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A new Late Viséan ammonoid assemblage from the Anti-Atlas (Early Carboniferous, Morocco)

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Abstract. A new, unusually composed Late Viséan ammonoid assemblage is described from the Gara el Itima (eastern Anti-Atlas, Morocco). In addition to the species *Goniatites rodioni*, the assemblage includes very large specimens of *Merocanites* and specimens of the new genus *Xenoglyphioceras* gen. nov., which is interpreted to occupy a phylogenetic position between *Beyrichoceras* and *Ferganoceras*. The new species *Merocanites consequius* sp. nov. and *Xenoglyphioceras eidos* gen. et sp. nov. are described.

Keywords. Ammonoida, Early Carboniferous, Viséan, Morocco, Anti-Atlas.

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Introduction

The Anti-Atlas is well known for its Palaeozoic succession of fossiliferous sedimentary rocks, which allowed for a large number of geological studies. However, the main focus of many stratigraphic investigations has been on Devonian rocks (e.g., Becker & House 2000). In contrast, comparatively few studies have been carried out on Carboniferous ammonoids and their stratigraphic succession (e.g., Korn *et al.* 2007). There are probably several reasons for this. The fossil content of the Carboniferous strata is usually much lower than that of the Devonian. Furthermore, the outcrop area is much smaller. Another very important obstacle is the geographical location of the best regions, in which the Carboniferous rocks are exposed; these are located close to the border with Algeria, and the consequent difficulty of access. The best sections are located around the Gara el Itima in the eastern Anti-Atlas is in this zone with very restricted access.

The vicinity of the Gara el Itima mesa, 34 km east-northeast of Taouz, has allowed the study of numerous Late Viséan and Early Serpukhovian sections (Korn *et al.* 1999, 2007; Klug *et al.* 2006). The subdivision of the sections on the basis of ammonoid assemblages shows several clearly definable units. However, these are difficult, if not impossible, to correlate with other regions such as the Subvariscan, the American Midcontinent and the South Urals due to increased provincialism (Korn *et al.* 2012; Korn & De Baets 2015).

It is well known that Late Viséan ammonoid assemblages are often dominated by representatives of *Goniatites* de Haan, 1825 and closely related genera; therefore, these forms are most important ammonoids for stratigraphic studies of this time interval (e.g., Korn & Klug 2015). However, there are other taxa that have received less attention. Such a hitherto largely undescribed assemblage with a surprising composition of other genera is available from the Gara el Itima and is described and discussed here.

Material and methods

A total of 28 specimens from the vicinity of Gara el Itima in the Anti-Atlas of Morocco were examined in this study. The figured and described specimens are housed in the fossil cephalopod collection at the Museum für Naturkunde, Berlin.

