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Cover illustration: The ammonite *Dorsetensia liostraca* Buckman from the Lower Bajocian (Middle Jurassic) Giganteuston Member of Öschingen, Middle Swabian Alb, Germany. For details, see Dietze, V. et al.: The Giganteuston Member of Öschingen (Humphriesianum Zone, Lower Bajocian, Swabian Alb), with comments on the genera *Dorsetensia* Buckman, 1892 and *Nannina* Buckman, 1927, pp. 209–236 in this issue.
Back cover: Atrium of the Munich Palaeontological Museum, view from the main entrance.

Umschlagbild: *Dorsetensia liostraca* Buckman, ein Ammonit aus dem Giganteuston des Unter-Bajociums (Mittlerer Jura) von Öschingen, Mittlere Schwäbische Alb, Deutschland. Für weitere Informationen siehe Dietze, V. et al.: The Giganteuston Member of Öschingen (Humphriesianum Zone, Lower Bajocian, Swabian Alb), with comments on the genera *Dorsetensia* Buckman, 1892 and *Nannina* Buckman, 1927, S. 209–236 in diesem Heft.
Rückseite: Lichthof des paläontologischen Museums München, Blick vom Haupteingang.

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Revision of Cenomanian-Turonian (Upper Cretaceous) gastropods from Egypt

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Abstract

Twenty gastropod taxa, belonging to thirteen genera and twelve families, are systematically described from the Cenomanian-Turonian rocks of eastern Sinai. Most of the gastropods are internal moulds, some of which are, in addition, incomplete (e.g., nerineids). Consequently, many species identified in the past had to be revised because they are junior synonyms or do not justify identification at the species level. Due to the lack of some important characters such ornamentation, protoconch, outer lip, and aperture the generic position of some gastropods cannot be identified with certainty. The genus *Sogdianella* Djalilov, 1972 of the family Acteonellidae Gill, 1871, hitherto known only from central Europe, the Middle East, and Transcaucasia, is recorded from the Lower Turonian of Egypt and North Africa for the first time. Similarly, *Ampullina dupinii* (Deshayes in Leymerie, 1842), *Sogdianella*? *laevis laevis* (J. de C. Sowerby, 1835), and *Diozoptyxis*? *blancheti* (Pictet & Campiche, 1864) are first records from Egypt. Two of the three genera of nerineids recorded in this study, namely *Neoptyxis* Pchelintsev, 1934 and *Pchelinsevia* Lisenko & Aliyev, 1987, can easily be recognised, because of their characteristic fold pattern, whereas the third genus, *Diozoptyxis* Cossmann, 1896, is not well preserved. The geographic distribution of the gastropod taxa suggests a Tethyan affinity of the fauna, which is most closely related to that of North Africa and the Eastern Mediterranean.

Key words: Cenomanian-Turonian (Upper Cretaceous), gastropods, taxonomy, Egypt

Zusammenfassung

Zwanzig Gastropodentaxa, die 13 Gattungen und 12 Familien angehören, werden aus Cenoman-Turon-Ablagerungen des östlichen Sinai beschrieben. Bei den meisten Gastropoden handelt es sich um Steinkerne, von denen einige (z.B. die Nerineen) zusätzlich unvollständig sind. Viele Arten, die aus diesen Schichten in der Vergangenheit bestimmt worden waren, werden als jüngere Synonyme erkannt oder sind für eine Bestimmung auf Artniveau zu schlecht erhalten. Da bei einigen Gastropoden wichtige Merkmale wie Ornamentierung, Protoconch, Außenlippe und Mündung fehlen, kann die Gattungszugehörigkeit nicht eindeutig festgelegt werden. Die Gattung *Sogdianella* Djaliloev, 1972 der Familie Acteonellidae Gill, 1871, bislang nur aus Mitteleuropa, dem Mittleren Osten und Transkaukasien bekannt, wird erstmals aus dem unteren Turon von Ägypten und Nordafrika beschrieben. In ähnlicher Weise werden *Ampullina dupinii* (Deshayes in Leymerie, 1842), *Sogdianella*? *laevis laevis* (J. de C. Sowerby, 1835) und *Diozoptyxis*? *blancheti* (Pictet & Campiche, 1864) erstmals aus Ägypten nachgewiesen. Zwei der drei Nerineen-Arten, die hier dokumentiert werden, nämlich *Neoptyxis* Pchelintsev, 1934 und *Pchelinsevia* Lisenko & Aliyev, 1987, lassen sich aufgrund ihres charakteristischen internen Faltenmusters leicht identifizieren. Im Gegensatz dazu ist die dritte Gattung, *Diozoptyxis* Cossmann, 1896, nicht gut erhalten. Die geographische Verbreitung der Gastropodentaxa zeigt einen deutlichen Bezug zur Tethys. Die engsten Verwandtschaftsbeziehungen bestehen mit der Gastropodenfauna von Nordafrika und dem östlichen Mittelmeergebiet.

Schlüsselwörter: Ägypten, Cenoman-Turon (Oberkreide), Gastropoden, Taxonomie

1. Introduction

The earliest studies on Cretaceous gastropods from Egypt were carried out by Quaas (1902), Wanner (1902), Dacque (1903), Douvillé (1916), Awad (1952), Abbass (1963), and Fawzi (1963). Recently, Abdel-Gawad & Gameil (1992), Zakhera (2002), Abdel-Gawad et al. (2004a, b), El Qot (2006), Mekawy (2007), and Mekawy & Abu Zied (2008) identified and described some Cretaceous gastropods from different

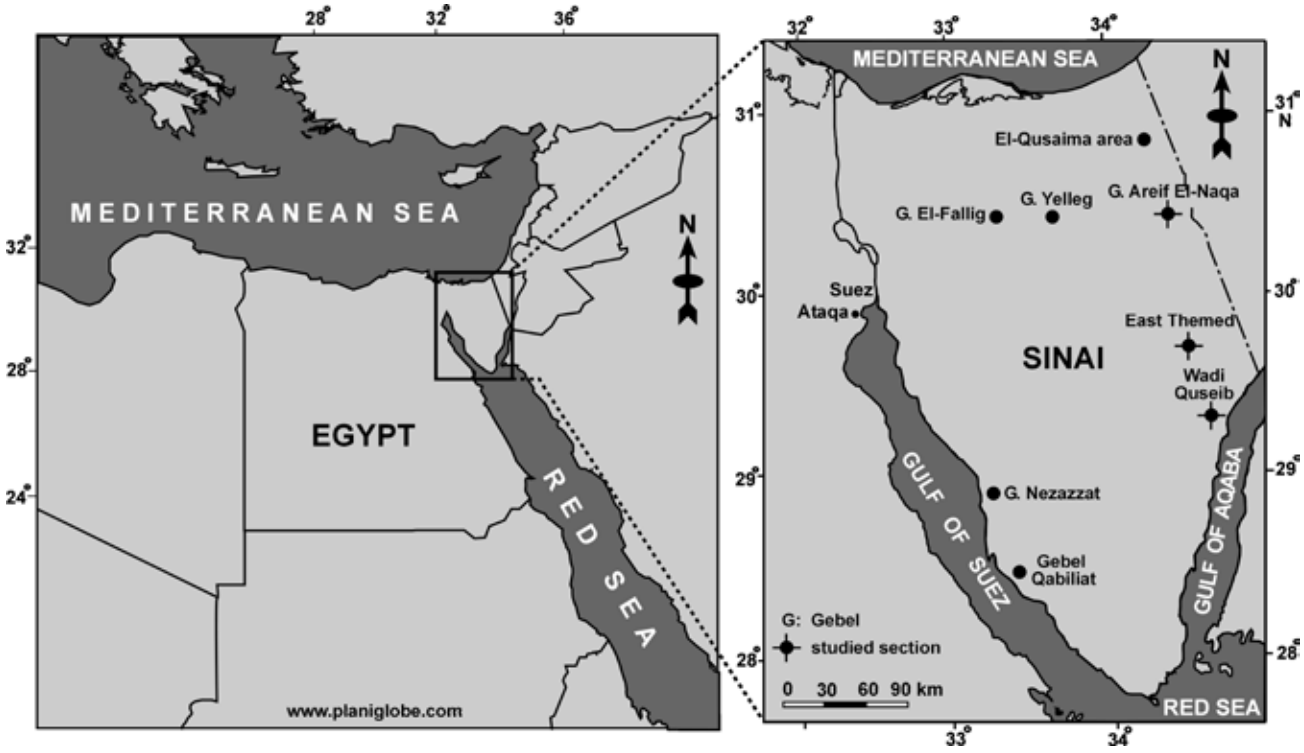

Figure 1: Locality map.

localities in the Eastern Desert and the Sinai Peninsula. Due to diagenetic processes, the preservation of the studied material is, in general, poor. Except for large nerineids, which are commonly fragmented, the gastropods are mostly complete but preserved as internal and composite moulds.

A taxonomic study of internal or composite moulds appears to be of little use and a proper classification of Upper Cretaceous gastropods from the area must await better preserved material. In the present study we address the question, to which taxonomic level such poorly preserved specimens can be identified with confidence. After all, many of the specimens lack important taxonomical characters such as protoconch, outer lip, ornamentation, and growth lines. However, as gastropods were important elements of Cretaceous benthic communities and, in some cases, are of biostratigraphic value identification even at the family level is important. Nerineids, for example, form part of subtropical to tropical Tethyan rudist-coral assemblages and are a useful tool for recognizing various Jurassic and Cretaceous stages in carbonate platform setting (Sohl 1987; Sirna 1995; Saul & Squires 2002). Moreover, the study of nerineids is of great importance for understanding the ecosystem of such carbonate platforms. For example, according to Abdel-Gawad (2001: 304) the presence of *Nerinea* associated with coralline sponges and corals possibly indicates restricted lagoonal facies. The identification of nerineids is, however, also very difficult. Apart from varying in outline and ornamentation they possess internal shell structures, which are the most important taxonomic criterion for their classification at the generic level. These structures consist of internal folds on the columella and outer lip, which vary in number, arrangement, and strength. Therefore, the longitudinal whorl sections of some nerineid specimens have been investigated.

Three sections have been studied along the eastern side of Sinai Peninsula, which is bounded by the Suez Rift to the west and the Aqaba-Dead Sea Rift to the east (Fig. 1). The northeastern section is Gebel Areif El-Naqa, which lies between latitudes 30°20´ and 30°24´N and longitudes 34°24´ and 34° 30´E. The second section is Wadi Quseib, near the Gulf of Aqaba, 140 km south of Gebel Areif El-Naqa (co-ordinates: 29°16´47”N and 34°43´12”). The East Themed section lies between these two sections and is very close to the Wadi Quseib section (Fig. 1).

2. Lithostratigraphy

The Cenomanian-Turonian succession of Gebel Areif El-Naqa is 457 m thick and has been subdivided into three formations, which from older to younger are the Halal Formation (Upper Albian-Cenomanian) (301 m), the Abu Qada Formation (Lower-?Middle Turonian) (96 m), and the Wata Formation (Upper Turonian) (60 m). The Halal Formation unconformably overlies the Lower Cretaceous Malha Formation (Fig. 2). The latter is not described in detail, but plays an important role for recognizing the unconformable boundary. The Halal Formation has been subdivided into three informal members. The formation is composed mainly of carbonate rocks (about 65% of the total thickness of the formation), while the Abu Qada Formation is easily distinguished by its characteristic

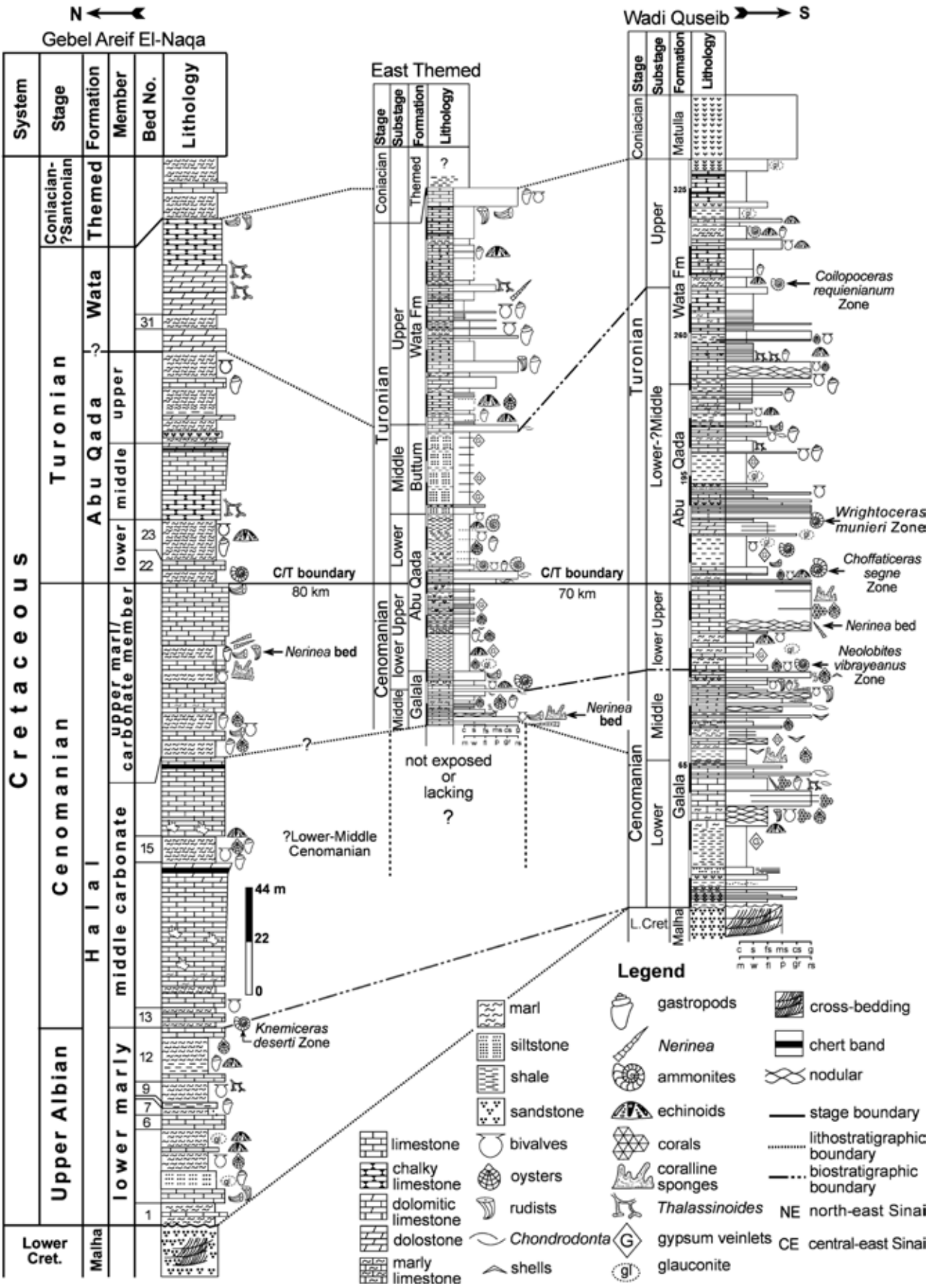

Figure 2: Litho- and biostratigraphic correlation of the three studied sections. The lithostratigraphic scale is applied only to the East Themed and Wadi Quseib sections. c: clay; s: silt; fs: fine sand; ms: medium sand; cs: coarse sand; g: gravel; m: mudstone; w: wackestone; f: floatstone; p: packstone; g: grainstone; rs: rudstone.

green fossiliferous marls and shales, which are interbedded with limestone and marly limestone (ammonite bed). The Wata Formation can easily be distinguished from the underlying Abu Qada Formation by its thick-bedded, cliff-forming chalky and partly dolomitic limestones with chert nodules.

In the East Themed area, the Cenomanian-Turonian succession is 239 m thick and has been subdivided into four formations which, from older to younger, are the Galala (Middle-lower Upper Cenomanian), Abu Qada (Upper Cenomanian-Lower Turonian), Buttum (Middle Turonian), and Wata formations (Upper Turonian). The basal part of the Cenomanian Galala Formation is not exposed. The Galala Formation is composed mainly of grey to yellowish grey, hard, fossiliferous limestone (floatstone to rudstone) with intercalations of shales and marls. The Buttum Formation is 40 m thick and consists mainly of variegated gypsum/claystone interbeds.

Three formations have been recognized in the third section (Wadi Quseib), which are the Galala (Cenomanian; 143 m), Abu Qada (Lower-?Middle Turonian;100 m), and Wata formations (upper Middle-Upper Turonian; 91 m). The Galala Formation has been subdivided into three informal members. The Cenomanian Galala Formation is rich in macrobenthos except for the lower shale member at Wadi Quseib. The latter member (33.5 m) consists mainly of ochre shale with intercalations of fine- to coarse-grained sandstone, thin reddish clay horizons, and lacks any macrobenthic fauna. The Galala Formation is predominantly siliciclastic (gypsiferous shales and sandstones) at the base, more calcareous in the middle part (floatstone to rudstone), and dolomitic at the top (*Cladocora*-*Chondrodonta* rudstone). The Abu Qada Formation consists mainly of variegated, fossiliferous, gypsiferous shale with dolomitic *Chondrodonta*-rudist rudstone to floatstone interbeds in the lower part, thick-bedded, cavernous, fine-grained dolostone followed by hard, stylolitic, molluscan calcareous rudstone in the middle, and siliciclastic rocks (65%; shale and marl) with hard limestone and dolomitic limestone at the top. The Wata Formation is composed mainly of thick-bedded, hard, massive limestone, chalky limestone with chert layers and intercalations of marl and shale. The mixed siliciclastic-carbonate rocks increase in abundance towards the south at the expense of carbonates, while the total thickness gradually decreases (East Themed and Wadi Quseib sections). In contrast, carbonates increase in abundance toward the north (deep carbonate facies as in Gebel Areif El-Naqa) (Fig. 2).

3. Systematic palaeontology

The terminology for the description of the gastropods follows the glossary presented by Cox (1960) in the *Treatise on Invertebrate Paleontology*, Part 1 (Gastropoda). For the spire and size of the specimens, the present work follows Yin et al. (1983). They divided the specimens according to size into small (< 1.0 cm); moderately small (1.0 to 1.5 cm); medium (1.5–2.0 cm); moderately large (2.0–2.5 cm); and large (>2.5 cm). They classified the spire into low-spired (pleural angle >110º); moderately low-spired (angle 90º–110º); moderately high-spired (angle 50º–90º), and high-spired (< 50º). The classification used here is that of Bouchet & Rocroi (2005).

All linear measurements (taken with Vernier Caliper) are given in millimetres. Abbreviations of measured parameters:

n: number of measured specimens;
H: height;
D: maximum diameter;
HL: height of last whorl;
HA: height of aperture;
WA: width of aperture;
PAº: pleural angle (in degrees);
nr: number of axial ribs;
ns: number of spiral lines;
nw: number of whorls;
WQ : Wadi;
ET: East Themed;
AEN: Gebel Areif El-Naqa; and
G: Gastropod.

The material on which this study is based is housed in the collections of the Geology Department, Faculty of Science of El-Menoufiya University, Egypt, under the collection numbers MGDMU.

Class Gastropoda Cuvier, 1797
Clade Vetigastropoda Salvini-Plawen, 1980
Superfamily Trochoidea Rafinesque, 1815
Family Trochidae Rafinesque, 1815
Subfamily Trochinae Rafinesque, 1815

Genus *Calliomphalus* Cossmann, 1888

Remarks: *Calliomphalus* has a relatively elevated spire, convex whorls, circular aperture, wide umbilicus, and spiral cords on body whorl. According to Squires & Saul (2003: 52), *Calliomphalus* is characterized by the presence of a wide umbilicus. *Solariella* Wood, 1842 and *Calliomphalus* often develop very similar adult shells, but differ in the sculpture of the first whorl (Kiel & Bandel 2001). While *Solariella* starts with a spiral sculpture, *Calliomphalus* starts with axial ribs (Kiel & Bandel 2001). Therefore and due to the lack of the first whorl, assignment of the present specimens to the genus *Calliomphalus* is tentative. The genus has a wide geographic distribution in the later part of the Late Cretaceous and stratigraphically even ranges into the Paleogene in Europe (Sohl 1960) and Upper Eocene in Egypt (Abbass 1967).

Calliomphalus? *orientalis* (Douvillé, 1916)
Fig. 3

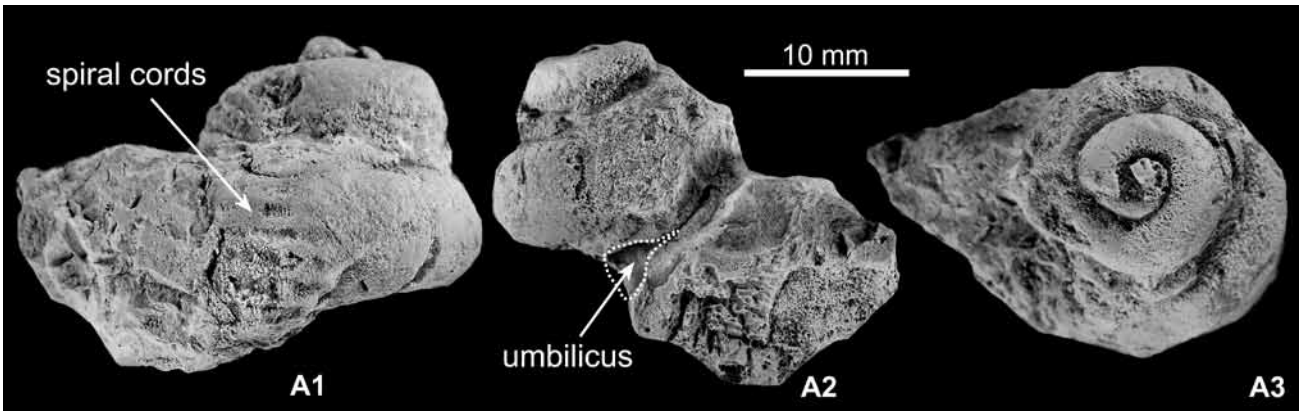

Figure 3: Composite mould of *Calliomphalus*? *orientalis* (Douvillé, 1916) from the upper carbonate member of the Cenomanian Galala Formation at Wadi Quseib. A1: Abapertural view, A2: apertural view, A3: apical view; MGDMU:WQ.G.44.227. Scale bar: 10 mm.

1916 *Metriomphalus orientalis* sp. nov. – Douvillé: 145, pl. 18, fig. 31.
1991 *Metriomphalus orientalis* Douvillé – Aboul Ela et al.: pl. 2, fig. 1.
1992 *Calliomphalus* (*Calliomphalus*) *orientalis* (Douvillé) – Abdel-Gawad & Gameil: 71, fig. 2/1.
2006 *Calliomphalus* (*Calliomphalus*) *orientalis* (Douvillé) – El Qot: 93, pl. 19, fig. 1.
2008 *Calliomphalus* (*Calliomphalus*) *orientalis* (Douvillé) – Mekawy & Abu Zied: 317, pl. 4, fig. 3.

Material and occurrence: Two composite moulds from the upper carbonate member of the Cenomanian Galala Formation, bed 44, at Wadi Quseib (MGDMU:WQ.G.44.227–228).

Description: Medium-sized, trochiform, moderately high-spired gastropod, wider than high (D/H=1.28), and phaneromphalous. Spire conical and consisting of two overlapping convex, smooth whorls. Sutures weakly impressed. Body whorl accounting for more than half (62%) of the total shell height. Umbilicus deep and funnel-shaped. Aperture large, nearly circular and oblique. Inner lip concave. Base rounded. Ornamentation consisting of fine spiral cords separated by wide interspaces, which are well developed on the body whorl (Fig. 3A1).

Table 1: Dimensions (in mm) of *Calliomphalus*? *orientalis* (Douvillé)

	H	D	HL	HA	WA	D/H	HL/H	WA/HA
n=1	21	27	13	12	15	1.28	0.62	1.25

Occurrence: *Calliomphalus orientalis* is known from the Upper Barremian to Upper Cenomanian of Egypt.

