

Research article

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## Early Carboniferous nautiloids from the Central Sahara, southern Algeria

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**Abstract.** Coiled nautiloids of the Tournaisian and early to middle Viséan (Early Carboniferous) have so far only become known from a few regions. Here we describe material from five localities in southern Algeria; these belong to four stratigraphic horizons (two horizons in the late Tournaisian, one horizon near the Tournaisian–Viséan boundary, one horizon in the early to middle Viséan). From these, the new genera *Stroborineceras* gen. nov. and *Trilobitoceras* gen. nov. and the following new species are described: *Rineceras tenerum* sp. nov., *Stroborineceras insalahensis* gen. et sp. nov., *Stroborineceras felis* gen. et sp. nov., *Stroboceras mane* sp. nov., *Stroboceras ancilis* sp. nov., *Vestinautilus angulatus* sp. nov., *Vestinautilus papilio* sp. nov., *Vestinautilus inflexus* sp. nov., *Vestinautilus bicristatus* sp. nov., *Trilobitoceras peculiaris* gen. et sp. nov., *Aphelaeceras azzelmattiense* sp. nov., *Maccoyoceras saharensis* sp. nov., *Maccoyoceras habadraense* sp. nov. and *Maccoyoceras concavum* sp. nov.

**Keywords.** Nautiloidea, Early Carboniferous, Algeria, morphology.

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### Introduction

The coiled nautiloids underwent a very irregular evolution, in which periods of rapid or slow morphological development alternated with declines in morphological diversity (Dzik 1984). A phase with strongly restricted diversity is the Late Devonian up to across the Devonian–Carboniferous boundary; very few records are known from either side of this biocrisis. For instance, only a few finds are known from the Famennian. Dzik & Korn (1992) described the new genus *Dasbergoceras* with the species ‘*Cyrtoceras alternans*’ from the topmost Late Devonian Wocklum Limestone, a species previously reported by Tietze (1871) from Silesia. The better specimens from the Rhenish Mountains still represent the only well-preserved material of latest Famennian nautiloids.

Coiled nautiloids from the earliest Carboniferous, i.e., the early Tournaisian, have apparently not yet become known; this means that there is a record gap of several million years. Only from the middle and late Tournaisian are coiled nautiloids known from various areas:

- (1) American Midcontinent: middle to early late Tournaisian nautiloids were described from the Chouteau Limestone of Missouri (Miller & Furnish 1939), the Rockford Limestone of Indiana (Gutschick & Treckman 1957) and the Marshall Sandstone of Michigan (Miller & Garner 1953). These three formations are among the oldest strata yielding Carboniferous nautiloids.
- (2) Belgium: from the ‘calschiste des environs de Tournai’ de Koninck (1844, 1878, 1880) described numerous nautiloids, probably from different stratigraphic horizons in the early late Tournaisian.

Here, we describe some Early Carboniferous coiled nautiloids with emphasis on early late Tournaisian assemblages. Most of them come from the central Sahara Desert of the Mouydir area (South Algeria). Because of their stratigraphic position slightly above the nautiloid gap spanning the Devonian–Carboniferous boundary, they contribute to the knowledge of the evolutionary history of this hitherto comparatively little studied fossil group. It is, after the description of the nautiloids from the Dalle à *Merocanites* of Timimoun (Korn *et al.* 2022), so far only the second monographic treatment of Carboniferous nautiloids from North Africa.

## Material and methods

A total of 108 specimens were examined, they come from the following localities (Fig. 1) and stratigraphic horizons (Fig. 2):

- (1) Sebkhia de Timimoun 14.5 km west-southwest of Timimoun (locality TIM-C8); Argiles de Timimoun supérieur (Upper *Bollandoceras* Assemblage; early to middle Viséan). The locality and its stratigraphy were outlined by Conrad (1984); the diverse ammonoid assemblage was monographically described by Bockwinkel *et al.* (2010).

*Stroboceras ancilis* sp. nov.  
*Stroboceras* sp.

5 specimens  
 1 specimen

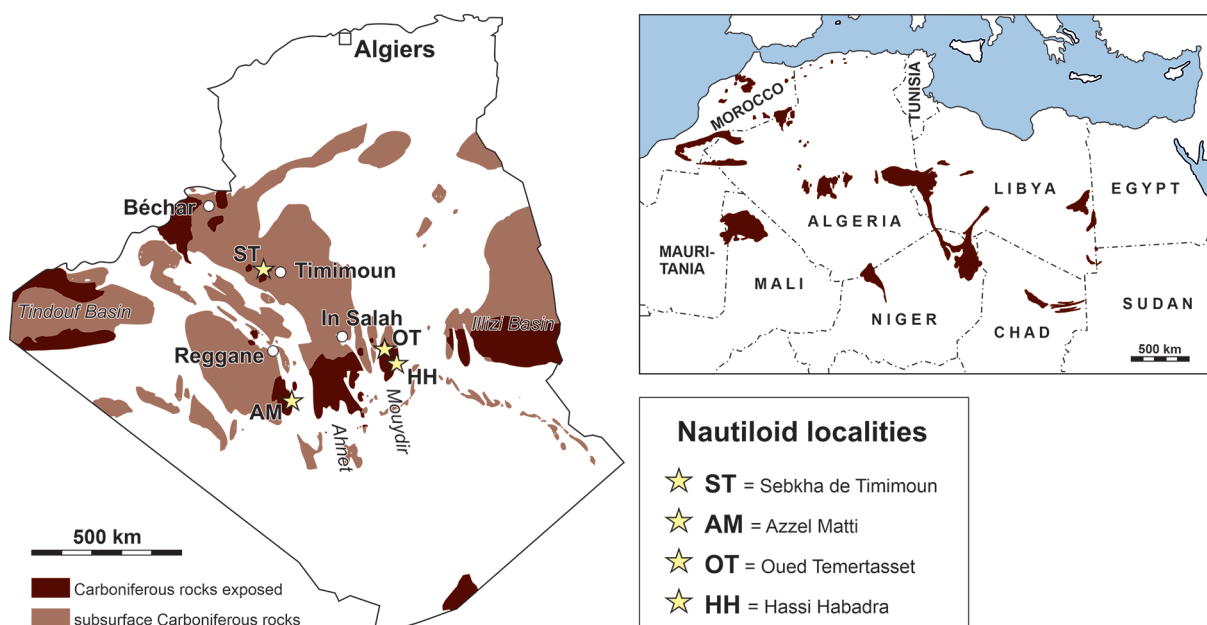


Fig. 1. Geographic position of the fossil sites with the coiled nautiloid specimens described here.

- (2) Sebkhâ de Timimoun 11 km south-west of Timimoun (locality TIM-B0); grès du Kahla supérieur (early late Tournaisian). The ammonoid assemblages were described by Korn *et al.* (2010a).

*Stroborineceras insalahensis* gen. et sp. nov. 1 specimen  
*Stroborineceras* sp. 6 specimens  
*Vestinautilus angulatus* sp. nov. 1 specimen

- (3) West-southwest of Gara Azzel Matti (Ahnet), 150 kilometres south-southeast of Reggane; 25.4732° N, 0.7067° E); Dalle des Iridet (*Ammonellipsites-Merocanites* Assemblage; Tournaisian–Viséan boundary interval). The stratigraphic section and the world-famous mud mounds of this locality were described by Wendt *et al.* (1997, 2009), ammonoids were described by Korn *et al.* (2010b).

*Aphelaeceras azzelmattiense* sp. nov. 2 specimens  
*Maccoyoceras concavum* sp. nov. 1 specimen  
*Lispoceras* sp. 2 1 specimen

- (4) Area of Oued Temertasset, 150 kilometres east-southeast of the town In Salah (central coordinates: 26.6178° N, 3.8392° E); Argiles de Teguentour. The fossil site was probably discovered by Follot (1951) and later mentioned by Conrad & Pareyn (1968) and Conrad (1984). Korn *et al.* (2010c) described diverse ammonoid assemblages from a number of localities in this area; the nautiloid-bearing single assemblages can, according to their lithology, be grouped in two stratigraphic units. Haematitic specimens represent the upper *Pericyclus-Progoniatites* Assemblage and sideritic specimens are from the younger *Helicocyclus-Ouaoufilalites* Assemblage. Both are early late Tournaisian in age.

*Pericyclus-Progoniatites* Assemblage:  
*Rineceras tenerum* sp. nov. 10 specimens  
*Stroborineceras insalahensis* gen. et sp. nov. 22 specimens

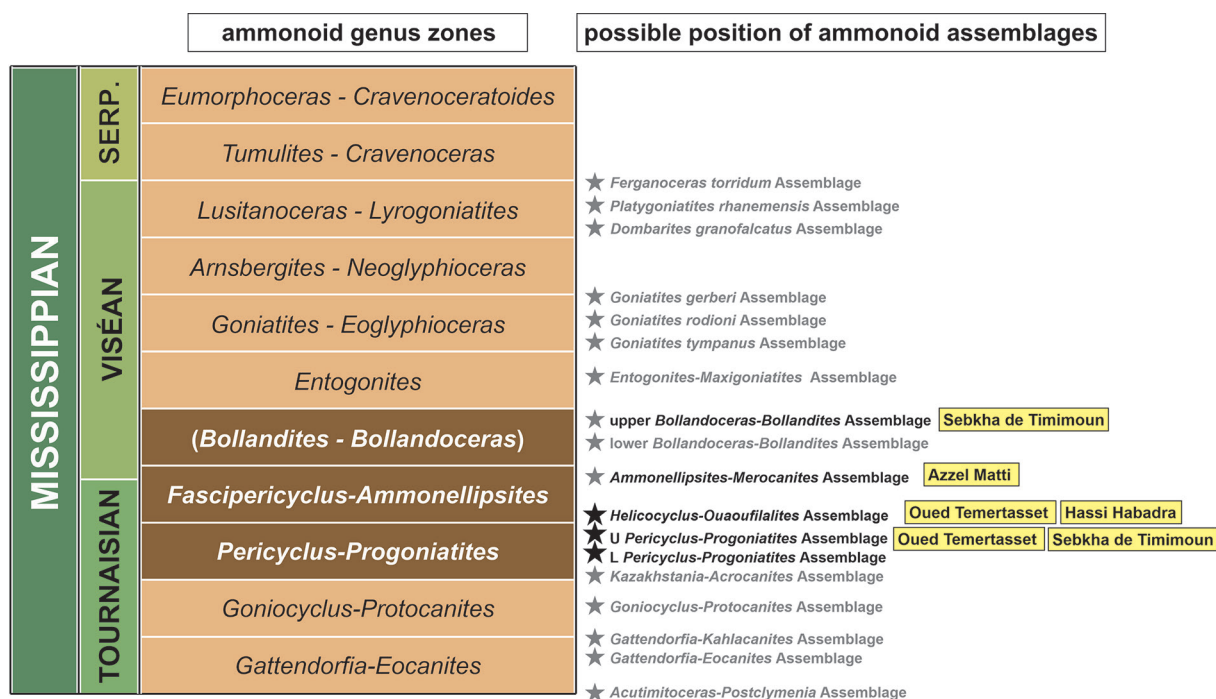


Fig. 2. Stratigraphic position of the fossil sites with the coiled nautiloid specimens described here.

<i>Stroborinoceras felis</i> gen. et sp. nov.	1 specimen
<i>Stroboceras mane</i> sp. nov.	2 specimens
<i>Vestinautilus angulatus</i> sp. nov.	22 specimens
<i>Vestinautilus papilio</i> sp. nov.	12 specimens
<i>Vestinautilus inflexus</i> sp. nov.	3 specimens
<i>Trilobitoceras peculiaris</i> gen. et sp. nov.	2 specimens
<i>Maccoyoceras saharensis</i> sp. nov.	9 specimens

*Helicocyclus-Ouaoufilalites* Assemblage:

<i>Vestinautilus bicristatus</i> sp. nov.	4 specimens
<i>Vestinautilus</i> sp.	1 specimen
<i>Lispoceras</i> sp. 1	1 specimen

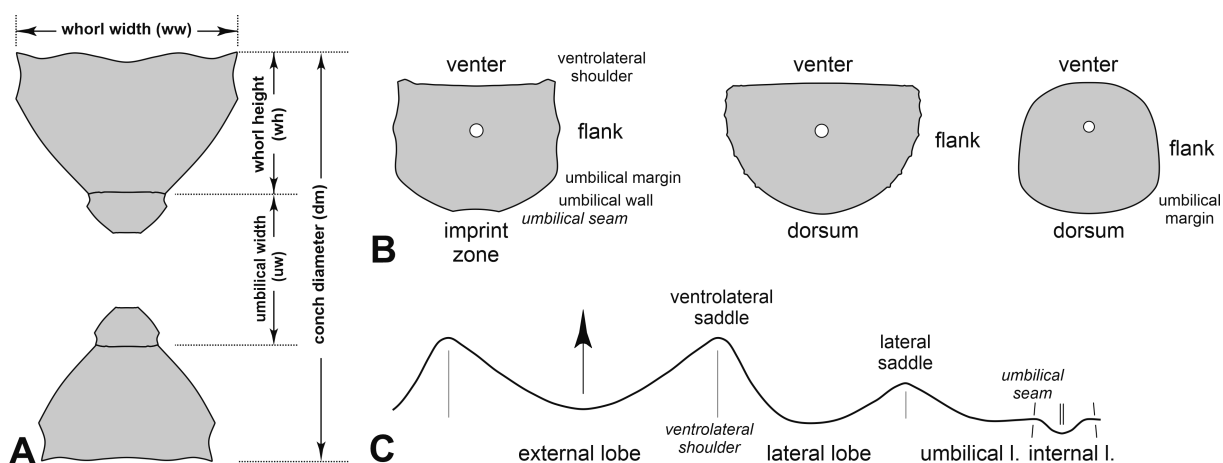
(5) Area of Hassi Habadra, 180 kilometres east-southeast of the town In Salah (central coordinates: 26.6178° N, 3.8392° E); Argiles de Teguentour (*Helicocyclus-Ouaoufilalites* Assemblage).

<i>Maccoyoceras habadraense</i> sp. nov.	1 specimen
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The material is present in three different types of preservation, depending on the lithology of the fossil-bearing strata:

- (1) Calcitic – the specimens from Azzel Matti come from carbonate layers of the ‘Dalle des Iridet’; they are preserved as internal moulds with partial shell preservation.
- (2) Sideritic – the specimens from Hassi Habadra and the locality MOU-C1 of Oued Temertasset are sideritic nodules. They are mostly internal moulds with rare shell preservation.
- (3) Haematitic – all others, and in fact the vast majority of the specimens, are from dark shales and are preserved as internal moulds. Almost the complete material consists of phragmocone fragments; body chambers are rarely present. In most cases the fragments are quite small and belonged to specimens less than 50 mm in diameter.

The description of the specimens follows the terminology of conch, ornament and suture line proposed by Korn (2010) and Klug *et al.* (2015) for the description of ammonoids (Fig. 3). The terminology of conch geometry used here largely corresponds to that proposed by Teichert (1964). The only differences are in the following terms: umbilical angle or shoulder (= umbilical margin) and umbilical area (= umbilical width).



**Fig. 3.** The conch and suture line parameters used in the taxonomic descriptions. **A.** Conch parameters. **B.** Descriptive terms of whorl profiles. **C.** Suture line terminology.



### Abbreviations

ah	=	apertural height
dm	=	conch diameter
IZR	=	imprint zone rate
MB.C.	=	Cephalopod collection of the Museum für Naturkunde, Berlin
uw	=	umbilical width
WER	=	whorl expansion rate
wh	=	whorl height
ww	=	whorl width

### Results

Order Nautilida Agassiz, 1847  
Suborder Tainoceratina Shimansky, 1957  
Superfamily Trigonoceratoidea Hyatt, 1884  
Family Trigonoceratidae Hyatt, 1884

Genus *Rineceras* Hyatt, 1893

### Type species

*Gyroceras propinquum* de Koninck, 1880; subsequent designation by Foord (1900).

### Diagnosis

Genus of the family Trigonoceratidae with evolute conch; whorls detached or slightly in contact; whorl profile elliptical or rounded-triangular with broad venter. Ornament with coarse growth lines and fine or coarse spiral lines; coarse granulation at the crossing points of growth lines and spiral ridges. Suture line with shallow external and lateral lobes. Siphuncle small with subcentral position (after Kummel 1964; emended by Korn *et al.* 2022).

### Included Early Carboniferous species

*Rhineceras alapaevskensis* Kruglov, 1934, Urals; *Pararineceras balladoolense* Turner, 1954, Isle of Man; *Nautilus canaliculatus* von Eichwald, 1857, South Urals; *Rineceras carinatiforme* Shimansky, 1967, Kazakhstan; *Nautilus carinatus* von Eichwald, 1857, Western Russia; *Nautilus (Discus) digonus* Meek & Worthen, 1860, Indiana; *Nautilus Luidii* Fleming, 1828, Derbyshire; *Gyroceras Meyerianum* de Koninck, 1844, Belgium; *Rineceras multituberculatum* Korn, Miao & Bockwinkel, 2022, Algeria; *Rineceras ohioense* Miller & Garner, 1953, Ohio; *Triboloceras patteiskyi* Schmidt, 1951, Rhenish Mountains; *Gyroceras propinquum* de Koninck, 1880, Belgium; *Rineceras rectangulatum* Korn, Miao & Bockwinkel, 2022, Algeria; *Nautilus rhenanus* Holzappel, 1889, Rhenish Mountains; *Rineceras tenerum* sp. nov., Algeria.

### Remarks

Due to differing opinions on the significance of the general shape of the conch, there is disagreement on the species spectrum of the genus *Rineceras*. Turner (1953) revised the species originally described by Martin (1793, 1809) as “Conchylolithus N. Ammonites (*Luidii*)”, and subsequently, he introduced the genus *Pararineceras* on the basis of this species (Turner 1954). This species differs from the type species of *Rineceras* only by the more densely coiled conch and the supposed “straightening out in late maturity”. The first of these two characters might be gradual and not useful for a separation of genera and the second cannot really be demonstrated in the holotype, which has a conch diameter of only 28 mm.