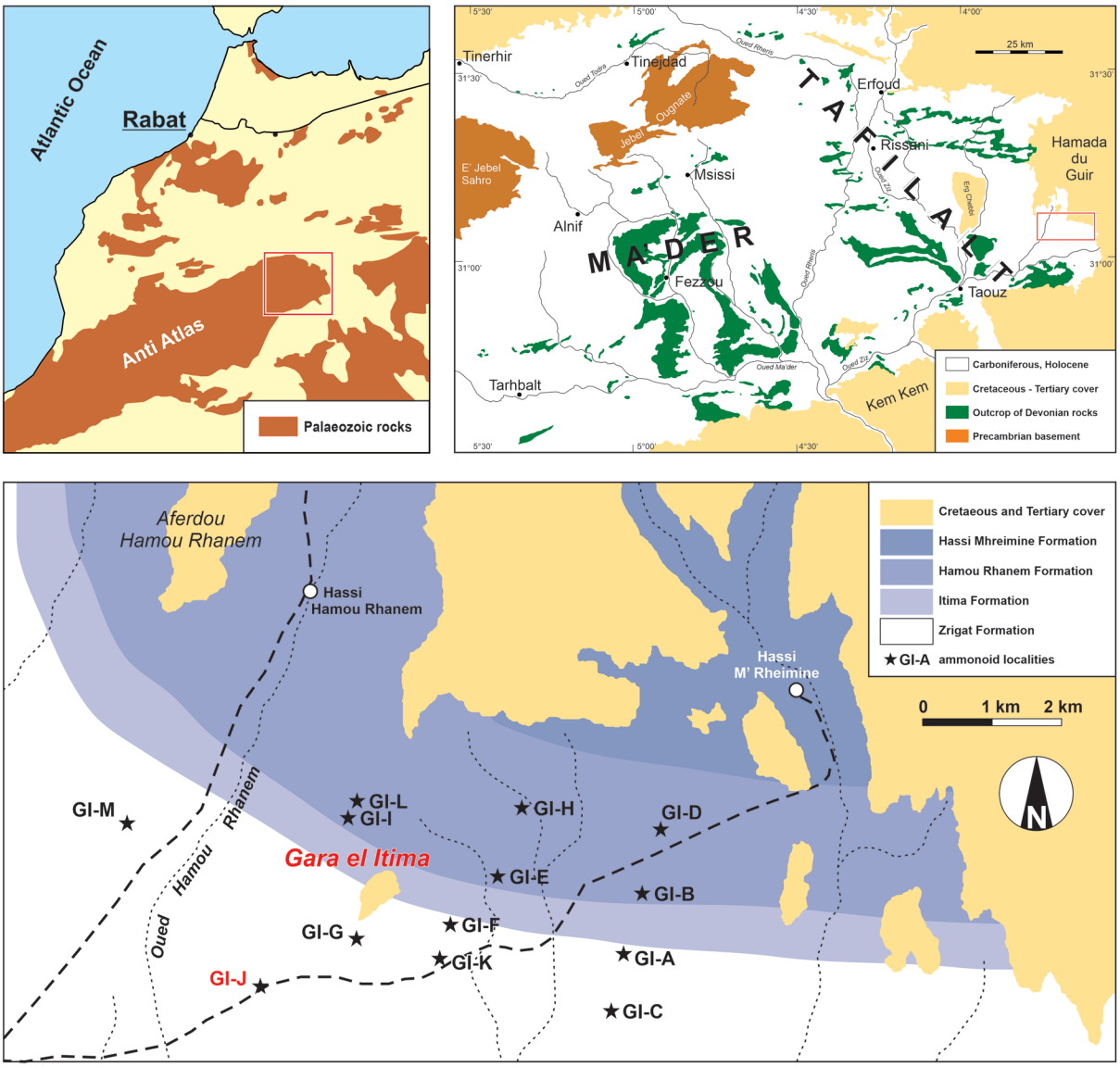

Fig. 1. Locality map showing the positions of the fossil localities described by Klug *et al.* (2006) in the vicinity of the Gara el Itima in the eastern Anti-Atlas (Morocco). Locality GI-J described in this article highlighted.

Korn & Ebbighausen (in Klug *et al.* 2006) described ammonoids of apparent late Asbian (Late Viséan) age from horizon GI-1 of the Gara el Itima fossil site GI-J. This yielded the four new species *Itimaites parabolicus* Korn & Ebbighausen, 2006, *Calygirtyoceras zrigatense* Korn & Ebbighausen, 2006, *Goniatites rodioni* Korn & Ebbighausen, 2006 and *Prolecanites maeandricus* Korn & Ebbighausen, 2006.

After the publication of the study by Klug *et al.* (2006) another site, very close to Gara el Itima locality GI-J, with a similar ammonoid assemblage was found. This site, apparently weathered from a largely fine clastic sequence, is located 2.8 km south-west of Gara el Itima (Fig. 1). The ammonoids were collected from the surface over an area of approximately 20 × 250 m. All specimens are of identical preservation, being sideritic-siliceous, well-preserved internal moulds. Despite the nature of the surface collection, contamination from other sites can be ruled out simply by distance. The nautiloid species *Vestinautilus kesslerae* Korn & Klug, 2023 was collected at this site Korn & Klug (2023). A total of 27 specimens are available for this study:

- *Goniatites rodioni* Korn & Ebbighausen, 2006 – 11 specimens
- *Xenoglyphioceras eidos* gen. et sp. nov. – 12 specimens
- *Merocanites consequius* sp. nov. – 4 specimens

The descriptive methods used in this paper follow those outlined in the key for the description of Palaeozoic ammonoid species published by Korn (2010) and Klug *et al.* (2015), which includes an explanation of the methods.

Abbreviations

ah = apertural height
dm = conch diameter
IZR = imprint zone rate
uw = umbilical width
WER = whorl expansion rate
wh = whorl height
ww = whorl width

Repository

MB.C. = collection of fossil cephalopods in the Museum für Naturkunde, Berlin

Results

Class Cephalopoda Cuvier, 1795
Subclass Coleoidea Bather, 1888
Superorder Ammonoida Haeckel, 1866
Order Goniatitida Hyatt, 1884
Suborder Goniatitina Hyatt, 1884
Superfamily Goniatitoidea de Haan, 1825
Family Goniatitidae de Haan, 1825
Subfamily Goniatitinae de Haan, 1825
Genus *Goniatites* de Haan, 1825

Goniatites rodioni Korn & Ebbighausen, 2006
Fig. 2

Goniatites rodioni Korn & Ebbighausen in Klug *et al*., 2006: 24, text-figs 20–21, 22a.

Goniatites crenistria – Delépine 1941: 66, pl. 4 figs 2–3.

Diagnosis (from Korn & Ebbighausen, 2006, emended here)

Species of *Goniatites* with a conch reaching a diameter of 70 mm. Conch globular to spindle-shaped at 20 mm diameter (ww/dm 0.90–1.10), pachyconic to globular at 40 mm diameter (ww/dm 0.70–0.90) and pachyconic at 60 mm diameter (ww/dm 0.65–0.75). Umbilicus very narrow in all stages larger than 20 mm dm (uw/dm 0.05–0.15). Shell ornament with crenulated, biconvex and rursiradiate growth lines with prominent dorsolateral projection. External sinus very shallow. Suture line with a moderately narrow external lobe (0.40–0.45 of the external lobe depth) and a low median saddle (0.25–0.35 of the external lobe depth).

Type material

Holotype

MOROCCO – **Anti-Atlas** • Gara el Itima locality GI-J; Zrigat Formation, horizon GI-1 (Late Viséan); 2004; Ebbighausen and Korn leg.; MB.C.9084.1; illustrated by Korn & Ebbighausen (in Klug *et al.* 2006: text-fig. 20a–b).

Paratypes

MOROCCO – **Anti-Atlas** • 71 specs; same data as for the holotype; 2004; Ebbighausen and Korn leg.; MB.C.9084.2 to MB.C.9084.72.

Other material examined

MOROCCO – **Anti-Atlas** • 11 specs; Gara el Itima, near locality GI-J; 31°02.747′ N, 3°42.429′ W; Zrigat Formation, horizon GI-1 (Late Viséan); 2007; Korn *et al*. leg.; MB.C.32197.1 to MB.C.32197.11.