Discussion: The present specimens closely resemble *Calliomphalus orientalis* (Douvillé, 1916), which was originally described from the Albian of Gebel Manzour. They are also very similar to *C. orientalis* (Douvillé) as figured and described by Mekawy & Abu Zied (2008) from the Upper Barremian-Lower Albian of Sinai. According to Abdel-Gawad & Gameil (1992), *C. orientalis* differs from *C*. (*C*.) *dichotomus* (Alth, 1850) by its less convex whorls and the possession of tubercles. *C*. (*C*.) *biomstrofensis* (Griepenkerl, 1889) differs in having a large number of spiral cords with narrow interspaces. *Solariella mexcalensis* (Perrilliat et al., 2000), which has been described by Kiel et al. (2002: 322, fig. 1/4) from the Maastrichtian of southern Mexico closely resembles the present material in general outline, umbilicus, and aperture but differs in being smaller and in having less convex whorls.

Clade Caenogastropoda Cox, 1960
Clade Sorbeoconcha Ponder & Lindberg, 1996
Superfamily Cerithioidea Fleming, 1822
Family Cerithiidae Fleming, 1822

Remarks: The small specimens are too poorly preserved for a precise determination. The whorls in most individuals are similar to the genus *Mesalia* Gray, 1842. In many specimens, the aperture is incomplete. For these reasons, the present specimens are assigned herein to Cerithiidae gen. et sp. indet.

Cerithiidae gen. et sp. indet.
Fig. 4

Material and occurrence: Numerous composite moulds (about 100 specimens) from the Upper Turonian Wata Formation, beds 55, 85, and 92, at Wadi Quseib (MGDMU:WQ.G.55.21-70, 85.1–100, 92.1–3).

Description: Small- to moderately small-sized (H=5–13 mm, D=3–5 mm), turriculate to conical, and high-spired gastropods (spire angle 28–38°). Spire elongated and consisting of about 6–8 overlapping whorls separated by moderately deep sutures. Whorl surfaces slightly convex to flat, whorl width nearly twice the whorl height. Aperture small and lanceolate with small anterior notch. Each whorl ornamented with about 6–8 tuberculate spiral cords.

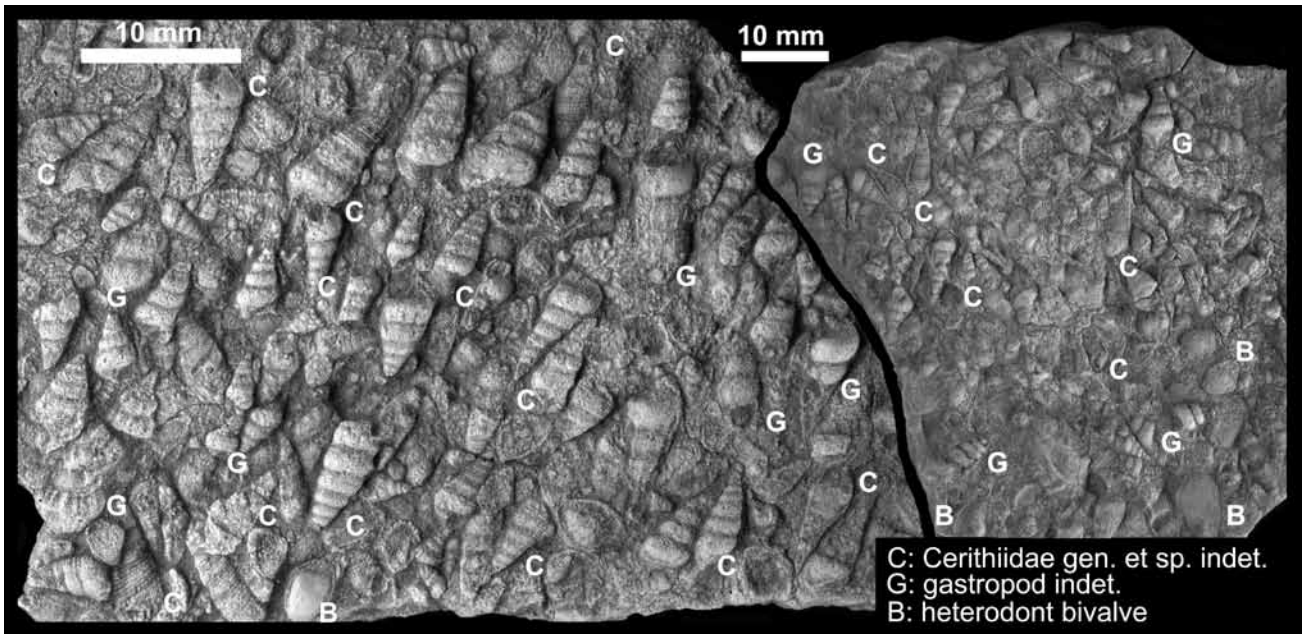

Figure 4: Near-monospecific concentration of composite moulds of Cerithiidae gen. et sp. indet. (C) with very rare gastropod indet. (G) and heterodont bivalves (B) from the Turonian Wata Formation of Wadi Quseib. Scale bar: 10 mm.

Discussion: *Tympanotonos* (*Exechocirsus*) *cingillatus* Zekeli, 1852 of Kiel & Bandel (2004: 120, fig. 7D, E) from the Cenomanian of Germany resembles the present material in general shape (turriculate), size (H=12 mm, D= 5 mm), and whorl width, but differs in the style of tuberculation.

Family Batillariidae Thiele, 1929
(=Pyrazidae Hacobjan, 1972 = Tiaracerithiinae Bouniol, 1981)

Genus *Pyrazus* Montfort, 1810

Pyrazus valeriae (de Verneuil & de Lorière, 1868)
Fig. 5

1868	*Cerithium Valeriae* sp. nov. – de Verneuil & de Lorière: 11, pl. 2, fig. 1.
1916	*Pyrazus Valeriae* de Verneuil & de Lorière – Douvillé: 136, pl. 18, figs 6–8.
?1927	*Cerithium* (?*Pyrazus*) *magnicostatum* Conrad – Blanckenhorn: 161, pl. 8 (4), fig. 75.
?1927	*Cerithium* (*Pyrazus*) *zumoffeni* sp. nov. – Blanckenhorn: 160, pl. 8, fig. 73.
1992	*Pyrazus valeriae* (de Verneuil & de Lorière) – Abdel-Gawad & Gameil: 74, fig. 2/11, 2/12.
1986	*Pyrazus* (*Echinobathra*) *valeriae* (de Verneuil & de Lorière) – Buitrón: 25, figs 14, 15.
1995	*Pyrazus* (*Echinobathra*) *valeriae* (de Verneuil & de Lorière) – Sánchez & Tinajero: 162, pl. 1, figs 7–9.
2004b	*Pyrazus valeriae* (de Verneuil & de Lorière) – Abdel-Gawad et al.: pl. 5, fig. 1.
2006	*Pyrazus* (*Pyrazus*) *valeriae* (de Verneuil & de Lorière) – El Qot: 97, pl. 19, figs 9–11.
2008	*Pyrazus* (*Pyrazus*) *valeriae* (de Verneuil & de Lorière) – Mekawy & Abu Zied: 322, pl. 4, fig. 14.

Material and occurrence: 16 composite moulds from the Upper Cenomanian-Lower Turonian Abu Qada Formation, beds 3 and 16, at East Themed (MGDMU:ET.G.3.130–132, 16.465–477), three composite moulds from the middle carbonate member of the Cenomanian Halal Formation, bed 15, at Gebel Areif El-Naqa (MGDMU:AEN.G.15.128–130), and a single specimen from the middle siliciclastic/carbonate member of the Cenomanian Galala Formation, bed 31, at Wadi Quseib (MGDMU:WQ.G.31.29).

Description: Large pyramidal gastropod with spire of 3–4 overlapping whorls, forming about 72% of the total height. Protoconch and first whorls not preserved. Whorls strongly convex, their width nearly twice the height, and separated by deep sutures. Diameter of whorls increasing gradually from apex to aperture. Body whorl small with strongly convex flanks. Base slightly rounded. Aperture oval, with incomplete outer lip, inner lip concave. Each whorl ornamented with 11–14 fine spiral cords, separated by smooth interspaces, and crossed by 6–8 strong axial ribs (Fig. 5).

Occurrence: *Pyrazus valeriae* has been recorded from the Upper Aptian-Lower Albian of Spain, Lower Cretaceous of Mexico, Aptian of Syria, and Albian-Cenomanian of Egypt.

Discussion: The shape and ornamentation of the present material closely resembles *Pyrazus valeriae* described by de Verneuil & de Lorière (1868) from the Upper Aptian-Lower Albian of Spain and by Sánchez & Tinajero (1995) from the Lower Cretaceous of Mexico. According to the latter authors, *P. valeriae* is similar to *P. scalariformis* described by Nagao (1934:

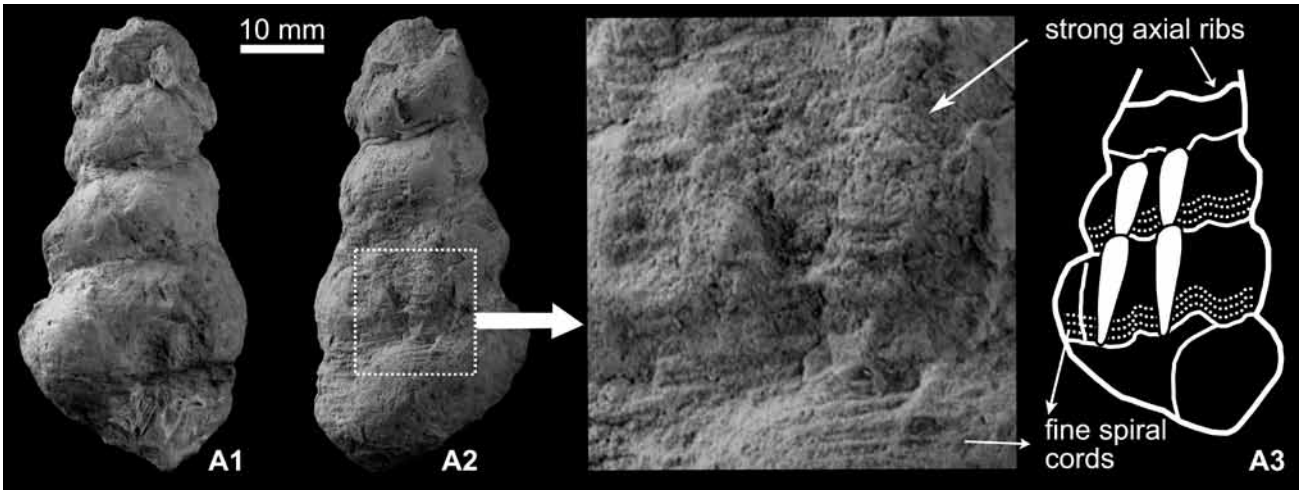

Figure 5: Composite mould of *Pyrazus valeriae* (de Verneuil & de Lorière, 1868) from the middle carbonate member of the Upper Albian-Cenomanian Halal Formation at Gebel Areif El-Naqa. A1: Apertural view, A2: abapertural view, A3: sketch showing the fine spiral cords crossed by strong axial ribs; MGDMU:AEN.G.15.128. Scale bar: 10 mm.

257, pl. 36, fig. 24) and by Kase (1984: 137, pl. 20, figs 18, 19) from the Upper Aptian-Lower Albian of Japan. However, the present species has strong axial ribs, crossed by spiral cords, which more closely resemble Verneuil & de Lorière's species.

P. (*Echinobathra*) *magharensis* Abbass (1963: 54, pl. 3, fig. 11) from the Albian of the Maghara area is similar to the present species in turriculate shape but differs in having a greater number of axial ribs (11–12) and spiral cords (20–25). *P. themedensis* (Abbass, 1963: 56, pl. 3, figs 13–16) from the Santonian of the Themed area differs in having deep sutures with six primary spiral cords separated by wide interspaces with secondary spiral lines.

Cerithium (*Pyrazus*) *zumoffeni* Blanckenhorn (1927: 160, pl. 8, fig. 73) from the Aptian of Syria resembles *P. valeriae* in general shape and ornamentation but differs in having more developed spiral cords in the upper half of the middle whorls which weaken in the lower half. *C.* (*P.*?) *magnicostatum* (Conrad, 1852) figured by Blanckenhorn (1927) differs in having deep sutures. However, this difference is not distinct enough to recognize two different species. Therefore, Blanckenhorn's specimens may belong to *P. valeriae.*

Superfamily Campaniloidea Douvillé, 1904
Family Campanilidae Douvillé, 1904

Genus *Campanile* Bayle (in P. Fischer, 1884)

Remarks: Many fossil species referable to the genus *Campanile* Bayle in Fischer, 1884 have been proposed under the genera *Cerithium* Bruguière 1792, *Potamides* Brongniart, 1810, *Telescopium* Montfort, 1810, and *Nerinea* Defrance, 1825 (Matsubara 2009: 285). However, no comprehensive taxonomic studies have been performed. For instance, early workers classified *Campanile* as cerithiid (Lamarck 1804; Cossmann 1906; Wenz 1938) due to similarities of shell ornament and shape. Wenz (1938) united *Campanile* and *Plesiotrochus* Fischer, 1878 among a few other doubtful genera in the subfamily Campanilinae Douvillé, 1904 within the Cerithiidae. Delpey (1939), however, considered *Campanile* to be a descendant of *Nerinea* Deshayes, 1827 because of the occurrence of columellar folds. According to Kiel et al. (2000: 17) the genus *Campanile* has a turriform shell and its whorls are ornamented with a broad, tuberculate subsutural collar, spiral cords which may be beaded, and a cover of fine, incised striae. In addition, columellar and parietal folds may occur and the ornament may change on the last whorl. Delpey (1939: 208) confirmed that the longitudinal whorl section of the genus *Campanile* is characterized by a medium parietal fold with two columellar folds. The present material is not well enough preserved (internal moulds) to decide whether it belongs to *Campanile* or other genera of the Campanilidae. However, it is tentatively placed with *Campanile* on the basis of its turriculate outline, convex whorls with deep sutures, and with two small columellar folds and a

Table 2: Dimensions (in mm) of *Pyrazus valeriae* (de Verneuil & de Lorière).

n=2	H	D	HL	HA	WA	PA°	nw	D/H	HL/HW	WA/HA
Range	23-50	15-23	10-26	9-17	8-13	38-42°	3-5	0.46-0.65	0.43-0.52	0.76-0.88
Mean	36.50	19	18	13	10.50	40°	4	0.55	0.47	0.82

slightly deeper parietal fold (Fig. 6A5, B3). The columellar structure is also observed in some species of *Campanile* such as *C. bussoni* by Albanesi & Busson (1974: pl. 22, fig. 2a) from the Upper Cretaceous of Algeria and *C. ganesha* (Noetling, 1897) as figured by Greco (1916: 121 (63), pl. 15 (7), figs 10, 11) from the Maastrichtian of the Eastern Desert, Egypt, which probably confirm that the parietal and columallar folds are distinct characters of this genus. For more details about the taxonomy of the genus *Campanile* see Houbrick (1981, 1989), Kiel et al. (2000), and Matsubara (2009).

Campanile? sp.
Fig. 6

Material and occurrence: 11 composite moulds from the middle siliciclastic/carbonate and upper carbonate members of the Cenomanian Galala Formation, beds 31, 44, and 47, at Wadi Quseib (MGDMU:WQ.G.31.30, 44.229–233, 47.56–60).

Description: Large-sized, turriculate, and highly conical gastropod. Spire consisting of three overlapping wide whorls which have slightly convex surfaces and form about 65% of the total height. Whorls separated by moderately deep sutures and gradually decreasing toward the apex. Base flat. Apex commonly damaged. Aperture small and ovate to rectangular with convex outer lip. Ornamentation not preserved, although some faint spiral cords can be

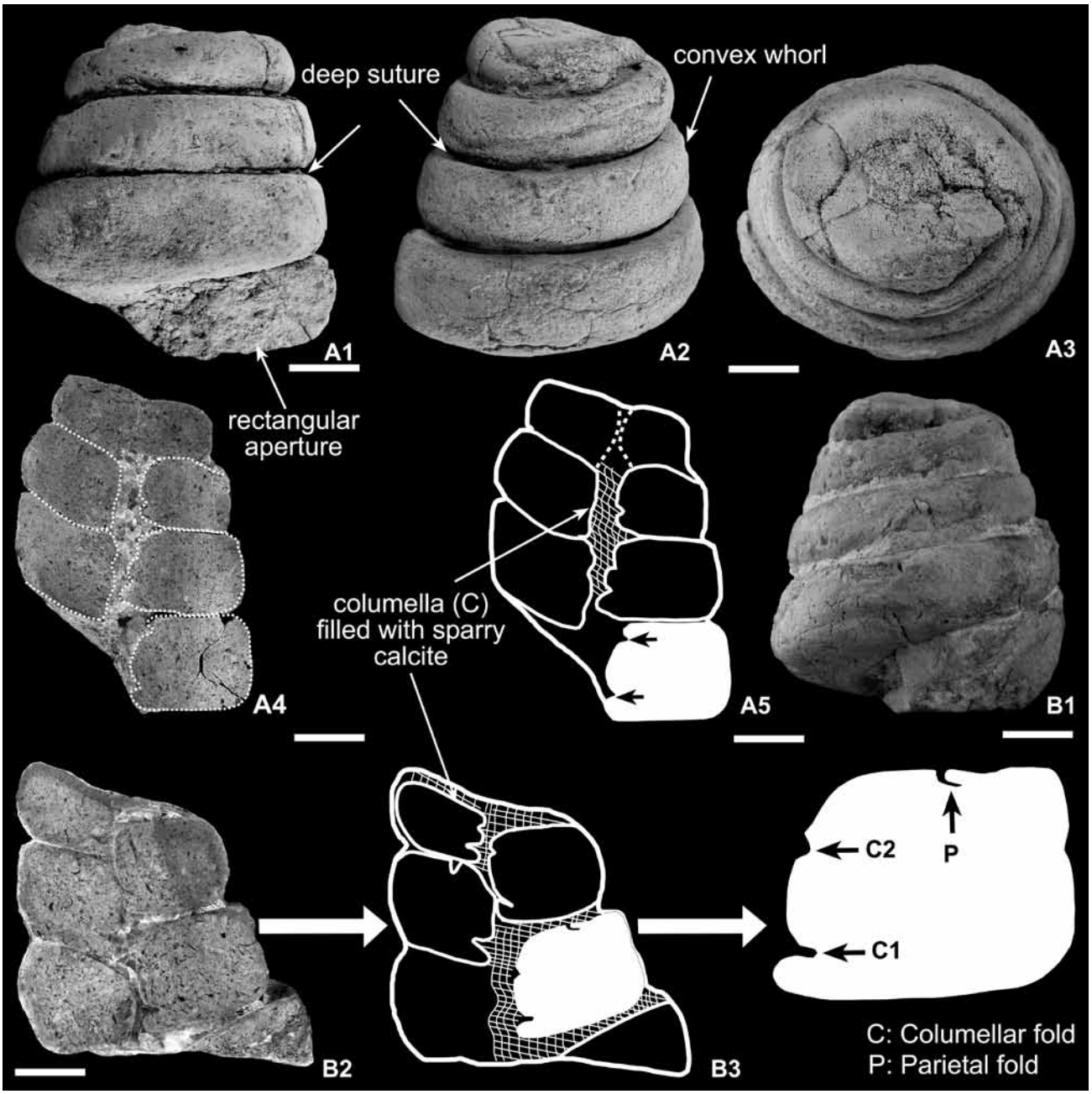

Figure 6: Internal mould of *Campanile*? sp. from the upper carbonate member of the Cenomanian Galala Formation at Wadi Quseib. A1: Apertural view, A2: abapertural view, A3: apical view, A4–A5, longitudinal whorl sections showing the internal folds; MGDMU:WQ.G.44.229. B1*:* Apertural view, B2–B3: axial whorl sections showing the whorl folds (arrowed); MGDMU:WQ.G.44.230. C: Columellar fold, P: parietal fold. Scale bars: 10 mm.

Table 3: Dimensions (in mm) of *Campanile*? sp.

n=3	H	D	HL	PA°	nw	D/H	HL/H
Range	?40-70	34-43	12-30	45-50	4	0.61-0.85	0.30-0.42
Mean	55	39	20	48	4	0.73	0.36

observed. The longitudinal whorl section shows two small columellar folds (C_1 and C_2) with medium and slightly deep parietal fold (P) (Fig. 6A5, B2, 3).

Discussion: The present material is similar to *Campanile ganesha* (Noetling), which has been figured for example by Greco (1916: 121 (63), pl. 15 (7), figs 10, 11) and El Qot (2006: 98, pl. 19, figs 12, 14) from the Upper Cenomanian-Maastrichtian of Egypt and by Collignon (1971: 17 (159), pl. C, fig. 5) from the Maastrichtian of Algeria. Their specimens are preserved as incomplete internal moulds. Considering their preservation, identification at the species level is doubtful. The longitudinal sections of *C.* (*C.*) *bussoni* of Albanesi & Busson (1974: pl. 22, fig. 2a) from Algeria and of *Cerithium* sp. (cf.) *inauguratum* Stoliczka of Quaas (1902: pl. 26, fig. 27) from the Western Desert, Egypt, closely resemble the longitudinal whorl section of the present material. Morphologically, the specimens of these authors differ in having a longer spire with 6–8 overlapping convex whorls. Moreover the whorl height is greater than in the present species with wider and deeper sutures. *C. houbricki* Kiel & Perrilliat (Kiel et al. 2000: 18, pl. 1, figs 1–5) from the Maastrichtian of Mexico differs in being smaller, more slender, and lacking columellar folds.

Genus *Cimolithium* Cossmann, 1906

Remarks: Cossmann (1906) described tubercles at the adapical suture and the four-cornered aperture of the genus *Cimolithium*, but he did not provide any information about internal structures. Delpey (1941–42) grouped *Cimolithium* together with forms which possess columellar and parietal folds. Recently, Kollmann (1979) described a short columellar plait and a long and thin parietal plait in *Cimolithium.* This parietal fold is situated close to the adapical end of the columella. Delpey (1941–42) and Kollmann (1979) considered the type species, *C. belgicum* d'Archiac, 1846, as a possible early member of the Campanilidae Douvillè, 1904. Kiel & Bandel (2004: 118) stated that the protoconch of the type species of *Cimolithium* has not yet been described, and thus the taxonomic position of the genus remains uncertain. Subsequently, Kaim (2004: 51) described the protoconch of the genus *Diatrypesis* Tomlin, 1929. He suggested that the shells of *Diatrypesis* are similar to those of the genus *Cimolithium* and that the two taxa may be congeneric. Kiel (2006: 459) described and figured the protoconch of the genus *Metacerithium* Cossmann, 1906 of the family Campanilidae. According to him the first four whorls of *Metacerithium* aff. *trimoline* Michelin, 1838 are ornamented with opisthocyrt ribs crossed by six fine, spiral cords that disappear afterwards. In certain species of *Campanile*, the whorls are ornamented with a broad, tuberculated, sub-sutural cord and some sub-equal, fine, spiral cords (Delpey 1941). The genus *Cimolithium* (with other related genera) differs from *Campanile* in the style of ornamentation but probably belongs to the family Campanilidae.

Cimolithium? sp.
Fig. 7

Material and occurrence: Eight internal moulds from the lower marly and middle carbonate members of the Halal Formation (Upper Albian-Cenomanian), beds 1 and 15, at Gebel Areif El-Naqa (MGDMU:AEN.G.1.111–113, 15.133–137), and two specimens from the middle siliciclastic/carbonate member of the Cenomanian Galala Formation and the Lower Turonian Abu Qada Formation, beds 29 and 45, at Wadi Quseib (MGDMU:WQ.G.29.13. 45.86).

