved shell in its posterior part, internal mould with distinct ventral apertural muscle scar, x 3.6. First Bani Group, Hassi Brahim, loc. 950. NM - S 2136.

Gamalites ? sp.

14. operculum; composite mould, x 8.6. Lower Fezouata Formation, loc. 1691. NM - S 2139.

Pl. V

Sololites ? clausus sp. n.

- 1—3. holotype, internal mould of conch with somewhat displaced operculum; 1—dorsal side; 2 — ventral side; 3 — left lateral view, x 2.3. NM - S 2138.
4, 5. incomplete operculum associated with conch; 4 — internal mould; 5 — latex cast of internal mould, x 4.3. Ktaoua Formation, Isk-n-Ifroukht, loc. 1266. NM - S 2138.

Elegantilites ? sp. D

- 6, 7. conch; 6 — anterior part of internal mould, dorsal view, x 1.8; 7 — complete internal mould of the same specimen, x 1.4. Lower Ktaoua Formation, Jbel bou-Isidane, loc. 1822. NM - S 2147.

Gompholites sp. C

8. conch; dorsal side of internal mould with paired muscle scars, x 2.8. Roud Aissa Formation, Jbel Aroudane, loc. 569. NM - S 2140.

Joachimilites ? orphanus sp. n.

- 9, 10. holotype, conch with preserved shell; 9 — dorsal side; 10 — ventral side, x 4.8. Ktaoua Formation, Jbel Gaiz, loc. 134. NM - S 2137.

Pl. VI

„*Hyolithes*“ *orthothecoides* sp. n.

- 1—3. holotype, internal mould of conch with partly preserved shell; 1 — dorsal side; 2 — ventral side; 3 — left lateral view, x 3.3. Lower Ktaoua Formation, Jbel Gaiz, loc. 134. NM S 2148.

Gompholites sp. D

4. conch; dorsal side, x 1.9. Lower Ktaoua Formation, Jbel Ahchahach, loc. 1816. NM - S 2141.

Pauxillites pauxillus meridionalis subsp. n.

- 5, 6. conch; 5 — holotype, latex cast of dorsal side, x 5.6. NM - S 2142; 6 — another specimen, ventral side of internal mould, x 5. Tachilla Formation, Arhembou n'Dali, loc. 1050. NM - S 2143.
7. opercula; internal moulds, x 6. Tachilla Formation, Arhembou n'Dali, loc. 1050. NM - S 2144.

Pauxillites sp. n.

- 8, 9. conch; 8 — latex cast of a slope of dorsal side, x 7.7; 9 — ventral side of internal mould, x 8.6. Upper Fezouata Formation, Jbel el-Khannfra, loc. 983.
10. operculum; internal mould, x 8.2. Upper Fezouata Formation, Jbel el-Khannfra, loc. 983. NM - S 2145.

Gompholites sp. E

11. conch; fragment of internal mould with paired muscle scars, x 2.3. Lower Ktaoua Formation, Alkhikh, loc. 1785. NM - S 2142.

Leolites sp.

12. conch; ventral internal surface with well developed ventro-lateral muscle tracks, x 7. Lower Ktaoua Formation, Jbel Gaiz, loc. NM - S 2146.

HYOLITI ORDOVIKU ANTI-ATLASU (MAROKO)

Práce se zabývá marockými ordovickými hyolity ve stratigrafickém rozpětí od tremadoku do ashgilu. Při geologickém mapování Anti-Atlasu je nashromáždil dr. J. Destombes z Geologické služby Maroka a autorovi je zapůjčil ke studiu. Ačkoliv materiál není příliš početný, bylo možno téměř všechny druhy s jistotou rodově zařadit.

Všechny zjištěné rody se vyskytují v českém ordoviku, odkud byly již dříve autorem popsány. Jsou to dva rody řádu Orthothecida (*Nephrotheca*, *Panitheca*) a pět rodů řádu

Celkem je v práci popsáno 28 druhů hyolitů, z toho 17 druhů zůstává následkem Hyolitida (*Cavernolites*, *Elegantilites*, *Gompholites*, *Pauxilites* a *Leolites*). Kromě posledně zmíněného rodu se ostatní čtyři objevují v Maroku dříve než v Čechách — *Cavernolites* a *Elegantilites* již v tremadoku, *Gompholites* a *Pauxilites* v arenigu. V barrandienském ordoviku je nejstarší výskyt těchto rodů znám až z llánvirnu, kromě rodu *Elegantilites* zastoupeného v Čechách vzácným druhem *E. Klabavensis* (HOLUB) v arenigu. Rody *Joachimilites*, *Sololites* a *Gamalites* nebyly v Maroku bezpečně doloženy.

Ve svrchním tremadoku Maroka byly zjištěny 2 rody (*Cavernolites*, *Elegantilites*). Čtyři rody (*Cavernolites*, *Pauxilites* a pravděpodobně i *Gompholites* a *Gamalites*) pocházejí z arenigu. V llánvirnu byly nalezeny rody *Elegantilites* a *Pauxilites*, zatímco v llandeilu *Gompholites* a snad i *Elegantilites*. Nejbohatší na rody a druhy je karadok, kde se vyskytuje *Nephrotheca*, *Panitheca*, *Leolites* a s určitými pochybami i *Elegantilites*, *Sololites* a *Joachimilites*. V ashgillu byl naproti tomu zjištěn jen rod *Elegantilites*.

Celkem je v práci popsáno 28 druhů hyolitů, z toho 17 druhů zůstává následkem nedostatečného materiálu v otevřené nomenklatuře. Autor je toho názoru, že není žádoucí tvořit nové taxony hyolitů ani na úrovni druhů (neboť ty se nejhůř likvidují) bez seriózních důvodů, a to zejména bez znalosti jejich víček.

Práce poprvé dokázala blízké vztahy mezi českým a marockým ordovikem také u hyolitových společenstev této geologické periody.