Description

All the newly available specimens are fragments, with MB.C.32197.1 being the best preserved (Fig. 2A). It is from a specimen with a conch diameter of 44 mm, which is spherical and very narrowly umbilicate at this ontogenetic stage (ww/dm = 0.95; uw/dm = 0.11). The suture line has a very narrow, V-shaped external lobe with almost straight flanks. The external lobe, the ventrolateral saddle and the adventive lobe are approximately equally wide; the adventive lobe displays weakly sinuous flanks (Fig. 2B).

Remarks (from Korn & Ebbighausen in Klug *et al*. 2006)

A comparison of *Goniatites rodioni* with the other species of the genus that lack spiral ornament is rather easy. *Goniatites sphaericus* (Sowerby, 1814) has a similar conch, but differs in the much higher median saddle (0.45 of the external lobe depth) from *G. rodioni* (0.25). *Goniatites crenistria* Phillips, 1836

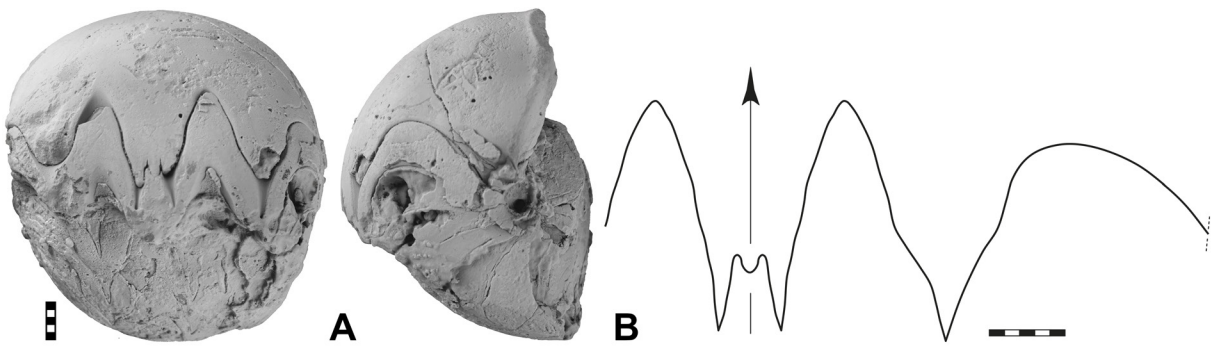

Fig. 2. *Goniatites rodioni* Korn & Ebbighausen, 2006, specimen MB.C.32197.1 (Korn *et al*. 2007 Coll.) from the Gara el Itima GI-J section. **A**. Ventral and lateral views. **B**. Suture line, at ww = 42.5 mm, wh = 23.2 mm. Scale bar units = 1 mm.

has, unlike *G. rodioni*, growth lines that run with almost linear course across flanks and venter. In this respect, *G. hudsoni* Bisat, 1934 and *G. americanus* Gordon, 1971 resemble *G. rodioni*, but these species differ in the suture line: *G. rodioni* has a very narrow external lobe, which is narrower than the adventive lobe than the other two. Furthermore, the growth lines in *G. rodioni* show a much higher dorsolateral projection.

Superfamily Neoglyphioceratoidea Plummer & Scott, 1937

Family **Ferganoceratidae** Ruzhencev, 1960

Remarks

Ruzhencev & Bogoslovskaya (1971: 330) were uncertain about the origin of the family Ferganoceratidae (translated from Russian): "The origin of the family is not entirely clear. Apparently, the genus *Ferganoceras* is related to *Neoglyphioceras*, because the conch shape and the general character of the suture line are similar." The possible ancestry of these forms is discussed below.

Genus ***Xenoglyphioceras*** gen. nov.
urn:lsid:zoobank.org:act:134ED820-9F3E-4524-83DC-E6D6154E7845

Type species

Xenoglyphioceras eidos gen. et sp. nov.

Diagnosis

Genus of the family Ferganoceratidae with a discoidal conch. Shell ornament with dense spiral lines. Adult stage with constrictions that bend forward in the ventrolateral area to continue in a single longitudinal groove.

Etymology

Combination of the Greek '*ξενος*' = 'strange' and *Glyphioceras* Hyatt, 1884 (neuter).

Remarks

The new genus *Xenoglyphioceras* gen. nov. occupies a morphological position between the genera *Beyrichoceras* Foord, 1903 and *Ferganoceras* Librovitch, 1957, meaning that it combines a thickly discoidal conch with a shell ornamentation composed of delicate spiral lines and a shape of the venter that is bordered by deep longitudinal grooves. At first glance, this may seem surprising, particularly as these two genera have distinctly different stratigraphic positions. *Beyrichoceras* is known from an interval ranging from the *Entogonites nasutus* Zone to the *Goniatites crenistria* Zone in the Rhenish Mountains, and from the B1 Zone to the P1a Zone in northern England. In Lancashire and Derbyshire, *Beyrichoceras* is particularly species-rich in the B2 Zone, where it is found alongside *Goniatites hudsoni* (Bisat 1934; Korn & Tilsley 2006).

In contrast, *Ferganoceras* is known from considerably younger strata (Ruzhencev & Bogoslovskaya 1971), specifically from the Viséan-Serpukhovian boundary interval (*Hypergoniatites–Ferganoceras* genus zone). The genus, first described based on material from Fergana (Uzbekistan) by Librovitch (1957), is one of the most important components of the ammonoid assemblages in the southern Urals (Ruzhencev & Bogoslovskaya 1971). The genus *Ruddelites* Malinky & Mapes, 1982, described based on material from Arkansas (Malinky & Mapes 1982), is likely a junior synonym of *Ferganoceras*. To date, *Ferganoceras* is known from the Anti-Atlas by only a single species, *F. torridum* Korn & Ebbighausen, 2006, represented by just one specimen (Klug *et al.* 2006).