Kummel (1964) accepted both genera without providing clear distinguishing characters, but Shimansky (1967) and Dzik (1984) regarded *Pararineceras* as a synonym of *Rineceras*. In the following, we treat *Pararineceras* as a junior synonym of *Rineceras* until a clear separation can be demonstrated.

*Rineceras* is restricted here to those species that have a whorl profile with a rounded outline. This means that the species *Nautilus (Trematodiscus) Meekianus* Winchell, 1862 and *Nautilus (Trematodiscus) strigatus* Winchell, 1862, both with longitudinal grooves on the venter, placed in *Rineceras* by Miller & Garner (1953), are excluded from *Rineceras* and listed in the new genus *Stroborineceras* gen. nov.

*Rineceras* belongs to the ancestral Early Carboniferous genera in the evolution of the nautilid family Trigonoceratidae. This is supported not only by the early stratigraphic occurrence in strata of the early late Tournaisian, but also by the morphology with a rather simple overall whorl profile without the longitudinal grooves and ridges often present in many derived forms, which there lead to a more complex geometry.

***Rineceras tenerum* sp. nov.**

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Figs 4–5, Table 1

**Diagnosis**

Species of *Rineceras* with weakly depressed, rounded-trapezoidal whorl profile ( $ww/wh \sim 1.45$ ), venter slightly flattened, ventrolateral shoulder broadly rounded. Whorls not embracing. Ornament with a few spiral lines on the flank and the venter.

**Etymology**

From the Latin ‘*tenerum*’, meaning ‘tender’ and referring to the comparatively delicate spiral lines.

**Type material**

**Holotype**

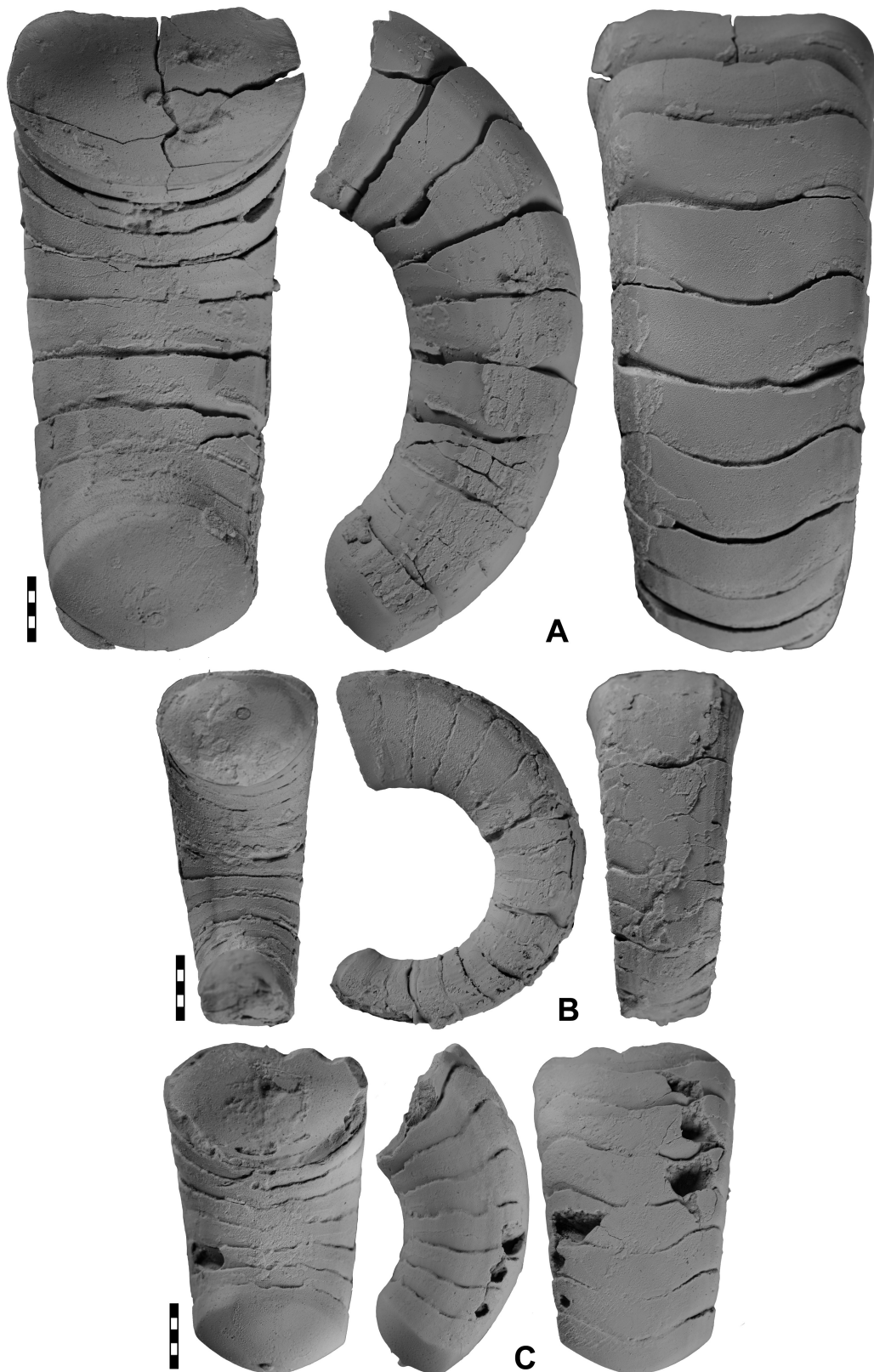
ALGERIA • Mouydir, south of Oued Temertasset (locality MOU-Z); Argiles de Teguentour (Upper *Pericyclus-Progoniatites* Assemblage; early late Tournaisian); Korn *et al.* 2002 Coll.; illustrated in Fig. 4A–B; MB.C.30440.1.

**Paratypes**

ALGERIA • 1 specimen; Mouydir, south of Oued Temertasset (locality MOU-E07); Argiles de Teguentour (Upper *Pericyclus-Progoniatites* Assemblage; early late Tournaisian); Korn *et al.* 2002 Coll.; illustrated in Fig. 4C; MB.C.30441 • 8 specimens; Mouydir, south of Oued Temertasset (localities MOU-Z, MOU-C5, MOU-B1, MOU-D1); Argiles de Teguentour (Upper *Pericyclus-Progoniatites* Assemblage; early late Tournaisian); Korn *et al.* 2002 Coll.; MB.C.30440.2, MB.C.30442, MB.C.30443.1–MB.C.30443.2, MB.C.30444.1–MB.C.30444.4.

**Description**

Holotype MB.C.30440.1 is a haematitic internal mould consisting of two fully chambered segments; however, some chambers between the two segments are missing (Fig. 4A–B). The total diameter is about 49 mm. At this diameter, the whorl profile is rounded-triangular with a somewhat flattened venter and continuously rounded dorsum. There is no overlap upon the previous whorl (Fig. 5A). On the flanks and the outer part of the venter, there are twelve spiral lines on each side. The suture line shows a low amplitude; there is a wide, shallow external lobe and a low, tightly rounded ventrolateral saddle. On the flanks and dorsum the suture line is almost straight (Fig. 5B).



**Fig. 4.** *Rinoceras tenerum* sp. nov. from Oued Temertasset (all Korn *et al.* 2002 Coll.). **A.** Holotype MB.C.30440.1 (larger segment). **B.** Holotype MB.C.30440.1 (smaller segment). **C.** Paratype MB.C.30441. Scale bar units=1 mm.

**Table 1.** Conch dimensions (in mm) and ratios of *Rineceras tenerum* sp. nov.

Specimen	dm	ww	wh	uw	ah	ww/dm	ww/wh	uw/dm	WER	IZW
MB.C.30440.1	48.8	21.4	14.7	23.5	14.7	0.44	1.45	0.48	2.05	0.00
MB.C.30440.1	27.7	12.7	9.4	13.3	9.4	0.46	1.35	0.48	2.29	0.00
MB.C.30442	–	32.5	21.9	–	–	–	1.48	–	–	–
MB.C.30441	–	15.6	10.9	–	–	–	1.49	–	–	–

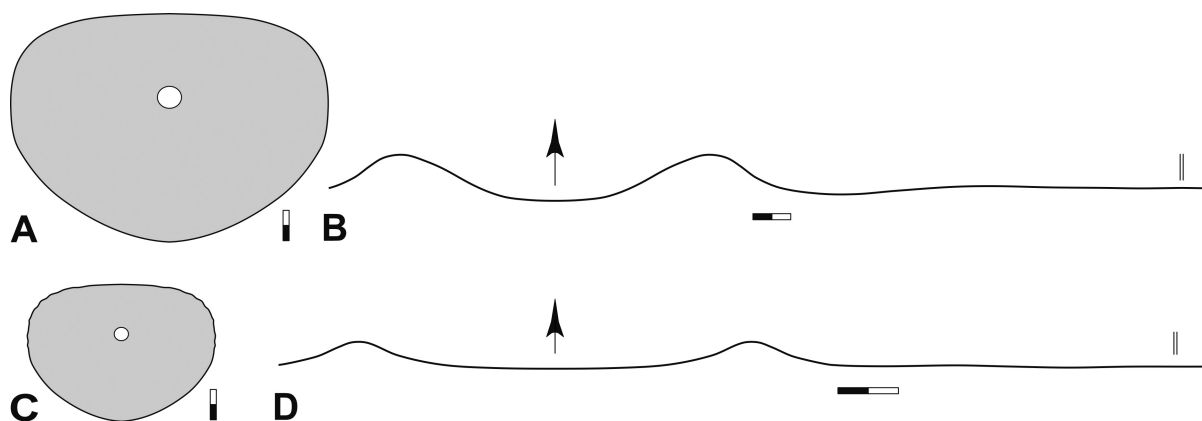
The segment of the younger stage (Fig. 4B) shows the conch dimensions and proportions better. The conch is evolute at 28 mm diameter ( $uw/dm=0.48$ ). The whorl profile is similar to the large segment, but the venter is slightly more flattened and the ventrolateral shoulder is more pronounced with a very shallow submarginal ventral groove (Fig. 5C). From the margin of the venter and on the flank, there are about 12 spiral lines. However, it can be seen that the number of spiral lines decreases during ontogeny; over a distance of 180 degrees, the initially coarse spiral lines in the submarginal area of the venter become weaker gradually. The siphuncle has a position slightly off centre on the ventral side. The suture line shows a broad and shallow external lobe and a very shallow lateral lobe (Fig. 5D).

Paratype MB.C.30441 closely resembles the holotype but has a slightly more pronounced ventrolateral shoulder (Fig. 4C). The large unfigured paratype MB.C.30442 has, at a whorl height of 21 mm, a whorl profile almost identical to the holotype; it also possesses twelve coarse spiral lines on the flanks and the outer part of the venter.

**Remarks**

The species of the genus *Rineceras* can be divided into different groups according to various aspects: general conch shape (whorls detached or embracing), whorl profile (depressed oval, rounded-triangular or trapezoidal), formation of the ventrolateral shoulder (rounded or angular), spiral ornament (spirals equally strong or differently strong) etc.

*Rineceras tenerum* sp. nov. differs from all other species of the genus by the combination of rather weak spiral lines that are restricted to the flank, the non-embracing whorls, and the whorl profile with a rounded-triangular outline.



**Fig. 5.** *Rineceras tenerum* sp. nov., holotype MB.C.30440.1 (Korn *et al.* 2002 Coll.) from Oued Temertasset. **A.** Whorl profile of the larger segment. **B.** Suture line, at  $ww=19.7$  mm,  $wh=13.7$  mm. **C.** Whorl profile of the smaller segment. **D.** Suture line, at  $dm=26.3$  mm,  $ww=11.3$  mm,  $wh=8.0$  mm. Scale bar units=1 mm.

Genus *Stroborineceras* gen. nov.

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### Type species

*Stroborineceras insalahensis* gen. et sp. nov.

### Diagnosis

Genus of the family Trigonoceratidae with evolute conch; whorls not embracing; whorl profile depressed and rounded-triangular (escutcheon-shaped) with flattened or weakly concave venter and pronounced ventrolateral shoulders. Ornament with some spiral ridges on the flank, sometimes also on the margin of the venter. Suture line with broad, shallow external lobe and narrowly rounded ventrolateral saddle. Siphuncle small with subcentral position slightly shifted towards the venter.

### Etymology

A combination of the two genus names *Stroboceras* and *Rineceras*, because of the presence of characters of both genera in the new genus.

### Included species

*Stroborineceras insalahensis* gen. et sp. nov., Algeria; *Stroborineceras felis* gen. et sp. nov., Algeria; and questionably *Nautilus (Trematodiscus) Meekianus* Winchell, 1862, Michigan and *Nautilus (Trematodiscus) strigatus* Winchell, 1862, Michigan.

### Remarks

*Stroborineceras* gen. nov. combines the morphological features of the apparently ancestral genus *Rineceras* (simple whorl profile and spiral lines on the flank) and descendant genera such as *Stroboceras* or *Vestinautilus* (pronounced ventrolateral shoulder with sharp longitudinal ridges and submarginal ventral grooves).

*Stroborineceras* gen. nov. differs from *Rineceras* in the more pronounced ventrolateral shoulder, which is reinforced by some raised longitudinal ridges, whereas in *Rineceras* it is rounded. In addition, the submarginal ventral longitudinal groove, which in *Rineceras* is only present on the juvenile stage, is still distinct in *Stroborineceras* gen. nov. in the middle growth stage.

*Stroborineceras* gen. nov. differs from *Stroboceras* and *Vestinautilus* in the absence of the strong longitudinal ridges and broad longitudinal grooves that cause a polygonal whorl profile in these two genera. Instead, *Stroborineceras* gen. nov. merely has spiral lines on the flanks.

*Stroborineceras insalahensis* gen. et sp. nov.

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Figs 6–7, Table 2

### Diagnosis

Species of *Stroborineceras* gen. nov. with depressed, rounded-triangular whorl profile ( $ww/wh \sim 1.50$ ), venter strongly flattened, ventrolateral shoulder subangular with sharp longitudinal ridges. Whorls not embracing. Ornament with fine spiral ridges in the submarginal ventral position; five or six spiral ridges are located on the flank.

### Etymology

Named after the town of In Salah in the central Sahara Desert.



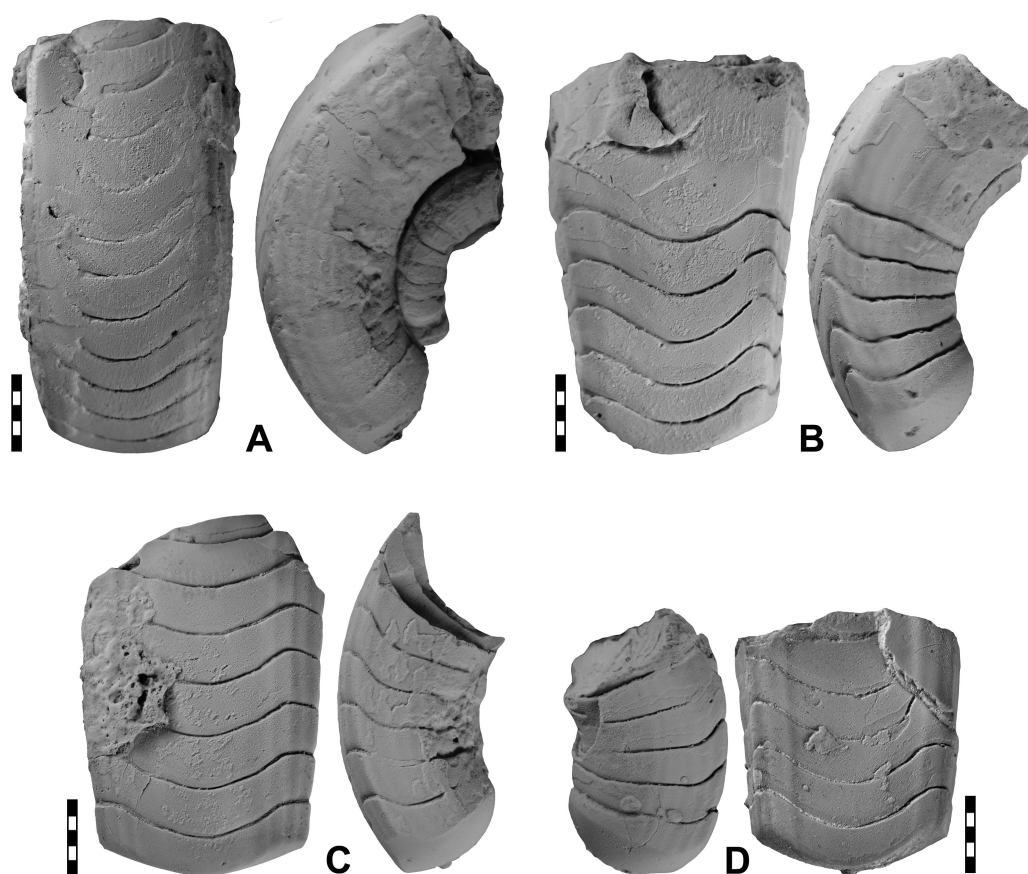
## Type material

### Holotype

ALGERIA • Mouydir, south of Oued Temertasset (locality MOU-E07); Argiles de Teguentour (Upper *Pericyclus-Progoniatites* Assemblage; early late Tournaisian); Korn *et al.* 2002 Coll.; illustrated in Fig. 6B; MB.C.30445.1.