Description: Moderately large- to large-sized, turriculate, high-spired gastropods. Spire long, consisting of 4–6 overlapping whorls and forming about 69% of the total height. Whorls strongly convex in some individuals, their width nearly twice the height, with very deep sutures. In other individuals, the flanks of the whorls are nearly flat, less-elevated, and separated by moderately deep sutures. Diameter of specimens increasing gradually from the apex to the aperture. Apex commonly damaged. Body

Table 4: Dimensions (in mm) of *Cimolithium*? sp.

n=5	H	D	HL	HA	WA	PA°	nw	D/H	HL/H	WA/HA
Range	19-37	17-24	7-12	4-10	6-14	35-41°	4-6	0.65-0.89	0.26-0.36	1.00-1.20
Mean	27	20	8.66	7.33	9.33	38°	5	0.77	0.31	1.13

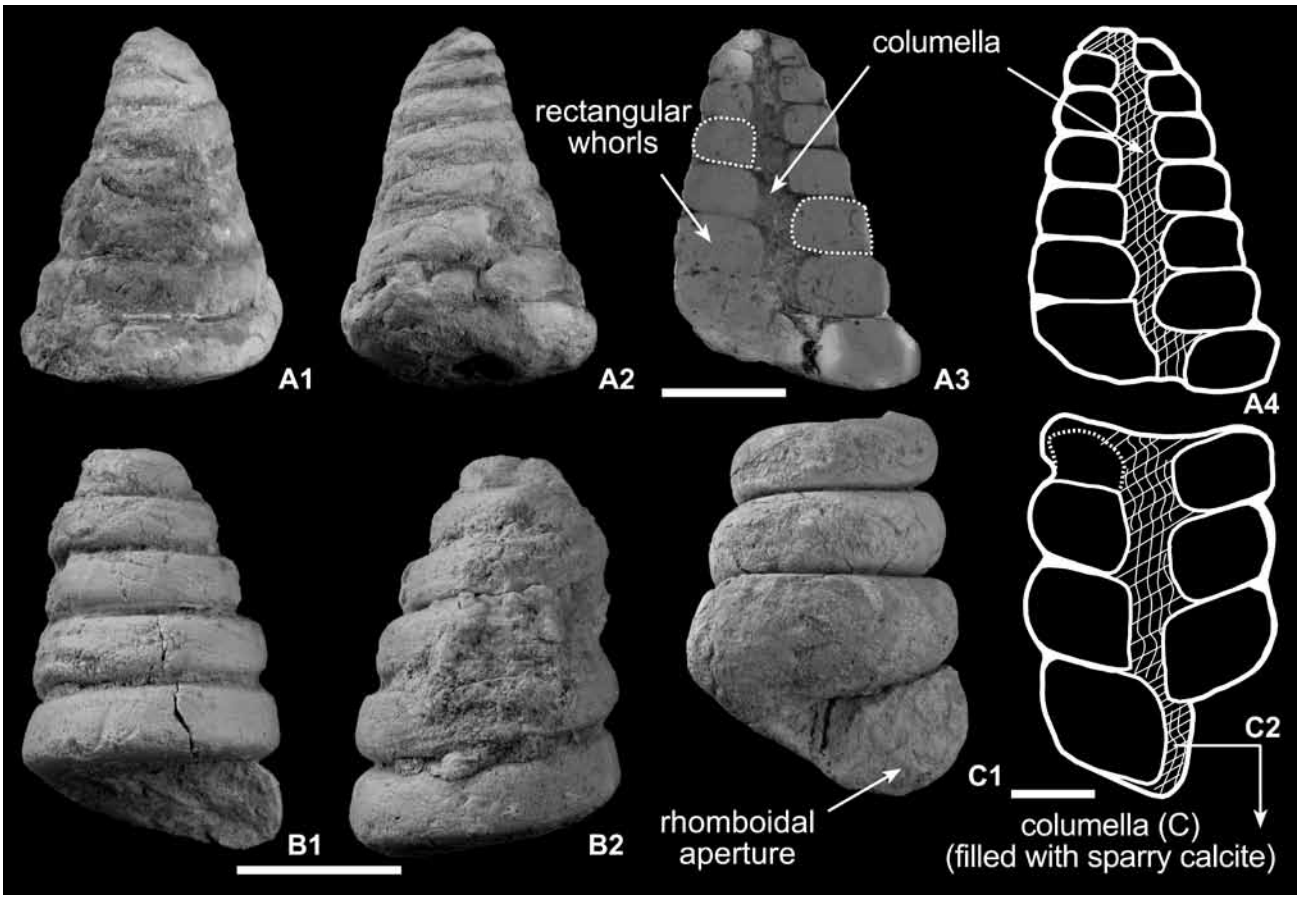

Figure 7: (A) Internal moulds of *Cimolithium*? sp. from the middle siliciclastic/carbonate member of the Cenomanian Galala Formation at Wadi Quseib. A1: Abapertural view, A2: apertural view, A3: axial whorl section, A4: sketch showing rectangular whorls; MGDMU:WQ.G.29.13. **(B)** Specimens from the middle carbonate member of the Upper Albian-Cenomanian Halal Formation at Gebel Areif El-Naqa. B1: Apertural view, B2: Abapertural view; MGDMU:AEN.G.1.111. **(C)** C1. Apertural view showing the rhomboidal aperture, C2. axial section showing the rectangular whorls without distinct folds; MGDMU:WQ.G.45.86. Scale bars: 10 mm.

whorl small and strongly rounded with nearly flat base. Aperture small and rhomboidal (Fig. 7C1). Most specimens are internal moulds that do not record features of the original ornamentation but show some spiral cords extending regularly from the earliest to the last whorl and are separated by wider interspaces (bands). The longitudinal section shows quadrangular whorls without distinct folds (Fig. 7A4, C2).

Discussion: The present material is tentatively placed in *Cimolithium* on the basis of the turriculate outline, weakly convex to flat whorls, rhomboidal aperture, small anterior notch, and rectangular whorls without distinct folds (Fig. 7A4, C2). Morphologically, the present material closely resembles *C. tenouklense* Coquand (1862: 176, pl. 4, fig. 6) from the Upper Cretaceous of Algeria in the convexity of whorls and aperture outline (rhomboidal). As Coquand erected *C. tenouklensis* based on an internal mould the species should be considered a *nomen dubium* (see discussion above). *C. tenouklense* has a wide stratigraphic range, from the Cenomanian to the Maastrichtian. It has also been recorded from the Cenomanian of Tunisia, Algeria, Libya, Egypt, Syria, and Palestine.

Cimolithium inauguratum (Stoliczka, 1871), described by Zakhera (2002: 311, fig. 5/2, 5/3) from the Upper Turonian of northern and southern Galala (Eastern Desert), resembles the present material in the convexity of whorls and general outline (turriform), but differs in being higher (more slender), and in having highly conical and narrow whorls with deeper sutures. *C.* cf. *belgicum* d'Archiac, figured by Kiel & Bandel (2004: 118, fig. 7A, B) from the Cenomanian of Germany differs in having concave whorls, a long conical spire (about 10 whorls), and a sharp base. The internal characters of *Campanile* (*Diozoptyxis*) *moniliferum* d'Orbigny (1842), figured and described by Delpey (1939: 209; textfigs 166, 167) from the Cenomanian of Lebanon, are nearly identical to the present material, but morphologically the specimens differ in having well preserved axial and spiral ribs.

Family Ampullinidae Cossmann, 1919
(=Gyrodinae Wenz, 1938)

Remarks: The present specimens are placed here in the Ampullinidae rather than the Naticidae Forbes (1838), because their umbilical features are character-

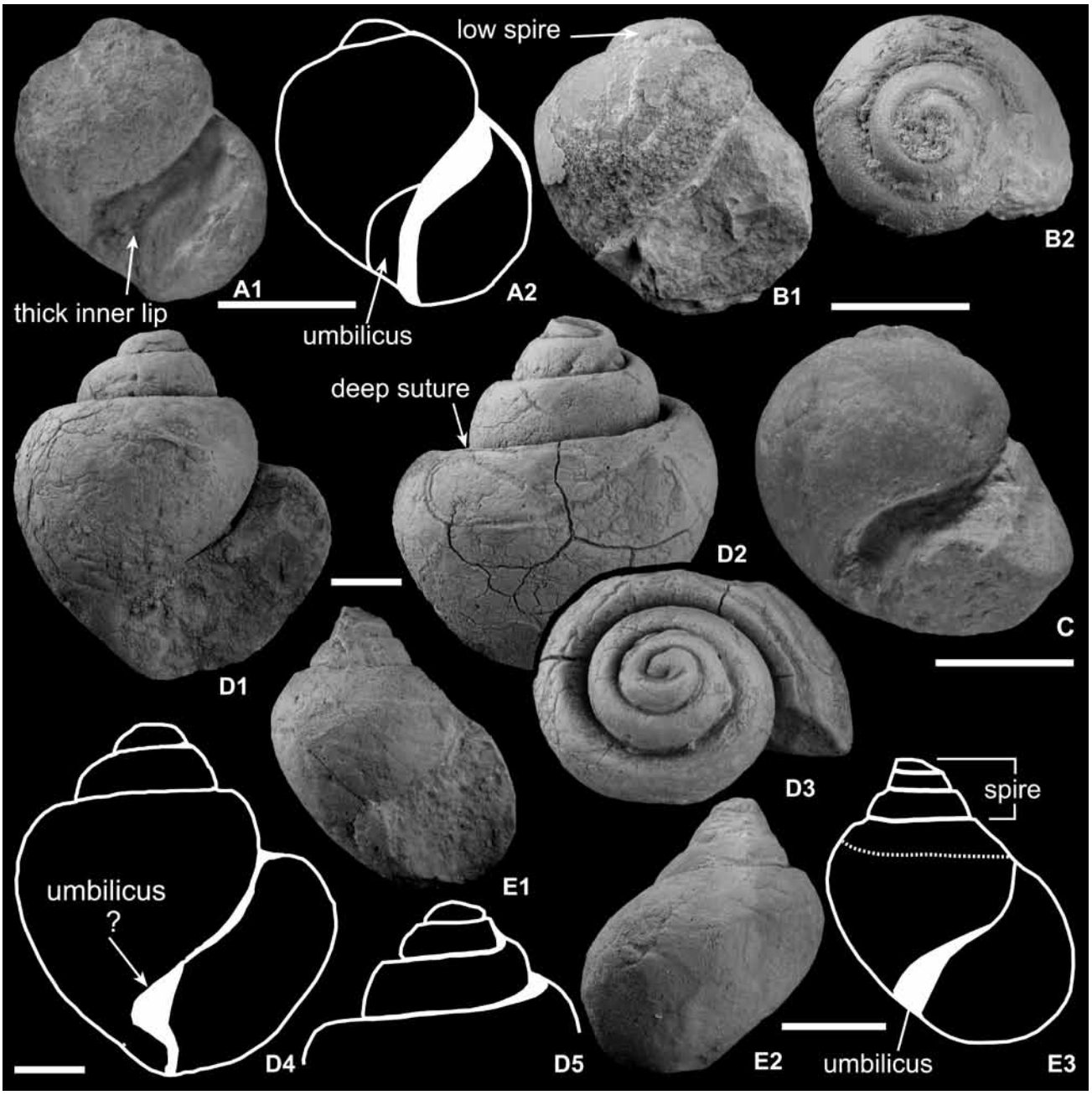

Figure. 8: (A–C) Internal moulds of *Ampullina dupinii* (Deshayes in Leymerie, 1842) from the middle siliciclastic/carbonate member of the Cenomanian Galala Formation at Wadi Quseib. A1–A2: Apertural view showing the slightly folded, thick inner lip; MGDMU:WQ.G.22.79. B1: Apertural view, B2 apical view; MGDMU:WQ.G.31.31. C. Apertural view; MGDMU:WQ.G.31.32. **(D)** Internal mould of *Ampullina* sp. 1 from the Upper Turonian Wata Formation at Wadi Quseib. D1: Apertural view, D2: abapertural view, D3: apical view, D4–D5: sketches of spiral part and umbilical area; MGDMU:WQ.G.97.29. **(E)** Internal mould of *Ampullina* sp. 2 from the middle carbonate member of the Cenomanian Halal Formation at Gebel Areif El-Naqa. E1: Apertural view, E2: abapertural view, E3: sketch of apertural side; MGDMU:AEN.G.15.138. Scale bars: 10 mm.

istic of ampullinids (Kase & Ishakawa 2003). Bouchet & Rocroi (2005: 249) assigned the subfamily Gyrodina to the family Ampullinidae because it also exhibits similar umbilical features. Kollmann (2009: 46) separated Ampullinidae and Gyrodidae Wenz, 1941 into two families. Important characters distinguishing the latter two families are the shape of the subsutural ramp (broad, concave, flat or slightly convex), the growth lines (prosocline or opisthocline), and the size and shape of umbilicus, callus, and protoconch. For instance, Sohl (1960: 116) subdivided the genus *Gyrodes* Conrad, 1860 into three main types, based upon characters of the umbilical margin and suture. Cossmann (1925: 103) emphasized that *Gyrodes* has a columella not a callus. Another example is *Pseudamaura* Fischer, 1885 (family Ampullinidae), the protoconch of which is diagnostic of the genus. Kowalke & Bandel (1996) established the family Pseudamauridae based on the protoconch character of the type species. By studying the protoconchs of other genera, this genus has been assigned to the Ampullinidae (for more details, see Szabó & Jaitly

2004: 20). Although the present material consists of internal moulds, the subovate aperture, relatively low spire, and moderately wide umbilicus suggest that the specimens belong to the genus *Ampullina.*

Genus *Ampullina* Bowdich, 1822

Ampullina dupinii (Deshayes in Leymerie, 1842)
Fig. 8A–C

1842 *Natica Dupinii* Leymerie – d'Orbigny: 158, pl. 173, figs 5, 6.
2005 *Ampullina dupinii* (Deshayes) – Kollmann: 60, pl. 8, fig. 7.

Material and occurrence: Five internal moulds from the middle siliciclastic/carbonate member of the Cenomanian Galala Formation, beds 22, 31, and 39, at Wadi Quseib (MGDMU:WQ.G.22.79–80, 31.31–32, 39.185).

Description: Moderately large, subglobose to ovate and low-spired gastropods. Spire conical and consisting of at least two overlapping whorls separated by moderately deep sutures. Sub-sutural ramp narrow and slightly convex. Whorls rapidly decreasing toward the apex with straight to slightly convex surfaces. Body whorl large and forming the main part of the specimen with rounded flanks. Aperture relatively large and tear-shaped to semi-rounded with moderately wide umbilicus (Fig. 8A1, A2). Base rounded. Outer lip strongly convex. Inner lip slightly convex, thick and meeting the base of the shell at a right angle.

Occurrence: *Ampullina dupinii* has been recorded from the Albian of France and from the Cenomanian of Egypt. This is the first record of the species from Egypt.

Discussion: *Ampullina dupinii* is characterized by medium- to large-sized, subglobose, low-spired shells, moderately wide umbilicus, and subovate or semi-rounded aperture. In addition, the inner lip is straight to slightly folded, broad, and meeting the basal edge of shell at right angle. *A. uchauxiensis* Cossmann, 1896 which has been described and figured by Kollmann (2005: 62, pl. 8, figs 5, 6) from the Turonian of France differs in having a narrow umbilicus, deep sutures, and high spire. *A. raulini-ana* (d'Orbigny 1842: pl. 174, fig. 1) from the Albian of France resembles the present species in having a low spire, thick and slightly convex inner lip, and a tear-shaped aperture but differs in having a small umbilicus.

Ampullina sp. 1
Fig. 8D

Material and occurrence: Seven internal moulds from the Upper Turonian Wata Formation, beds 93, and 97, at Wadi Quseib (MGDMU:WQ.G.93.19–21, 97.29–34).

Description: Small to moderately large moulds, globular to ovate, and moderately low-spired. Spire conical and consisting of 2–3 overlapping, moderately convex whorls (step-like arrangement), separated by deep sutures (canaliculated) and raised shoulders (Fig. 8/D2, D3). Sub-sutural ramp slightly convex. Body whorl large, rounded in outline, much inflated, and accounting for the main part of the mould (about 87% of the total height). Base broadly round-ed. Apex commonly broken off. Aperture oval and narrow with strongly convex outer lip and slightly concave inner lip. All specimens are internal moulds without relicts of ornamentation.

Discussion: Due to the poor preservation of the

Table 5: Dimensions (in mm) of *Ampullina dupinii* (Deshayes in Leymerie, 1842).

n=2	H	D	HL	HA	WA	PA°	nw	D/H	HL/H	WA/HA
Range	21-22	18	16	14-16	13	108-115°	2	0.82	0.73	0.81-0.93
Mean	21.5	18	16	15	13	111.5°	2	0.82	0.73	0.87

Table 6: Dimensions (in mm) of *Ampullina* sp. 1

n=5	H	D	HL	HA	WA	PA°	nw	D/H	HL/H	WA/HA
Range	22-67	17-60	20-58	15-50	9-28	70-90°	2-3	0.75-1.09	0.69-0.97	0.33-0.76
Mean	43.27	36.27	37.90	32	16.70	81°	2	0.85	0.87	0.52

Table 7: Dimensions (in mm) of *Ampullina* sp. 2.

n=1	H	D	HL	HA	WA	PA°	nw	D/H	HL/H	WA/HA
	28	24	24	18	13	68	3	0.86	0.86	0.72

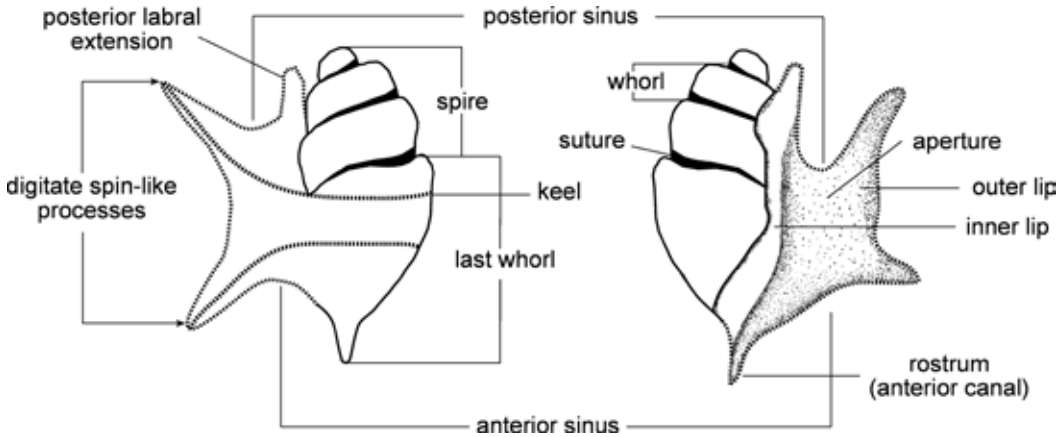

Figure 9: Sketch showing the outline of complete outer lip of aporrhaids.

specimens, identification at the species level is very difficult. However, the present material strongly resembles *Natica bulbiformis* Sowerby as figured by d'Orbigny (1842: 160, pl. 174, fig. 3) and *Pseudamaura subbulbiformis* (d'Orbigny, 1850) of Kollmann (2005: 63, pl. 8, figs 12–15) from the Turonian of France in being globular with moderately inflated and shouldered whorls and depressed sutures (canaliculated), but our material differs in having a small umbilicus. *Ampullina ervyna* (d'Orbigny 1842: 159, pl. 173, fig. 7) from the Albian of France differs in having a low spire, narrow whorls, small umbilicus, nearly straight inner lip, and in being smaller. *A. uchauxiensis* Cossmann of Kollmann (2005: 62, pl. 8, figs. 5, 6) from the Turonian of France differs only in having a low spire and in being smaller.

Ampullina sp. 2
Fig. 8E

Material and occurrence: Two specimens from the middle carbonate member of the Cenomanian Halal Formation, bed 15, at Gebel Areif El-Naqa (MGDMU:AEN.G.15.138–139).

Description: Moderately large, subglobose to ovate, naticoid, and moderately high-spired gastropod. Spire conical, consisting of three slightly convex whorls, which gradually decrease in height toward the apex and are separated by moderately deep sutures. Apex broken off. Body whorl large and forming the main part of the specimen (about 86% of the total height), flanks rounded with raised shoulder. Base rounded. Aperture relatively large (about 64% of the total height), broad, and ovate with small and narrow umbilicus (Fig. 8E3). Outer lip strongly convex, inner lip concave.

Discussion: The specimens are characterized by their globose shape, narrow umbilicus, moderately high spire, narrow whorls, and acute apex (Fig. 8E3). They strongly resemble *Ampullina uchauxiensis* Cossmann, 1896 as figured by Kollmann (2005: 62, pl. 8, figs 5, 6) from the Turonian of France but differ in having narrow whorls (not shouldered) with moderately deep suture and in being larger (H= 43 mm, D= 36 mm in the present material and H=12 mm, D=11 mm in Kollmann's specimens). *A. bulanoides* (D'Orbigny 1842: pl. 172, figs 2, 3) is also very similar to the present material but differs in being less globose. *A.* (*A.*) *plesiolyrata* (Pethö) of Albanesi & Busson (1974: pl. 24, fig. 3) from Algeria differs in having wider whorls.