The new genus is characterised by the peculiarity that in its middle ontogenetic stage, it resembles typical representatives of *Beyrichoceras*, but in its adult stage, it develops a morphology more similar to *Ferganoceras*. This can be seen as a case of hypermorphosis in *Xenoglyphioceras* gen. nov. The ventrolateral grooves typical of *Ferganoceras*, which appear at a relatively small conch diameter of about 8 mm (Ruzhencev & Bogoslovskaya 1971), do not develop in *Xenoglyphioceras* until the end of ontogeny, when the conch diameter reaches about 50–60 mm.

This raises the question of whether some of the species described from the British Isles or Central Europe and attributed to *Beyrichoceras* might actually belong to *Xenoglyphioceras* gen. nov. However, most of these species have been described from relatively small specimens, usually with diameters of less than 50 mm (Bisat 1934; Korn & Tilsley 2006). It is worth noting that larger specimens of *Beyrichoceras* from these regions have been rarely reported. *Beyrichoceras mempeli* Schmidt, 1941, with a conch diameter of 60 mm, is an exception (Schmidt 1941; Korn 2006). Unlike *Xenoglyphioceras*, the type specimen at this size shows no evidence of ventrolateral longitudinal grooves.

The hypothetical evolutionary scenario suggested by this new discovery can be explained through alternating processes of heterochrony (e.g., McNamara 1986; McKinney 1990). The ancestral form, *Beyrichoceras*, does not yet exhibit a specific adult morphology that fundamentally differs from earlier ontogenetic stages. Through hypermorphosis, *Xenoglyphioceras* gen. nov. adds an additional stage at the end of ontogeny, characterised by sharply forward-directed constrictions in the ventrolateral area, which develop into ventrolateral longitudinal grooves. In a subsequent step, these features are shifted to an earlier ontogenetic stage in *Ferganoceras* through acceleration.

This new discovery also prompts a reconsideration of the systematic classification of the family Ferganoceratidae. This family was placed in the superfamily 'Neoglyphioceratacea' by Ruzhencev & Bogoslovskaya (1971). However, this classification may now be questioned, or it might only be upheld if *Neoglyphioceras* and similar genera could also be derived from *Beyrichoceras* and *Xenoglyphioceras* gen. nov.

The origin of the Neoglyphioceratoidea remains unresolved. The superfamily appeared suddenly with its oldest known species, *Neoglyphioceras spirale* (Phillips, 1841), in the *Neoglyphioceras spirale* Zone (P1d of the British zonation). No species that could be considered a direct ancestor has yet been identified. With its unusually slender conch geometry and prominent spiral lines, *N. spirale* is an anomaly in the *Neoglyphioceras spirale* Zone and cannot be phylogenetically linked to any stratigraphically older species.

It is possible that *Xenoglyphioceras* gen. nov. is the ancestor of *Neoglyphioceras*. However, this would require significant modifications to the conch (whorls becoming more slender) and ornamentation (reduction in the number of spiral lines). The suture line of *Xenoglyphioceras* differs less markedly from that of *Neoglyphioceras*. Both genera share similarities in the shape of the external lobe and the ventrolateral saddle.

Xenoglyphioceras eidos gen. et sp. nov.
urn:lsid:zoobank.org:act:9E318F16-BB75-4DCA-B078-51384494F14B
Figs 3–4; Table 1

Diagnosis

Species of *Xenoglyphioceras* gen. nov. with a conch reaching a diameter of 80 mm. Conch thickly discoidal and involute at 30 mm diameter (ww/dm ~ 0.55; uw/dm ~ 0.10) and thinly discoidal and subinvolute at 60 mm diameter (ww/dm ~ 0.40; uw/dm ~ 0.20). Shell ornament with dense spiral lines

and biconvex growth lines. Adult stage with constrictions that bend forward in the ventrolateral area to continue in longitudinal grooves. Suture line with a moderately wide external lobe (0.60–0.65 of the external lobe depth) and a moderately low median saddle (0.35–0.40 of the external lobe depth).

Etymology

From the Greek '*τὸ εἶδος*' (noun in apposition) = 'the beauty'; because of the combination of morphological characters.

Type material

Holotype

MOROCCO – **Anti-Atlas** • Gara el Itima, near locality GI-J; 31°02.747′ N, 3°42.429′ W; Zrigat Formation, horizon GI-1 (Late Viséan); 2007; Korn *et al*. leg.; MB.C.32198.1; illustrated in Fig. 3A.

Paratypes

MOROCCO – **Anti-Atlas** • 11 specs; same data as for the holotype; MB.C.32198.2 to MB.C.32198.12.