### Paratypes

ALGERIA • 2 specimens; Mouydir, south of Oued Temertasset (locality MOU-E07); Argiles de Teguentour (Upper *Pericyclus-Progoniatites* Assemblage; early late Tournaisian); Korn *et al.* 2002 Coll.; illustrated in Fig. 6A, C; MB.C.30445.2–MB.C.30445.3 • 1 specimen; Mouydir, south of Oued Temertasset (locality MOU-D2); Argiles de Teguentour (Upper *Pericyclus-Progoniatites* Assemblage; early late Tournaisian); Korn *et al.* 2002 Coll.; illustrated in Fig. 6D; MB.C.30446.1 • 18 specimens; Mouydir, south of Oued Temertasset (localities MOU-D2, MOU-A, MOU-C5, MOU-D1, MOU-E06, MOU-V, MOU-Z); Argiles de Teguentour (Upper *Pericyclus-Progoniatites* Assemblage; early late Tournaisian); Korn *et al.* 2002 Coll.; MB.C.30446.2, MB.C.30447.1–MB.C.30447.4, MB.C.30448.1–MB.C.30448.2, MB.C.30449.1–MB.C.30449.6, MB.C.30450, MB.C.30451, MB.C.30452.1–MB.C.30452.3 • 1 specimen; Sebkhha de Timimoun 11 km south-west of Timimoun (locality TIM-B0); Grès de Kahla supérieur (Upper *Pericyclus-Progoniatites* Assemblage; early late Tournaisian); Korn *et al.* 2002 Coll.; MB.C.30453.



**Fig. 6.** *Strobolineceras insalahensis* gen. et sp. nov. from Oued Temertasset (all Korn *et al.* 2002 Coll.). A. Paratype MB.C.30445.2. B. Holotype MB.C.30445.1. C. Paratype MB.C.30445.3. D. Paratype MB.C.30446.1. Scale bar units = 1 mm.

**Table 2.** Conch dimensions (in mm) and ratios of *Stroborineceras insalahensis* gen. et sp. nov.

Specimen	dm	ww	wh	uw	ah	ww/dm	ww/wh	uw/dm	WER	IZW
MB.C.30445.3	–	15.9	10.4	–	–	–	1.53	–	–	–
MB.C.30445.1	–	15.6	10.3	–	–	–	1.51	–	–	–
MB.C.30446.1	–	14.5	9.3	–	–	–	1.56	–	–	–
MB.C.30445.2	–	13.6	9.2	–	–	–	1.49	–	–	–

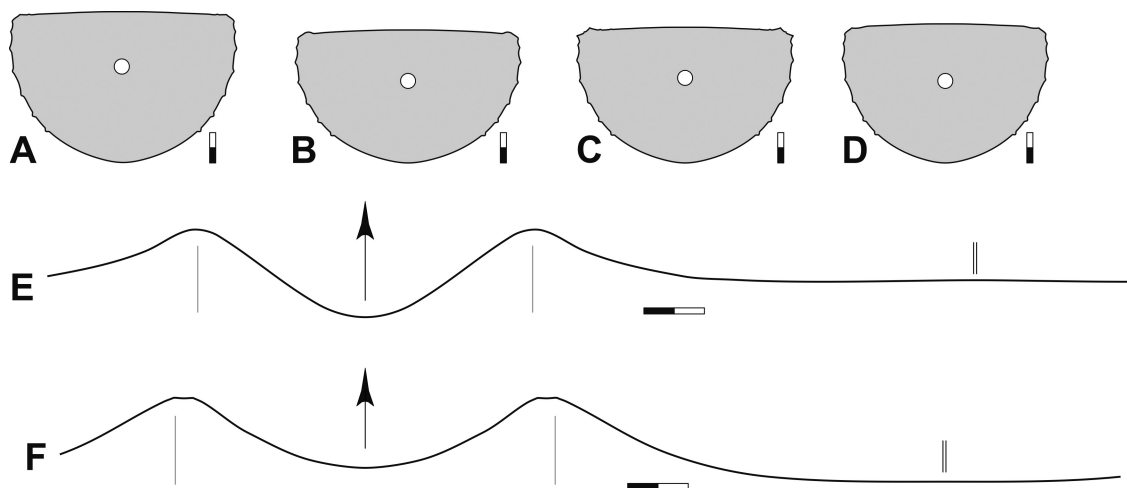
### Description

Holotype MB.C.30445.1 is a whorl fragment of about 90 degrees angular length, consisting of the last chambers of the phragmocone and part of the body chamber (Fig. 6B). The maximum whorl height is 11 mm. The whorl profile is rounded-triangular and depressed ( $ww/wh=1.51$ ) with a flattened venter and an almost semi-circular area encompassing the flanks and dorsum (Fig. 7A); the ventrolateral shoulder is subangular. The specimen bears at least eight longitudinal lines, two of which are on the edge of the venter and six on the flank. The suture line shows a broad, almost semi-circular external lobe, a tightly rounded ventrolateral saddle and a shallow and very broad lateral lobe. On the dorsum the suture line shows an almost straight course (Fig. 7E).

The paratypes illustrate that the variation is quite low; all specimens show very similar whorl profiles, ornament and suture line. Compared to the holotype, the paratype MB.C.30445.2 (Fig. 6A) has more strongly developed spiral lines on the flanks and the paratypes MB.C.30445.3 (Fig. 6C) and MB.C.30446.1 (Fig. 6D) show slightly more distinct submarginal ridges on the venter.

### Remarks

*Stroborineceras insalahensis* gen. et sp. nov. differs from *S. felis* gen. et sp. nov. by the more depressed whorl profile ( $ww/wh=1.55$  in *S. insalahensis* gen. et sp. nov. but only 1.25 in *S. felis* gen. et sp. nov.), by the flattened or weakly convex venter (concave in *S. felis* gen. et sp. nov.) and by the considerably stronger spiral lines (weakly developed and absent on the venter in *S. felis* gen. et sp. nov.).



**Fig. 7.** *Stroborineceras insalahensis* gen. et sp. nov. from Oued Temertasset (all Korn *et al.* 2002 Coll.). **A.** Whorl profile of holotype MB.C.30445.1. **B.** Whorl profile of paratype MB.C.30446.1. **C.** Whorl profile of paratype MB.C.30445.3. **D.** Whorl profile of paratype MB.C.30445.2. **E.** Suture line of holotype MB.C.30445.1, at  $ww=15.3$  mm,  $wh=10.2$  mm. **F.** Suture line of paratype MB.C.30445.3, at  $ww=15.1$  mm,  $wh=9.8$  mm. Scale bar units=1 mm.

*Stroborineceras felis* gen. et sp. nov.

urn:lsid:zoobank.org:act:406664D9-FD31-430B-8988-AD7510B6B36A

Fig. 8, Table 3

**Diagnosis**

Species of *Stroborineceras* gen. nov. with weakly depressed, rounded-pentagonal whorl profile (ww/wh  $\sim 1.20$ ), venter concave, ventrolateral shoulder angular. Whorls not embracing. Ornament with five faint spiral ridges located on the flank.

**Etymology**

From the Latin '*felis*', meaning 'cat' and referring to the characteristic whorl profile resembling a cat's head.

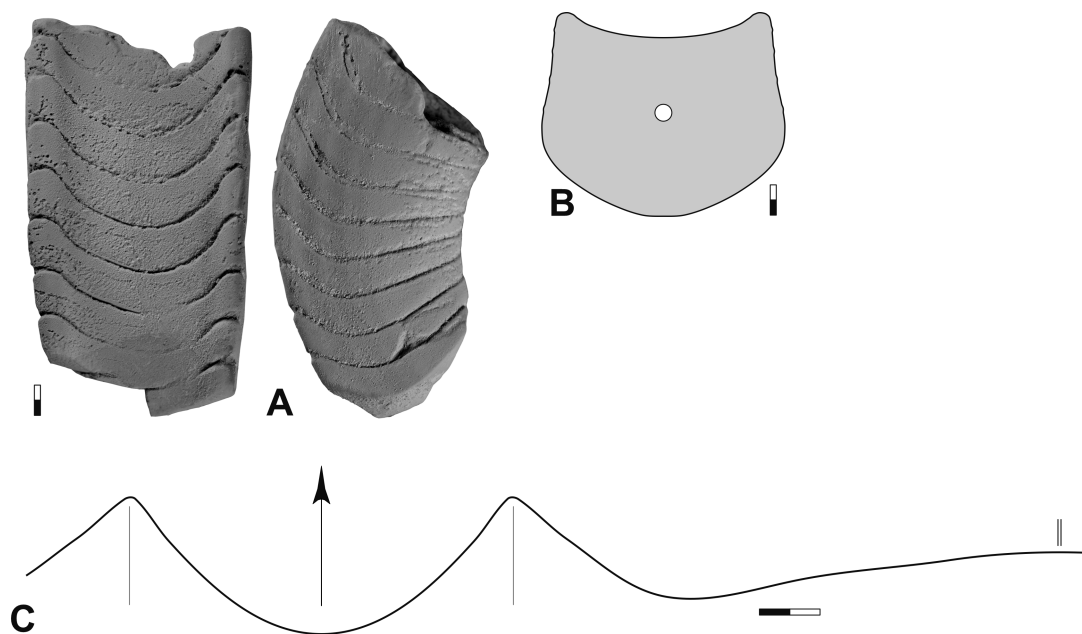
**Type material**

**Holotype**

ALGERIA • Mouydir, south of Oued Temertasset (locality MOU-D1); Argiles de Teguentour (Upper *Pericyclus-Progoniatites* Assemblage; early late Tournaisian); Korn *et al.* 2002 Coll.; illustrated in Fig. 8A; MB.C.30454.

**Description**

Holotype MB.C.30454 is a phragmocone fragment of slightly less than 90 degrees in length (Fig. 8A). It reaches a whorl height of 13 mm and the profile is weakly depressed (ww/wh = 1.22). The characteristic whorl profile has the outline of a cat's head shape (Fig. 8B); its general shape is rounded-pentagonal. The venter is concavely incurved and is bordered by the very prominent, angular ventrolateral shoulder. The profile is widest at the middle of the whorl height; from here the flanks converge with a slight concave incurvation. The dorsum is broadly rounded. On the flank about five spiral lines are visible; they become weaker towards the dorsum. The suture line shows a deep, almost semicircular external



**Fig. 8.** *Stroborineceras felis* gen. et sp. nov., holotype MB.C.30454 (Korn *et al.* 2002 Coll.) from Oued Temertasset. **A.** Ventral and lateral views. **B.** Whorl profile. **C.** Suture line, at ww=15.6 mm, wh=12.7 mm. Scale bar units=1 mm.

**Table 3.** Conch dimensions (in mm) and ratios of *Stroborineceras felis* gen. et sp. nov.

Specimen	dm	ww	wh	uw	ah	ww/dm	ww/wh	uw/dm	WER	IZW
MB.C.30454	–	16.0	13.1	–	–	–	1.22	–	–	–

lobe, a subacute ventrolateral saddle, a shallow, very broadly rounded lateral lobe and a very broad, low internal saddle (Fig. 8C).

### Remarks

*Stroborineceras felis* gen. et sp. nov. differs from *S. insalahensis* gen. et sp. nov. by the less depressed whorl profile ( $ww/wh \sim 1.25$  in *S. felis* gen. et sp. nov. but  $\sim 1.55$  in *S. insalahensis* gen. et sp. nov.), by the concave venter (flattened or weakly convex in *S. felis* gen. et sp. nov.) and by the considerably weaker spiral lines (coarse and sharp in *S. insalahensis* gen. et sp. nov.).

### *Stroborineceras* sp.

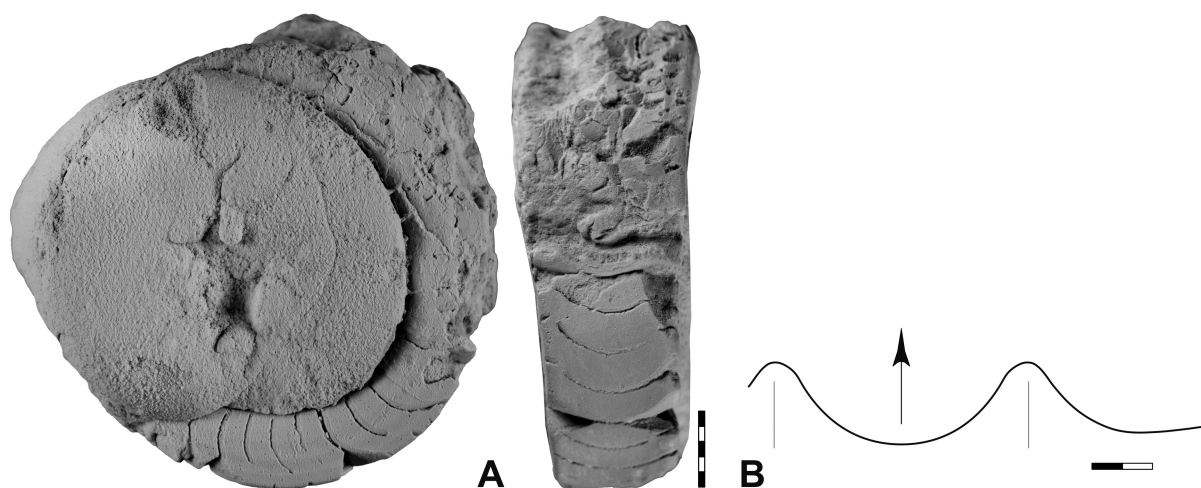
Fig. 9, Table 4

### Material examined

ALGERIA • 1 specimen; Sebkhia de Timimoun 11 km south-west of Timimoun (locality TIM-B0); Grès de Kahla supérieur (Upper *Pericyclus-Progoniatites* Assemblage; early late Tournaisian); Korn *et al.* 2002 Coll.; illustrated in Fig. 9; MB.C.30455 • 6 specimens; Mouydir, south of Oued Temertasset (localities MOU-X, MOU-Y); Argiles de Teguentour (Upper *Pericyclus-Progoniatites* Assemblage; early late Tournaisian); Korn *et al.* 2002 Coll.; MB.C.30456.1–MB.C.30456.5, MB.C.30457.

### Description

Specimen MB.C.30455 is a 30 mm diameter phragmocone partially embedded in a haematite nodule (Fig. 9A). About half a whorl is recognisable, though some of it is damaged. The whorl profile is depressed and rectangular with a flat venter, angular ventrolateral shoulder and parallel flanks. On the flank there are four spiral lines of slightly different strength. The suture line shows a broadly rounded external lobe and a broadly rounded lateral lobe (Fig. 9B).



**Fig. 9.** *Stroborineceras* sp. from Oued Temertasset, specimen MB.C.30455 (Korn *et al.* 2002 Coll.). **A.** Lateral and ventral views. **B.** Suture line, at  $ww=9.4$  mm,  $wh=6.6$  mm. Scale bar units = 1 mm.



**Table 4.** Conch dimensions (in mm) and ratios of *Stroboceras* sp.

Specimen	dm	ww	wh	uw	ah	ww/dm	ww/wh	uw/dm	WER	IZW
MB.C.30455	–	16.0	13.1	–	–	–	1.22	–	–	–

Genus *Stroboceras* Hyatt, 1884

**Type species**

*Gyroceras Hartii* Dawson, 1858; by original designation.

**Diagnosis**

Genus of the family Trigonoceratidae with discoidal, evolute conch; whorls slightly embracing, outer whorl may have loose contact with preceding whorls. Adult conch with a polygonal whorl profile; venter slightly convex, flattened, less often slightly concave, flanks almost flat or irregularly concave, dorsum slightly concave. Prominent longitudinal keels usually well developed, separated by concave zones. Suture line with small lobes and saddles reflecting keels and longitudinal grooves on the surface of the conch. Siphuncle small with subcentral position between septum centre and venter (after Shimansky 1967; emended).

**Included species**

*Nautilus ammonicus* Eichwald, 1857, South Urals; *Stroboceras anglicum* Hyatt, 1893, Yorkshire; *Nautilus bicarinatus* de Verneuil, 1845, South Urals; *Stroboceras evansi* Ramsbottom & Moore, 1961, Ireland; *Stroboceras gordonii* Niko & Mapes, 2005, Arkansas; *Gyroceras Hartii* Dawson, 1858; Nova Scotia; *Coelonautilus humerosus* Schmidt, 1951, Rhenish Mountains; *Stroboceras intermedium* Miller & Garner, 1953, Michigan; *Stroboceras mstense* Shimansky, 1967, Moscow Basin; *Stroboceras trifer* Schmidt, 1951, Silesia; *Stroboceras mane* sp. nov., Algeria; *Stroboceras ancilis* sp. nov., Algeria.

**Remarks**

A systematic treatment of the morphologically diverse *Stroboceras* form complex is difficult and it is not clear what the relationships between the numerous species are. Turner (1954) introduced the genus *Epistroboceras* to separate the laterally compressed forms. These forms are supposed to differ from *Stroboceras* by the narrower coiling: *Stroboceras* should be tarphophioceraconic (i.e., with the last whorl detached), while *Epistroboceras* should be tarphyceraconic (i.e., with the last whorl in close contact with the preceding one).

This distinguishing criterion was also mentioned by Kummel (1964), but Gordon (1965) pointed out that only the type species *S. hartii* has a straightened-out whorl at maturity. However, Miller & Garner (1953) had already pointed out that the holotype of this species is “slightly crushed”. They also reported “... that the conch is coiled and is very slightly involute; though at full maturity the adoral portion of the body chamber straightens and loses contact with the preceding whorl but retains, however, the slight impressed zone.” (Miller & Garner 1953: 134). This combination of characters is questionable; a concave whorl zone is practically always created by enclosing the preceding whorl. Therefore, it cannot be excluded that it is a preservation effect. Gordon (1965) accepted *Epistroboceras* only as a subgenus of *Stroboceras*, distinguished by the loss of longitudinal sculpture in late ontogeny.

Shimansky (1967) discussed the relationship between the two genera in detail and concluded that the relationships and boundaries of the genera *Stroboceras* and *Epistroboceras* were not entirely clear. He considered it possible that, in addition to the whorl profile, the size of the umbilical window could also serve to distinguish between the two genera.



Histon (1999) characterised the genus *Epistroboceras*, among other characteristics, by the strongly compressed conch, converging flanks and narrow concave venter. More recently, Niko & Mapes (2004) discussed the relationship between *Stroboceras* and *Epistroboceras*; in distinguishing the two genera, they upheld the presumed detachment of the adult whorl in *Stroboceras*. As a further difference between the two genera, they mentioned that the "... lateral grooves developed in the juvenile stage become obsolescent with maturity" in *Epistroboceras* (Niko & Mapes 2004: 341).

The distinction between the two genera is an issue that cannot be solved with the material available from the Sahara Desert, it is beyond the scope of our investigations. For the time being, we follow the path suggested by Shimansky (1967) of grouping the forms with a broad venter under *Stroboceras* and those with a narrow venter under *Epistroboceras*.