Superfamily Stromboidea Rafinesque, 1815
Family Aporrhaidae Gray, 1850
Subfamily Aporrhainae Gray, 1850

Remarks: The diagnostic characters of the subfamily Aporrhainae are (1) a moderately high to high spire, (2) a labral wing with broad adapical and abapical sinuses (Kollman 2009: 51), which are almost symmetrical and situated at opposite proximal margins of outer lip, (3) an wing-shaped outer lip with two finger-like extensions, (4) an ornamentation consisting mainly of spiral ribs with tubercles along whorl shoulders, (5) angular, multi-angular or convex whorls, and (6) a columella, usually bent towards the right side, which extends into a long grooved rostrum (Popenoe 1983: 752). The two sinuses and ornamentation taken together form a character that is distinctive of this group of gastropod (Fig. 9). Autecologically, these sinuses help the organism to enter the substrate at a low angle to the surface and to establish a chamber for separating the inhalant and exhalant currents (e.g., Popenoe 1983; Kollmann 2005). The Aporrhainae include many genera e.g., *Aporrhais* da Costa, 1778, *Monocuphus* Piette, 1876, and *Dicroloma* Gabb, 1868, which are easily distinguished by their whorl and labral morphology. Since these parts are broken off in our specimens, they are only assigned to the subfamily Aporrhainae. In addition, dozens of aporrhaid genera of the same preservation quality are very similar. The present specimens resemble moulds of Apporhaidae, where the basal whorl extends slightly over the ear-

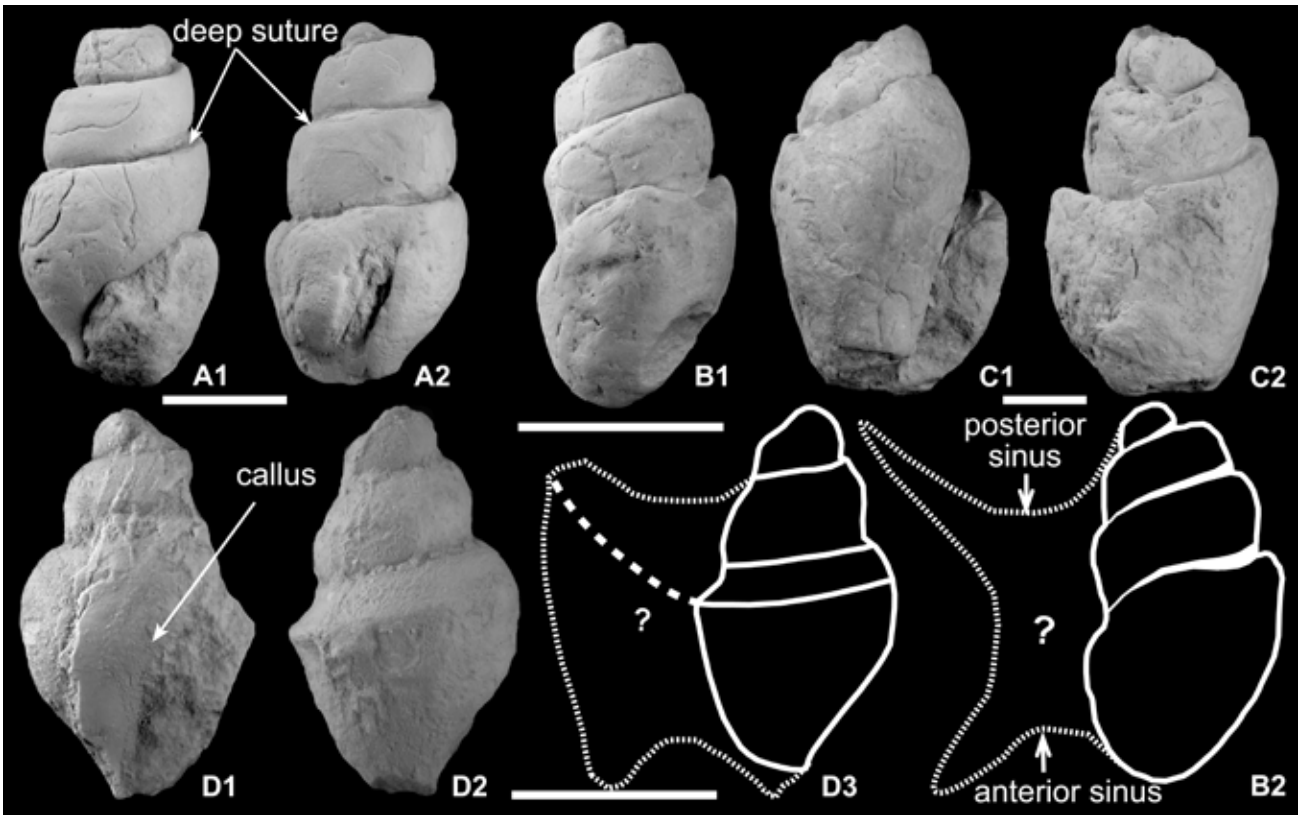

Figure 10: (A, B) Incomplete internal moulds of Aporrhainae gen. et sp. indet.1 from the middle carbonate member of the Upper Albian-Cenomanian Halal Formation at Gebel Areif El-Naqa. A1: Apertural view, A2: adapertural view; MGDMU:AEN.G.15.158. B1. Abapertural view, B2: sketch showing the suggested outline of the complete outer lip; MGDMU:AEN.G.15.159. **(C)** Incomplete internal mould of Aporrhainae gen. et sp. indet. 2 from the Lower Turonian Abu Qada Formation at Gebel Areif El-Naqa. C1: Apertural view, C2: abapertural view; MGDMU:AEN.G.23.1. **(D)** Internal mould of "Arrhoginae gen. et sp. indet. from the upper carbonate member of the Cenomanian Galala Formation and Lower Turonian Abu Qada Formation at Wadi Quseib, D1: Apertural view, D2: abapertural view, D3: sketch showing the suggested outline of the complete outer lip; MGDMU:WQ.G.44.234. Scale bars: 10 mm.

lier whorl, which indicates the wing- or finger-shaped processes.

Aporrhainae gen. et sp. indet. 1
Fig. 10A, B

Material and occurrence: 20 internal moulds from the lower marly, middle carbonate, and upper carbonate/marl members of the Halal Formation (Upper Albian-Cenomanian) beds 1, 5, 15, and 19, at Gebel Areif El-Naqa (MGDMU:AEN.G.1.119–122, 5.46–52, 15.158–165, 19.14), and 11 specimens from the Cenomanian Galala Formation, bed 15, of the East Themed area (MGDMU:ET.G.15.22–32).

Description: Medium to large-sized, spindle-shaped, and moderately high-spired gastropod. Spire consisting of three overlapping whorls with a convex outline, which form about 28% of the total height and continuously enlarge anteriorly. Whorls separated by deeply impressed sutures. Apex damaged in most specimens. Body whorl relatively large and accounting for about half of the height of the specimen; with short anterior canal. Aperture small and oval with commonly incomplete outer lip.

Discussion: The present material resembles *Aporrhais dutrugei* (Coquand, 1862) as described and figured by (Abdel-Gawad & Gameil 1992), Abdallah et al. (2001), El Qot (2006), and Mekawy (2007) from the Cenomanian-Turonian of Egypt in the general outline and preservational quality (internal moulds). How-ever, due to the absence of some diagnostic features such as adapical and abapical sinuses and ornamentation, identification, even at the generic level, is impossible (Fig. 9). *Aporrhais fourneli* (Co-

Table 8: Dimensions (in mm) of Aporrhainae gen. et sp. indet. 1

n=11	H	D	HL	HA	WA	PA°	nw	D/H	HL/H	WA/HA
Range	18-35	12-20	14-30	9-10	7-10	45°-63°	3-5	0.53-0.78	0.63-0.85	0.37-0.83
Mean	26.5	15.8	19.20	13.5	8.50	54°	4	0.60	0.72	0.63

Table 9: Dimensions (in mm) of Aporrhainae gen. et sp. indet. 2

	H	D	HL	HA	WA	PA°	nw	D/H	HL/H	WA/HA
n=1	50	28	32	27	10	68°	2	0.5	0.64	0.37

Table 10: Dimensions (in mm) of Arrhoginae gen. et sp. indet.

n=1	H	D	HL	HA	WA	PA°	D/H	HL/H	WA/HA
16	9	10	9	?5	58°	0.56	0.62	0.56	

quand, 1862) of Abdel-Gawad & Zalat (1992: pl. 5, fig. 1) from the Coniacian of Um Heriba (Sinai) and El Qot (2006: 100, pl. 20, fig. 9) from the Coniacian of East Themed (Sinai) differs in having three carinae on the last whorl.

Aporrhainae gen. et sp. indet. 2
Fig. 10C

Material and occurrence: One internal mould from the lower member of the Lower Turonian Abu Qada Formation, bed 23, at Gebel Areif El-Naqa (MGDMU:WQ.G.23.1).

Description: Internal mould of moderately large and moderately high-spired gastropod. Spire conical and consisting of two overlapping convex-sided whorls separated by deep sutures. Body whorl accounting for two-thirds of the total height of the specimen. Aperture long, narrow, and oval with incomplete outer lip.

Discussion: The present specimen differs from *Aporrhais dutrugei* (Coquand, 1862) in being larger, having fewer whorls, and in the last whorl representing two-thirds of the total height of the specimen. Zakhera (2002: 318, pl. 7/1, 2) erected the new species *Aporrhais blanckenhorni* from the Cenomanian of the Eastern Desert on the basis of internal moulds. In fact, a new species based on internal moulds and incomplete specimens is doubtful. The present material resembles Zakhera' species in general outline and size, but differs in lacking a big shoulder with a blunt median carina.

Subfamily Arrhoginae Popenoe, 1983

Remarks: The diagnostic features of Arrhoginae are (1) a moderately high spire, (2) an inflated, wing-shaped body whorl approximately one-half or more of the total height of shell, which expands into a broad, quadrate outer lip, (3) rounded whorls, (4) a columella one-half of the height of the body whorl, and (5) whorls ornamented with strong axial ribs (see Popenoe 1983 for details). The present material resembles the genus *Arrhoges* Gabb, 1868 but due to the incomplete outer lip, a more precise identification is impossible.

Arrhoginae gen. et sp. indet.
Fig. 10D

Material and occurrence: Three specimens from the upper carbonate member of the Cenomanian Galala Formation and Lower Turonian Abu Qada Formation, beds 44 and 45 at Wadi Quseib (MGDMU:WQ.G.44.234–235, 45.87).

Description: Small- to medium-sized, spindle-shaped, and moderately high-spired gastropod. Spire consisting of three overlapping convex-sided whorls, twice as wide as high, and separated by deep sutures. Body whorl inflated and accounting for more than half of the total height of the specimens. Outer lip incomplete. Aperture long and narrow with straight inner lip. Rostrum or anterior canal short. The specimens lack ornamentation but the spire shows axial ribs preserved in some parts.

Discussion: The present material is similar to *Arrhoges* (*Latiala*)? *alpina* (d'Orbigny, 1843) of Kollmann (2005: pl. 13, fig. 12) from the Cenomanian of France in general shape, size, and in having a carinated body whorl, but axial ribs are not well preserved and the outer lip is incomplete. *A.* (*Latiala*)? *dupiniana* (d'Orbigny 1843: pl. 206, figs 1, 3) from the same locality differs in having angular whorls with tubercles along whorl shoulders. *Latiala*? *tegulata* (Stoliczka, 1868) and *L.*? cf. *lobata* (Wade, 1926) from the Cenomanian of Germany described by Kiel & Bandel (2002: 85, figs 1F, G) differ in having a high spire. This is also the case in *A.* (*L.*)? *robinaldina* (d'Orbigny 1843: pl. 206, figs 4, 5) from the Cenomanian of France.

Subfamily Harpagodinae Pchelintsev, 1963

Remarks: Pchelintsev (1963) erected the new family Harpagodesidae (recte Harpagodidae), which is characterised by a globular shell, small basal notch, and a broadly expanded labral wing. Kollmann (2005) allocated the subfamily Harpagodinae to the family Strombidae on the basis of the basal notch. Due to the presence of an identical small basal notch in the Aporrhaidae, Bouchet & Rocroi (2005) and Kollmann (2009) placed the Harpagodinae in the family

Aporrhaidae. In addition, the Harpagodinae possess about four angulations, which strengthen the broadly expanded labrum. The subfamily includes some genera such as *Harpagodes* Gill, 1870, *Phyllocheilus* Gabb, 1868, *Harpospira* Neagu & Pana, 1995, *Harpodactylus* Kollmann, 2005, and *Quadrinervus* Cossmann, 1904. It is easy to differentiate the latter genera on the basis of the whorl profile (convex, angular, multi-angular) and on the ornamentation of the whorls, body whorl outline (e.g., spindle-shaped, cylindrical), and the general outline of the labral wing. For more details on the subfamily Harpagodinae see Kollmann (2009: 51–52).

Genus *Harpagodes* Gill, 1870

Remarks: According to Gill (1870: 138) and Kollmann (2009: 51), the genus *Harpagodes* is characterized by a large, moderately high-spired, obconical or globular shell and convex to angular whorls with strong, spiral ribs. The body whorl bears at least five strong ribs extending into broadly expanded labral wings, where they end in spines, which are strongly curved and occasionally furcate. For more details, see Wenz (1938: 921) and Delpey (1939: 111).

Harpagodes nodosus (J. de C. Sowerby, 1823) Fig. 11A–C

1823 *Dolium nodosum* sp. nov. – J. de C. Sowerby: 34, pl. 426–427.
1842 *Pterocera incerta* sp. nov. – d'Orbigny: 308, pl. 215, fig. 1.
1912 *Strombus* (?) *incertus* d'Orbigny – Pervinquière: 27, pl. 2, figs 19–23.
1916 *Strombus* (?) *incertus* d'Orbigny – Greco: 160 (102), pl. 11 (14), fig. 10.
1939 *Strombus incertus* d'Orbigny – Delpey: 117; textfigs 81–83.
1958 *Strombus incertus* (d'Orbigny) – Barber: 33, pl. 9, fig. 1.
1963 *Strombus incertus* (d'Orbigny) – Fawzi: 96, pl. 7, fig. 6.
1963 *Strombus* (*Dilatilabrum*) *tihensis* sp. nov. – Abbass: 84, pl. 8, figs 7, 8.
1971 *Strombus incertus* (d'Orbigny) – Collignon: 10 (152), pl. A, fig. 5.
1981 *Strombus incertus* (d'Orbigny) – Amard et al.: pl. 15, fig. 9.
1985 *Harpagodes incertus* (d'Orbigny) – Kollmann: 101, fig. 4j–k.
1992 *Strombus incerta* (d'Orbigny) – Abdel-Gawad & Gameil: 81, fig. 3/17.
1992 *Pterocera incerta* d'Orbigny – Abdel-Gawad & Zalat: pl. 1, fig. 2a, b.
1993 *Strombus* (*Dilatilabrum*) *tihensis* Abbass – Orabi: pl. 1, fig. 24.
1994 *Strombus incertus* (d'Orbigny) – Kassab & Ismael: 230, fig. 4/2.
2001 *Pterocera incerta* d'Orbigny – Abdallah et al.: pl. 1, figs 8, 9.
2001 *Strombus incerta* (d'Orbigny) – Zakhera: pl. 3, fig. 3.
2001 *Strombus tihensis* Abbass – Zakhera: pl. 3, fig. 4.
2004 *Strombus incertus* (d'Orbigny) – Khalil & Mashaly: pl. 2, fig. 9.
2004a *Pterocera incerta* d'Orbigny – Abdel-Gawad et al.: pl. 6, fig. 1.
2004b *Pterocera incerta* d'Orbigny – Abdel-Gawad et al.: pl. 5, fig. 11.
2005 *Harpagodes nodosus* (J. de C. Sowerby, 1823) – Kollmann: 133, pl. 15, fig. 5a, b.
2006 *Pterocera incerta* d'Orbigny – El Qot: 105, pl. 22, fig. 1.
2007 *Pterocera incerta* d'Orbigny – Mekawy: 163, pl. 2, fig. 6.
2008 *Pterocera incerta* d'Orbigny – Mekawy & Abu Zied: 326, pl. 5, fig. 2.

Material and occurrence: 30 internal moulds from the lower marly, middle carbonate, and upper carbonate/marl members of the Halal Formation (Upper Albian-Cenomanian), beds 1, 15, 17, and 19, at Gebel Areif El-Naqa (MGDMU:AEN.G.1.114–118, 15.140–157, 17.9–12, 19.11–13), 15 specimens from the Cenomanian Galala Formation and Upper Cenomanian-Lower Turonian Abu Qada Formation, beds 15 and 19, of the East Themed area (MGDMU:ET.G.15.11–21, 19.101–104), and four specimens from the middle siliciclastic/carbonate member of the Cenomanian Galala Formation, beds 37 and 42, at Wadi Quseib (MGDMU:WQ.G.37.12, 42.75–77).

Description: Very large, obconical, and low-spired gastropod. Spire slightly protruding above the basal whorl and consisting of two compressed whorls with deep sutures (canaliculated). Body whorl very large, conical, roundly swollen at shoulder, and accounting for the main part of mould (about 90% of the total height). Body whorl ornamented with about eight, strong, spiral ribs (Fig. 11B) with an anterior adapertural fasciolar band. Aperture large, elongated, lanceolate to semi-oval, and only a little shorter than the length of the body whorl. Anterior siphonal canal short and bent slightly towards left. Base broad and slightly concave. Outer lip with a posterior wing-like expansion, the upper end of which projects slightly upward. Strombid notch not preserved. Inner lip straight to slightly concave.

Occurrence: *Harpagodes nodosus* has been recorded from the Cenomanian of France, Tunisia, Algeria, Lower Turonian of Nigeria and from the Lower Albian-Turonian of Egypt. According to El Qot (2006: 106), the species is widely distributed in the Upper Albian-Cenomanian of the Tethys.

Discussion: Although poorly preserved, the composite mould can be attributed to *Harpagodes nodosus* (J. de C. Sowerby) on the basis of size, shape of aperture, and ornamentation. The present material differs only in having a less rounded body whorl, a result of the poor preservation (distorted composite moulds). The widely cited *H. incertus* (d'Orbigny, 1842) from the Cenomanian of France has been regarded as a junior synonym of *H. nodosus* (J. de C. Sowerby, 1823) by Kollmann (2005), a view followed here.

Delpey (1939) noted that the smaller specimens are double cone-shaped (biconical) but in adult individuals, the basal part exhibits an acute angulation. *Pterocera incerta* of Abdel-Gawad et al. (2004a)

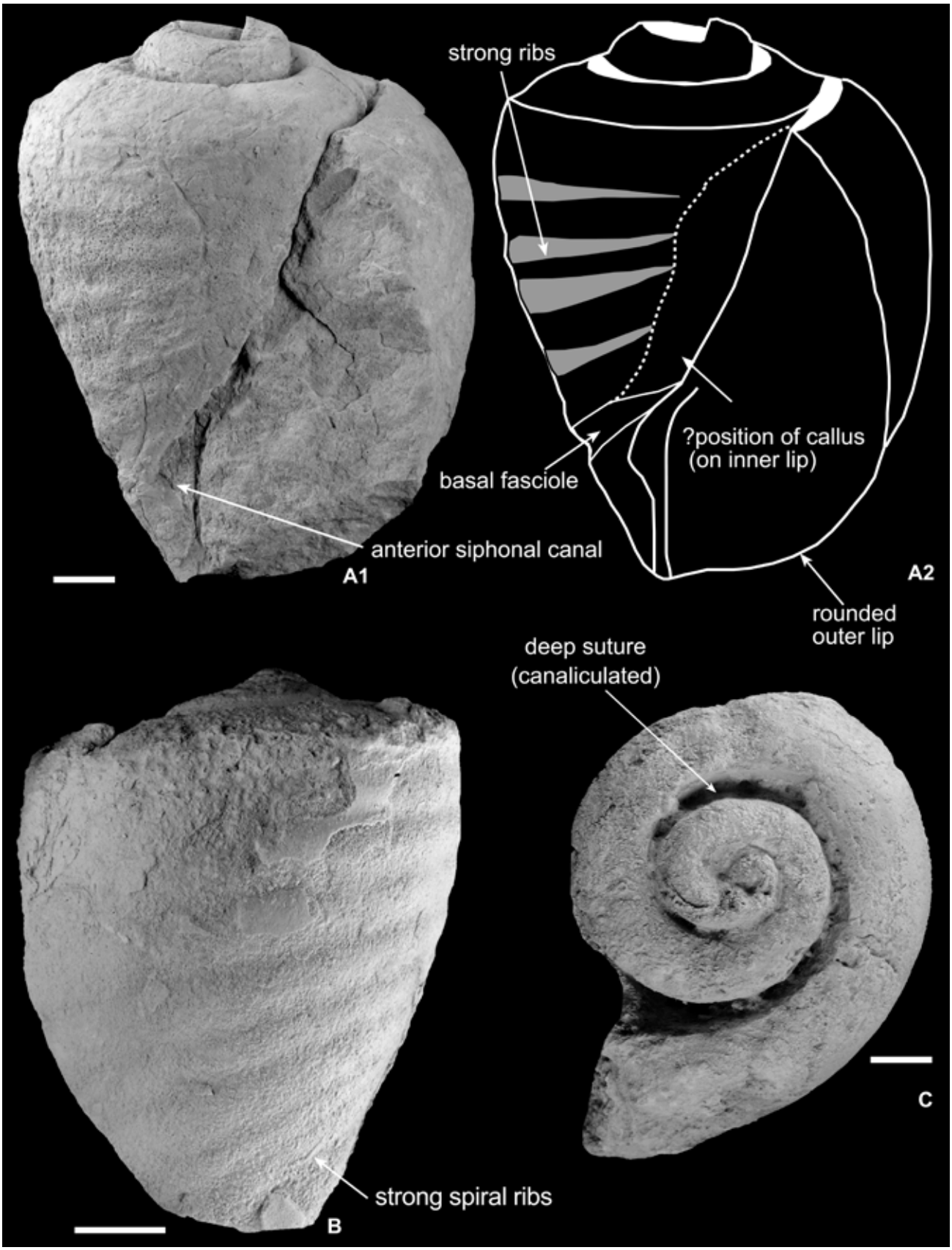

Figure 11: Composite moulds of *Harpagodes nodosus* (J. de C. Sowerby, 1823) from the lower marly and middle carbonate members of the Halal Formation (Upper Albian-Cenomanian) at Gebel Areif El-Naqa. **(A)** Apertural view; MGDMU:AEN.G.1.114, **(B)** Abapertural view; MGDMU:AEN.G.15.140. **(C)** Internal mould from the middle siliciclastic/carbonate member of the Cenomanian Galala Formation at Wadi Quseib. Apical view; MGDMU:WQ.G.42.75. Scale bars: 10 mm.

Table 11: Dimensions (in mm) of *Harpagodes nodosus* (J. de C. Sowerby, 1823).

n=5	H	D	HL	HA	WA	PA°	ns	D/H	HL/H	WA/HA
Range	75-111	59-81	69-95	70-84	30-39	112-140°	9-10	0.61-0.98	0.68-0.79	0.43-0.48
Mean	94	70.20	48.60	78.60	34.80	125 °	10	0.76	0.84	0.44

and El Qot (2006) is small-sized and biconical rather than obconical. According to the latter authors the spire varies from short to very short, particularly in large forms. In the present study, two forms of *Harpagodes nodosus* are recognized; biconical small individuals as mentioned by Delpey (1939) and as figured by Abdel-Gawad et al. (2004a) and El Qot (2006), and obconical adult individuals. According to Abdel-Gawad & Gameil (1992) the young individuals are ornamented with spiral ribs on the last whorl, whereas adults are smooth. In the present material, however, both juiveniles and adults are ornamented with 8–12 strong spiral cords (Fig. 11A1, A2; see also El Qot 2006: 106).

Abbass (1963) erected the new species *Strombus* (*Dilatilabrum*) *tihensis* from the Cenomanian of Gebel Tih, Sinai, differing from *H. nodosus* in having shouldered whorls with a less expanded outer lip. However, his figures (pl. 8, figs 7, 8) are identical to *H. nodosus* of Abdel-Gawad & Zalat (1992), Kassab & Ismael (1994), and Abdel-Gawad et al. (2004b) figured as *H. incertus*. Therefore, *S.* (*D.*) *tihensis* Abbass is considered herein as a junior synonym of *H. nodosus*.

S. numidus Coquand (1862: 183, pl. 5, fig. 1) from the Upper Cretaceous of Algeria resembles the present species in adapical view but differs in lacking spiral cords (due to their preservation as internal mould). *S. mermeti* of the same author (Coquand 1862: 184, pl. 5, fig. 2) is similar to the present species in ornamentation (spiral ribbons) but differs in having a more elongated shell with narrow and short spire.

Harpagodes cf. *heberti* (Thomas & Peron, 1889)
Fig. 12A–D

cf.1889 *Harpagodes Heberti* Thomas & Peron – Greco: 157 (99), pl. 18 (10), fig. 7.
cf.1963 *Harpagodes* aff. *heberti* (Thomas & Peron) – Fawzi: 95, pl. 7, fig. 5.
cf.1992 *Harpagodes heberti* (Thomas & Peron) – Abdel-Gawad & Gameil: 80, fig. 4/10.
cf.2004b *Harpagodes heberti* (Thomas & Peron) – Abdel-Gawad et al.: pl. 5, fig. 7.
cf.2006 *Harpagodes heberti* (Thomas & Peron) – El Qot: 102, pl. 21, figs 2, 3.
cf.2007 *Harpagodes heberti* (Thomas & Peron) – Mekawy: 161, pl. 2, fig. 1.

Material and occurrence: 12 internal moulds from the lower marly, middle carbonate, and upper carbonate/marl members of the Halal Formation (Upper Albian-Cenomanian), beds 1, 15 and 19, at Gebel Areif El-Naqa (MGDMU:AEN.G.1.123–129, 15.166–169, 19.15). Nine specimens from the Cenomanian Galala Formation, bed 15, of the East Themed area (MGDMU:ET.G.15.33–41), and two specimens from the middle siliciclastic/carbonate member of the Cenomanian Galala Formation, bed 42, at Wadi Quseib (MGDMU:WQ.G.42.78–79).

Description: Specimens large, spindle-shaped to globular, and moderately high-spired. Spire consisting of 2–3 overlapping convex-sided whorls, which account for about 35% of the total height. These whorls are separated by deep sutures (canaliculated). Last whorl large and accounting for more than half of the total height, with two strong angulations on the abapical side (Fig. 12B, D). Abapical whorl face concave. Rostrum and wing not preserved. Aperture oval to lanceolate with a short anterior canal (Fig. 12A1). Outer lip thick, incomplete, slightly expanded and folded externally.