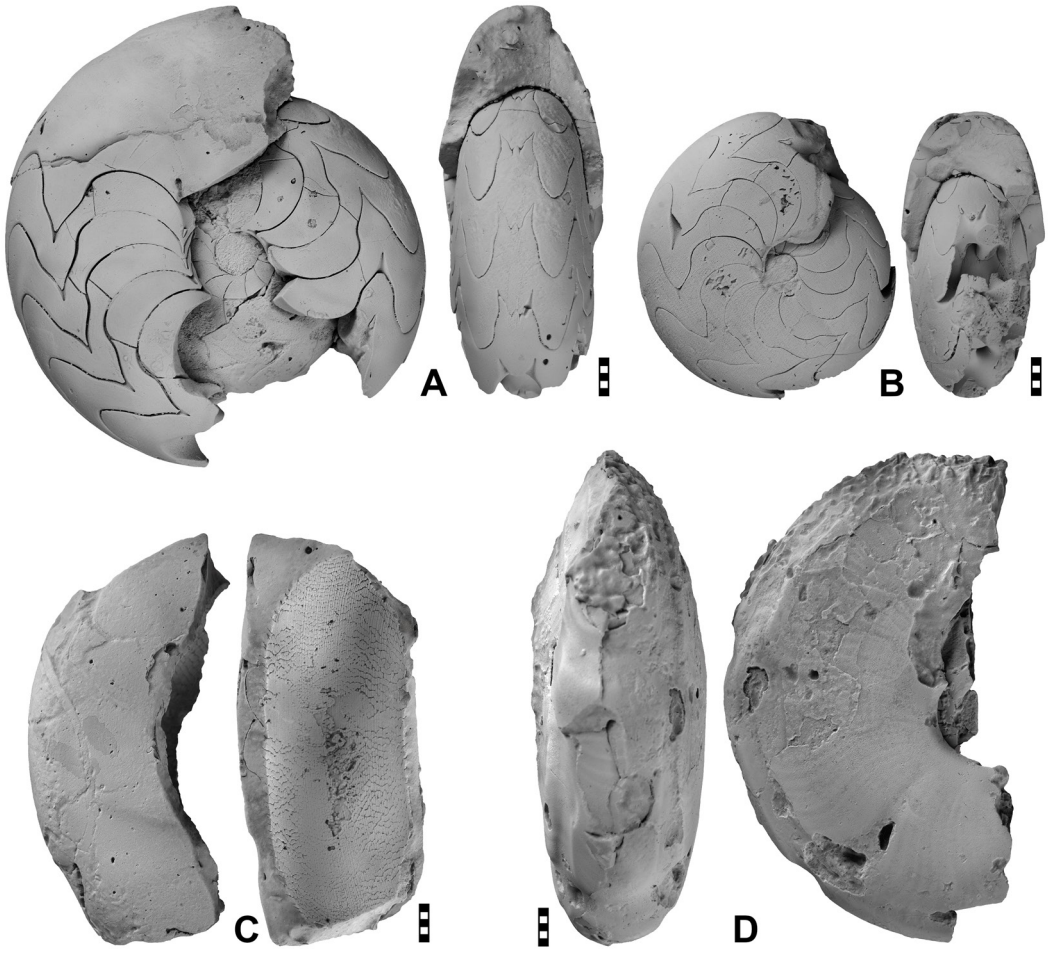

Fig. 3. *Xenoglyphioceras eidos* gen. et sp. nov. from the Itima GI-J section (Korn *et al*. 2007 Coll.). **A**. Holotype MB.C.32198.1, lateral and dorsal views. **B**. Paratype MB.C.32198.2, lateral and dorsal views. **C**. Paratype MB.C.32198.4, lateral view and impression of penultimate whorl. **D**. Paratype MB.C.32198.3m, ventral and lateral views. Scale bar units = 1 mm.

Description

Holotype MB.C.32198.1 is an almost completely chambered internal mould with a conch diameter of 61 mm (Fig. 3A). Less than a quarter of a volution belongs to the incomplete body chamber. The conch is thinly discoidal and subinvolute (ww/dm = 0.38; uw/dm = 0.20). It should be noted that the umbilicus opens rather clearly on the last volution of the phragmocone. The whorl profile is weakly compressed (ww/wh = 0.93) with a uniformly rounded venter that merges into the slightly convex, weakly convergent flanks via a broadly rounded ventrolateral shoulder. The umbilical margin is subangular and separates the flank from the flattened, almost vertical umbilical wall. The coiling rate is very low (WER = 1.48).

The surface of the internal mould appears to be completely smooth, although traces of very fine spiral lines can be seen in some small areas. The last volution shows five shallow constrictions, which are arranged at somewhat irregular distances from one another. They have a weakly biconvex course with very low dorsolateral and ventrolateral projections and a very deep ventral sinus. The last of the constrictions differs in its course from the others in that the ventrolateral projection is very prominent. It cannot be said if the constrictions and grooves were also present on the shell surface or if the just represent internal shell thickenings.

The suture line has a V-shaped external lobe with clearly sinuous flanks; the median saddle reaches a height of 0.36 the depth of the external lobe. The ventrolateral saddle is somewhat asymmetrical and bluntly rounded; the adventitious lobe is almost symmetrical with convex flanks (Fig. 4A).

Paratype MB.C.32198.2 is a completely chambered internal mould specimen with a conch diameter of 38 mm (Fig. 3B). The conch is thickly discoidal and involute (ww/dm = 0.49; uw/dm = 0.13). The umbilicus opens only slowly on the last volution of the phragmocone. The whorl profile is weakly depressed (ww/wh = 1.06) with a uniformly rounded venter that merges into the slightly convex, weakly convergent flanks via a broadly rounded ventrolateral shoulder. The umbilical margin is narrowly