***Stroboceras mane* sp. nov.**

[urn:lsid:zoobank.org:act:D423198E-EA1D-44F1-A1E3-C1E31F6FDC4E](http://urn:lsid:zoobank.org:act:D423198E-EA1D-44F1-A1E3-C1E31F6FDC4E)

Fig. 10, Table 5

**Diagnosis**

Species of *Stroboceras* with weakly depressed, rounded-trapezoidal whorl profile ( $ww/wh \sim 1.45$ ), venter strongly flattened, ventrolateral shoulder angular with sharp longitudinal ridges. Whorls not embracing. Whorl profile with wide longitudinal groove on the outer flank near the ventrolateral margin.

**Etymology**

From the Latin '*mane*', meaning 'early, morning' and referring to the stratigraphically early occurrence of the species.

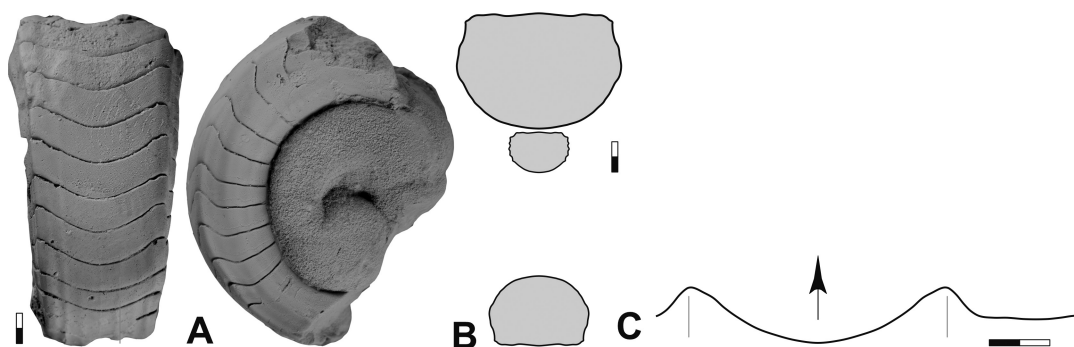
**Type material**

**Holotype**

ALGERIA • Mouydir, south of Oued Temertasset (locality MOU-Y); Argiles de Teguentour (Lower *Pericyclus-Progoniatites* Assemblage; early late Tournaisian); Korn *et al.* 2002 Coll.; illustrated in Fig. 10A; MB.C.30458.1.

**Paratype**

ALGERIA • Mouydir, south of Oued Temertasset (locality MOU-Y); Argiles de Teguentour (Lower *Pericyclus-Progoniatites* Assemblage; early late Tournaisian); Korn *et al.* 2002 Coll.; MB.C.30458.2.



**Fig. 10.** *Stroboceras mane* sp. nov. from Oued Temertasset, holotype MB.C.30458.1 (Korn *et al.* 2002 Coll.). **A.** Ventral and lateral views. **B.** Cross section. **C.** Suture line, at  $ww=9.9$  mm,  $wh=5.5$  mm. Scale bar units=1 mm.

**Table 5.** Conch dimensions (in mm) and ratios of *Stroboceras mane* sp. nov.

Specimen	dm	ww	wh	uw	ah	ww/dm	ww/wh	uw/dm	WER	IZW
MB.C.30458.1	22.0	11.2	7.6	9.9	7.6	0.51	1.47	0.45	2.34	0.0

### Description

Holotype MB.C.30458.1 is a phragmocone fragment with about 22 mm conch diameter; it is partly embedded in a haematite nodule (Fig. 10A) and was sectioned for the study of the whorl profile. The conch is discoidal and evolute ( $ww/dm=0.51$ ;  $uw/dm=0.45$ ). The whorl profile is rounded-trapezoidal with almost flat venter separated from the convex flanks by an angular ventrolateral shoulder. Next to this shoulder is a shallow, wide longitudinal groove (Fig. 10B). The whorls apparently do not touch each other, but this may be caused by dissolution of the shell wall.

The suture line has a very broad external lobe, an angular ventrolateral saddle in the area of the ventrolateral shoulder and a flat, somewhat undulating lateral lobe (Fig. 10C). The siphuncle has a subcentral position.

### Remarks

*Stroboceras mane* sp. nov. is an ancestral species of the genus and differs from almost all other species by the non-embracing whorls. Another distinguishing criterion is the very weak formation of longitudinal ridges and grooves.

### *Stroboceras ancilis* sp. nov.

[urn:lsid:zoobank.org:act:BA91AA8E-DD89-4E1E-8781-0BF2ADB763E1](https://zoobank.org/act:BA91AA8E-DD89-4E1E-8781-0BF2ADB763E1)

Figs 11–12, Table 6

### Diagnosis

Species of *Stroboceras* with weakly depressed, rounded-trapezoidal whorl profile ( $ww/wh \sim 1.40$ ), venter flat, ventrolateral shoulder angular with sharp longitudinal ridges. Whorls weakly embracing. Whorl profile with a wide longitudinal groove on the outer flank near the ventrolateral margin and a midflank longitudinal ridge.

### Etymology

From the Latin noun ‘*ancilis*’, meaning ‘shield’ and referring to the whorl profile.

### Type material

#### Holotype

ALGERIA • Sebkhia de Timimoun 14.5 km west-southwest of Timimoun (locality TIM-C8); Argiles de Timimoun supérieur (Upper *Bollandoceras* Assemblage; early to middle Viséan); Korn *et al.* 2002 Coll.; illustrated in Fig. 11C; MB.C.30459.1.

#### Paratypes

ALGERIA • 4 specimens; Sebkhia de Timimoun 14.5 km west-southwest of Timimoun (locality TIM-C8); Argiles de Timimoun supérieur (Upper *Bollandoceras* Assemblage; early to middle Viséan); Korn *et al.* 2002 Coll.; MB.C.30459.2–MB.C.30459.5.

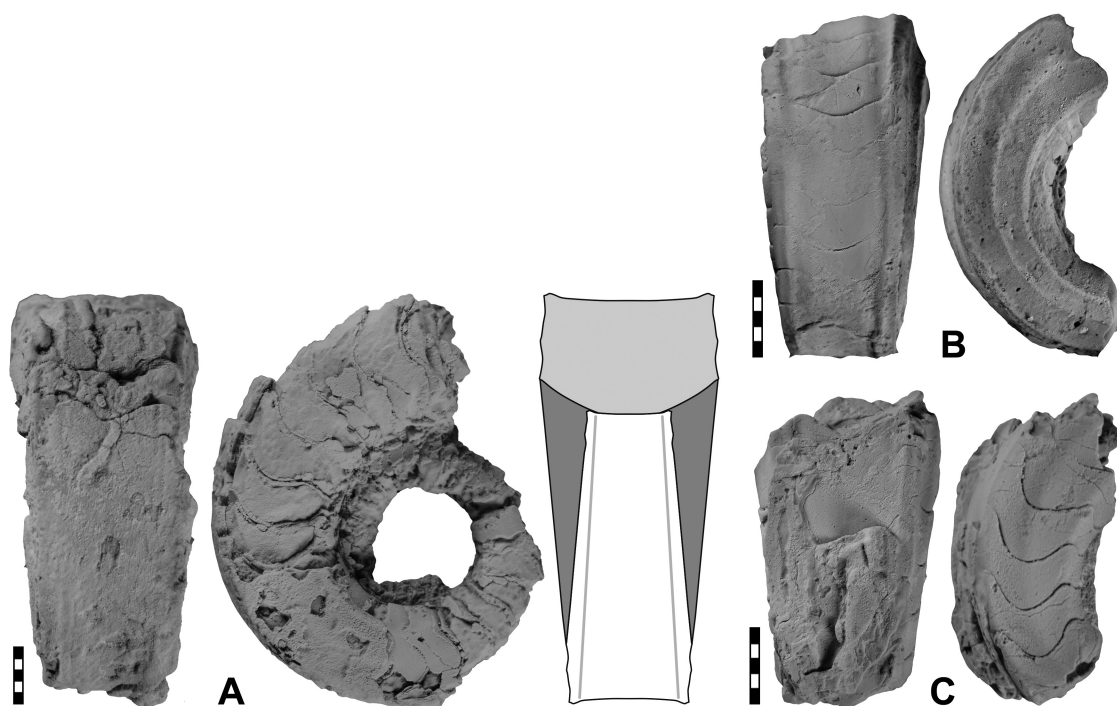
**Table 6.** Conch dimensions (in mm) and ratios of *Stroboceras ancilis* sp. nov.

Specimen	dm	ww	wh	uw	ah	ww/dm	ww/wh	uw/dm	WER	IZW
MB.C.30459.3	36.6	16.8	12.1	15.1	12.1	0.46	1.39	0.41	2.23	0.00
MB.C.30459.1	–	12.5	9.2	–	–	–	1.36	–	–	–
MB.C.30459.2	–	10.7	7.8	–	–	–	1.37	–	–	–
MB.C.30459.4	–	10.8	8.0	–	–	–	1.36	–	–	–
MB.C.30459.5	–	7.5	5.7	–	–	–	1.31	–	–	–

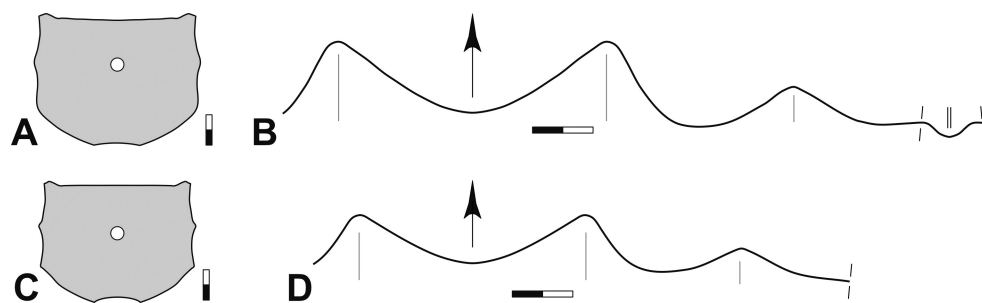
### Description

Holotype MB.C.30459.1 is a phragmocone fragment of a quarter whorl without shell preservation (Fig. 11C). It has a depressed pentagonal whorl profile and is widest at about the middle of the flank. The outer half of the flank is occupied by a shallow longitudinal groove, delimited on the ventral side by an angular ventrolateral shoulder and on the umbilical side by a rounded ridge. On the venter, near the ventrolateral shoulder, there is a finer ridge accompanied on both sides by a shallow longitudinal groove. The venter is slightly concave. The umbilical wall is oblique and almost flat; it ends at the umbilical seam. There is a small, very shallow dorsal whorl zone (Fig. 12A).

The suture line shows four rounded lobes each on the venter, flank, umbilical wall and dorsal whorl zone (Fig. 12B). Of these, the rounded V-shaped external lobe is the deepest; the lateral lobe is somewhat asymmetrical and broadly rounded and the lobe on the umbilical wall is shallow. The internal lobe is small and broadly V-shaped.



**Fig. 11.** *Stroboceras ancilis* sp. nov. from Timimoun (all Korn *et al.* 2002 Coll.). **A.** Paratype MB.C.30459.3. **B.** Paratype MB.C.30459.2. **C.** Holotype MB.C.30459.1. Scale bar units = 1 mm.



**Fig. 12.** *Stroboceras ancilis* sp. nov. from Timimoun (both Korn *et al.* 2002 Coll.). **A.** Whorl profile of holotype MB.C.30459.1. **B.** Suture line of holotype MB.C.30459.1, at ww=11.6 mm, wh=8.8 mm. **C.** Whorl profile of paratype MB.C.30459.2. **D.** Suture line of paratype MB.C.30459.2, at ww=10.4 mm, wh=7.1 mm. Scale bar units=1 mm.

The paratypes show little variation in conch shape and suture line. The ww/wh ratio is between 1.30 and 1.40 in all specimens and the whorl profile has a very similar shape. Paratype MB.C.30459.2 (Fig. 11B), however, shows slightly more sharply defined longitudinal ridges; its suture line (Fig. 12D) has slightly shallower lobes than the holotype.

Paratype MB.C.30459.3 is a heavily corroded specimen 37 mm in diameter (Fig. 11A). Although incomplete, it shows the general advolute conch form with whorls touching the preceding.

### Remarks

*Stroboceras ancilis* sp. nov. differs from all other species of the genus by its almost rectangular whorl profile with a right-angled ventrolateral shoulder.

### *Stroboceras* sp.

Fig. 13, Table 7

### Material examined

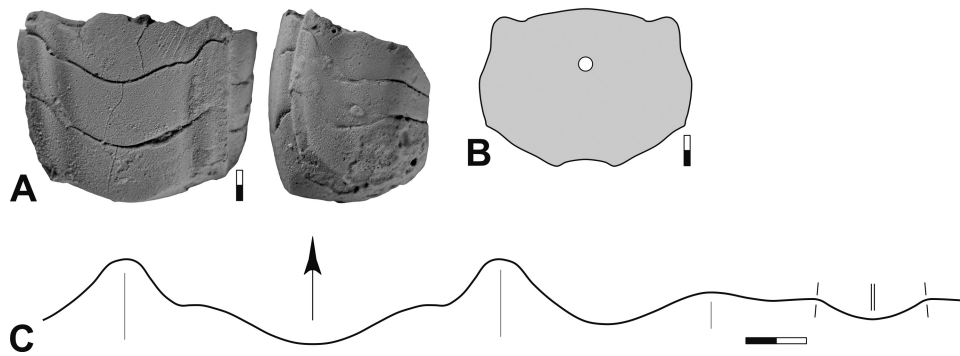
ALGERIA • 1 specimen; Sebkh de Timimoun 14.5 km west-southwest of Timimoun (locality TIM-C8); Argiles de Timimoun supérieur (Upper *Bollandoceras* Assemblage; early to middle Viséan); Korn *et al.* 2002 Coll.; illustrated in Fig. 13; MB.C.30460.

### Description

The only specimen present is a phragmocone fragment consisting of three chambers (Fig. 13A). It has, at 10.5 mm whorl height, a depressed pentagonal whorl profile (ww/wh=1.44). It shows a prominent, rounded ventrolateral shoulder accompanied by shallow longitudinal grooves. The centre of the venter is shallowly convex and the umbilical margin separates the weakly convex flank from the almost flat umbilical wall by a low ridge (Fig. 13B). A narrow, very shallow concave whorl zone is present. The suture line shows a course dependent on the outline of the whorl profile; saddles lie in the inflated areas of the profile and lobes in the indented ones (Fig. 13C). Therefore, the external lobe appears trilobate and the ventrolateral saddle is raised. An internal lobe is induced by the concave whorl zone.

**Table 7.** Conch dimensions (in mm) and ratios of *Stroboceras* sp.

Specimen	dm	ww	wh	uw	ah	ww/dm	ww/wh	uw/dm	WER	IZW
MB.C.30460	–	15.0	10.4	–	–	–	1.44	–	–	–

**Fig. 13.** *Stroboceras* sp. from Timimoun, specimen MB.C.30460 (Korn *et al.* 2002 Coll.). **A.** Ventral and lateral views. **B.** Whorl profile. **C.** Suture line, at ww = 14.3 mm, wh = 10.3 mm. Scale bar units = 1 mm.Genus *Vestinautilus* Ryckholt, 1852**Type species**

*Nautilus Koninckii* d'Orbigny, 1850; subsequent designation by Hyatt (1883–1884).

**Diagnosis**

Genus of the family Trigonoceratidae with evolute conch; whorls slightly impressed; whorl profile rounded-triangular or trapezoidal with flattened or weakly concave venter and pronounced ventrolateral shoulder. Ornament with fine lines and very coarse spiral ridges around the ventrolateral shoulder, sometimes also on the venter. Suture line slightly sinuous. Siphuncle small with subcentral position (after Kummel 1964; emended by Korn *et al.* 2022).

**Included species**

*Nautilus (Trematodiscus) altidorsalis* Winchell, 1862, Michigan; *Nautilus biangulatus* Sowerby, 1825, Southwest England; *Nautilus cariniferus* Sowerby, 1825, Ireland; *Vestinautilus concinnus* Korn, Miao & Bockwinkel, 2022, Algeria; *Triboloceras formosum* Foord, 1900, Ireland; *Nautilus Koninckii* d'Orbigny, 1850, Belgium; *Nautilus multicarinatus* Sowerby, 1825, Ireland; *Vestinautilus padus* Korn, Miao & Bockwinkel, 2022, Algeria; *Coelonutilus paucicarinatus* Foord, 1891, Ireland; *Nautilus pinguis* de Koninck, 1844, Belgium; *Vestinautilus semiglaber* Foord, 1900, Ireland; *Vestinautilus semiplicatus* Foord, 1900, Ireland; *Vestinautilus angulatus* sp. nov., Algeria; *Vestinautilus papilio* sp. nov., Algeria; *Vestinautilus inflexus* sp. nov., Algeria; *Vestinautilus bicristatus* sp. nov., Algeria.

**Remarks**

In the description of the nautiloids from the Dalle à *Merocanites*, Korn *et al.* (2022) discussed the relationships between the genera *Vestinautilus* and *Subvestinautilus*; they considered the latter as a junior synonym.



*Vestinautilus* differs from the other genera of the family Trigonoceratidae by the rather weakly ornamented shell in combination with a rounded-triangular or trapezoidal whorl profile. However, it should be noted that some of these genera, such as *Rineceras*, *Vestinautilus* and *Stroboceras*, show quite similar conch and ornament morphology at the beginning of their occurrence in the Tournaisian.

*Vestinautilus angulatus* sp. nov.

[urn:lsid:zoobank.org:act:6A498E25-5D60-4511-8BF2-5C868B8D12DF](https://doi.org/10.21203/rs.3.rs-1234567)

Figs 14–15, Table 8

**Diagnosis**

Species of *Vestinautilus* with depressed, rounded-trapezoidal whorl profile (ww/wh ~1.50), venter flattened, bordered by two sharp ridges, ventrolateral shoulder angular with sharp longitudinal ridges. Whorls not embracing. Ornament with two or three weak but sharp ridges on the flank.