Occurrence: *Harpagodes heberti* has been recorded from the Cenomanian of Tunisia and from different localities in Egypt.

Discussion: The present species differs from other species of *Harpagodes* by lacking spiral ribs on and between angulations (two on the abapical side). *H. heberti* is characterized by the presence of two strong angulations on the adapical side of the last whorl. These two angulations occasionally extend over the entire last whorl (see Abdel-Gawad & Gameil 1992; El Qot 2006) or are restricted to the outer lip (not extending over the entire last whorl) as observed in the present material and also in the specimens figured by Peron (1889: pl. 21, fig. 1) from Tunisia. The two morphologies may reflect different states of preservation or possibly are ecophenotypic

Table 12: Dimensions (in mm) of *Harpagodes* cf. *heberti* (Thomas & Peron, 1889).

n=5	H	D	HL	HA	WA	PA°	D/H	HL/H	WA/HA
Range	55-79	35-63	44-62	37-49	15-27	56°-72°	0.66-0.80	0.72-0.80	0.53-0.86
Mean	66	49.20	50.40	42.60	21.80	62°	0.74	0.76	0.60

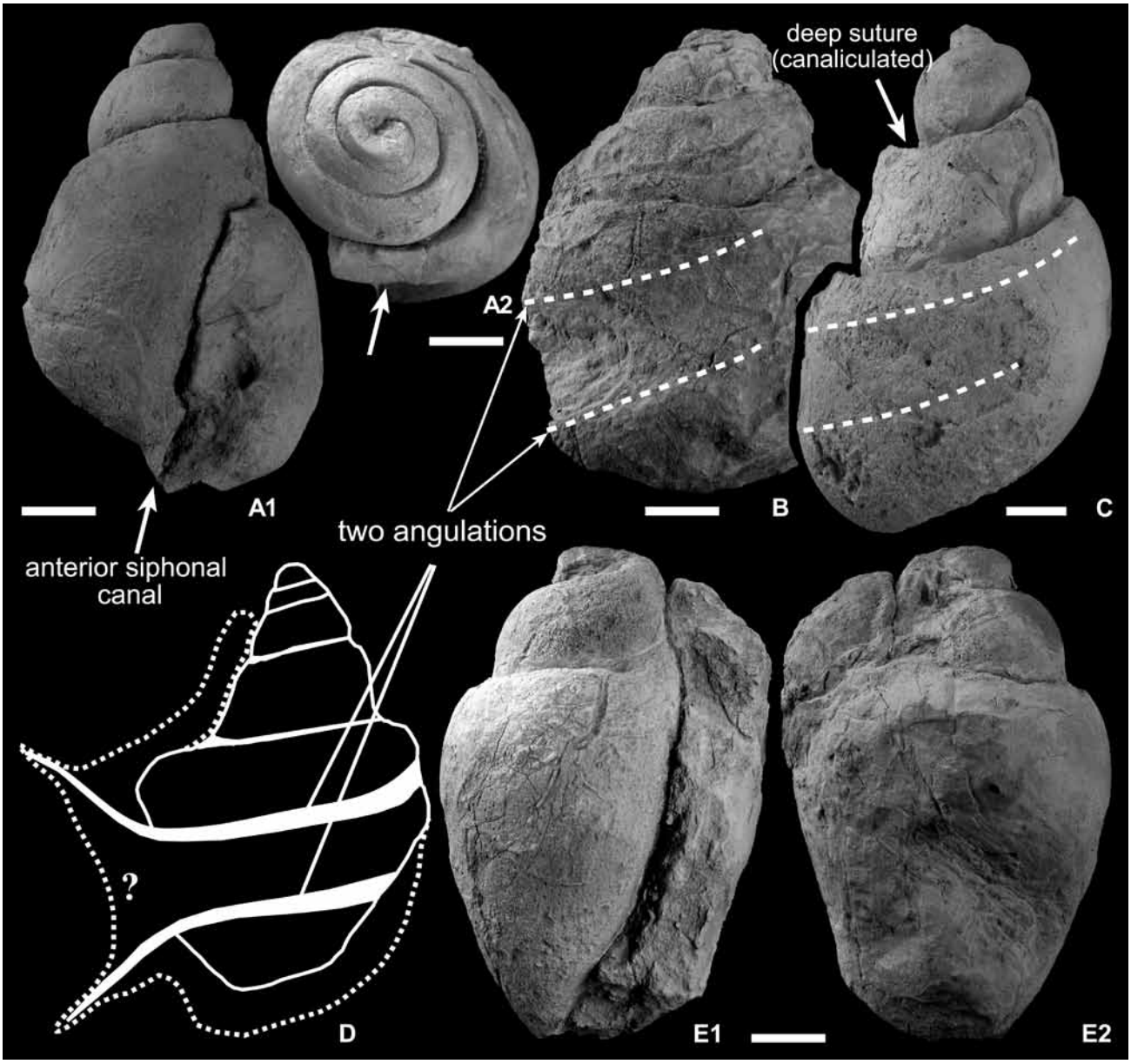

Figure 12: (A–D) Incomplete internal moulds of *Harpagodes* cf. *heberti* (Thomas & Peron, 1889) from the middle carbonate and upper carbonate/marl members of the Halal Formation (Upper Albian-Cenomanian) at Gebel Areif El-Naqa. A1: Apertural view showing the anterior siphonal canal, A2: apical view; MGDMU:AEN.G.15.166. B: Side view with two strong angulations (arrowed); MGDMU:AEN.G.15.167. C: Internal mould from the Cenomanian Galala Formation of Wadi Quseib, abapertural view; MGDMU:WQ.G.42.78. D: Sketch showing the abapertural view of *H. heberti.* E. Internal mould of *Harpagodes*? sp. from the middle carbonate member of the Upper Albian-Cenomanian Halal Formation at Gebel Areif El-Naqa. E1: Apertural view, E2: abapertural view; MGDMU:AEN.G.15.174. Scale bars:10 mm.

features. The present specimens strongly resemble *H. heberti* as figured by Thomas & Peron (1889) from the Cenomanian of Tunisia. They are preserved as internal moulds with incomplete outer lip. Therefore, identification at the species level is doubtful.

H. pelagi (Brongniart, 1822) described by Delpey (1939: 113, fig. 79) and *H. jaccardi* Pictet & Campiche, 1864 described by the same author (1939: 114, fig. 80) from Lebanon differ from the present species in having three strong angulations separated by wide interspaces (spiral bands), which are occupied by 3–7 spiral ribs. *H. desori* (Pictet & Campiche, 1864) as figured by Kollmann (2005: pl. 15, fig. 4) from the Hauterivian of France and *H. germeri* (Blanckenhorn, 1927) from the Cenomanian of Syria differ in having approximately four spiral ribs between the two strong angulations on the abapical side of last whorl with three axial ribs on the first whorls. In addition, Blanckenhorn's species has a narrow and oval aperture with broadly expanded labral wing. *H. beaumontiana* (d'Orbigny 1842: pl. 213) from the Upper Barremian of France has four strong angulations with three broad, spiral ribs.

Harpagodes? sp.
Fig. 12E

Material and occurrence: Three internal moulds

from the middle carbonate and upper carbonate/marl members of the Cenomanian Halal Formation, beds 15 and 19, at Gebel Areif El-Naqa (MGDMU:AEN.G.15.174, 19.18–19).

Description: Large-sized, ovate, and moderately high-spired gastropods. Spire conical and consisting of three continuously enlarging convex whorls separated by moderately deep sutures. Body whorl large, broad, and accounting for about 80% of the total height. Basal whorl with two angulations, enlarged at the aperture to form a large, wing-shaped structure. Apex not preserved. Base and outer lip broken off. Aperture narrow, ovate, and elevated. Inner lip slightly convex.

Discussion: The present material is similar to *Pterodonticeras germeri* Blanckenhorn (1927: 168, pl. 5, figs 90–92) from the Cenomanian of Syria. Blanckenhorn (1927: 167) erected the new genus *Pterodonticeras.* He noted that this genus is transitional between *Pterodonta* d'Orbigny, 1842 and *Harpagodes* Gill, 1870. However, his material is poorly preserved, no apertural view is figured, and his discussion is not sufficient to erect a new genus. Therefore, Blanckenhorn' material is probably *Harpagodes.* The present material differs from *Harpagodes heberti*, discussed above, in having an ovate and narrow aperture, straight outer lip and a high body whorl (75–86% of total shell height).

Family Colombellinidae Fischer, 1884
(=Columbellariidae Zittel, 1895= Zitteliidae, Schilder, 1936)

Genus *Columbellina* d'Orbigny, 1842

Remarks: The main characters of the genus *Columbellina* d'Orbigny, 1842 are convex whorls with spiral cords and axial ribs, a fusiform, short anterior canal and a prominent posterior canal, a short spire, a very thick and wing-shaped outer lip, a narrow and curved aperture, and the lack of an umbilicus.

Columbellina cf. *fusiformis* Douvillé, 1916
Fig. 13A

cf.1916 *Columbellina fusiformis* sp. nov. – Douvillé: 132, pl. 18, figs 1–3.
cf.1963 *Columbellina* (*Columbellina*) *fusiformis* Douvillé – Abbass: 82, pl. 8, figs 1–3.
cf.1982 *Columbellina fusiformis* Douvillé – Böttcher: 32, pl. 5, fig. 8.
cf.1992 *Columbellina* (*Columbellina*) *fusiformis* Douvillé – Abdel-Gawad & Gameil: 80, fig. 3/9–12.
cf.2001 *Columbellina fusiformis* Douvillé – Abdallah et al.: pl. 1, figs 4, 5.
cf.2001 *Columbellina* (*Columbellina*) *fusiformis* Douvillé – Zakhera: pl. 3, figs 25–27.
cf.2004b *Columbellina* (*Columbellina*) *fusiformis* Douvillé – Abdel-Gawad et al.: pl. 5, fig. 9.
cf.2006 *Colombellina* (*Colombellina*) *fusiformis* Douvillé – El Qot: 104, pl. 21, figs 6, 7.
cf.2008 *Colombellina* (*Colombellina*) *fusiformis* Douvillé – Mekawy & Abu Zied: 325, pl. 5, fig. 1.

Material and occurrence: Five internal moulds from the Upper Cenomanian-Lower Turonian Abu Qada Formation, bed 26, of East Themed (MGDMU:ET.G.26.155–159), and four internal moulds from the lower marly member of the Upper Albian-Cenomanian Halal Formation, beds 1 and 9, at Gebel Areif El-Naqa (MGDMU:AEN.G.1.130–132, 9.52).

Description: Moderately large-sized, fusiform, and moderately high-spired gastropod. Spire conical and consisting of 2–3 overlapping whorls with slightly convex surfaces. Whorls separated by moderately deep sutures. Body whorl accounting for about 54% of the total height. Apex broken off. Base nearly acute. Aperture narrow, slightly elongated, and lanceolate to ovate. Ornamentation consisting of 10–14 slightly oblique, strong, axial ribs, separated by wide interspaces (Fig. 13A1).

Occurrence: *Columbellina* cf. *fusiformis* has been recorded from the Upper Barremian-Cenomanian of Egypt.

Discussion: The present specimens closely resemble *Columbellina fusiformis* as figured and described by Douvillé (1916) from the Albian of Egypt, differing solely in being larger. In addition, the anterior and posterior canals are not preserved. Delpey (1939) and Fawzi (1963) considered *Columbellina fusiformis* as a synonym of *C. petrosa* Conrad, 1852. *C. petrosa* Conrad of Delpey (1939: 122, figs 85, 86) has nodose whorls and a flat base (Abdel-Gawad & Gameil, 1992). The fusiform, ovate to elongated aperture, sharp base, and axial ribs with fine spiral cords are the most distinct characteristics of *C.* (*C.*) *fusiformis*. The latter characters are not clearly seen in *C.* (*C.*) *fusiformis* Douvillé figured by Kora et al. (2001: pl. 3, fig. 3) from the Lower Turonian of Gebel Mukattab, which have a more globular last whorl

Table 13: Dimensions (in mm) of *Harpagodes* sp.

n=2	H	D	HL	HA	WA	PA°	nw	D/H	HL/H	WA/HA
Range	60-75	42-65	52-56	51-70	18-20	67-80°	3-4	0.66-0.70	0.75-0.86	0.28-0.35
Mean	67.50	46	54	60.50	19	73°	4	0.68	0.80	0.31

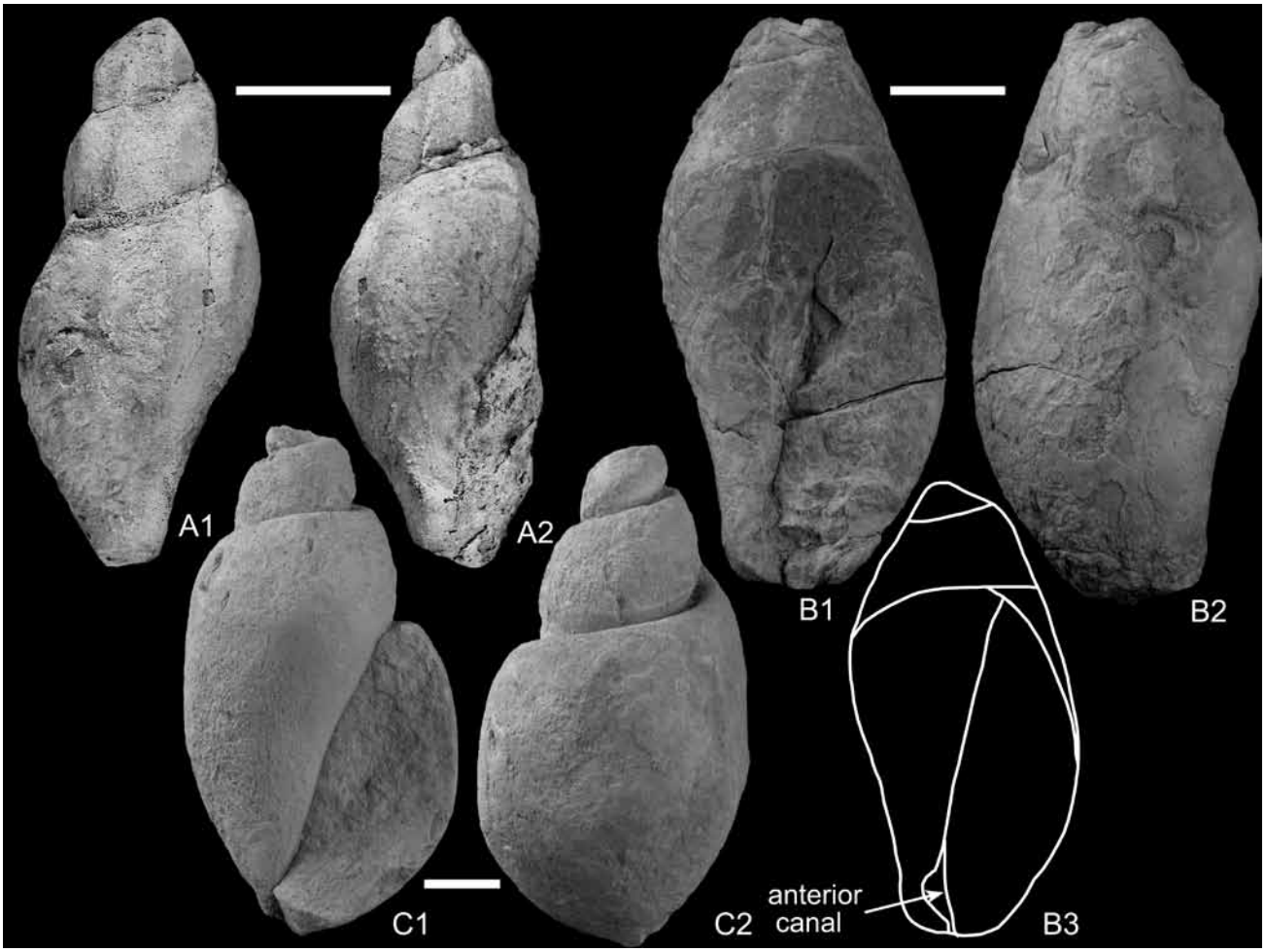

Figure 13: (A) Composite mould of *Columbellina* cf. *fusiformis* Douvillé, 1916 from the Upper Cenomanian-Lower Turonian Abu Qada Formation of the East Themed area. A1: Abapertural view, A2: Apertural view; MGDMU:ET.G.26.155. **(B)** Internal mould of *Pterodonta*? cf. *deffisi* Thomas & Peron, 1889 from the lower marly member of the Upper Albian-Cenomanian Halal Formation at Gebel Areif El-Naqa. B1: Apertural view, B2: abapertural view, B3: sketch of apertural side; MGDMU:AEN.G.1.133. **(C)** Internal mould of *Pterodonta*? sp. from the Upper Albian-Cenomanian Halal Formation at Gebel Areif El-Naqa. C1: Apertural view, C2: abapertural view; MGDMU:AEN.G.9.53. Scale bars: 10 mm.

with nearly flat base. *Fusus tevesthensis* Coquand, 1862 (187: pl. 4, fig. 13) from the Turonian of Algeria is very similar to *C. fusiformis* in outline (fusiform) but differs in being larger (H=100 mm) and in lacking spiral cords, which is probably due to its preservation as composite mould. *F. martinez* Gabb, 1864 differs in having more numerous axial ribs and an evenly convex whorl outline (Abbass 1963).

?Genus *Pterodonta* d'Orbigny, 1842

Remarks: Kollmann (1985) placed *Pterodonta* in the stromboidean family Columbellinidae Fischer, 1884. *Pterodonta* can be easily distinguished by its (1) large to very large shell, (2) globose adult last whorl, (3) low to medium spire, (4) deep sutures, (5) projected and anteriorly incurved outer lip with short anterior siphonal canal, and (6) small umbilicus. *Pterodonta* shows also some similarity to the genus *Paosia* Böhm, 1895 (Family Pseudomelaniidae Fischer, 1885) the latter having a much less globose adult last whorl and an incurved anterior outer lip. Squires & Saul (2004: 490) pointed out that *Pterodonta* is similar to *Paosia* but the latter genus differs in having more sinuous growth lines and in being anomphalous. *Pterodonta* differs from *Tylostoma* Sharpe, 1849 in having a less plump last whorl (naticiform), a projected and incurved outer lip, deep sutures, and

Table 14: Dimensions (in mm) of *Columbellina* cf. *fusiformis* Douvillé.

n=3	H	D	HL	HA	WA	PA°	D/H	HL/H	WA/HA
Range	20-35	12-19	14-17	11-19	6-10	57°-62°	0.40-0.60	0.40-0.70	0.53-0.66
Mean	29.33	15	15	14	8	59°	0.52	0.54	0.58

sinuous growth lines. Due to the poor preservation of the present material, identification, even at the generic level, is very difficult, because many genera of this family look very similar in this state of preservation.

Pterodonta? cf. *deffisi* Thomas & Peron, 1889
Fig. 13B

cf. 1889 *Pterodonta Deffisi* sp. nov. – Thomas & Peron in Peron: 83, pl. 20, figs 17, 18.
cf.1916 *Pterodonta Deffisi* Thomas & Peron – Greco: 158 (100), pl. 19 (11), figs 6–9.
cf.1934 *Pterodonta deffisi* Thomas & Peron – Blanckenhorn: 272.
cf.1963 *Pterodonta gigantica* sp. nov. – Abbass: 83, pl. 7, figs 1–2, 3, non figs 4–5, 7.
cf.1963 *Pterodonta deffisi* Thomas & Peron – Fawzi: 98, pl. 7, fig. 7.
cf.2006 *Pterodonta deffisi* Thomas & Peron – El Qot: 105, pl. 21, figs 9, 10.

Material and occurrence: Eight internal moulds from the lower marly, middle carbonate, and upper carbonate/marl members of the Upper Albian-Cenomanian Halal Formation, beds 1, 15, and 19, at Gebel Areif El-Naqa (MGDMU:AEN.G.1.133–134, 9.16–17, 15.170–173), eight specimens from the Cenomanain Galala Formation, beds 3 and 15, of the East Themed area (MGDMU:ET.G.3.133–134, 15.42–47), and eight internal moulds from the lower shale and middle siliciclastic/carbonate members of the Cenomanian Galala Formation, beds 12 and 41, at Wadi Quseib (MGDMU:WQ.G.12.41–44, 41.57–60).

Description: Moulds large-sized, elongated conical, and moderately high-spired. Spire consisting of two slightly convex to flat overlapping whorls. Protoconch not preserved. Teleoconch whorls approximately four. Suture slightly to moderately impressed. Body whorl large, cylindrical, elongated, slightly inflated, less globose than older whorls, and accounting for about 81% of the total height. Base narrow and nearly acute. Aperture elliptical with small anterior notch (Fig. 13B3). Outer lip slightly convex and with anterior end projected and incurved. Inner lip nearly straight to slightly concave. Ornamentation not preserved.

Occurrence: *Pterodonta*? cf. *deffisi* has been recorded from the Cenomanian-Turonian of Tunisia, Syria, and Egypt.

Discussion: The internal moulds are characterized by a less globose last whorl, lower spire, and small anterior canal. It resembles *Pterodonta deffisi* Thomas & Peron from the Cenomanian of Tunisia but differs in lacking the spiral groove of the last whorl, which is present in Thomas & Peron's and Abbass' specimens. *P. gigantica* Abbass (1963: pl. 7, figs 1–3) strongly resembles Thomas & Peron's species in size, outline, abapertural groove, and apertural outline. Some specimens of *P. gigantica* of Abbass are therefore synonyms of *P. deffisi* (see also Abdel-Gawad & Gameil 1992 and El Qot 2006). *P. subinflata* Coquand (1862: 179, pl. 6, fig. 1) and *P. inflata* d'Orbigny, 1843 described by Collignon (1971: 11, 153, pl. A, fig. 4) from the Lower Turonian of Algeria differ from the present species in having a more inflated and globose last whorl, and strongly convex outer and inner lips with a nearly rounded base. *P. elongata* d'Orbigny, 1843 of Kollmann (1985: 97, fig. 5f, g) from the Cenomanian-Santonian of France differs in having a sharp base with a concave inner lip.

Pterodonta? sp.
Fig. 13C

Material and occurrence. Three internal moulds from the lower marly member of the Upper Albian-Cenomanian Halal Formation, bed 9, at Gebel Areif El-Naqa (MGDMU:AEN.G.9.53–55).

Description: Large-sized, elongated conical, and low high-spired gastropods. Spire consisting of two convex overlapping whorls. Protoconch not preserved. Suture deeply impressed (canaliculate). Body whorl large, globose, and accounting for about 79% of the total height. Aperture ovate-shaped with short anterior canal. Outer lip strongly convex with rounded base. Inner lip nearly straight to slightly concave.

Discussion: The present material strongly resembles *Pterodonta gigantica* (Abbass 1963: 83, pl. 7, figs 4, 5, 7) in general outline, size, convexity of outer lip, aperture outline, and globose last whorl. Abbass erected *P. gigantica* based on internal moulds. Therefore this species should be considered a *nomen dubium.* The same is true of *P. homarensis* Blanckenhorn (1927: 169, pl. 9, fig. 94) from the Cenomanian of Syria. The latter species is poorly preserved and only one view (abapertural view) is shown.