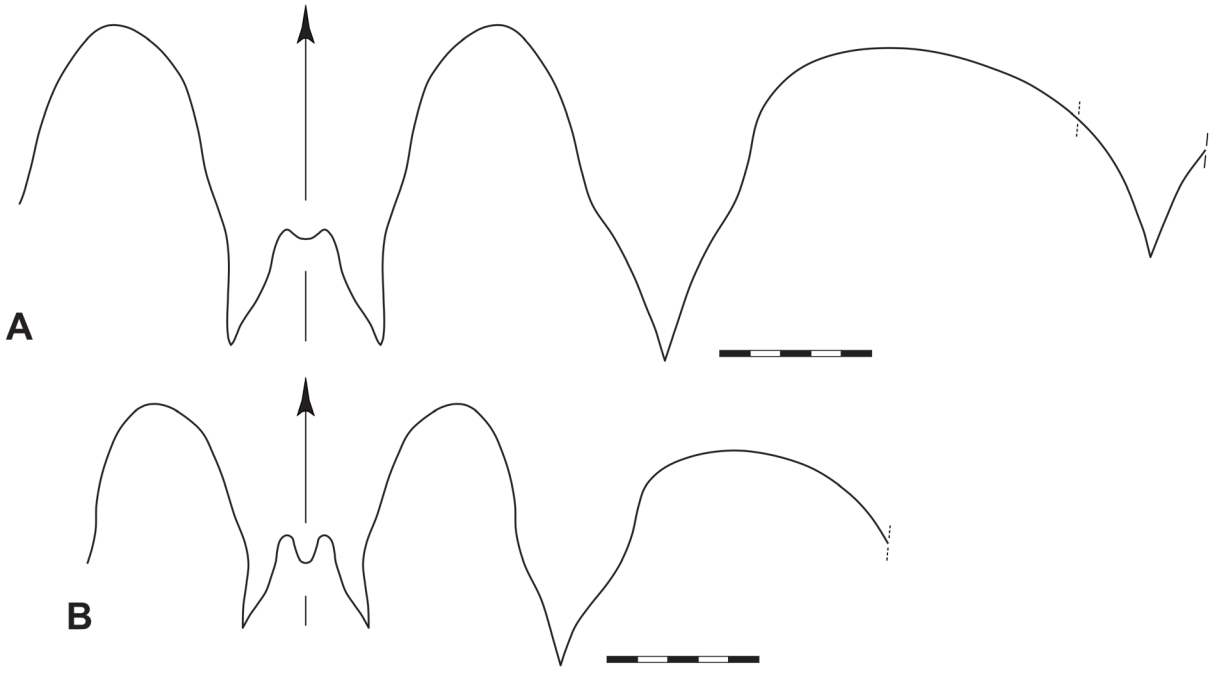

Fig. 4. *Xenoglyphioceras eidos* gen. et sp. nov. from the Itima GI-J section (Korn *et al*. 2007 Coll.). **A**. Holotype MB.C.32198.1, suture line at dm = 55.4 mm, ww = 24.8 mm, wh = 25.2 mm. **B**. Paratype MB.C.32198.2, suture line at dm = 35.4 mm, ww = 18.0 mm, wh = 17.5 mm. Scale bar units = 1 mm.

Table 1. Conch dimensions and ratios of selected specimens of *Xenoglyphioceras eidos* gen. et sp. nov. from the Gara el Itima.

	dm	ww	wh	uw	ah	ww/dm	ww/wh	uw/dm	WER	IZR
MB.C.32198.1	61.0	23.3	25.0	11.9	10.8	0.38	0.93	0.20	1.48	0.57
	51.0	20.8	20.0	8.6	–	0.41	1.04	0.17	–	–
MB.C.32198.2	37.7	18.5	17.5	4.9	6.3	0.49	1.06	0.13	1.44	0.64
	32.0	17.0	14.8	3.3	–	0.53	1.15	0.10	–	–

rounded. The last volution has three shallow constrictions, which are very weakly biconvex course with very low dorsolateral and ventrolateral projections and a deep, semicircular ventral sinus. The suture line (Fig. 4B) is similar to that of the holotype.

Paratype MB.C.32198.3 is a body chamber fragment of an approximately 75 mm large specimen (Fig. 3D). At a shell diameter of 55 mm, it already displays distinctly pronounced ventrolateral grooves, accompanied by clearly biconvex radial constrictions. Between these constrictions, very faint plications can be recognised on the flanks. As with the holotype, it cannot be determined whether the constrictions and ventrolateral grooves seen on the internal mould are also present on the shell surface, or if they represent internal thickenings of the shell.

The paratypes MB.C.32198.4 (Fig. 3C) and MB.C.32198.5, like paratype MB.C.32198.3, are fragments of the adult body chamber. Both show the characteristic constrictions and grooves. Both exhibit the impression of the shell of the penultimate whorl in the inner part of the body chamber. It is evident that the primary element of the shell ornamentation consists of very fine, closely spaced spiral lines. The shell surface of the penultimate whorl shows no constrictions or grooves.

Remarks

Xenoglyphioceras eidos gen. et sp. nov. resembles species of *Beyrichoceras* in the late juvenile and preadult ontogenetic stages but differs significantly in the adult stage due to the prominent constrictions and ventrolateral grooves.

Order Prolecanitida Miller & Furnish, 1954
Suborder Prolecanitina Miller & Furnish, 1954
Superfamily Prolecanitoidea Hyatt, 1884
Family Prolecanitidae Hyatt, 1884
Subfamily Protocanitinae Weyer, 1972

Genus ***Merocanites*** Schindewolf, 1922

Remarks

The co-occurrence of *Merocanites* and *Goniatites* has likely not been previously reported. Species of *Merocanites* are commonly found alongside much older ammonoid genera such as *Ammonellipsites* Parkinson, 1822 and *Muensteroceras* Hyatt, 1884 at the Tournaisian-Viséan boundary or slightly younger strata. They are particularly well known from Ireland (Foord 1900), northern England (Riley 1996), Belgium (de Koninck 1880), the Rhenish Mountains and the Harz (Holzapfel 1889; Schindewolf 1951; Korn 2006), the Cantabrian Mountains (Kullmann 1963), the Montagne Noire (Böhm 1935; Korn & Feist 2007), the Holy Cross Mountains in Poland (Dzik 1997), the Tien Shan in Kyrgyzstan (Popov 1968) and the Mouydir in Algeria (Ebbighausen *et al.* 2010).