**Etymology**

From the Latin ‘*angulatum*’, referring to the two angular ventrolateral ridges.

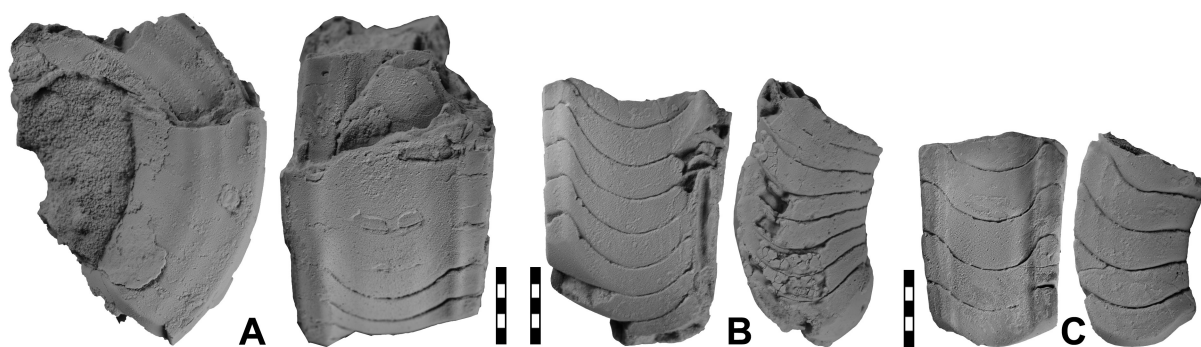
**Type material**

**Holotype**

ALGERIA • Mouydir, south of Oued Temertasset (locality MOU-E07); Argiles de Teguentour (Upper *Pericyclus-Progoniatites* Assemblage; early late Tournaisian); Korn *et al.* 2002 Coll.; illustrated in Fig. 14B; MB.C.30461.1.

**Paratypes**

ALGERIA • 1 specimen; Mouydir, south of Oued Temertasset (locality MOU-D1); Argiles de Teguentour (Upper *Pericyclus-Progoniatites* Assemblage; early late Tournaisian); Korn *et al.* 2002 Coll.; illustrated in Fig. 14A; MB.C.30462.1 • 1 specimen; Mouydir, south of Oued Temertasset (locality MOU-E07); Argiles de Teguentour (Upper *Pericyclus-Progoniatites* Assemblage; early late Tournaisian); Korn *et al.* 2002 Coll.; illustrated in Fig. 14C; MB.C.30461.2 • 19 specimens; Mouydir, south of Oued Temertasset (localities MOU-D1, MOU-A, MOU-B1, MOU-C4, MOU-D2, MOU-V, MOU-Z); Argiles de Teguentour (Upper *Pericyclus-Progoniatites* Assemblage; early late Tournaisian); Korn *et al.* 2002 Coll.; MB.C.30462.2–MB.C.30462.5, MB.C.30463.1–MB.C.30463.5, MB.C.30464.1–MB.C.30464.2, MB.C.30465.1–MB.C.30465.3, MB.C.30466.1–MB.C.30466.3, MB.C.30467, MB.C.30468 • 1 specimen; Sebkha de Timimoun 11 km south-west of Timimoun (locality TIM-B0); Grès de Kahla



**Fig. 14.** *Vestinautilus angulatus* sp. nov. from Oued Temertasset (all Korn *et al.* 2002 Coll.). **A.** Paratype MB.C.30462.1. **B.** Holotype MB.C.30461.1. **C.** Paratype MB.C.30461.2. Scale bar units = 1 mm.

**Table 8.** Conch dimensions (in mm) and ratios of *Vestinautilus angulatus* sp. nov.

Specimen	dm	ww	wh	uw	ah	ww/dm	ww/wh	uw/dm	WER	IZW
MB.C.30462.1	–	14.1	9.0	–	–	–	1.56	–	–	–
MB.C.30461.1	–	12.7	8.8	–	–	–	1.44	–	–	–
MB.C.30461.2	–	9.5	7.0	–	–	–	1.36	–	–	–

supérieur (Upper *Pericyclus-Progoniatites* Assemblage; early late Tournaisian); Korn *et al.* 2002 Coll.; MB.C.30469.

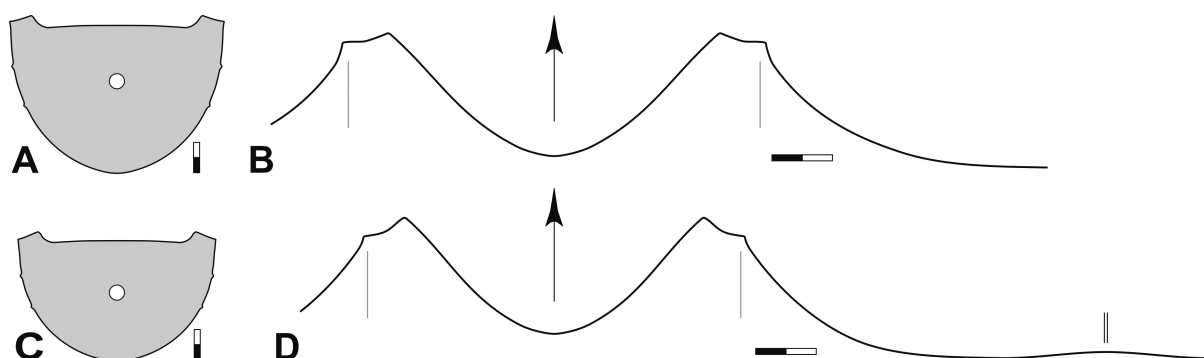
### Description

Holotype MB.C.30461.1 is a phragmocone segment of about a quarter whorl with almost 9 mm whorl height (Fig. 14B). It shows a triangular whorl profile with a shallow, almost flat venter that is bordered on both sides by two elevated, sharp longitudinal ridges. Flanks, umbilical wall and dorsum form a broadly curved, semi-circular unit. On the flanks there are two longitudinal ridges, which are considerably weaker than the ridges on the ventrolateral shoulder (Fig. 15C). The suture line shows a deep, broadly rounded outer lobe and a ventrolateral saddle which has two crests because of the two longitudinal ridges. The lateral lobe is very broad and continues into a very low internal saddle (Fig. 15D).

The two paratypes MB.C.30462.1 (9 mm wh; Fig. 14A) and MB.C.30461.2 (7 mm wh; Fig. 14C) are very similar to the holotype in conch form and suture line. The two-humped ventrolateral saddle is also pronounced in paratype MB.C.30462.1 (Fig. 15B).

### Remarks

*Vestinautilus angulatus* sp. nov. belongs to the few species of the genus with a moderately depressed whorl profile ( $ww/wh \sim 1.50$ ) and a very weak longitudinal sculpture; in these respects, the new species differs from all other species of the genus in which the whorls are not embracing.



**Fig. 15.** *Vestinautilus angulatus* sp. nov. from Oued Temertasset (both Korn *et al.* 2002 Coll.). **A.** Whorl profile of paratype MB.C.30462.1. **B.** Suture line of paratype MB.C.30462.1, at  $ww=14.1$  mm,  $wh=9.0$  mm. **C.** Whorl profile of holotype MB.C.30461.1. **D.** Suture line of holotype MB.C.30461.1, at  $ww=12.7$  mm,  $wh=8.8$  mm. Scale bar units = 1 mm.

*Vestinautilus papilio* sp. nov.

[urn:lsid:zoobank.org:act:F7146ECD-A229-4889-863C-4160E41BF1C4](https://doi.org/10.21203/rs.3.rs-1234567)

Figs 16–17, Table 9

**Diagnosis**

Species of *Vestinautilus* with moderately depressed, rounded-trapezoidal whorl profile (ww/wh ~ 1.60–1.80), venter weakly flattened, with three longitudinal grooves on each side, ventrolateral shoulder subangular. Whorls weakly embracing. Ornament with two or three weak but sharp ridges on the flank.

**Etymology**

From the Latin ‘*papilio*’, meaning ‘butterfly’ and referring to the shape of the whorl profile.

**Type material**

**Holotype**

ALGERIA • Mouydir, south of Oued Temertasset (locality MOU-D1); Argiles de Teguentour (Upper *Pericyclus-Progoniatites* Assemblage; early late Tournaisian); Korn *et al.* 2002 Coll.; illustrated in Fig. 16A; MB.C.30470.1.

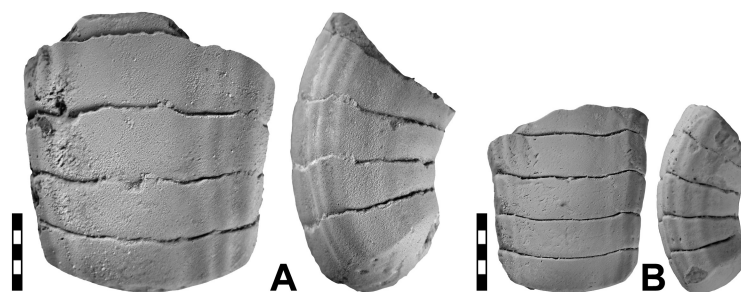
**Paratypes**

ALGERIA • 1 specimen; Mouydir, south of Oued Temertasset (locality MOU-D1); Argiles de Teguentour (Upper *Pericyclus-Progoniatites* Assemblage; early late Tournaisian); Korn *et al.* 2002 Coll.; illustrated in Fig. 16B; MB.C.30470.2 • 10 specimens; Mouydir, south of Oued Temertasset (localities MOU-D1, MOU-Z); Argiles de Teguentour (Upper *Pericyclus-Progoniatites* Assemblage; early late Tournaisian); Korn *et al.* 2002 Coll.; MB.C.30470.3–MB.C.30470.6, MB.C.30471.1–MB.C.30470.6.

**Description**

Holotype MB.C.30470.1 is a phragocone segment of about a quarter whorl with almost 10 mm whorl height; it consists of four chambers (Fig. 16A). The whorl profile is depressed (ww/wh=1.62) and kidney-shaped with a rounded venter, subangular ventrolateral shoulder and a convex curved area encompassing the flanks and umbilical wall (Fig. 17A). The whorl weakly encloses the preceding whorl. On the venter there are three longitudinal marginal grooves on each side; the ventrolateral shoulder is defined by two slightly raised edges. The flanks bear two coarse spiral lines near the ventrolateral shoulder. The suture line has a low amplitude course; it shows a very low external saddle and very shallow lateral lobe. Only the internal lobe is deeper and has a blunt V-shaped form (Fig. 17B).

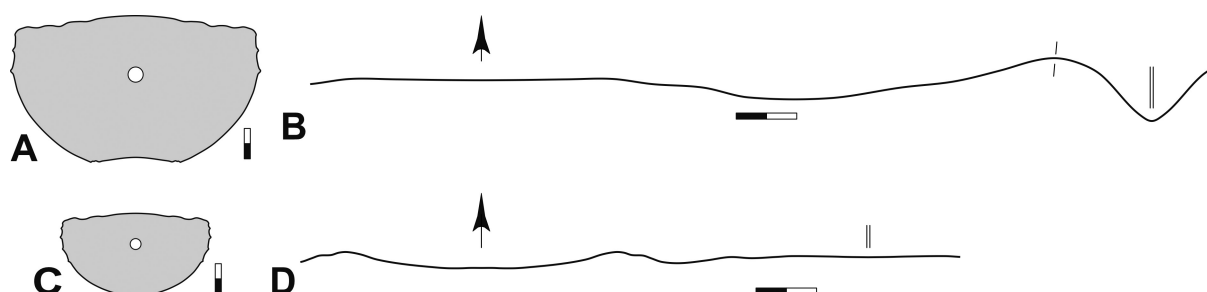
Paratype MB.C.30470.2 shows, at a whorl height of 6 mm (Fig. 16B), a largely similar morphology to the holotype. However, there is the big difference that it does not have a concave whorl zone (Fig. 17C),



**Fig. 16.** *Vestinautilus papilio* sp. nov. from Oued Temertasset (both Korn *et al.* 2002 Coll.). **A.** Holotype MB.C.30470.1. **B.** Paratype MB.C.30470.2. Scale bar units = 1 mm.

**Table 9.** Conch dimensions (in mm) and ratios of *Vestinautilus papilio* sp. nov.

Specimen	dm	ww	wh	uw	ah	ww/dm	ww/wh	uw/dm	WER	IZW
MB.C.30470.1	–	15.9	9.8	–	–	–	1.62	–	–	–
MB.C.30470.2	–	10.4	5.7	–	–	–	1.82	–	–	–



**Fig. 17.** *Vestinautilus papilio* sp. nov. from Oued Temertasset (both Korn *et al.* 2002 Coll.). **A.** Whorl profile of holotype MB.C.30470.1. **B.** Suture line of holotype MB.C.30470.1, at  $ww=15.5$  mm,  $wh=9.5$  mm. **C.** Whorl profile of paratype MB.C.30470.2. **D.** Suture line of paratype MB.C.30470.2, at  $ww=10.3$  mm,  $wh=5.6$  mm. Scale bar units = 1 mm.

probably due to its small size. Furthermore, the whorl profile is broader ( $ww/wh=1.82$ ). The suture line is almost straight; there is no internal lobe (Fig. 17D).

### Remarks

*Vestinautilus papilio* sp. nov. belongs to the species of the genus with a moderately depressed whorl profile ( $ww/wh \sim 1.70$ ), a character that distinguishes the new species from most of the other species of the genus with weakly embracing whorls. Another criterion that distinguishes the new species is the rather weak longitudinal sculpture.

### *Vestinautilus inflexus* sp. nov.

[urn:lsid:zoobank.org:act:7AEE52F5-6984-4497-8DC0-B23E712C1CF9](https://zoobank.org/act:7AEE52F5-6984-4497-8DC0-B23E712C1CF9)

Figs 18–19, Table 10

### Diagnosis

Species of *Vestinautilus* with moderately depressed, rounded-triangular whorl profile ( $ww/wh \sim 1.95$ ), venter weakly flattened, smooth, ventrolateral shoulder angular. Whorls not embracing. Ornament with three weak but sharp ridges on the flank. Septa inflexed to produce a deep external lobe.

### Etymology

From the Latin ‘*inflexus*’, referring to the incurved septum.

### Type material

#### Holotype

ALGERIA • Mouydir, south of Oued Temertasset (locality MOU-D1); Argiles de Teguentour (Upper *Pericyclus-Progoniatites* Assemblage; early late Tournaisian); Korn *et al.* 2002 Coll.; illustrated in Fig. 18B; MB.C.30472.1.

**Table 10.** Conch dimensions (in mm) and ratios of *Vestinautilus inflexus* sp. nov.

Specimen	dm	ww	wh	uw	ah	ww/dm	ww/wh	uw/dm	WER	IZW
MB.C.30472.1	–	15.1	7.8	–	–	–	1.94	–	–	–
MB.C.30472.2	24.5	15.8	8.2	11.8	8.2	0.65	1.93	0.48	2.26	0.00
MB.C.30472.3	16.2	9.0	4.7	8.5	4.7	0.55	1.91	0.53	1.91	0.00

### Paratypes

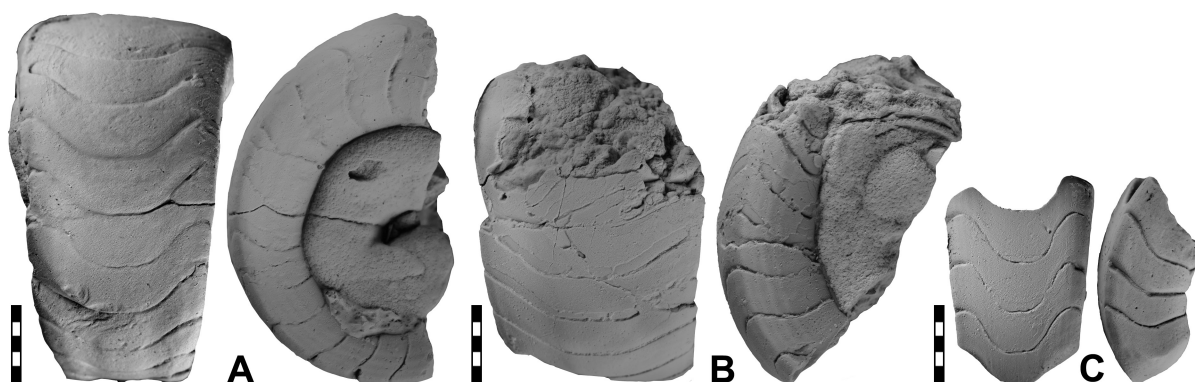
ALGERIA • 2 specimens; Mouydir, south of Oued Temertasset (locality MOU-D1); Argiles de Teguentour (Upper *Pericyclus-Progoniatites* Assemblage; early late Tournaisian); Korn *et al.* 2002 Coll.; illustrated in Fig. 18A, C; MB.C.30472.2–MB.C.30472.3.

### Description

Holotype MB.C.30472.1 is a phragmocone fragment from a quarter whorl with 15 mm whorl height (Fig. 18B). It has a moderately depressed whorl profile ( $ww/wh=1.94$ ) with a flattened venter and broadly rounded lateral and dorsal zones. The ventrolateral shoulder is subangular and reinforced by two sharp longitudinal ridges; there are two more, weaker ridges on the outer flank (Fig. 19B). The suture line shows a broad external lobe, flattened at the base. This particular shape is caused by an inflexion of the septum on the middle of the venter. There is a narrowly rounded saddle on the ventrolateral shoulder and a shallow, broadly rounded lobe on the flank (Fig. 19C).