Family Tylostomatidae Stoliczka, 1868

Genus *Tylostoma* Sharpe, 1849

Table 15: Dimensions (in mm) of *Pterodonta*? cf. *deffisi* Thomas & Peron.

n=3	H	D	HL	HA	WA	PA°	D/H	HL/H	WA/HA
Range	58-65	33-38	46-53	38-43	19-21	50°-57°	0.52-0.61	0.79-0.85	0.44-0.55
Mean	61.66	35	50.33	40	20.33	53°	0.57	0.81	0.51

Table 16: Dimensions (in mm) of *Pterodonta?* sp.

n=2	H	D	HL	HA	WA	PA°	nw	D/H	HL/H	WA/HA
Range	63-66	39-42	50-53	42-42	19-21	52-54°	?3	0.59-0.67	0.79-0.80	0.45-0.50
Mean	64.5	40.5	51.5	42	20	53°	?3	0.63	0.79	0.47

Tylostoma globosum Sharpe, 1849
Fig. 14A–C

1849 *Tylostoma globosum* sp. nov. – Sharpe: 379, pl. 9, figs 5, 6.
1912 *Tylostoma globosum* Sharpe – Pervinquière: 53, pl. 4, figs 9, 10.
1916 *Tylostoma globosum* Sharpe – Greco: 143 (85), pl. 17 (9), figs 11, 12.
1938 *Tylostoma* (*Tylostoma*) *globosum* Sharpe – Wenz: 1027; textfig. 2941.
1963 *Tylostoma* (*Tylostoma*) *gadensis* sp. nov. – Abbass: 90, pl. 10, figs 2–5.
1974 *Tylostoma* (*Tylostoma*) *globosum* Sharpe – Albanesi & Busson: 309, pl. 25, fig. 1.
1981 *Tylostoma globosum* Sharpe – Amard et al.: 70, pl. 5, fig. 3.
1985 *Tylostoma* aff. *globosa* Sharpe – Kollmann: 102, fig. 5k.

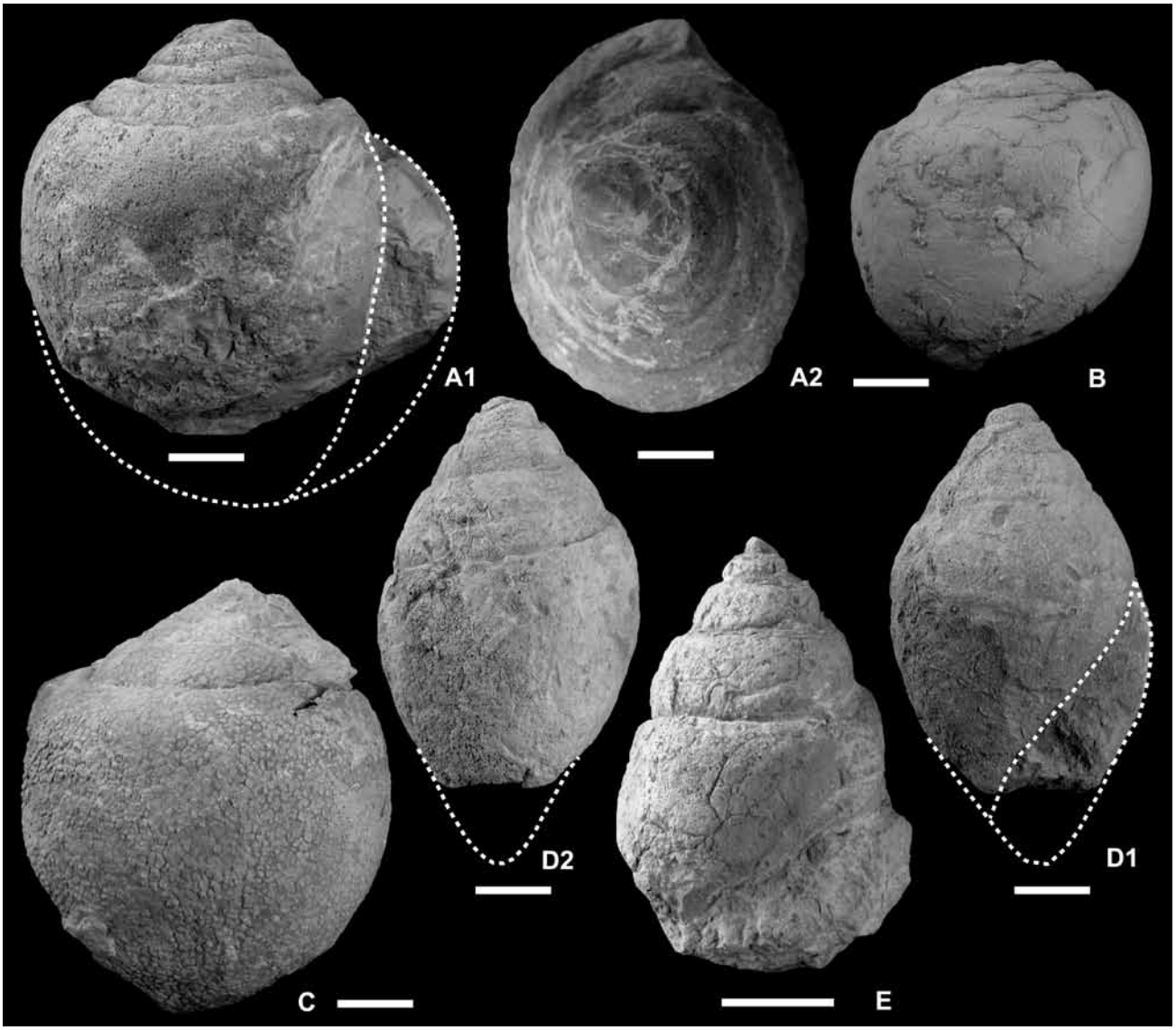

Figure 14: (A–C) Internal moulds of *Tylostoma globosum* Sharpe, 1849 from the Lower Turonian Abu Qada Formation at Wadi Quseib. A1: Apertural view, A2: apical view; MGDMU:WQ.G.55.71. B. Mould from the lower member of the Lower Turonian Abu Qada Formation at Gebel Areif El-Naqa. Abapertural view; MGDMU:AEN.G.23.2. C. Specimen from the Upper Turonian Wata Formation of the East Themed area. Abapertural view; MGDMU:ET.G.31.50. **(D, E)** Internal moulds of *Tylostoma pallaryi* (Peron & Fourtau, 1904) from the lower marly and middle carbonate members of the Halal Formation (Upper Albian-Cenomanian) at Gebel Areif El-Naqa. D1: Apertural view, D2: abapertural view; MGDMU:AEN.G.15.176; E. Apertural view; MGDMU:AEN.G.1.137. Scale bars: 10 mm.

Table 17: Dimensions (in mm) of *Tylostoma globosum* Sharpe.

n=6	H	D	HL	HA	WA	PA°	nw	D/H	HL/H	WA/HA
Range	23-62	18-55	20-58	17-47	9-21	100-115°	3-4	0.78-0.98	0.85-0.96	0.30-0.53
Mean	51	45.5	46.16	38.16	15	108°	4	0.88	0.90	0.43

1991 *Tylostoma* (*Tylostoma*) *globosum* Sharpe – Aboul Ela et al.: 211, pl. 4, fig. 1.
1992 *Tylostoma globosum* Sharpe – Abdel-Gawad & Gameil: 81, fig. 4/9.
2001 *Tylostoma globosum* Sharpe – Abdallah et al.: pl. 1, figs 14, 15.
2001 *Tylostoma globosum* Sharpe – Kora et al.: pl. 3, fig. 4.
2001 *Tylostoma globosum* Sharpe – Zakhera: pl. 3, fig. 10.
?2001 *Tylostoma gadensis* Abbass – Zakhera: pl. 3, figs 13, 14.
2004a *Tylostoma* (*Tylostoma*) *globosum* Sharpe – Abdel-Gawad et al.: pl. 6, fig. 2.
2006 *Tylostoma* (*Tylostoma*) *globosum* Sharpe – El Qot: 109, pl. 22, fig. 8.
2007 *Tylostoma* (*Tylostoma*) *globosum* Sharpe – Mekawy: 166, pl. 3, fig. 4.
2008 *Tylostoma* (*Tylostoma*) *globosum* Sharpe – Mekawy & Abu Zeid: 329, pl. 5, fig. 8.

Material and occurrence: 22 internal moulds from the Upper Cenomanian-Lower Turonian Abu Qada Formation and Upper Turonian Wata Formation, beds 25, 31, 50, and 53 of the East Themed area (MGDMU:ET.G.25.74–77, 31.50–61, 50.1, 53.2–6), five specimens from the Lower Turonian Abu Qada Formation, beds 47, 55, and 76 at Wadi Quseib bed (MGDMU:WQ.G.47.61–62, 55.71–72, 76.21), and three specimens from the lower member of the Lower Turonian Abu Qada Formation, bed 23, at Gebel Areif El-Naqa (MGDMU:AEN.G.23.2–4).

Description: Moderately large- to large-sized, ovoid to globose, and low-spired gastropods. Spire consisting of 3–4 rounded and nearly smooth whorls. These whorls are wide, compressed, and separated by slightly depressed sutures. Body whorl inflated with rounded flanks, smooth, and forming the greater part of the specimen (about 90% of the total height). Base broadly rounded. Lips meeting apically at a sharp angle (Fig. 14A1). Aperture narrow and semi-lunar. Outer lip strongly convex, inner lip slightly convex.

Occurrence: *Tylostoma globosum* is a widespread and easily identifiable Cretaceous gastropod of the Tethyan realm occurring especially in the Turonian of Portugal, Tunisia, Cenomanian-Turonian of Algeria, Santonian of France, and Upper Aptian-Turonian of Egypt. Thus, its stratigraphic range is from the Aptian to the Turonian.

Discussion: The genus *Tylostoma* was erected by Sharpe (1849), who described four species from the Turonian of Portugal. Kollmann et al. (2003) placed the family Tylostomatidae in the superfamily Stromboidea. For more details about the systematic history of Tylostomatidae see Bouchet & Rocroi (2005: 179, 277).

Tylostoma globosum is easily recognized by its globose to broadly oval shape and the low spire. *T.* (*T.*) *cossoni* Thomas & Peron differs in having a moderately high spire. *T.* (*T.*) *gadensis* Abbass, 1963 from the Turonian of Wadi Abu Qada is identical to *T. globosum* in general shape (globose), aperture outline, rounded base, and whorl number. Zakhera (2001) figured the latter two species from the Upper Cretaceous of west-central Sinai but without discussion. *T.* (*T.*) *gadensis* is regarded herein as a junior synonym of *T. globosum*.

Tylostoma pallaryi (Peron & Fourtau, 1904)
Fig. 14D, E

1904 *Pseudomelania Pallaryi* sp. nov. – Peron & Fourtau in Fourtau: 270, pl. 1, fig. 22.
1916 *Tylostoma Pallaryi* Peron & Fourtau – Greco: 151 (93), pl. 18 (10), figs 2–4.
1963 *Tylostoma pallaryi* Peron & Fourtau – Fawzi: 91, pl. 7, figs 1–3.
1974 *Tylostoma* (*Tylostoma*) *pallaryi* (Peron & Fourtau) – Albanesi & Busson: 310, pl. 24, fig. 6.
1985 *Tylostoma* cf. *pallaryi* (Peron & Fourtau) – Dominik: pl. 15, fig. 7.
?2001 *Tylostoma cossoni* (Thomas & Peron) – Abdallah et al.: pl. 1, figs 10, 11.
2001 *Tylostoma pallaryi* (Peron & Fourtau) – Zakhera: pl. 3, fig. 9.
2002 *Tylostoma pallaryi* (Peron & Fourtau) – Zakhera: 320, fig. 2/12–14.
2004b *Tylostoma pallaryi* (Peron & Fourtau) – Abdel-Gawad et al.: pl. 5, fig. 13.
2006 *Tylostoma* (*Tylostoma*) *pallaryi* (Peron & Fourtau) – El Qot: 109, pl. 22, fig. 10.

Table 18: Dimensions (in mm) of *Tylostoma pallaryi* (Peron & Fourtau).

n=5	H	D	HL	HA	WA	PA°	nw	D/H	HL/H	WA/HA
Range	34-40	23-26	23-31	15-22	8-14	62-70°	3-5	0.57-0.73	0.59-0.82	0.40-0.65
Mean	37.80	24.20	28.20	19.80	10.80	64°	4	0.64	0.75	0.54

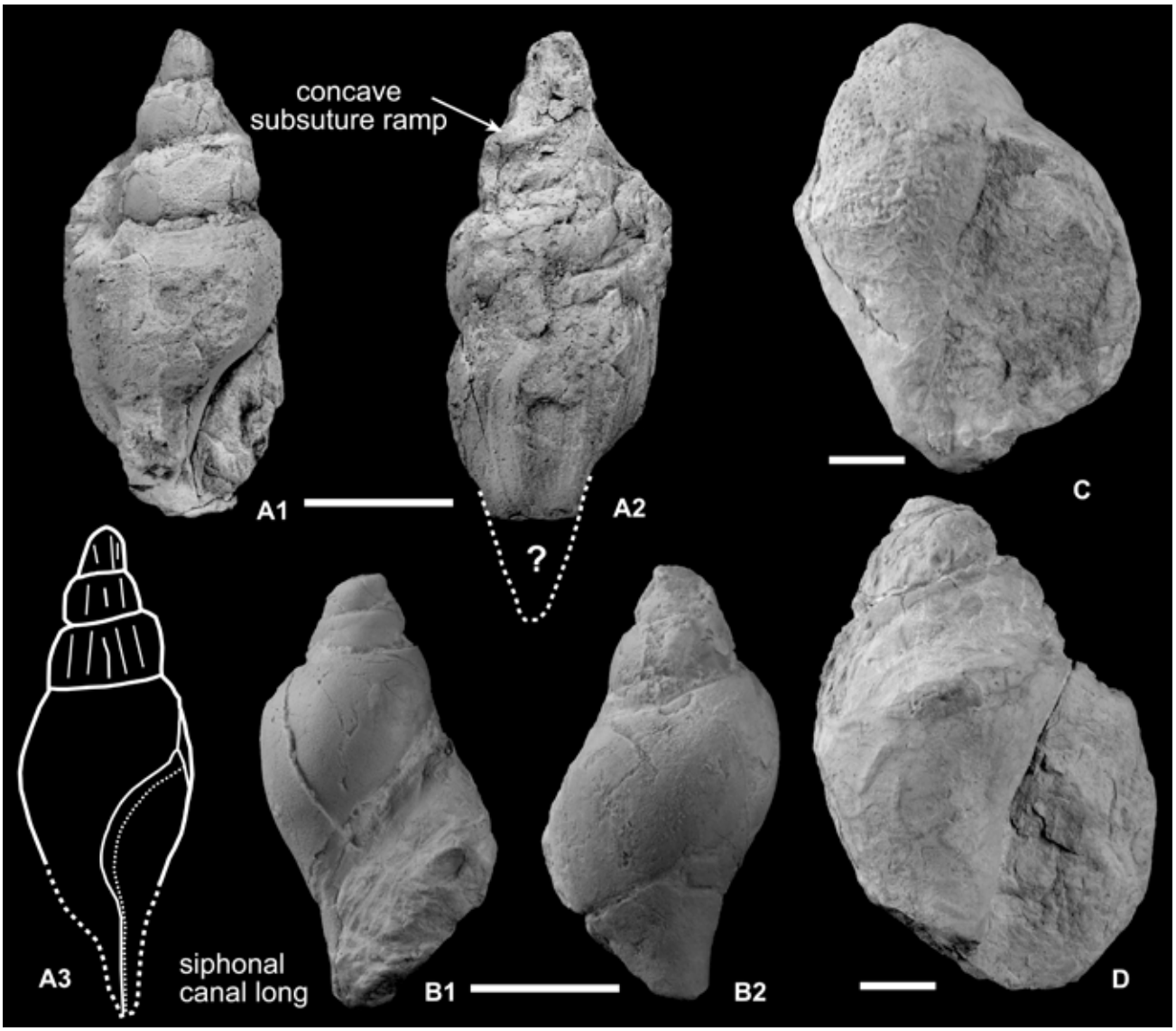

Figure 15: (A) Composite mould of ?Fasciolariidae gen. et sp. indet. from the Upper Cenomanian-Lower Turonian Abu Qada Formation of the East Themed area. A1: Apertural view, A2: abapertural view, A3: sketch of apertural side; MGDMU:ET.G.26.160. **(B)** Internal mould of Neogastropoda gen. et sp. indet. from the lower member of the Lower Turonian Abu Qada Formation at Gebel Areif El-Naqa. B1: Apertural view, B2: abapertural view; MGDMU:AEN.G.23.5. **(C, D)** Internal moulds of Volutidae? gen. et sp. indet. from the lower marly and middle carbonate members of the Halal Formation (Upper Albian-Cenomanian) at Gebel Areif El-Naqa. C: Apertural view; MGDMU:AEN.G.15.140. D: Apertural view; MGDMU:AEN.G.15.189. Scale bars: 10 mm.

2007 *Tylostoma* (*Tylostoma*) *pallaryi* (Peron & Fourtau) – Mekawy: 167, pl. 3, fig. 5.

Material and occurrence: 10 internal moulds from the lower marly and middle carbonate members of the Halal Formation (Upper Albian-Cenomanian), beds 1, 12, and 15, at Gebel Areif El-Naqa (MGDMU:AEN.G.1.137–140, 12.37, 15.176–188), and three specimens from the Cenomanian Galala Formation, bed 12, of the East Themed area (MGDMU:ET.G.12.133–135).

Description: Moderately large- to large-sized, ovate, and moderately high-spired gastropods (Fig. 14D1, E). Spire conical and consisting of three overlapping smooth whorls. These whorls are slightly convex and separated by slightly depressed sutures. Body whorl large, semi-conical, with convex

Table 19: Dimensions (in mm) of ?Fasciolariidae gen. et sp. indet.

n=1	H	D	HL	HA	WA	PA°	nw	D/H	HL/H	WA/HA
	43	19	30	22	6	25°	4	0.44	0.70	0.27

flanks, and accounting for about two-thirds of the total height. Aperture partly broken but most probably narrow and lanceolate. Lips meeting apically at a sharp angle. Ornamentation not seen.

Occurrence: *Tylostoma pallaryi* has been recorded from the Cenomanian of Algeria and Egypt.

Discussion: *Tylostoma pallaryi* (Peron & Fourtau) is smaller than *T. globosum* Sharpe and has a relatively high spire (Fig. 14D1). *T. syriacum* (Conrad, 1852) of Blanckenhorn (1927: 137, pl. 2, fig. 2) from the Cenomanian of Syria closely resembles *T. pallaryi* in general shape but differs in being larger and having a shallow umbilicus with slightly incised sutures.

Clade Neogastropoda Wenz, 1938
Superfamily Buccinoidea Rafinesque, 1815
Family Fasciolariidae Gray, 1853

Remarks: According to Squires & Saul (2006: 71), fasciolariids are of medium to large size, fusiform, and their spire accounts for 40–50% of the total shell height. The shell is ornamented with spiral or axial ribs. The shoulder bears tubercles; collabral ribs are most prominent on the shoulder, whereas spiral ribs dominate elsewhere. The columella has up to three folds, extending posteriorly upward into the aperture. The edge of the outer lip edge is smooth or with small teeth. The siphonal canal is long and narrow, and the siphonal fasciole is usually weak, slightly twisted to the left, and slightly upturned. Due to the poor preservation of the material and lack of the most distinct features (e.g., protoconch, columellar folds, well preserved ribs) identification, even at the family level, is difficult. However, based on the large, elongated, spindle-shaped shell, elevated spire, well developed anterior canal, and tuberculated shoulder the specimens are referred to the family Fasciolariidae with doubt.

?Fasciolariidae gen. et sp. indet.
Fig. 15A

Material and occurrence: Two composite moulds from the Upper Cenomanian-Lower Turonian Abu Qada Formation, bed 26, of the East Themed area (MGDMU:ET.G.26.160–161).

Description: Medium-sized, fusiform, elongated, and high-spired gastropods. Spire moderately high (51% of shell height) narrow, conical, and consisting of four overlapping whorls with slightly convex surfaces. Whorls weakly rounded, separated by moderately deep sutures. Sub-suture ramp short and concave. Aperture (peristome) oval, extending anteriorly into an elongated narrow canal (Fig. 15A3). Base nearly acute. Inner lip concave, outer one slightly convex. Spire ornamented with strong axial ribs separated by wide and concave interspaces. The spiral cords are not preserved. Body whorl ornamented with finer axial ribs, separated by narrow interspaces.

Discussion: The poorly preserved specimens resemble *Fasciolaria tournoueri* (Thomas & Peron in Peron 1889: 91, pl. 21, figs 19, 20) and Pervinquière (1912: 71, pl. 5, fig. 16) from the Turonian of Tunisia in ornamentation and outline but differ in having wider whorls and and a higher body whorl. *Fusus numidigus* Coquand as figured by Thomas & Peron (1889: 91, pl. 21, figs 13, 14) differs in having a wider shell and a larger drop-shaped aperture. In addition, the body whorl is ornamented with strong axial ribs, separated by wide interspaces.

Fasciolaria safrensis Abbass (1963: 93, pl. 8, figs, 4–6) from the Cenomanian of Gebel Safra, Egypt is similar to present material and differs only in being larger (H= 77 mm). Abbass erected *F. safrensis* based on internal and composite moulds lacking characteristic features. The species should therefore be considered a *nomen dubium. Fusus tevesthensis* Coquand (1862: 187, pl. 4, fig. 13) from the Upper Cretaceous of Algeria is quite similar to the present material in general shape (fusiform) and aperture outline but differs in having wider interspaces between the axial ribs and in being larger (H=100 mm). As in the case of *F. safrensis* of Abbass, Coquand's species has been erected on composite moulds and should therefore be considered a *nomen dubium*.

Neogastropoda gen. et sp. indet.
Fig. 15B

Material and occurrence: Two internal moulds from the lower member of the Lower Turonian Abu Qada Formation, bed 23, at Gebel Areif El-Naqa (MGDMU:AEN.G.23.5–6).

Description: Specimens large-sized, fusiform, and moderately high-spired. Spire consisting of two overlapping, slightly convex whorls separated by moderately deep sutures. Body whorl large and accounting for about 73% of the total height. Base nearly acute. Aperture large and lanceolate with strongly convex outer lip and slightly concave inner

Table 20: Dimensions (in mm) of Neogastropoda gen. et sp. indet.

	H	D	HL	HA	WA	PA°	nw	D/H	HL/H	WA/HA
n=1	34	18	25	20	11	60°	3	0.53	0.73	0.55

Table 21: Dimensions (in mm) of Volutidae? gen. et sp. indet.

n=2	H	D	HL	HA	WA	PA°	nw	D/H	HL/H	WA/HA
Range	63-67	42-47	48-54	42-51	23-30	60°-85°	3-4	0.66-0.70	0.72-0.86	0.54-0.59
Mean	65	44.50	51	46.50	26.50	72°	4	0.68	0.79	0.56

lip. Ornamented with faint axial ribs near the outer lip of the last whorl.

Discussion: The present material resembles *Sycum* (*Palaeatractus*) *figari* Greco (1916: 163, pl. 19, fig. 11) and *Palaeatractus figari* (Greco) of El Qot (2006: 110, pl. 22, fig. 9; pl. 23, fig. 1a, b) from the Cenomanian of the Eastern Desert and Sinai Peninsula, respectively in general shape and aperture outline. However, Greco's species has numerous axial ribs crossed by numerous spiral cords forming a characteristic network pattern. The present material lacks this reticulate pattern. Also, the suture angle is steeper than in Greco's species.

Superfamily Muricoidea Rafinesque, 1815
Family Volutidae Rafinesque, 1815

Volutidae? gen. et sp. indet.
Fig. 15C, D

Material and occurrence: Two internal moulds from the middle carbonate members of the Halal Formation (Upper Albian-Cenomanian), bed 15, at Gebel Areif El-Naqa (MGDMU:AEN.G.15.189–190).

Description: Large-sized, stromboid-shaped, and moderately low-spired gastropods. Spire consisting of three slightly convex whorls with shouldered sutures. Body whorl large, globular, and accounting for about 79% of the total height. Aperture large and semi-lanceolate with a strongly convex outer lip. Inner lip straight to slightly concave. Ornamentation not preserved.