Another unusual fact is the remarkable size of the material from Gara el Itima. Specimen MB.C.32199.2 is a fragment of a phragmocone with a whorl height of over 70 mm. This suggests that the conch, including the body chamber, had a diameter of approximately 360 mm. Large specimens of *Merocanites* have so far been known from early Viséan strata. Holzapfel (1889: pl. 5) illustrated a specimen of "*Prolecanites ceratitoides* von Buch" (= *Merocanites applanatus* Frech, 1899) nearly 200 mm in size and mentioned even larger specimens (Holzapfel 1889: 44). This material originates from the 'Erdbach Limestone' of the Kramberg near Erdbach in the Rhenish Mountains. Based on conodonts, this rock can be assigned to the early Viséan (Krebs 1968).

Pareyn (1961: pl. 6) illustrated a specimen of *Merocanites ogivalis* Pareyn, 1961 with a phragmocone diameter of nearly 200 mm, belonging to a conch with a diameter of almost 400 mm. This specimen came from the 'Série de Mazzer-Akacha' in the Saoura Valley of western Algeria. This assemblage can also be placed in the late Viséan based on the conodont fauna (Nemyrovska *et al.* 2006: 364).

In contrast, the representatives of *Merocanites* from the Tournaisian-Viséan boundary are often smaller. *Merocanites merocanites* Ebbighausen, Korn & Bockwinkel, 2010 from the Dalle à *Merocanites* of Timimoun in Algeria reaches a conch diameter 70 mm (Ebbighausen *et al.* 2010: 199), *M. djaprakensis* Librovitch, 1927 attains 120 mm (Popov 1968: 79) and *M. applanatus* from the 'Erdbach Limestone' of the Harz reaches a conch diameter about 150 mm (Korn 2006: 155). An exception is *Merocanites quadrilobus* Riley, 1996 from the Leagram Mudstone Member; the holotype has a phragmocone whorl height of 52 mm, corresponding to a total conch diameter of more than 250 mm (Riley 1996).

Merocanites consequius sp. nov.
urn:lsid:zoobank.org:act:15FA1A69-02FA-458B-9EDC-8877AC2C147C
Fig. 5; Table 2

Diagnosis

Species of *Merocanites* with a strongly applanate whorl cross section (ww/wh ~ 0.60 at 90 mm conch diameter); flanks flattened and subparallel and separated from the rounded venter by a rounded ventrolateral shoulder; umbilical margin rounded. Suture line with a small, V-shaped external lobe; three lobes present on the flanks, the adventive lobe is asymmetric with a steep dorsal flank, followed by the lateral lobe and the second umbilical lobe, which closely resemble each other. Width of the lateral lobe 0.26–0.28 of its depth.

Etymology

After the Latin '*consequius*' (adj. masc.) = 'following', because of the late occurrence of the species.

Type material

Holotype

MOROCCO – **Anti-Atlas** • Gara el Itima, near locality GI-J; 31°02.747′ N, 3°42.429′ W; Zrigat Formation, horizon GI-1 (Late Viséan); 2007; Korn *et al*. leg.; MB.C.32199.1; illustrated in Fig. 5B.

Paratypes

MOROCCO – **Anti-Atlas** • 3 specs; same data as for the holotype; MB.C.32199.2 to MB.C.32199.4.

Description

Holotype MB.C.32199.1 is the fragment of a phragmocone with a whorl height of 31 mm (Fig. 5B), which leads to a reconstructed phragmocone diameter of about 90 mm (Table 2). The ww/wh ratio is nearly 0.60. The whorl profile shows a semicircular venter, almost parallel and flattened flanks, a rounded umbilical margin and convex umbilical wall. The whorl embraces very little of the previous one.

The suture line has a small, V-shaped external lobe that is only half as deep as the three lobes on the flank (Fig. 5C). The outer of these three lobes, the adventive lobe, is asymmetrical with a strongly curved ventral and an almost vertical dorsal flank. Two more, almost identical lobes follow on the flank. Both are very narrow and deep; they are slightly wider than the neighbouring saddles. These lobes are slightly pouched and the saddles appear slightly inflated. On the umbilical wall there is another, short and V-shaped lobe. The internal lobe has parallel walls and is very narrow and very deep with nearly parallel flanks.

The larger paratype MB.C.32199.2 (71 mm wh) is also a fragment of the phragmocone and shows the same morphology as the holotype (Fig. 5A). The suture line is almost identical to that of the holotype.

Remarks

All species of *Merocanites* possess similar conch shapes, but differences can be recognised in the whorl profile, the width of the umbilicus and the suture line. It is important to note that the suture line changes during ontogeny, with the lobes on the flank becoming increasingly symmetrical and narrower during