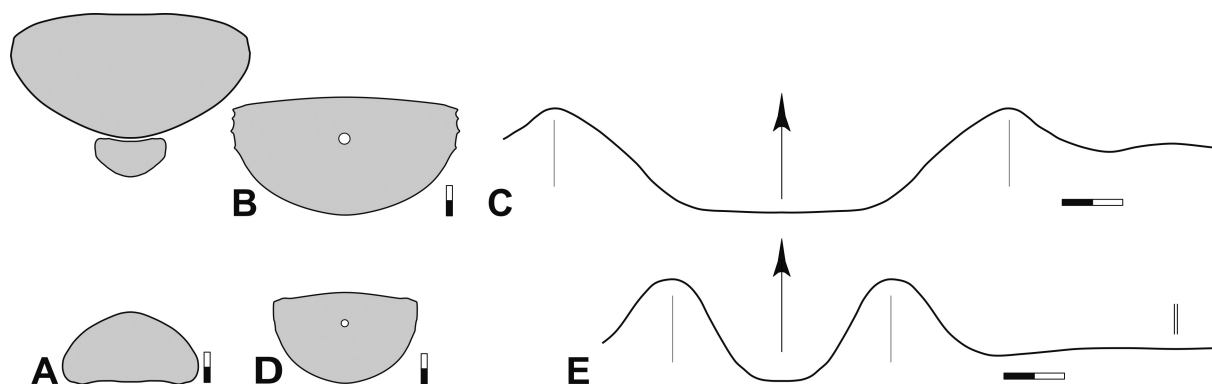
Paratype MB.C.30472.2 is a desert-polished specimen with half a whorl preserved; it has a diameter of 24.5 mm (Fig. 18A). It was sectioned and shows one and a half whorls, which possess a similar profile. The last preserved whorl does, at 24 mm conch diameter, not touch the preceding, but this may be caused by the lack of the original shell wall (Fig. 19A). The longitudinal ridges are only barely visible and rather weak when compared with the holotype. The suture line shows a deeper external lobe, which is less flattened at the base.

The smaller paratype MB.C.30472.3 (Fig. 18C) with 6 mm whorl height has a less depressed whorl profile, but shows very clearly the ventral inflexion of the septum and the resulting very deep external lobe (Fig. 19E).



**Fig. 18.** *Vestinautilus inflexus* sp. nov. from Oued Temertasset (both Korn *et al.* 2002 Coll.). A. Paratype MB.C.30472.2. B. Holotype MB.C.30472.1. C. Paratype MB.C.30472.3. Scale bar units= 1 mm.





**Fig. 19.** *Vestinautilus inflexus* sp. nov. from Oued Temertasset (both Korn *et al.* 2002 Coll.). **A.** Cross section of paratype MB.C.30472.2. **B.** Whorl profile of holotype MB.C.30472.1. **C.** Suture line of holotype MB.C.30472.1, at ww=15.2 mm, wh=7.2 mm. **D.** Whorl profile of paratype MB.C.30472.3. **E.** Suture line of paratype MB.C.30472.3, ww=8.7 mm, wh=5.8 mm. Scale bar units=1 mm.

### Remarks

*Vestinautilus inflexus* sp. nov. belongs to the species of the genus with a moderately depressed whorl profile (ww/wh ~1.95) and thus ranges between the more slender species *V. angulatus* sp. nov. (ww/wh ~1.50) as well as *V. papilio* sp. nov. (ww/wh ~1.70) and the stouter species *V. bicristatus* sp. nov. (ww/wh ~2.15). The new species differs from those species of the genus with a similar whorl profile in the very weak longitudinal ridges.

### *Vestinautilus bicristatus* sp. nov.

[urn:lsid:zoobank.org:act:69CABBA5-6CDA-4264-B156-0FB2321AEDD5](http://urn:lsid:zoobank.org:act:69CABBA5-6CDA-4264-B156-0FB2321AEDD5)

Figs 20–21, Table 11

### Diagnosis

Species of *Vestinautilus* with strongly depressed, rounded-trapezoidal whorl profile (ww/wh ~2.10), venter up to 30 mm conch diameter broadly arched with two shallow submarginal grooves, which disappear in the adult stage. Ventrolateral shoulder defined by a subangular margin; one sharp ridge is located on the umbilical wall near the ventrolateral shoulder. Whorls weakly embracing, coiling very high (WER ~2.55). Ornament with delicate growth lines.

### Etymology

From the Latin ‘*crista*’, meaning ‘crest’ and referring to the two lateral longitudinal ridges.

### Type material

#### Holotype

ALGERIA • Mouydir, south of Oued Temertasset (locality MOU-C1); Argiles de Teguentour (*Helicocyclus-Ouaoufilalites* Assemblage; early late Tournaisian); Wendt *et al.* Coll.; illustrated in Fig. 20; MB.C.30473.

#### Paratypes

ALGERIA • 3 specimens; Mouydir, south of Oued Temertasset (locality MOU-C1); Argiles de Teguentour (*Helicocyclus-Ouaoufilalites* Assemblage; early late Tournaisian); Korn *et al.* 2002 Coll.; illustrated in Fig. 21; MB.C.30474.1–MB.C.30474.3.

**Table 11.** Conch dimensions (in mm) and ratios of *Vestinautilus bicristatus* sp. nov.

Specimen	dm	ww	wh	uw	ah	ww/dm	ww/wh	uw/dm	WER	IZW
MB.C.30473	38.0	31.9	14.9	14.0	14.3	0.84	2.13	0.37	2.57	0.04

### Description

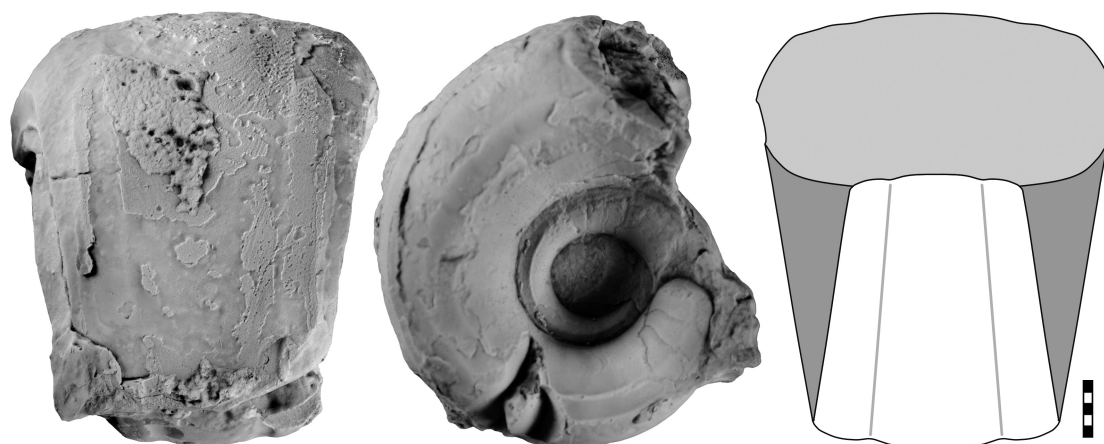
Holotype MB.C.30473 is a desert-polished specimen with a diameter of 38 mm, showing the conch shape and small areas of ornament (Fig. 20). The conch is broadly cylindrical and subevolute ( $ww/dm = 0.84$ ;  $uw/dm = 0.37$ ) with a very high coiling rate ( $WER = 2.57$ ). The whorl profile is strongly depressed ( $ww/wh = 2.13$ ) and shows a flattened venter, which possesses two submarginal external grooves at size stages between 17 and 35 mm diameter. These weaken considerably thereafter and are only visible as shallow longitudinal depressions at the maximum diameter of the specimen. The ventrolateral shoulder is distinguished by three edges, of which the two inner ones are strengthened by longitudinal ridges. Only small areas of shell ornament are visible; these show very fine growth lines on the venter with a deep external sinus.

Three paratypes in fragmentary preservation are available. They are larger specimens with whorl widths between 49 and 80 mm, thus belonged to conchs with 60 to 90 mm diameter. Two of them (MB.C.30474.2 and MB.C.30474.3; Fig. 21B–C) show the imprint of the preceding whorl with sublateral longitudinal grooves in the dorsal region; in paratype MB.C.30474.3 the edges of the ventrolateral shoulder are also still visible. Both have a broadly rounded venter. The largest paratype MB.C.30474.1 shows a shallow, broad depression in the middle of the venter at its largest diameter (Fig. 21A).

Paratype MB.C.30474.3 shows the suture line with a broad and shallow external lobe and a narrow and shallow lateral lobe, which has a position on the umbilical wall (Fig. 21C). The siphuncle has a slightly subcentral position towards the venter.

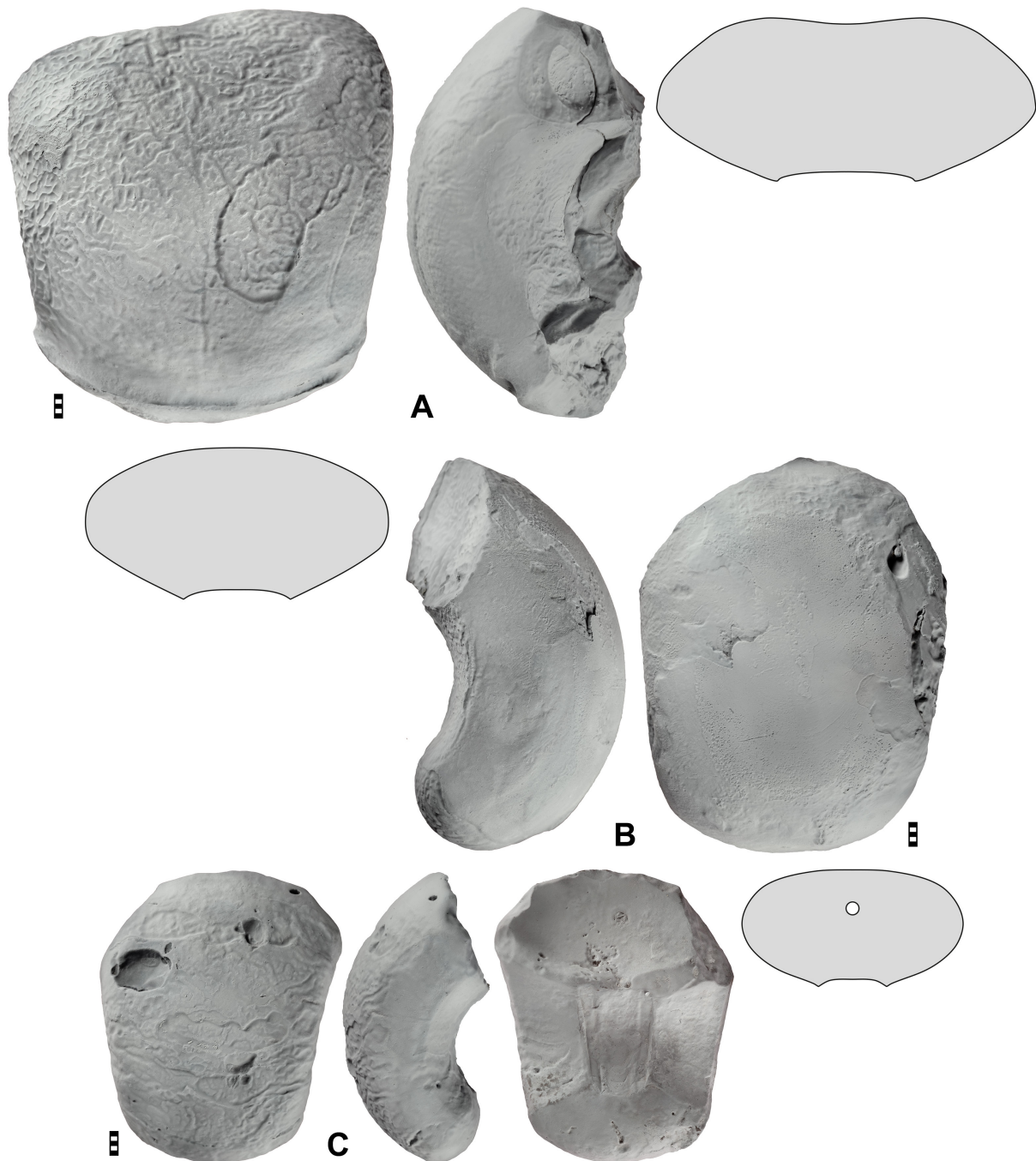
### Remarks

*Vestinautilus bicristatus* sp. nov. belongs to the species of the genus that possess a very broad whorl profile ( $ww/wh > 2.00$ ) and an ornament with only a few spiral ridges. In this respect, *V. cariniferus*,



**Fig. 20.** *Vestinautilus bicristatus* sp. nov., holotype MB.C.30473 (Wendt & Kaufmann Coll.) from Oued Temertasset. Scale bar units = 1 mm.

*V. paucicarinatus*, *V. pinguis* and *V. semiplicatus* are similar, but these four species have a concave venter at least at times in ontogeny (Sowerby 1825; de Koninck 1844; Foord 1891, 1900). The most similar *V. bicristatus* sp. nov. is the species *V. padus*, which shows the same conch dimensions, but differs in the lack of the submarginal ventral grooves (Korn *et al.* 2022).



**Fig. 21.** *Vestinautilus bicristatus* sp. nov. from Oued Temertasset (all Korn *et al.* 2002 Coll.). A. Paratype MB.C.30474.1. B. Paratype MB.C.30474.2. C. Paratype MB.C.30474.3. Scale bar units = 1 mm.

*Vestinautilus* sp.  
Fig. 22, Table 12

**Material examined**

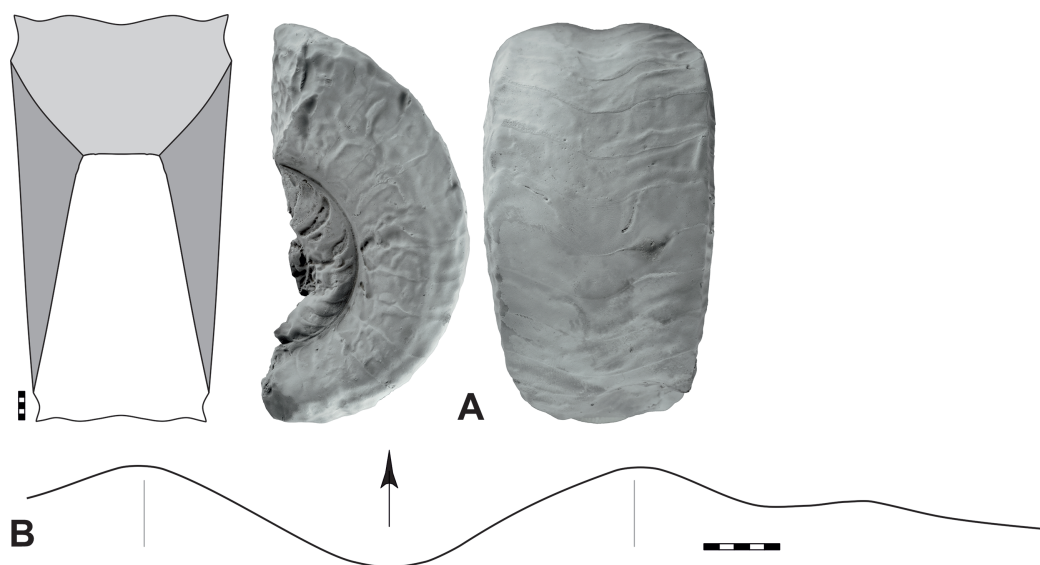
ALGERIA • 1 specimen; Mouydir, south of Oued Temertasset (locality MOU-C1); Argiles de Teguentour (*Helicocyclus-Ouaoufilalites* Assemblage; early late Tournaisian); Korn *et al.* 2002 Coll.; illustrated in Fig. 22; MB.C.30475.

**Description**

Specimen MB.C.30475 is a chambered fragment with a diameter of 72 mm, heavily affected by desert polishing (Fig. 22). Despite the erosion, the conch shape can still be recognised quite well; the conch is thickly discoidal and subevolute ( $ww/dm=0.54$ ;  $uw/dm=0.25$ ) with a depressed trapezoidal whorl profile ( $ww/wh=1.57$ ). The whorls overlap each other slightly. The venter is concave in the middle and separated from the almost flat area of the flank and umbilical wall by two sharp ridges on the ventrolateral shoulder.

**Table 12.** Conch dimensions (in mm) and ratios of *Vestinautilus* sp.

Specimen	dm	ww	wh	uw	ah	ww/dm	ww/wh	uw/dm	WER	IZW
MB.C.30475	71.8	38.9	24.8	33.7	24.5	0.54	1.57	0.35	2.30	0.01



**Fig. 22.** *Vestinautilus* sp., specimen MB.C.30475 (Korn *et al.* 2002 Coll.) from Oued Temertasset. **A.** Reconstructed dorsal, lateral and ventral views. **B.** Suture line, at  $ww=39.0$  mm,  $wh=20.5$  mm. Scale bar units= 1 mm.

Genus *Trilobitoceras* gen. nov.

[urn:lsid:zoobank.org:act:A9F94ED5-FE49-4E8E-A349-8D675BB2160B](https://zoobank.org/urn:lsid:zoobank.org:act:A9F94ED5-FE49-4E8E-A349-8D675BB2160B)

**Type species**

*Trilobitoceras peculiaris* gen. et sp. nov.

**Diagnosis**

Genus of the family Trigonoceratidae with distinctly tripartite venter caused by two deep longitudinal grooves.

**Etymology**

After the superficial similarity in ventral view with the trilobites.

**Included species**

*Nautilus (Trematodiscus) planidorsalis* Winchell, 1862, Michigan; *Trilobitoceras peculiaris* gen. et sp. nov., Algeria.

*Trilobitoceras peculiaris* gen. et sp. nov.

[urn:lsid:zoobank.org:act:D75CCA9E-1207-4384-8848-3AF713D0D894](https://zoobank.org/urn:lsid:zoobank.org:act:D75CCA9E-1207-4384-8848-3AF713D0D894)

Figs 23–24, Table 13

**Diagnosis**

Species of *Trilobitoceras* gen. nov. with moderately depressed whorl profile ( $ww/wh \sim 1.65$ ). Suture line with a broadly rounded median saddle.