Discussion: Most shells of the Volutidae are ovate to strombiform with a high to low spire. The ornamentation consists mainly of axial riblets often forming strong nodes on the shoulder. Occasionally the shells are completely smooth. Therefore, no precise identification of the internal moulds is possible. The specimens exhibit some similarity with *Caricella stromboides* (Munier-Chalmas, 1882) of Abdel-Gawad (2000: 1522, pl. 2, figs 5, 6) from the Coniacian-Santonian of Gebel Nezzazat and Magmar (Sinai) in general shape, but the latter species differs in being smaller and in having slightly concave whorls and a small aperture. *C. pyriformis* (Forbes) of Albanesi & Busson (1974: pl. 28, fig. 1) from the Senonian of Algeria differs in lacking the shouldered sutures, having a low spire, and a more convex last whorl.

Superfamily Acteonoidea d´Orbigny, 1843
Family Acteonellidae Gill, 1871
Subfamily Itieriinae Cossmann, 1896

Genus *Sogdianella* Djalilov, 1972

Remarks: The genus *Sogdianella* was included in the Acteonellidae by Djalilov (1972). Kollmann & Sohl (1979: A4) pointed out that the genus *Sogdianella* is closely similar to the genus *Peruviella* Olsson, 1944 but differs from the genus *Actaeonella* d'Orbigny, 1842, and therefore reassigned it to the Itieriidae in the superfamily Nerinaecea. In the classification of Bouchet & Rocroi (2005), the Itieriinae are considered as a subfamily of the Acteonellidae. *Peruviella* has wide whorls with a longer anterior canal than *Sogdianella*, and the columella exhibits a wide hollow space between the central pillar and the columellar lip of the following whorls. The genus *Actaeonella* has convex sides, the whorls are broader interiorly than in *Sogdianella*, and the columella has more or less parallel sides and is solid. Apart from a small projecting beak at the base of the body whorl, *Sogdianella* differs from *Actaeonella* in the posterior extension of the aperture being twisted antispirally.

Kollmann & Sohl (1979: A9) and Squires & Saul (2002: 47) characterized the genus *Sogdianella* by a sharp base of the body whorl, very narrow and numerous whorls (widened in the lower part of the shell), and a columella which forms an angle with the axis at the lower end and bears three folds (Fig. 16D). Sampling of *Sogdianella* from the hard dolomitic limestone in the Wadi Quseib section (Lower Turonian Abu Qada Formation) was difficult. Therefore, some important characters such as the aperture and ornamentation are not seen and, as a result, specific identification is also doubtful. However, the acute base of the body whorl, the three columellar folds, numerous narrow whorls, and a columella, which forms an angle with the axis, are diagnostic features of *Sogdianella.*

Sogdianella ranges from the Albian to the Upper Cretaceous and is known only from central Europe, the Middle East, and Transcaucasia (Kollmann & Sohl 1979: A11). This is the first record of the genus from the Lower Turonian of Egypt and North Africa.

Sogdianella? *laevis laevis*
(J. de C. Sowerby, 1835)
Fig. 16

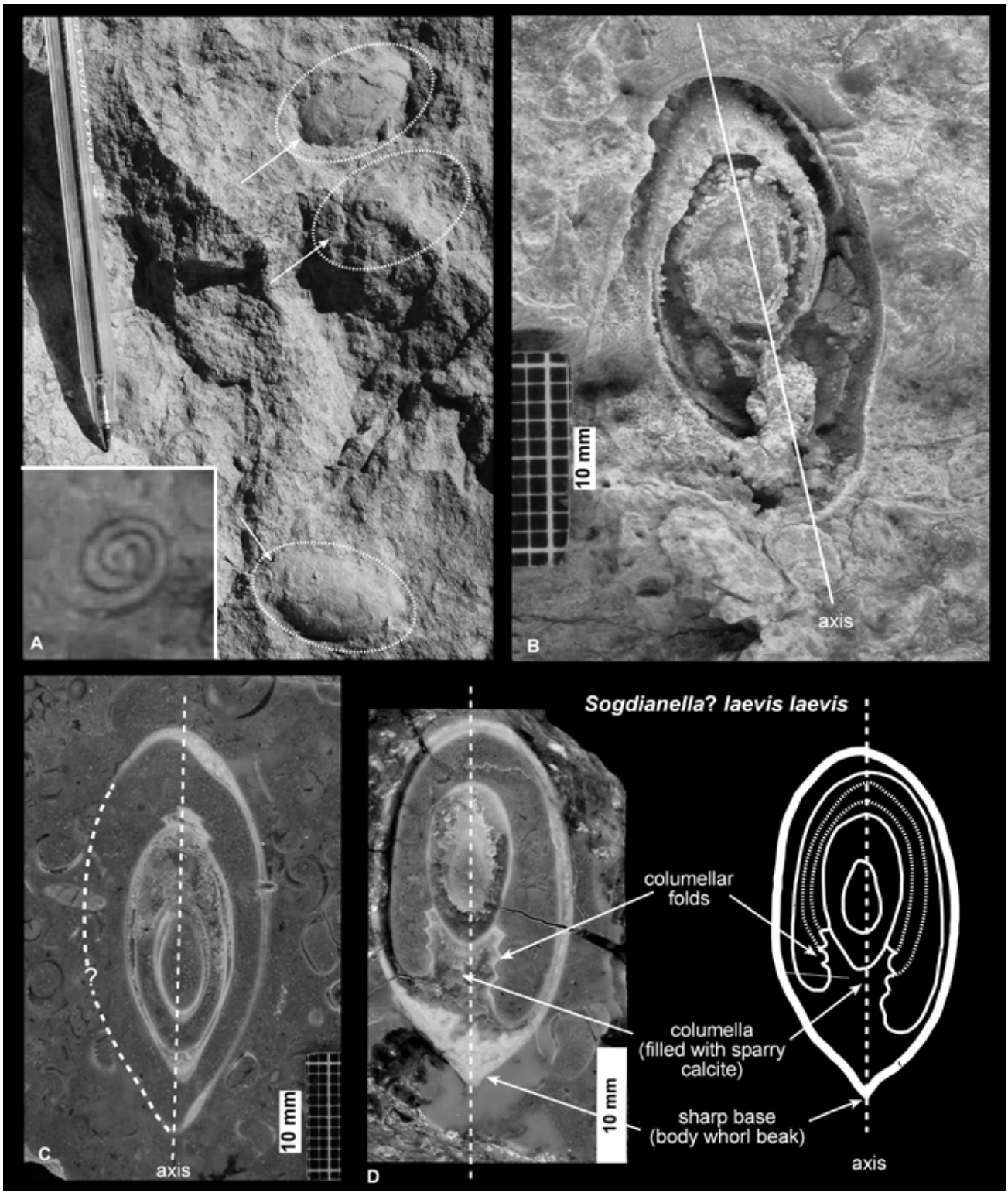

Figure 16: Axial sections and internal characters of *Sogdianella*? *laevis laevis* (J. de C. Sowerby, 1835) from bedding planes **(A–B)** of the Lower Turonian Abu Qada Formation at Wadi Quseib. **(C)** Polished section. **(D)** Polished section and sketch. Pen for scale in (A), mm-scale in (B) and (C).

1835 *Volvaria laevis* sp. nov. – J. de C. Sowerby in Sedgwick & Murchison: pl. 39, fig. 33.
?1845 *Actaeonella laevis* Sowerby – Reuss: 50, pl. 10, fig. 21a, b.
1865 *Volvulina laevis* Sowerby – Stoliczka: 39.
?1902 *Actaeonella laevis* Sowerby – Choffat: 110, pl. 1, figs 6, 7.
1965 *Actaeonella laevis laevis* (Sowerby) – Kollmann: 247, pl. 1, figs 5–8; pl. 4, fig. 23.

Material and occurrence: 78 specimens observed on bedding planes of the Lower Turonian Abu Qada Formation, beds 55, 59 and 78, at Wadi Quseib

(MGDMU:WQ.G.55.73–130, 59.1–10, 78.5–14).

Description: Small-sized (20–25 mm in height, 7–12 mm in diameter), sub-cylindrical to slender gastropods, widest at middle and pointed at terminal apices. Whorl sides convex. External surface smooth (Fig. 16A). Columella short with three plaits that decrease in strength anteriorly and are strongly inclined towards the axis at the lower end (Fig. 16B–D). Whorls narrow, numerous, and only slightly widened in the lower part of shell. Aperture not seen.

Occurrence: *Sogdianella laevis laevis* has been recorded from the Upper Cenomanian-Lower Turonian of Portugal, Czech Republic, and the Santonian-Campanian of the eastern Alps. This is the first record of the species from Egypt.

Discussion: *Sodianella*? *laevis laevis* can be easily distinguished by its small size, cylindrical shell, convex whorl sides, pointed apices, and short columella with three plaits that decrease in strength anteriorly and are strongly inclined towards the axis at the lower end. The present material strongly resembles *S. laevis laevis* (J. de C. Sowerby) as described and figured by Kollmann (1965) from the Santonian-Campanian of the Alps with respect to shell dimensions (length: 10–30 mm, W: 3–10 mm), cylindrical outline, and fold pattern.

Sogdianella syriaca (Conrad, 1852), described by Kollmann (1987: 50, pl. 3, figs 39, 40) from the Cenomanian of Greece, and *S. subcyclindrica* Kollmann & Sohl (1979: A11, fig. 6a–c) from the Maastrichtian of Cuba differ in being larger and in having well developed columellar folds. *Actaeonella caucasica grossouvrei* Zekeli and *A. caucasica caucasica* Cossmann differ from the present species in having wider shells, more convex whorl sides, and in being larger (40–70 and 30–65 mm in length, respectively). *A. elongata* Kollmann resembles *Sogdianella laevis laevis* in size but differs in being much narrower and in having three well developed plaits. The size and columellar folds of *S. oregonensis* from the lower Cenomanian of east-central Oregon figured by Squires & Saul (2002: 47, fig. 1/11–15) are similar to the present species. Their species differs only in being slightly wider than *S. laevis laevis.*

Superfamily Nerineoidea Zittel, 1873
Family Nerineidae Zittel, 1873
(=Phaneroptyxidae Pchelintsev, 1965
= Fibuloptygmatididae Hacobjan, 1973)

Remarks: Nerineids vary in outline and some also in their ornamentation, but the most important ele-

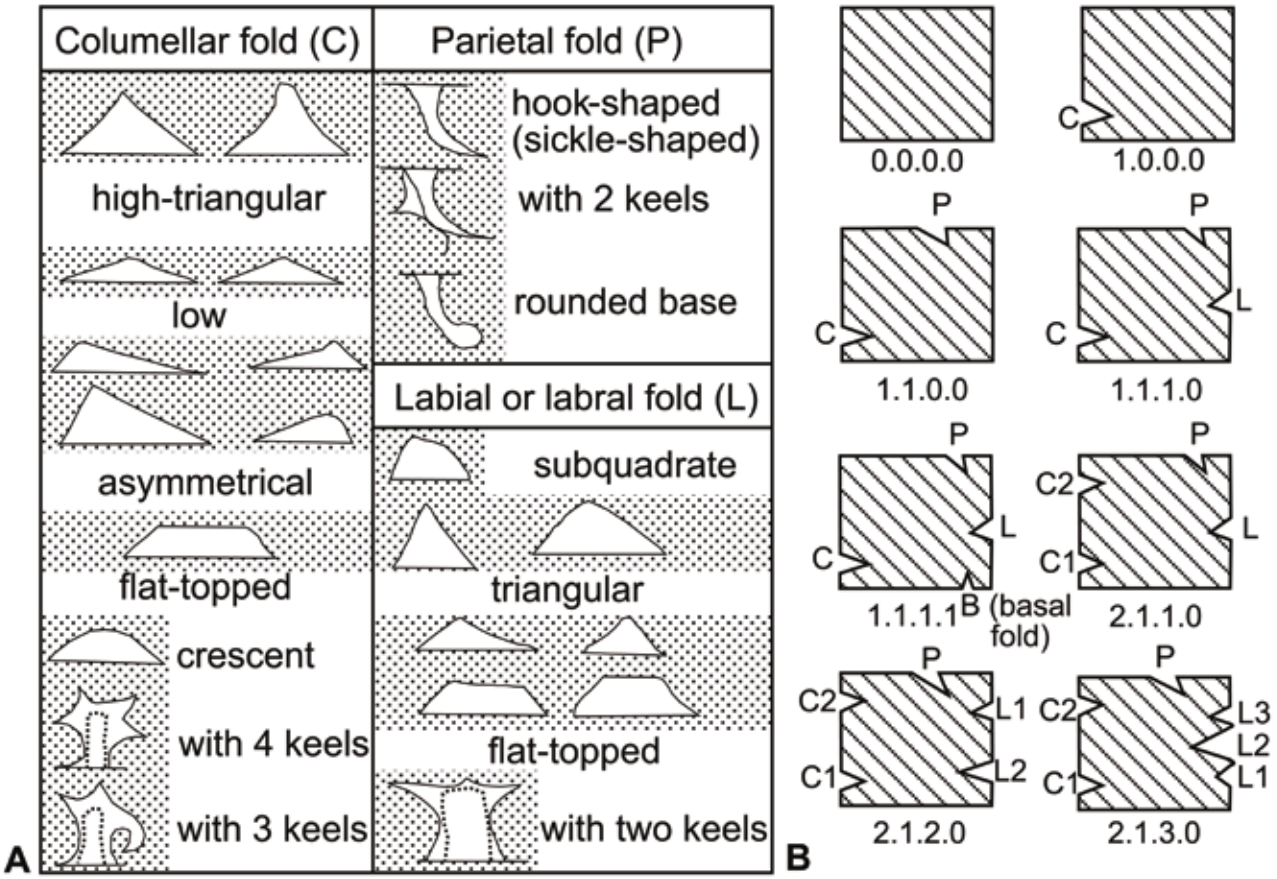

Figure 17: (A) Some internal fold variations in nerineids, redrawn after Shikama & Yui (1973: 20, textfig. 4). **(B)** Different schematic examples of fold complexity redrawn from Wieczorek (1979: 301, textfig. 2).

ments for their generic classification are the internal features of the shell. Most nerineids are characterized by the presence of internal folds on the columella and outer lip, which may carry from one to seven folds. The spiral folds have a variable shape and are referred to as parietal (P), columellar (C), labial or labral (L), and basal folds (B) (Barker, 1990) (Fig. 17). The number, arrangement, and strength of these internal folds are very important for the generic classification of nerineids. For instance, the fold formula of the genus *Neoptyxis* Pchelintsev, 1934 is 2110, where C=2, P=1, L=1, and B=0 (Wieczorek, 1979; Fig. 17B). Nerineids with four internal folds belong, for example, to the genera *Neoptyxis* and *Plesioptygmatis* Bose, 1906 (Delpey 1939). Nerineids with three internal folds, in contrast, belong to the genera *Eunerinea* Cox, 1949 and *Diozoptyxis* Cossmann, 1896. The general shape, presence or absence of an umbilicus, and ornamentation are other important features of nerineids, on which the classification is based. For more details about the taxonomy of nerineids see Delpey (1939), Cox (1949), Wieczorek (1979), Barker (1990), and Sirna (1995).

Three genera were identified in the present study. Two of these, namely *Neoptyxis* and *Pchelinsevia* Lisenko & Aliyev, 1987, can easily be classified, because they exhibit a characteristic fold pattern. The third genus, *Diozoptyxis*, is not well preserved.

Genus *Neoptyxis* Pchelintsev, 1934

Neoptyxis olisiponensis (Sharpe, 1850)
Fig. 18

1850 *Ptygmatis olisiponensis* sp. nov. – Sharpe: 114, pl. 13, fig. 3.
1916 *Nerinea* (*Ptygmatis*) *olisiponensis* Sharpe – Greco: 145 (87), pl. 17 (9), figs 14, 15.
1939 *Nerinea olisiponensis* Sharpe – Delpey: 196, pl. 11, figs 1–4.
1952 *Nerinea olisiponensis* (Sharpe) – Awad: 28, pl. 1, fig. 6.
1982 *Neoptyxis olisiponensis* (Sharpe) – Accordi et al.: 776, fig. 12a.
1987 *Neoptyxis olisiponensis* (Sharpe) – Kollmann: 45, pl. 2, figs 26, 27.
1992 *Nerinea olisiponensis* (Sharpe) – Abdel-Gawad & Gameil: 76, fig. 2/15–18; fig. 3/1–2.
1993 *Multiptyxis olisiponensis* (Sharpe) – Sirna & Mastroianni: pl. 2, fig. 3; pl. 3, fig. 1.
1995 *Multiptyxis olisiponensis* (Sharpe) – Sirna: pl. 2, fig. 1; pl. 3, fig. 1.
2006 *Nerinea olisiponensis* (Sharpe) – El Qot: 98, pl. 20, fig. 1.
2007 *Nerinea olisiponensis* (Sharpe) – Mekawy: 158, pl. 1, figs 9, 10.

Material and occurrence: Five internal moulds (mostly fragmented) from the lower shale, middle siliciclastic/carbonate, and upper carbonate members of the Cenomanian Galala Formation, beds 12, 15, and 44, at Wadi Quseib (MGDMU:WQ.G.12.46, 15.31, 44.236–238).

Description: The fragments indicate a turriform to slightly conical, high-spired nerineid. Spire consisting of ?9–14 overlapping whorls with nearly flat surfaces. Suture slightly impressed. Aperture small. Base flat without anterior notch. Apex broken off. Ornamentation not seen. Internally, the quadrate whorl cross-section shows five folds: a principal columellar fold (C1: narrow, deep, directed upwards and with triangular apex); a secondary columellar fold (C2: small with rounded apex, and located in the middle between the parietal and principal columellar folds); a parietal fold (P: sickle-shaped and bent towards

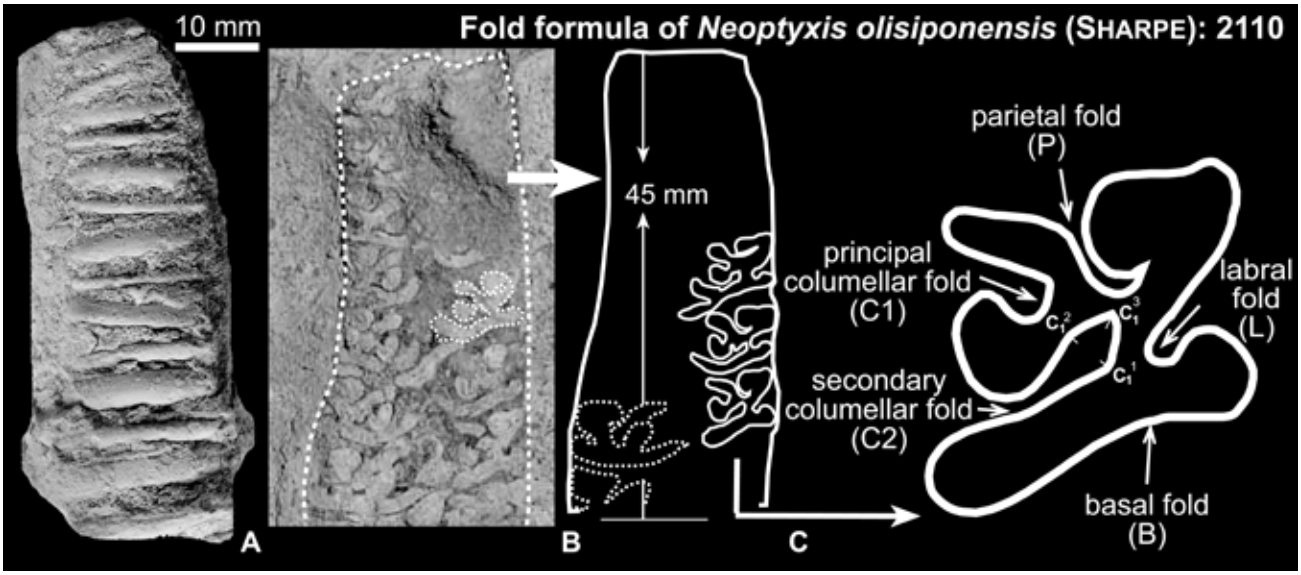

Figure 18: Longitudinal whorl section showing the fold pattern and internal character of *Neoptyxis olisiponensis* (Sharpe, 1850) from the Cenomanian Galala Formation of Wadi Quseib. **(A)** Side view; MGDMU:WQ.G.44.236. **(B, C)** Longitudinal whorl sections showing a wide columella; MGDMU:WQ.G.44.237. Scale bar: 10 mm.

the outer lip); and a labial fold (L: subtriangular with slightly convex apex). Basal fold (B) large with very shallow flexure (broad basis, Fig. 18). Subordinate folds are present only in the principal columellar fold C1 (C_1^1, C_1^2, C_1^3) and are situated in the apex corners (Fig. 18). The fold formula of *Pchelinsevia coquandiana* is 2110 (C=2, P=1, L=1, and B=0).

Table 22: Dimensions (in mm) of *Neoptyxis olisiponensis* (Sharpe).

	H	D	PA°	nw	D/H
n=1	?40	18	43°	15	0.45

Occurrence: *Neoptyxis olisiponensis* has been recorded from the Cenomanian-Turonian of Portugal, Lebanon, Italy, and Egypt. According to Accordi et al. (1982: 776), *Neoptyxis olisiponensis* is typical of sediments of the Upper Cenomanian of Istria, Syria, and the south-central Apennines (Italy).

Discussion: *Neoptyxis olisiponensis* can be easily distinguished by its concave whorls, the medium-sized secondary columellar fold, and truncated apex of labial fold (Kollmann 1987; Sirna & Mastroianni 1993). *N. olisiponensis* (Sharpe) resembles *N. requieniana* d'Orbigny, 1842 in having nearly flat whorls and shallow sutures but differs in having a larger number of whorls. Internally, *N. requieniana* differs in lacking a deep sickle-shaped parietal fold with slight principal columellar fold. *Neoptyxis schiosensis* Pirona, 1884 from the Upper Cenomanian of Portugal differs from the present species in having a shallow, acute, and triangular parietal fold, two equal-sized columellar folds, flat to moderately concave whorls, and raised sutures. According to Kollmann (1987: 46), *N. cylindrica* Hacobjan, 1976; *N. similis* Hacobjan, *N. fleuriausa* Hacobjan; *N. subgemmifera* Hacobjan, and *N. djogasensis* Hancobjan closely resemble *Neoptyxis olisiponensis,* the differences being not sufficiant to separate them into different species.

N. sinaiensis Fawzi (1963: 110, pl. 8, fig. 5) from the Cenomanian of the Minsherah area resembles the present species in general outline but differs in having a very shallow labial fold and a bifid columellar fold. Fawzi (1963: 109, pl. 8, fig. 4) also erected *N. minsherehensis* from the same locality based on fragmented material but his species slightly differs in the columellar structure.

Genus *Pchelinsevia* Lisenko & Aliyev, 1987

Pchelinsevia coquandiana (d'Orbigny, 1842)
Fig. 19

1842 *Nerinea coquandiana* sp. nov. – d'Orbigny: 75, pl. 156, figs 3, 4.
?1916 *Nerinea bicatenat*a sp. nov. – Coquand in Greco: 152 (94), pl. 18 (10), fig. 5.
?1927 *Nerinea cochleaeformis* Conrad var. *subgigantea* Blanckenhorn: 150, pl. 7 (3), figs 58, 59.
1939 *Nerinea coquandi* d'Orbigny – Delpey: 180, pl. 4, figs 1–5.
?1963 *Nerinea* (*Neoptyxis*) *akaadi* sp. nov. – Abbass: 74, pl. 5, fig. 6.
1976 *Nerinea coquandi* d'Orbigny – Praturlon & Sirna: 100, fig. 19 (with extensive synonymy).
1982 *Diozoptyxis coquandi* (d'Orbigny) – Accordi et al.: 775, fig. 16a, c.
1992 *Nerinea gemmifera* Coquand – Abdel-Gawad & Gameil: 77, fig. 3/3–4.
1993 *Pchelinsevia coquandiana* (d'Orbigny) – Sirna & Mastroianni: 143, pl. 1, fig. 7; pl. 3, fig. 8.
1993 *Nerinea gemmifera* Coquand – Orabi: pl. 2, fig. 18.
1995 *Pchelinsevia coquandiana* (d'Orbigny) – Sirna: pl. 2, fig. 3.
2001 *Nerinea gemmifera* Coquand – Abdallah et al.: pl. 1, figs 6, 7.
2004b *Nerinea gemmifera* Coquand – Abdel-Gawad et al.: pl. 5, fig. 4.
2007 *Nerinea gemmifera* Coquand – Mekawy: 158, pl. 1, fig. 8.