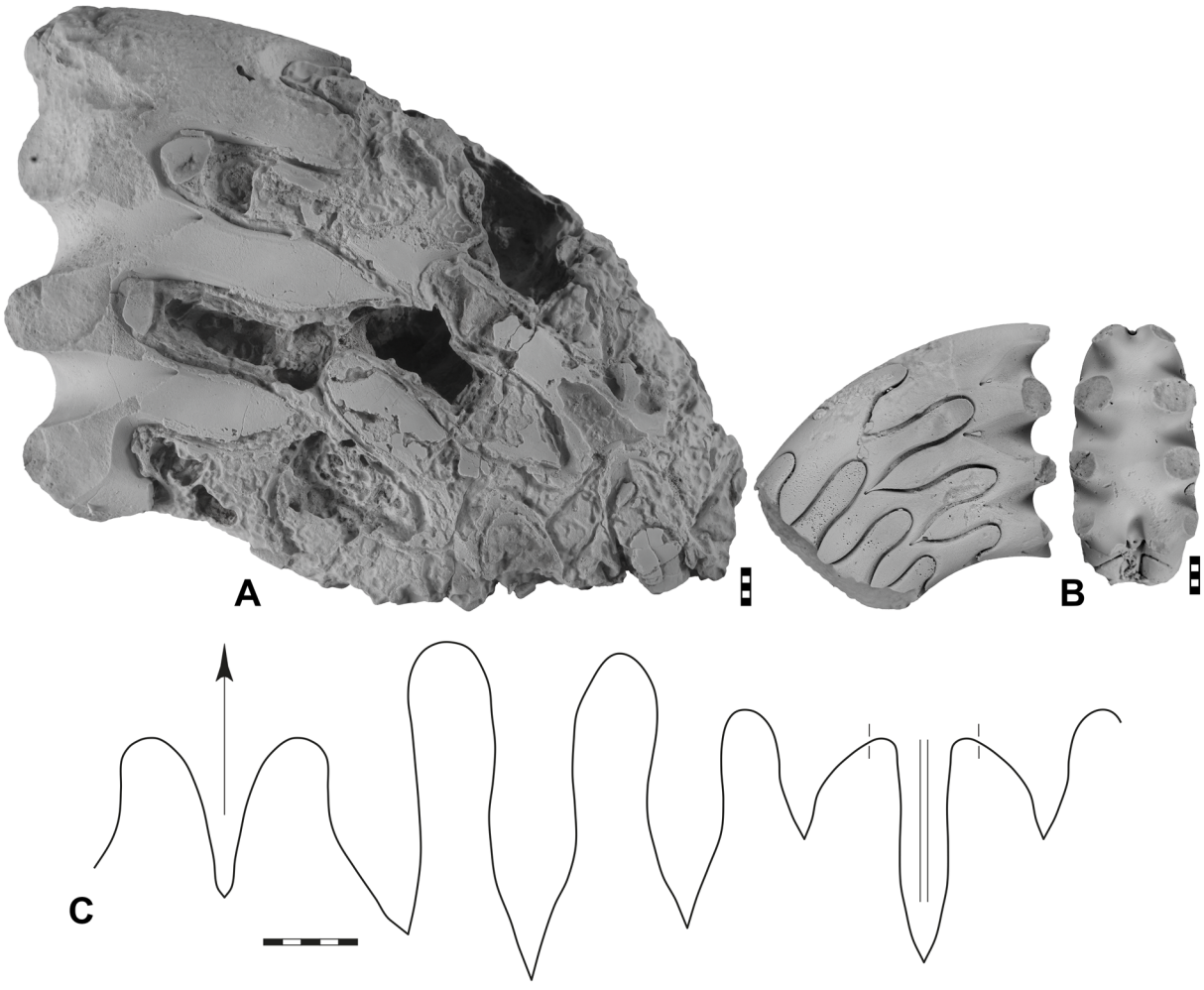

Fig. 5. *Merocanites consequius* sp. nov. from the Gara el Itima GI-J section (Korn *et al*. 2007 Coll.). **A**. Paratype MB.C.32199.2, lateral view. **B**. Holotype MB.C.32199.1, lateral and septal views. **C**. Holotype MB.C.32199.1, suture line, at ww = 16.5 mm, wh = 29.5 mm. Scale bar units = 1 mm.

Table 2. Conch dimensions and ratios of selected specimens of *Merocanites consequius* sp. nov. from the Gara el Itima; reconstructed values in italics.

	dm	ww	wh	uw	ah	ww/dm	ww/wh	uw/dm	WER	IZR
MB.C.32199.1	*90.0*	17.6	30.0	*37.5*	28.5	*0.20*	0.59	*0.42*	*2.14*	0.05
MB.C.32199.2	–	36.5	70.6	–	–	–	0.52	–	–	–

ontogeny. Any comparison of species must take this into account. A potential phylogenetic trend may also be discernible, with younger species displaying narrower lobes compared to older ones.

Merocanites consequius belongs to those species that already exhibit very narrow lobes at a relatively early ontogenetic stage, with a whorl height of 30 mm. The lateral lobe has a width-to-depth ratio of 0.26, compared to approximately 0.30 in *M. quadrilobus*. A similar suture line to *M. consequius* can be found in *M. ogivalis*, but this species differs from *M. consequius* by having a significantly narrower umbilicus (uw/dm = 0.32) than *M. consequius* (uw/dm > 0.40).

Discussion

A small ammonoid assemblage from Gara el Itima (eastern Anti-Atlas, Morocco), which can be dated to the late Asbian (early Late Viséan) based on the species *Goniatites rodioni*, is notable for its unusual composition in several respects:

(1) In addition to *Goniatites rodioni*, the four-species assemblage includes specimens of the newly described genus and species *Xenoglyphioceras eidos* gen. et sp. nov. This species probably occupies a morphological position between the genera *Beyrichoceras* Foord, 1903 and *Ferganoceras* Librovitch, 1957, and thus between the families Maxigoniatitidae Korn, Klug & Mapes, 1999 and Ferganoceratidae Ruzhencev, 1960. The new genus could therefore also be significant for the Neoglyphioceratoidea Plummer & Scott, 1937, as the phylogenetic origin of this superfamily has not yet been clarified.

(2) Another noteworthy component of the assemblage described here is the newly established species *Merocanites consequius*. *Merocanites* is a genus whose representatives are primarily known from strata of the Tournaisian-Viséan boundary and the early Viséan. One of the newly discovered specimens had a conch diameter of over 35 cm, a size that is extraordinarily rare among ammonoids from the Late Viséan.

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