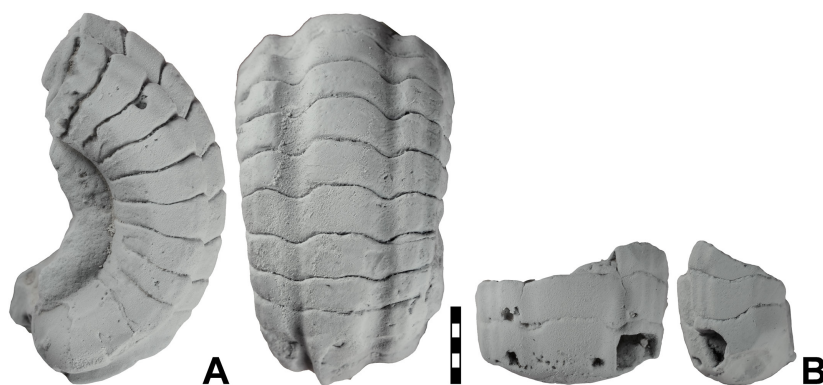
**Etymology**

From the Latin ‘*peculiaris*’, meaning ‘peculiar’ and referring to the unusual conch shape.

**Type material**

**Holotype**

ALGERIA • Mouydir, south of Oued Temertasset (locality MOU-Z); Argiles de Teguentour (Upper *Pericyclus-Progoniatites* Assemblage; early late Tournaisian); Korn *et al.* 2002 Coll.; illustrated in Fig. 23A; MB.C.30477.



**Fig. 23.** *Trilobitoceras peculiaris* sp. nov. from Oued Temertasset (both Korn *et al.* 2002 Coll.). A. Holotype MB.C.30477. B. Paratype MB.C.30478. Scale bar units = 1 mm.



**Table 13.** Conch dimensions (in mm) and ratios of *Trilobitoceras peculiaris* gen. et sp. nov.

Specimen	dm	ww	wh	uw	ah	ww/dm	ww/wh	uw/dm	WER	IZW
MB.C.30477	–	14.3	8.8	–	–	–	1.63	–	–	–
MB.C.30478	–	13.6	7.9	–	–	–	1.72	–	–	–

### Paratype

ALGERIA • 1 specimen; Mouydir, south of Oued Temertasset (locality MOU-D1); Argiles de Teguentour (Upper *Pericyclus-Progoniatites* Assemblage; early late Tournaisian); Korn *et al.* 2002 Coll.; illustrated in Fig. 23B; MB.C.30478.

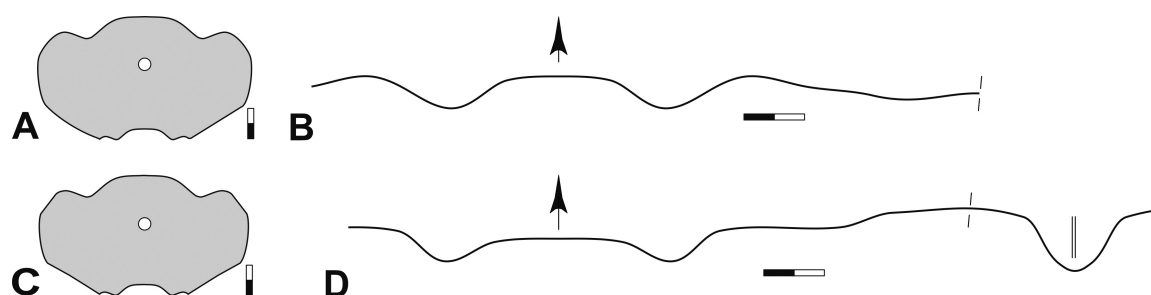
### Description

Holotype MB.C.30477 is a phragmocone fragment with almost half a whorl length (Fig. 23A). It has a depressed whorl profile ( $ww/wh=1.63$ ) with a broadly rounded venter characterised by two deep and wide ventral grooves. The flanks are almost parallel in their middle and the umbilical wall is almost flat (Fig. 24A). The suture line, whose course is determined by the shape of the whorl profile, has a very wide external lobe in which a low, broadly rounded median saddle rises (Fig. 24B).

Paratype MB.C.30478 is a fragment consisting of only two chambers of the phragmocone (Fig. 23B). The conch geometry is very similar to the holotype, although the  $ww/wh$  ratio is slightly higher with a value of 1.72. (Fig. 24C) The suture line is also similar to the holotype; however, the specimen also shows the rather narrow, rounded V-shaped internal lobe (Fig. 24D).

### Remarks

*Trilobitoceras peculiaris* gen. et sp. nov. has a very similar conch morphology like *T. planidorsale*, but differs in the course of the suture line: *T. peculiaris* gen. et sp. nov. possesses a mid-ventral saddle but *T. planidorsale* possesses a mid-ventral lobe.



**Fig. 24.** *Trilobitoceras peculiaris* sp. nov. from Oued Temertasset (both Korn *et al.* 2002 Coll.). **A.** Whorl profile of holotype MB.C.30477 (dorsal portion reconstructed). **B.** Suture line of holotype MB.C.30477, at  $ww=13.6$  mm,  $wh=7.7$  mm. **C.** Whorl profile of paratype MB.C.30478. **D.** Suture line of paratype MB.C.30478, at  $ww=13.6$  mm,  $wh=7.9$  mm. Scale bar units = 1 mm.

Genus *Aphelaeceras* Hyatt, 1884

**Type species**

*Nautilus (Discites) disciformis* Meek & Worthen, 1873; subsequent designation by Miller & Garner (1953).

**Diagnosis**

Genus of the family Trigonoceratidae with subevolute to evolute conch; whorls slightly impressed; whorl profile compressed, venter concave and bordered by an angular ventrolateral shoulder, flanks convex, convergent; umbilical margin rounded or subangular. Suture line with shallow external and lateral lobes. Siphuncle small with subcentral position (after Kummel 1964; emended).

**Included species**

*Nautilus (Discites) disciformis* Meek & Worthen, 1873, Illinois; *Nautilus (Discites) mutabilis* M'Coy, 1844, Ireland; *Nautilus (Discites) trochlea* M'Coy, 1844, Ireland; *Aphelaeceras arkansanum* Gordon, 1965, Arkansas; *Nautilus difficilis* de Koninck, 1878, Belgium; *Nautilus discoideus* de Koninck, 1878, Belgium; *Nautilus exaratus* de Koninck, 1878, Belgium; *Discitoceras discus* Sowerby, 1813, Ireland; *Discites Hibernicus* Foord & Crick, 1893, Ireland; *Aphelaeceras azzelmattiense* sp. nov., Algeria.

*Aphelaeceras azzelmattiense* sp. nov.

[urn:lsid:zoobank.org:act:88F44087-A4B4-4FD7-9C36-CF189028289E](https://zoobank.org/act:88F44087-A4B4-4FD7-9C36-CF189028289E)

Fig. 25, Table 14

**Diagnosis**

Species of *Aphelaeceras* reaching about 130 mm conch diameter. Conch with weakly compressed whorl profile ( $ww/wh \sim 0.65$ ); venter double-keeled with narrow longitudinal groove; flanks convergent, umbilical margin subangular, umbilical wall oblique, weakly concave. Shell surface nearly smooth.

**Etymology**

Named after the type locality Gara Azzel Matti.

**Type material**

**Holotype**

ALGERIA • Ahnet, west-southwest of Gara Azzel Matti; 'Dalle des Iridet' (*Ammonellipsites-Merocanites* Assemblage; Tournaisian–Viséan boundary interval); Wendt and Kaufmann 1995 Coll.; illustrated in Fig. 25; MB.C.30479.1.

**Paratype**

ALGERIA • 1 specimen; Ahnet, west-southwest of Gara Azzel Matti; 'Dalle des Iridet' (*Ammonellipsites-Merocanites* Assemblage; Tournaisian–Viséan boundary interval); Wendt and Kaufmann 1995 Coll.; MB.C.30479.2.

**Description**

Holotype MB.C.30479.1 is an incomplete, partially broken and desert-eroded specimen with a conch diameter of almost 120 mm (Fig. 25). The conch is very thinly discoidal ( $ww/dm=0.19$ ) with a rather wide umbilicus ( $uw/dm=0.44$ ) and moderate coiling rate ( $WER=1.95$ ). The conspicuous, lyriform whorl profile is widest at the distinct, subangular umbilical edge. It shows an oblique, concave umbilical wall, convergent flanks and a double-keeled venter with a deep longitudinal median groove.

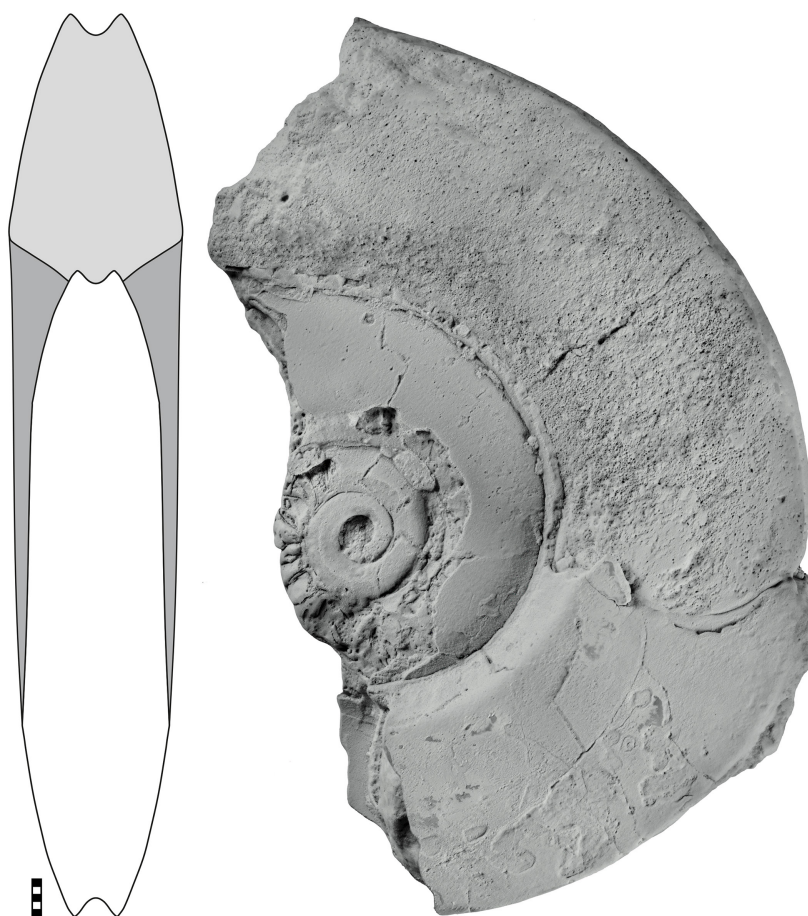
**Table 14.** Conch dimensions (in mm) and ratios of *Aphelaeceras azzelmattiense* sp. nov.

Specimen	dm	ww	wh	uw	ah	ww/dm	ww/wh	uw/dm	WER	IZW
MB.C.30479.1	119.2	22.9	35.6	52.9	33.8	0.19	0.64	0.44	1.95	0.05

Paratype MB.C.30479.2 is an incomplete specimen with 60 mm diameter, which largely complements the morphology of the holotype.

#### Remarks

*Aphelaeceras azzelmattiense* sp. nov. differs from all the other species of the genus in the concave umbilical wall.



**Fig. 25.** *Aphelaeceras azzelmattiense* sp. nov., holotype MB.C.30479.1 (Wendt & Kaufmann 1995 Coll.) from Azzel Matti. Scale bar units=1 mm.

Genus *Maccoyoceras* Miller, Dunbar & Condra, 1933

**Type species**

*Nautilus (Discites) discors* M'Coy, 1844; original designation.

**Diagnosis**

Genus of the family Trigonoceratidae with evolute conch; whorls slightly impressed; whorl profile hexagonal or pentagonal with flattened or slightly concave venter and narrowly rounded umbilical margin. Ornament in the adult stage with coarse growth lines, in the preadult stage with fine spiral lines. Suture line with shallow external and lateral lobes. Siphuncle small with subcentral position (after Kummel 1964; emended by Korn *et al.* 2022).

**Included species**

*Nautilus (Trematodiscus) discoidalis* Winchell, 1862, Michigan; *Nautilus (Discites) discors* M'Coy, 1844, Ireland; *Nautilus Leveilleanus* de Koninck, 1844, Belgium; *Maccoyoceras pentagonum* Korn, Miao & Bockwinkel, 2022, Algeria; *Discitoceras Wrightii* Foord, 1900, Ireland; *Maccoyoceras saharensis* sp. nov., Algeria; *Maccoyoceras habadraense* sp. nov., Algeria.

*Maccoyoceras saharensis* sp. nov.

[urn:lsid:zoobank.org:act:029ECCD2-153E-4624-8C6B-B1D24CF0E940](https://zoobank.org/act:029ECCD2-153E-4624-8C6B-B1D24CF0E940)

Figs 26–27, Table 15

**Diagnosis**

Species of *Maccoyoceras* with subquadrate whorl profile ( $ww/wh \sim 1.05$ ), venter slightly flattened, ventrolateral shoulder broadly rounded. Whorls not embracing.

**Etymology**

Named after the occurrence in the Sahara Desert.

**Type material**

**Holotype**

ALGERIA • Mouydir, south of Oued Temertasset (locality MOU-A); Argiles de Teguentour (Upper *Pericyclus-Progoniatites* Assemblage; early late Tournaisian); Korn *et al.* 2002 Coll.; illustrated in Fig. 26A; MB.C.30480.1.

**Paratypes**

ALGERIA • 1 specimen; Mouydir, south of Oued Temertasset (locality MOU-D1); Argiles de Teguentour (Upper *Pericyclus-Progoniatites* Assemblage; early late Tournaisian); Korn *et al.* 2002 Coll.; illustrated in Fig. 26B; MB.C.30481 • 7 specimens; Mouydir, south of Oued Temertasset (localities MOU-A, MOU-B5, MOU-E07, MOU-D2); Argiles de Teguentour (Upper *Pericyclus-Progoniatites* Assemblage; early late Tournaisian); Korn *et al.* 2002 Coll.; MB.C.30480.2–MB.C.30480.3, MB.C.30482.1–MB.C.30482.2, MB.C.30483.1–MB.C.30483.2, MB.C.30484.

**Description**

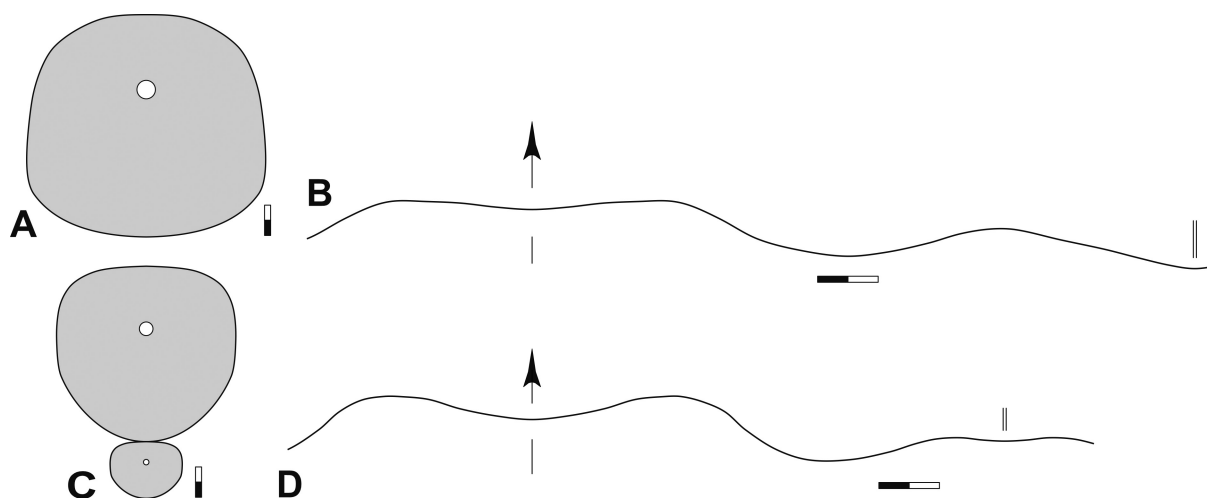
Holotype MB.C.30480.1 is the fragment of a phragmocone of a quarter whorl length (Fig. 26A); it has a whorl height of 16 mm. The whorl profile is subquadratic with flattened, very weakly convergent flanks, a broadly rounded venter and a broadly rounded dorsum (Fig. 27A). The internal mould shows no ornament, but very faint remnants of spiral striation are visible. The suture line extends with a slight

**Table 15.** Conch dimensions (in mm) and ratios of *Maccoyoceras saharensis* sp. nov.

Specimen	dm	ww	wh	uw	ah	ww/dm	ww/wh	uw/dm	WER	IZW
MB.C.30480.1	–	16.4	15.7	–	–	–	1.04	–	–	–
MB.C.30481	–	11.7	11.2	–	–	–	1.04	–	–	–



**Fig. 26.** *Maccoyoceras saharensis* sp. nov. from Oued Temertasset (all Korn *et al.* 2002 Coll.). A. Holotype MB.C.30480.1. B. Paratype MB.C.30481. Scale bar units=1 mm.



**Fig. 27.** *Maccoyoceras saharensis* sp. nov. from Oued Temertasset (both Korn *et al.* 2002 Coll.). A. Whorl profile of holotype MB.C.30480.1. B. Suture line of holotype MB.C.30480.1, at ww=16.2 mm, wh=14.8 mm. C. Whorl profile of paratype MB.C.30481. D. Suture line of paratype MB.C.30481, at ww=10.9 mm, wh=14.8 mm. Scale bar units=1 mm.



depression on the venter, a slightly deeper, very broadly rounded lobe on the flank and a very shallow internal lobe (Fig. 27B).

Paratype MB.C.30481 shows the chambered remains of two whorls that touch but do not overlap (Fig. 26B). On the outer whorl with 12 mm whorl height, the profile is subquadrate ( $ww/wh=1.04$ ) with a wider, flattened venter, weakly divergent, also flattened flanks and a more tightly rounded dorsum (Fig. 27C). The penultimate whorl, 3.8 mm high, is rounded-triangular in profile and somewhat depressed ( $ww/wh=1.28$ ). The suture line is similar to that of the holotype, but shows a higher ventral area with a slightly deeper external lobe (Fig. 27D).