Material and occurrence: 34 internal and composite moulds (mostly fragmented) from the upper carbonate/marl member of the Cenomanian Halal Formation, beds 19 and 20, at Gebel Areif El-Naqa (MGDMU:AEN.G.19.20–34, 20.1–19); 72 internal moulds from the Cenomanian Galala Formation, beds 2, 3, and 15, at the East Themed area (MGDMU:ET.G.2.1–45, 3.135–159, 15.56–57); 39 specimens from the middle siliciclastic/carbonate member of the Cenomanian Galala Formation, beds 12, 21, 22, 31, and 37, at Wadi Quseib (MGDMU:WQ.G.12.47–51, 21.31–35, 22.81, 31.35–60, 37.13–15).

Description: Specimens medium- to large-sized, turriculate, and high-spired. Spire long and consisting of 5–8 overlapping wide whorls with strongly concave surfaces and raised sutures. Apex commonly damaged. Aperture small and ovate. Longitudinal whorl section displaying a large columellar and rhomboidal whorl cross-section which shows three simple folds. Parietal fold triangular with rounded apex; columellar one also triangular, larger and with more acute apex; labial fold with large base, shallow, and situated at middle part of the outer lip. In a few other whorl sections, parietal folds show a sickle-shape (Fig. 19A3–C). The fold formula of *Pchelinsevia coquandiana* is 1110 (C=1, P=1, L=1, and B=0). In some specimens, the whorls are closely spaced adaxially without distinct axial columella in-between (Fig. 19 B2, B3). These specimens are crushed, because the internal whorl sections are touching each other and this surely was not the original state.

Occurrence: *Pchelinsevia coquandiana* has been recorded from the Aptian of southern France, Italy, and Lebanon. According to Accordi et al. (1982: 775) and Sirna & Mastroianni (1993), *P. coquandiana* is known from the Aptian of Portugal, Spain, Lebanon, North Africa, Somaliland, and Asia. In the present study, the species has been recorded from Ceno-

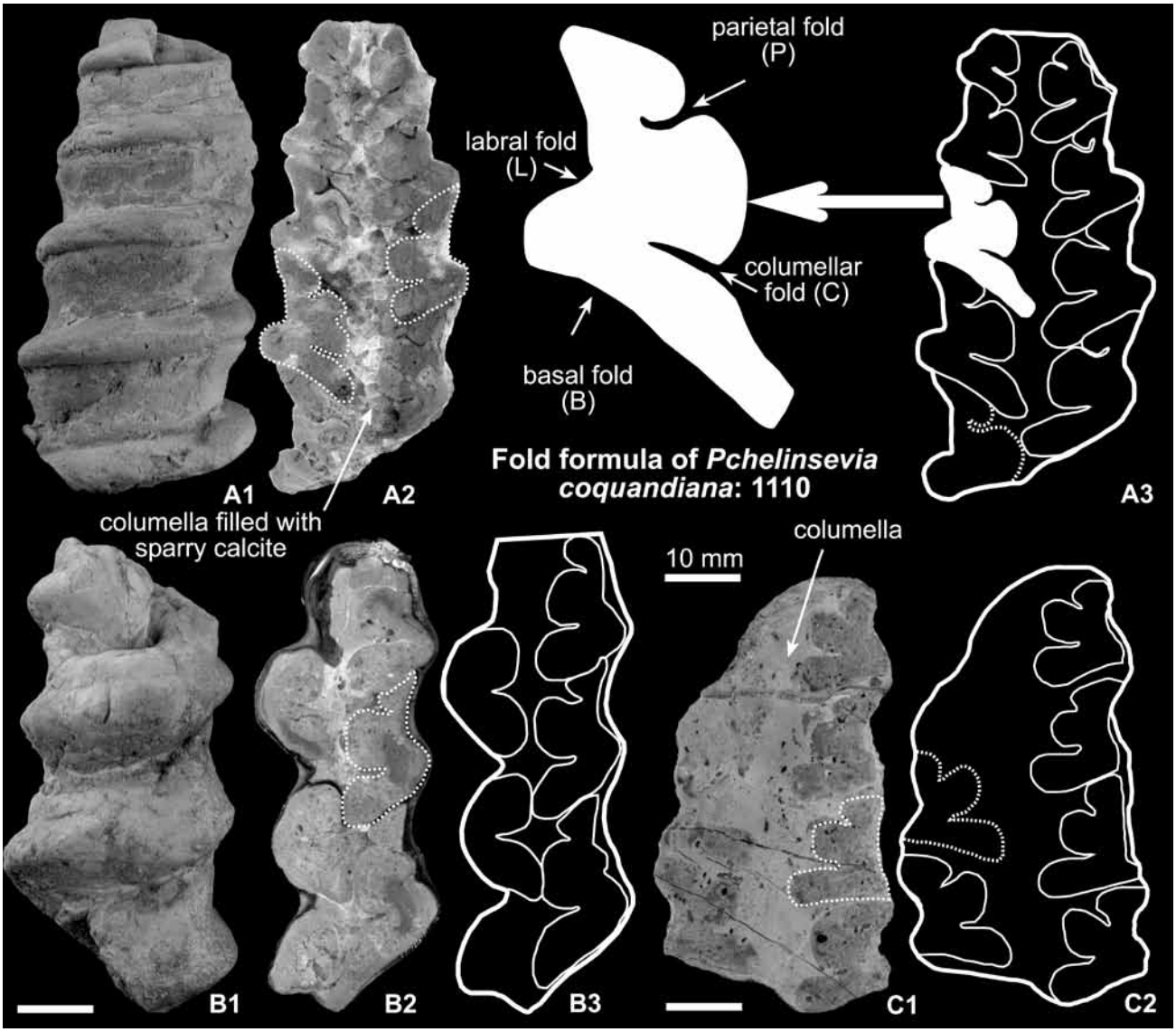

Figure 19: Internal moulds of *Pchelinsevia coquandiana* (d'Orbigny, 1842) from the middle siliciclastic/carbonate member of the Cenomanian Galala Formation at Wadi Quseib. A1: Side view, A2–A3: longitudinal whorl sections showing the fold pattern and internal characters of *P. coquandiana*; MGDMU:WQ.G.12.47. B1: Side view, B2–B3: longitudinal whorl sections with evidence of distortion of the specimens; MGDMU:WQ.G.22.81. C1–C2: Longitudinal whorl sections showing a wide columella; MGDMU:WQ.G.31.35. Scale bar: 10 mm.

manian strata. Thus *P. coquandiana* ranges from the Aptian to the Cenomanian.

Discussion: *Pchelinsevia coquandiana* can be easily distinguished by its strongly concave whorls which are separated by a strongly raised suture, a wide columella, rhomboidal whorl cross-section, and lack of a sickle-shaped parietal fold in most individuals (Fig. 19C). The present material closely resembles *Nerinea coquandiana*, described and figured by d'Orbigny (1842) from the Lower Cretaceous of France, in general whorl outline and fold pattern. Most of the nerineids from Egypt, which have been identified as *Nerinea gemmifera* Coquand (1862) by many taxonomists such as Abdel-Gawad & Gameil (1992) and Mekawy (2007) (see synonymy list), more closely resemble d'Orbigny's species than Coquand's species. *N. gemmifera* Coquand (1862: 177, pl. 4, fig. 4) from the Cretaceous of Algeria differs in having a conical shell (shorter spire), sharp apex, and concave whorls with a distinct medium spiral furrow separating an upper and a lower half,

Table 23: Dimensions (in mm) of *Pchelinsevia coquandiana* (d'Orbigny).

n=12	H	D	HL	PA°	nw	D/H	HL/H
Range	>33-80	18-36	9-20	29-39°	5-8	0.45-0.88	0.25-0.47
Mean	44.16	26	15.66	33.66°	6	0.52	0.33

both of which exhibit axial ribs ending in two rows of small tubercles.

Nerinea (*Neoptyxis*) *akaadi* Abbass (1963: pl. 5, figs 3, 5; non. fig. 6) from the Albian of the Maghara area, Sinai, is identical to *N. gemmifera* in general shape, whorl concavity, ornamentation, and whorl number. Other specimens (his pl. 5, fig. 6) closely resemble *P. coquandiana*. Abbass did not discuss the differences between his new species and other nerineid species such as *P. coquandiana*. *N.* (*N.*) *akaadi* is therefore regarded as a junior synonym of the present species.

Nerinea cochleaeformis Conrad var. *subgigantea* Blanckenhorn, 1927 from the Turonian of Syria also resembles the present material in having a large columella and strongly concave whorls. In addition the internal characters of Blanckenhorn's variety (columellar, parietal, and palatal folds) are identical to those of *P. coquandiana*. Therefore, *N. cochleaeformis* Conrad var. *subgigantea* Blanckenhorn is regarded herein as a junior synonym of the present species.

Material and occurrence: A single internal mould from the middle siliciclastic/carbonate member of the Cenomanian Galala Formation, bed 29 at Wadi Quseib (MGDMU:WQ.G.29.14).

Description: Specimen of moderate size, turriculate, and high-spired. Spire consisting of five overlapping whorls with slightly concave sides. The whorls are separated by acute and deep sutures. Aperture incomplete with nearly flat base. Apex not preserved. The fold formula of *Diozoptyxis*? *blancheti* is 1110 (C=1, P=1, L=1, and B=0, Fig. 20). The rhomboidal whorl cross-section shows three folds: a slight and sickle-shaped parietal fold, a well developed triangular columellar fold with acute apex, and triangular labral fold with variable apical angle.

Occurrence: *Diozoptyxis blancheti* has been recorded from the Aptian of southern France, Italy, and Lebanon. This is the first record of the species from Egypt.

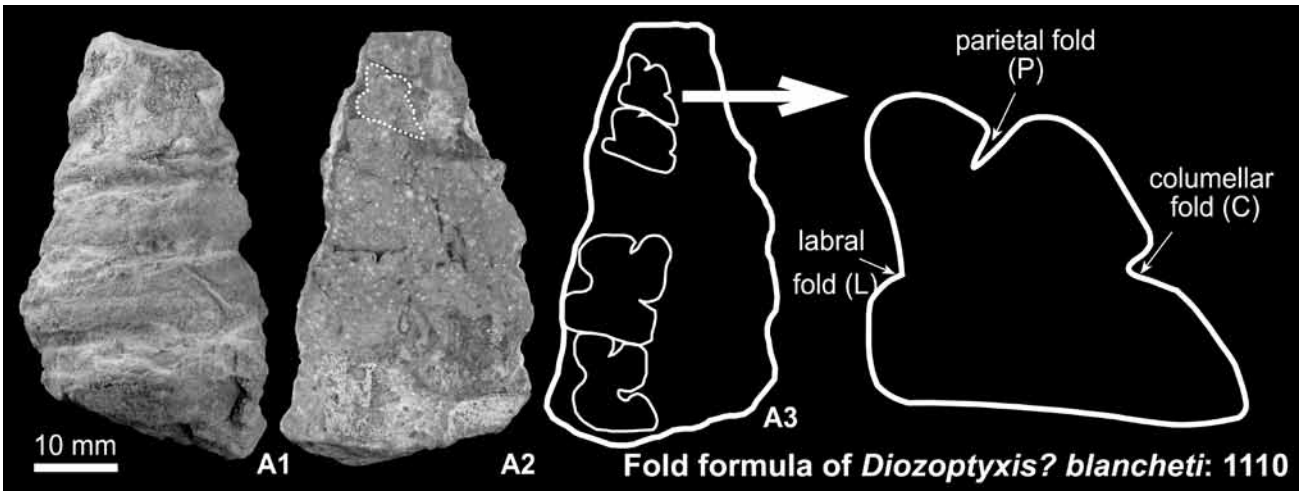

Figure 20: Whorl section and internal character of *Diozoptyxis*? *blancheti* (Pictet & Campiche, 1864) from the Cenomanian Galala Formation at Wadi Quseib. A: Side view, A2–A3: longitudinal whorl sections showing a wide columella; MGDMU:WQ.G.29.14.

Genus *Diozoptyxis* Cossmann, 1896

Diozoptyxis? *blancheti* (Pictet & Campiche, 1864)
Fig. 20

1864 *Nerinea Blancheti* sp. nov. – Pictet & Campiche: pl. 66, figs 1–4.
1939 *Nerinea Blancheti* Pictet & Campiche – Delpey: 183, pl. 3, fig. 7.
1982 *Diozoptyxis blancheti* (Pictet & Campiche) – Accordi et al.: 774.

Discussion: Delpey (1941) considered the genus *Campanile* Bayle (in P. Fischer 1884) to be a descendant of the genus *Diozoptyxis*. He thought that a close relationship existed between the two genera. In the present study, *Campanile*? sp. (Fig. 6) is characterized by the presence of two small columellar folds with a medium and slightly deep parietal fold (fold formula=2110). In contrast, *Diozoptyxis*? *blancheti* has shallow columellar and parietal folds (fold formula=1110).

Table 24: Dimensions (in mm) of *Diozoptyxis*? *blancheti* (Pictet & Campiche).

	H	D	PA°	nw	D/H
n=1	52	28	48	7	0.54

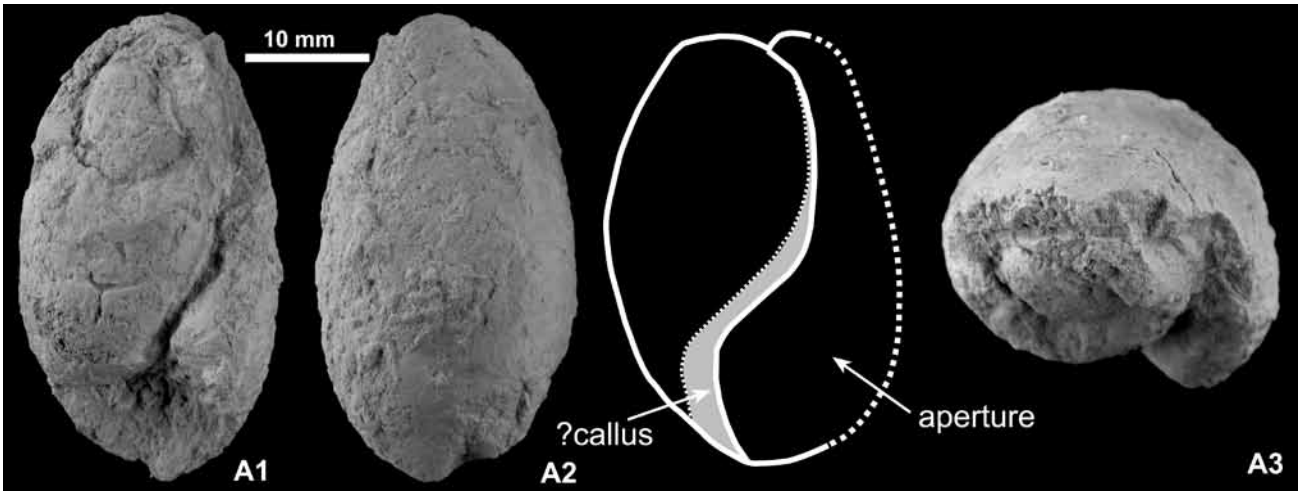

Figure 21: Internal mould of *Cylichna*? sp. from the Upper Cenomanian Galala Formation of the East Themed area. A1: Apertural view, A2: abapertural view; A3: apical view, x1; MGDMU:ET.G.3.160.

The present material is very similar to *Nerinea blancheti* Pictet & Campiche in general outline and the internal fold pattern. *Diozoptyxis blancheti* can be easily distinguished by its shallow sickle-shaped columellar and parietal folds (simple folds) and rhomboidal whorls. However, the parietal, columellar, and labial folds slightly vary from apex to base. According to Waite et al. (2008: 553), the internal sculpture of fold-bearing nerineoids is unique. However, folds are incrementally emplaced as the animal grows, and their morphology becomes progressively more complex. Therefore, the differences in the folding style of *D. blancheti* are probably related to the ontogeny of the organism.

The internal folds show some strong resemblance to those of *Nerinea* sp. described by Delpey (1939: 195, pl. 7, fig. 13) from the Cenomanian of Lebanon. Delpey's species differs in having a high-spired shell with a larger number of whorls.

Clade Cephalaspida Fischer, 1883.
Superfamily Philinoidea Gray, 1850
Family Cylichnidae Adams & Adams, 1854
(=Scaphandridae Sars, 1878 = Tornatinidae Fischer, 1883
=Acteocinidae Dall, 1913 = Triclidae Winckworth, 1932)

Genus *Cylichna* Lovén, 1846

Remarks. The genus *Cylichna* has a wide stratigraphic distribution from the Late Cretaceous to Recent (Kaim & Beisel 2005). The genus is characterized by (1) a small size, (2) cylindrical shape, (3) truncated apex and perforate in early growth stages, (4) aperture posteriorly narrow and widened anteriorly, (5) columellar lip with low fold (Sohl 1964), and (6) surface ornamented with fine spiral ribs, separated by wide interspaces. As the present specimen is an internal mould, identification, even at the generic level, is very difficult because many genera of the family are very similar in this state of preservation.

Cylichna? sp.
Fig. 21

Material and occurrence: A single internal mould from the Upper Cenomanian Galala Formation, bed 3 of the East Themed area (MGDMU:ET.G.3.160).

Description: Medium-sized and subcylindrical gastropods with very low spire. Spire involute, apically truncated, and consisting of two compressed whorls. Body whorl large, accounting for the main part of the specimen (about 98% of total height), and extending over the earlier whorl, suggesting the existence of wing-shaped processes. Base nearly rounded. Inner lip slightly convex. Aperture elongated, adapically narrow and widened abapically. The protoconch is not preserved, the teleoconch not ornamented.

Discussion: The specimen resembles *Bulla tevesthensis* Coquand (1862: 189, pl. 5, fig. 9) from the Turonian of Algeria. Pervinquière (1912: 88, pl. 6, fig. 1) and El Qot (2006: 113, pl. 23, fig. 12) follow-

Table 25: Dimensions (in mm) of *Cylichna*? sp.

	H	D	HL	HA	WA	nw	D/H	HL/H	WA/HA
n=1	39	22	38	36	8	3	0.56	0.98	0.23

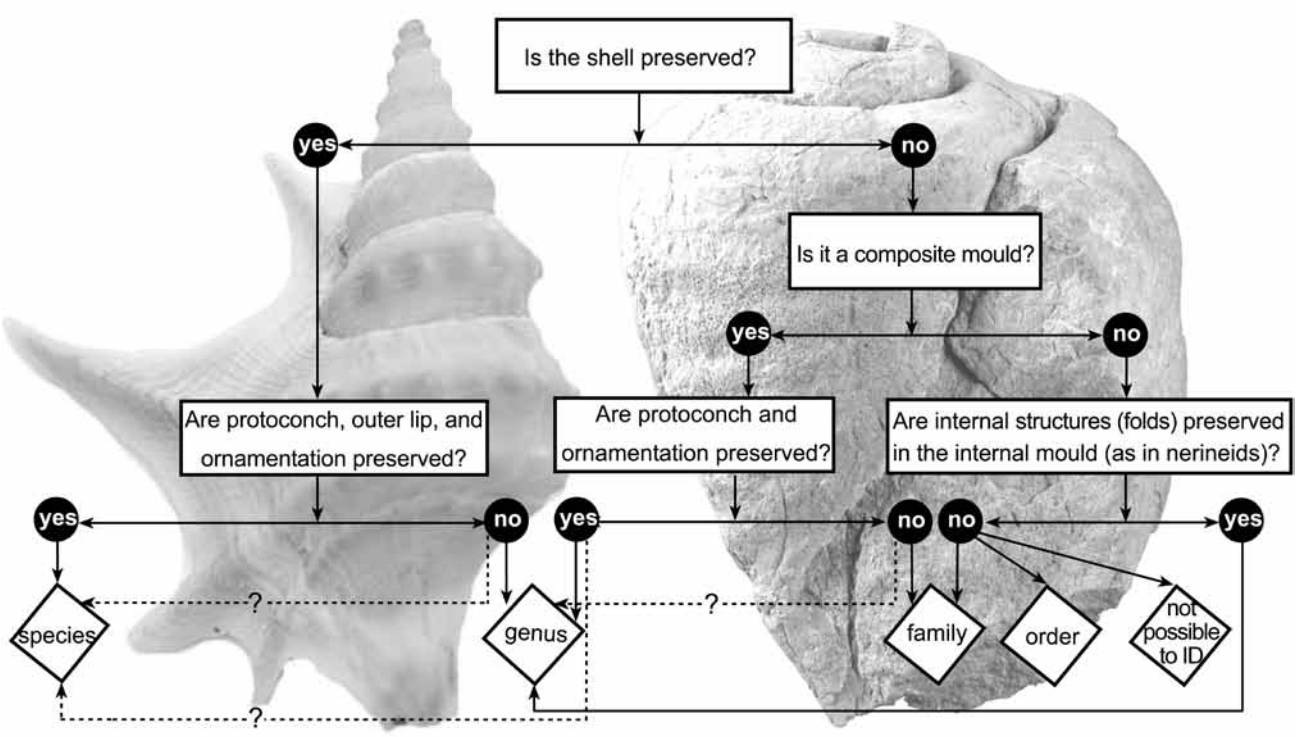

Figure 22: Flow chart relating the preservation of specimens to realistic taxonomic levels of identification.

ed the identification of Coquand and reported the same species in their material as *Akera thevestensis*. Coquand erected *B. tevesthensis* based on internal moulds. Therefore, the species should be considered as *nomen dubium*. The same is true of *Acera modjibensis*, a species created by Blanckenhorn (1927: 184, pl. 10 (6), fig. 117) based on inner moulds from the Cenomanian of Syria.

4. Concluding remarks

According to Wignall (1989) a good preservational state may be the result of high sedimentation rates combined with frequent episodic burial, protecting the shells from diagenetic alteration. In addition, the aragonitic shells of gastropods are metastable at normal surface temperatures/pressure conditions and thus are prone to alteration. All in all, five factors are thought to controll the preservation quality of faunal elements, in particular of gastropods: (1) sedimentation rate, (2) burial events, (3) facies type, (4) shell fabric and mineralogy, and (5) tectonic setting. The majority of Cretaceous gastropods from Egypt (and also in the present study) are internal moulds and some of them are incomplete. Zakhera (2002) identified 48 gastropod species from the Upper Cretaceous of northern and southern Galala (Eastern Desert), four of them being new and 15 being recorded from Egypt for the first time. Most of his specimens are incomplete internal and composite moulds. Similarly in North Africa and the Middle East (e.g., Algeria, Tunisia, Lebanon), Cretaceous gastropods are preserved as internal and composite moulds (e.g., Coquand 1862; Pervinquière 1912; Delpey 1939; Amard et al. 1981). Clearly, species-level identification of gastropods preserved as internal moulds are commonly cases of taxonomic over-interpretation, and the results gained this way appear to be of little use. For example, *Cimolithium tenouklensis* Coquand (1862: 176, pl. 4, fig. 6) from the Upper Cretaceous of Algeria is based on an internal mould providing only limited morphological information. Such species should be considered as *nomina dubia.* Moreover, we find Coquand's species inappropriate for lenghty palaeogeographic discussions based on comparisons of internal moulds from different countries (Kaim, personal communication, 2011). When dealing with internal moulds, taxonomists should indicate that their identification is doubtful or questionable by using confer (cf.), affinis (sp. aff.), or question marks. In some cases, it may be better to use only the family or subfamily level, if the genus cannot be identified. In Figure 22 the relationship between preservation quality of specimens and a realistic level of identification is illustrated.

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