### Remarks

*Maccoyoceras saharensis* sp. nov. differs from the other species of the genus by the whorl profile form with a strongly rounded ventrolateral shoulder. Another difference could be the strength of the ornament; in *M. saharensis* sp. nov. no spiral lines were impressed into the internal mould. However, since no shell specimens of the new species are known, it is impossible to say whether spiral lines were actually present. It is therefore also possible that the new species belongs to another genus, for example *Lispoceras*.

### *Maccoyoceras habadraense* sp. nov.

[urn:lsid:zoobank.org:act:CDDDB23E7-2380-4600-BCF0-71E3F2159BF2](https://zoobank.org/urn:lsid:zoobank.org:act:CDDDB23E7-2380-4600-BCF0-71E3F2159BF2)

Fig. 28, Table 16

### Diagnosis

Species of *Maccoyoceras* reaching about 100 mm conch diameter. Conch with weakly depressed whorl profile ( $ww/wh \sim 1.10$ ); venter flattened, ventrolateral shoulder narrowly subangular. Whorls just touching the preceding. Ornament in the juvenile stage with few coarse, granulated spiral lines on the flank, in the adult stage without spiral lines. Fine, sharp growth lines on the flank, with weakly biconvex course with a shallow lateral sinus and a moderately high ventrolateral projection. Venter with delicate growth lines with deep sinus.

### Etymology

Named after the type locality Hassi Habadra.

### Type material

#### Holotype

ALGERIA • Mouydir, west of Hassi Habadra (locality MOU-W); Argiles de Teguentour (*Helicocyclus-Ouaoufilalites* Assemblage; early late Tournaisian); Korn *et al.* 2002 Coll.; illustrated in Fig. 28N; MB.C.30485.

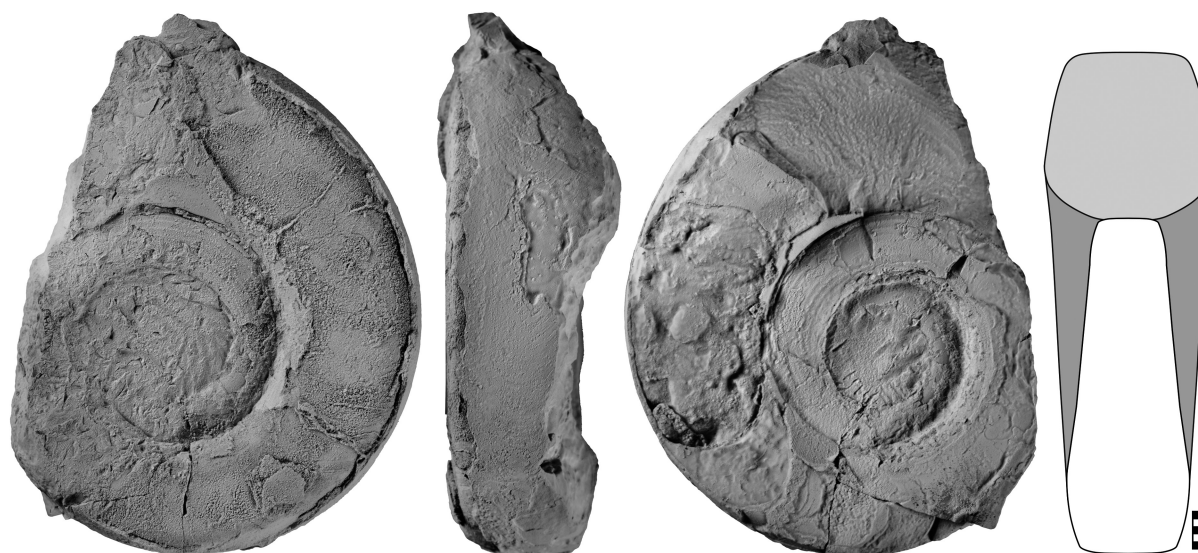
### Description

Holotype MB.C.30485 is an incomplete specimen with 66 mm conch diameter (Fig. 28). It allows the study from both sides. The conch is extremely discoidal ( $ww/dm=0.34$ ) and evolute ( $uw/dm=0.46$ ) with a high coiling rate ( $WER=2.17$ ). The whorl profile is weakly depressed hexagonal ( $ww/wh=0.93$ ) and widest at the rounded umbilical margin. The flanks converge barely towards the subangular ventrolateral shoulder that separates the flanks from the flattened venter. The umbilical wall is convexly rounded.

There are two ontogenetic stages in the ornament development; the first ranges up to about 35 mm conch diameter and possesses about ten spiral lines on the flank. The second stage does not show spirals but

**Table 16.** Conch dimensions (in mm) and ratios of *Maccoyoceras habadraense* sp. nov.

Specimen	dm	ww	wh	uw	ah	ww/dm	ww/wh	uw/dm	WER	IZW
MB.C.30485	65.5	22.4	21.0	30.0	21.0	0.34	1.07	0.46	2.17	0.00



**Fig. 28.** *Maccoyoceras habadraense* sp. nov., holotype MB.C.30485 (Korn *et al.* 2002 Coll.) from Hassi Habadra. Scale bar units= 1 mm.

only fine, narrow-standing growth lines with weakly biconvex course. These are restricted to the flanks, while the venter shows very delicate growth lines forming a very deep sinus.

#### Remarks

*Maccoyoceras habadraense* sp. nov. has similarities with *M. pentagonum*, but has a wider umbilicus ( $uw/dm=0.45$  in *M. habadraense* sp. nov. but only 0.40 in *M. pentagonum*). Furthermore, the spiral lines are markedly coarser in *M. habadraense* sp. nov.; this feature also distinguishes the new species from the other species of the genus.

#### *Maccoyoceras concavum* sp. nov.

[urn:lsid:zoobank.org:act:CC00C3E7-5DF4-4FA9-844C-AAA60F1F5016](https://zoobank.org/urn:lsid:zoobank.org:act:CC00C3E7-5DF4-4FA9-844C-AAA60F1F5016)

Fig. 29, Table 17

#### Diagnosis

Species of *Maccoyoceras* reaching about 100 mm conch diameter. Conch with weakly compressed whorl profile ( $ww/wh \sim 0.90$ ); venter weakly concave, ventrolateral shoulder narrowly subangular. Whorls weakly embracing the preceding. Ornament in the juvenile stage with few coarse, granulated spiral lines on the flank, in the adult stage without spiral lines. Fine, sharp growth lines on the flank, with weakly biconvex course with a shallow lateral sinus and a moderately high ventrolateral projection. Venter with delicate growth lines with deep sinus.

#### Etymology

After Latin ‘*concavum*’, referring to the shape of the venter.

**Table 17.** Conch dimensions (in mm) and ratios of *Maccoyoceras concavum* sp. nov.

Specimen	dm	ww	wh	uw	ah	ww/dm	ww/wh	uw/dm	WER	IZW
MB.C.30486	66.9	21.7	23.4	27.6	23.3	0.32	0.93	0.41	2.35	0.00

**Type material****Holotype**

ALGERIA • Ahnet, west-southwest of Gara Azzel Matti; ‘Dalle des Iridet’ (*Ammonellipsites-Merocanites* Assemblage; Tournaisian–Viséan boundary interval); Wendt and Kaufmann 1995 Coll.; illustrated in Fig. 29; MB.C.30486.

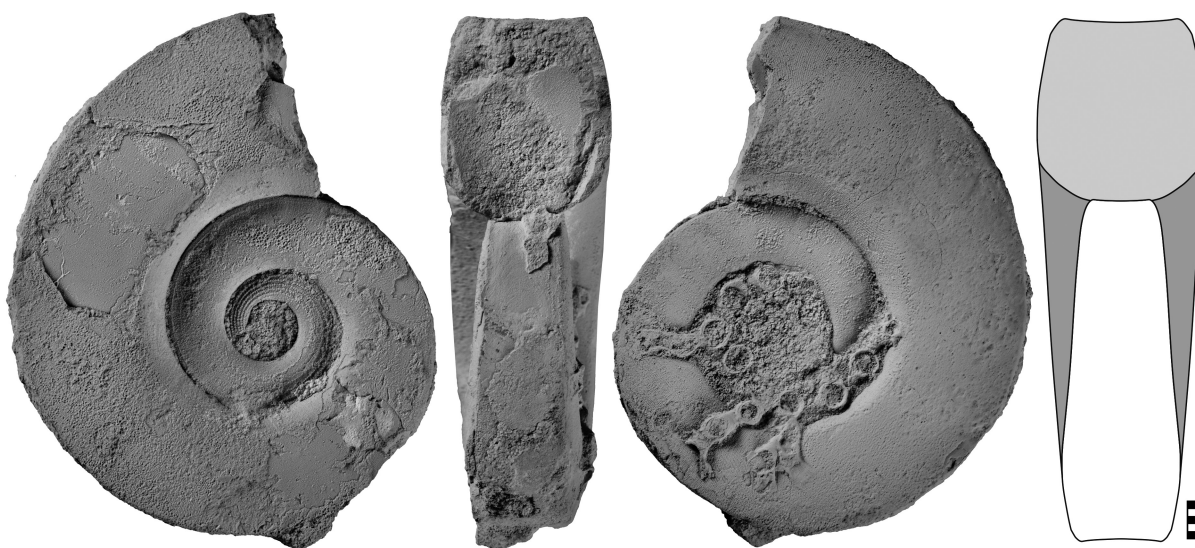
**Description**

Holotype MB.C.30486 is a rather well-preserved, almost completely chambered specimen with 76 mm conch diameter, from which the last, poorly preserved segment was removed before photography (Fig. 29). The specimen allows the study from both sides. The conch is extremely discoidal ( $ww/dm=0.32$ ) and subevolute ( $uw/dm=0.41$ ) with a very high coiling rate ( $WER=2.35$ ). The whorl profile is compressed hexagonal ( $ww/wh=0.93$ ) and widest at the rounded umbilical margin. The flanks stand almost parallel and converge barely towards the angular ventrolateral shoulder that separates the flanks from the weakly concave venter. The umbilical wall is convexly rounded.

Two ontogenetic stages of the ornament development can be separated: up to 17 mm conch diameter, six coarse, crenulated spiral lines on the flank are the dominant elements in the juvenile stage. Thereafter, fine but sharp narrow-standing growth lines with weakly biconvex course form the ornament on the flanks, but the venter bears very delicate growth lines with a deep ventral sinus. The suture line shows a shallow ventral lobe and a shallow lateral lobe. The siphuncle is almost central.

**Remarks**

*Maccoyoceras concavum* sp. nov. has conch proportions very similar to those of *M. pentagonum* from the contemporaneous ‘Dalle à *Merocanites*’ of Timimoun. However, the new species differs from this and from the other species of the genus by the concave venter.



**Fig. 29.** *Maccoyoceras concavum* sp. nov., holotype MB.C.30486 (Wendt and Kaufmann 1995 Coll.) from Azzel Matti. Scale bar units = 1 mm.

Genus *Lispoceras* Hyatt, 1893

**Type species**

*Lispoceras trivolve* Hyatt, 1893; original designation.

**Diagnosis**

Genus of the family Trigonoceratidae with evolute conch; whorls just touching each other; whorl profile weakly depressed elliptical or circular. Ornament in the adult stage with fine growth lines, in the preadult stage with fine spiral lines. Suture line with shallow external and lateral lobes. Siphuncle small with subcentral position (after Kummel 1964; emended by Korn *et al.* 2022).

**Included species**

*Lispoceras orbis* Korn, Miao & Bockwinkel, 2022, Algeria; *Lispoceras proconsul* Shimansky, 1967, Kazakhstan; *Lispoceras rotundum* Hyatt, 1893, Ireland; *Lispoceras trivolve* var. *simplum* Hyatt, 1893, Belgium; *Lispoceras trivolve* Hyatt, 1893, Belgium.

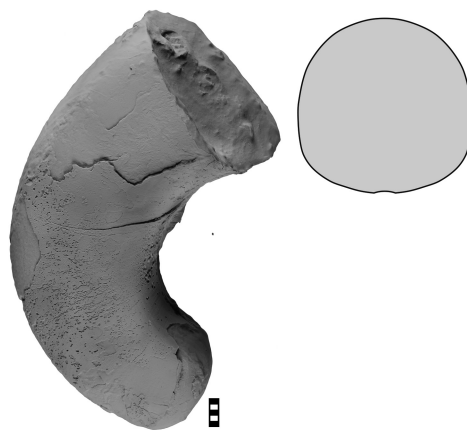
*Lispoceras* sp. 1  
Fig. 30, Table 18

**Material examined**

ALGERIA • 1 specimen; Mouydir, south of Oued Temertasset (locality MOU-C1); Argiles de Teguentour (*Helicocyclus-Ouaoufilalites* Assemblage; early late Tournaisian); Korn *et al.* 2002 Coll.; illustrated in Fig. 30; MB.C.30487.

**Description**

Specimen MB.C.30487 is a body chamber fragment that belonged to a conch approximately 10 mm diameter (Fig. 30). It has an almost circular whorl profile with a slightly clearer umbilical margin. The last whorl only slightly encompassed the previous one, recognisable by the very small dorsal whorl zone. The shell surface, although marred by desert grinding, is clearly recognisable. The ornament consists of fine growth lines running in a slightly posterior direction across the umbilical wall and flanks, then forming a deep ventral sinus.



**Fig. 30.** *Lispoceras* sp. 1, specimen MB.C.30487 from Oued Temertasset (Korn *et al.* 2002 Coll.); lateral view and whorl profile. Scale bar units = 1 mm.



**Table 18.** Conch dimensions (in mm) and ratios of *Lispoceras* sp. 1.

Specimen	dm	ww	wh	uw	ah	ww/dm	ww/wh	uw/dm	WER	IZW
MB.C.30487	–	–	46.4	46.2	–	–	1.00	–	–	–

*Lispoceras* sp. 2  
Fig. 31, Table 19

**Material examined**

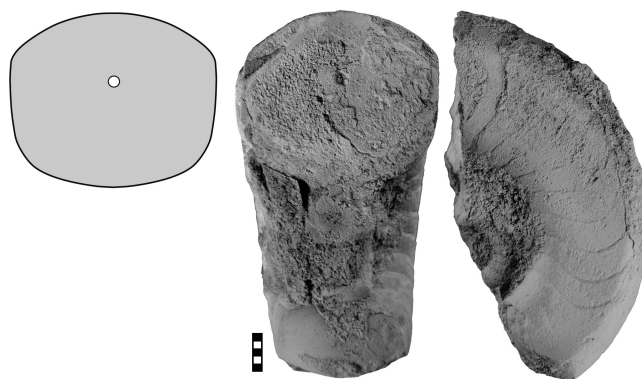
ALGERIA • Ahnet, west-southwest of Gara Azzel Matti; ‘Dalle des Iridet’ (*Ammonellipsites-Merocanites* Assemblage; Tournaisian–Viséan boundary interval); Wendt and Kaufmann 1995 Coll.; illustrated in Fig. 31; MB.C.30488.

**Description**

Specimen MB.C.30488 is a fragmented conch with a diameter of almost 70 mm, it consists of a part of the body chamber, the phragmocone of the last whorl and a small piece of the second last whorl (the best-preserved piece is illustrated in Fig. 31). The conch is discoidal and subevolute ( $ww/dm=0.46$ ;  $uw/dm=0.41$ ) with a depressed rectangular whorl profile. The flanks are almost parallel and separated from the flattened venter by a rounded but distinct ventrolateral shoulder. Any overlap of the whorls is not visible. The suture line shows a broadly rounded external lobe and a rounded lateral lobe.

**Table 19.** Conch dimensions (in mm) and ratios of *Lispoceras* sp. 2.

Specimen	dm	ww	wh	uw	ah	ww/dm	ww/wh	uw/dm	WER	IZW
MB.C.30488	66.8	30.7	25.2	27.5	24.9	0.46	1.22	0.41	2.54	0.01

**Fig. 31.** *Lispoceras* sp. 2, specimen MB.C.30488 (Wendt and Kaufmann 1995 Coll.) from Azzel Matti; lateral view and whorl profile. Scale bar units=1 mm.



## Discussion

Coiled nautiloids of the Tournaisian and Viséan (Early Carboniferous) are only known from a few localities in North Africa. Here, we describe material from five localities in southern Algeria. These belong to four stratigraphic horizons (named in terms of ammonoid stratigraphy):

- (1) *Pericyclus-Progoniatites* Assemblage (early late Tournaisian) with the species: *Rinecerases tenerum* sp. nov., *Stroborinecerases insalahensis* gen. et sp. nov., *Stroborinecerases felis* gen. et sp. nov., *Stroboceras mane* sp. nov., *Vestinautilus angulatus* sp. nov., *Vestinautilus papilio* sp. nov., *Vestinautilus inflexus* sp. nov., *Trilobitoceras peculiaris* gen. et sp. nov., *Maccoyoceras saharensis* sp. nov.
- (2) *Helicocyclus-Ouaoufilalites* Assemblage (early late Tournaisian) with the species: *Vestinautilus bicristatus* sp. nov., *Vestinautilus* sp., *Maccoyoceras habadraense* sp. nov., *Lispoceras* sp. 1.
- (3) *Ammonellipsites-Merocanites* Assemblage (Tournaisian–Viséan boundary interval): *Aphelaeceras azzelmattiense* sp. nov., *Maccoyoceras concavum* sp. nov., *Lispoceras* sp. 2.
- (4) Upper *Bollandoceras* Assemblage (early to middle Viséan): *Stroboceras ancilis* sp. nov., *Stroboceras* sp.

Of these assemblages, the first is particularly important because it is one of the oldest Early Carboniferous occurrences of coiled nautiloids. All species belong to the family Trigonoceratidae Hyatt, 1884.

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The specimens described here were collected during fieldwork by Jobst Wendt and Bernd Kaufmann (Tübingen) and the authors together with the late Volker Ebbighausen (Odenthal) and Dieter Weyer (Berlin) – we would like to express our sincere thanks for making this material available. We greatly acknowledge Markus Brinkmann (Berlin) for the preparation as well as Jenny Huang and Oskar Werb (Berlin) for the photography of the specimens. The Deutsche Forschungsgemeinschaft (DFG) provided financial support to DK (project Ko1829/3-1). We also greatly acknowledge the reviews by Martina Aubrechtová (Prague) and Kathleen Histon (Valganna).

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