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RESEARCH PAPER

Thanetian gastropods from the Mesopotamian high folded zone in northern Iraq

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Abstract An assemblage of gastropods from the Thanetian of the Kolosh Formation from the Zakho region in northern Iraq is documented for the first time. The ten species represent the families Campanilidae Douvillé 1904, Potamididae H. & A. Adams 1854, Batillariidae Thiele 1929, Thiaridae Gill 1871, Pachychilidae Fischer & Crosse 1892, Cerithiidae Fleming 1822 and Pseudolividae de Gregorio 1880, suggesting a littoral to shallow sublittoral depositional environment. Six of the species are new and five are formally described as new species. At least seven species are also known from the Thanetian and/or Early Ypresian of the Ankara region in Turkey. Only a single species occurs also in the Paleocene of the Paris Basin. No relation to Paleocene and Eocene faunas of Pakistan and India is detectable. This points to a considerably bioprovincialism along the northern coast of the Tethys. Consequently we suppose the existence of an *Anatolian Province* in the Thanetian/Ypresian *Mediterranean Region* of the *Tethys Realm*, represented by rather homogeneous mollusc faunas from western Turkey and northern Iraq. *Campanile zakhoense* nov. sp., *Pyrazopsis hexagonpyramidalis* nov. sp., *Pachymelania islamogluae* nov. sp., *"Faunus" dominicii* nov. sp. and *Pseudoaluco mesopotamicus* nov. sp. are introduced as new species. *Varicipotamides* Pacaud & Harzhauser nov. nom. is proposed as the replacement name for *Exechestoma* Cossmann (1889) non Brandt (1837).

Keywords Gastropoda · Thanetian · Tethys · Biogeography · Anatolian Province · Iraq

Kurzfassung Erstmals wird eine Gastropoden-Vergesellschaftung aus dem Thanetium der Kolosh-Formation in der Zakho Region des Nordiraks dokumentiert. Die 10 Arten sind Vertreter der Campanilidae Douvillé 1904, Potamididae H. & A. Adams 1854, Batillariidae Thiele 1929, Thiaridae Gill 1871, Pachychilidae Fischer & Crosse 1892, Cerithiidae Fleming 1822 und Pseudolividae de Gregorio 1880, was auf litorale bis flach sublitorale Ablagerungsbedingungen hinweist. Sechs der Arten sind neu und fünf davon werden formal als neue Arten beschrieben. Zumindest sieben Arten treten auch im Thanetium und/oder unterem Ypresium der Region um Ankara in der Türkei auf. Lediglich eine einzige Art ist auch aus dem Paleozän des Pariser Beckens bekannt, während keinerlei Beziehungen zu den paleozänen und eozänen Faunen von Pakistan und Indien feststellbar sind. Dies deutet auf eine beachtliche Bioprovinzialisierung entlang der nördlichen Tethys Küste. Daher wird die Existenz einer *Anatolischen Provinz* innerhalb der thanetisch-ypresischen *Mediterranen Region* des *Tethys Realms* diskutiert. Diese zeichnet sich durch relative homogene Zusammensetzung der Molluskenfaunen von der westlichen Türkei bis in den Nordirak aus. *Campanile zakhoense* nov. sp., *Pyrazopsis hexagonpyramidalis* nov. sp., *Pachymelania islamogluae* nov. sp., *"Faunus" dominicii* nov. sp. und *Pseudoaluco*

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mesopotamicus nov. sp. werden als neue Arten eingeführt. *Varicipotamides* Pacaud & Harzhauser nov. nom. wird als Ersatzname für *Exechestoma* Cossmann (1889) non Brandt (1837) vorgeschlagen.

Schlüsselwörter Gastropoda · Thanetium · Tethys · Biogeographie · Anatolische Provinz · Irak

Introduction

Our knowledge on the Paleocene and Eocene mollusc faunas of Eurasia is strongly based on the extraordinary rich, diverse and well-preserved assemblages of the Paris Basin. These were largely described already during the nineteenth and early twentieth centuries in a wealth of monographs and became the standard for all comparisons with other Paleocene and Eocene faunas. During the last decades, the faunas of the North Sea and the polar region became increasingly well known as well (e.g. Kollmann and Peel 1985; Pacaud and Schnetler 1999; Schnetler and Petit 2010; Schnetler 2001). Additional data on Paleocene faunas from the Ukraine and Poland were provided by Arkhanguelskt (1904), Makarenko (1969, 1976), Moroz (1972) and Krach (1963, 1969).

In the western Tethys region, classical Eocene faunas from Italy and the Balkans became known by numerous contributions of de Gregorio (1880; 1866), Oppenheim (e.g. 1894; 1896/1897; 1901; 1912) and Dainelli (1915) among several others. Soon after, a series of papers focussed on the Paleocene and Eocene of Pakistan and India, representing the eastern branch of the Tethys coast (e.g. Douvillé 1928, 1929; Cox 1930). The huge area in between, comprising the Arabian and Anatolian plates, has remained poorly studied, and monographs, comparable to the French and Italian milestone papers, are completely missing. After a first description of Eocene molluscs from Turkey by d'Archiac in Tchihatcheff (1866) and Armenia by Abich (1882), little attention has been paid to the faunas up to the first synthesis of Stchépinsky (1946). Only during the last years, several new papers of Okan and Hoşgör (2008; 2009), Hoşgör and Okan (2011) and İslamoğlu et al. (2011) tried to shed light on the Thanetian and Ypresian mollusc faunas of Western-Central Turkey. Recently, Hoşgör and Kosták (2012) provided a more detailed overview on the Upper Cretaceous to Lower Eocene successions in the Hakkari area of SE Turkey. Even less known is the Iraqi Kurdistan area from where the herein described assemblage derives. Although the presence of molluscs is frequently mentioned in reports on the geology of Iraq, the Paleocene mollusc fauna of the Kolosh formation is nearly unknown. An exception is the description of a teredinid bivalve by Elliott (1963) from the Duhok and al-Mosul area, which lies ca. 50–80 km SES of the Zakho region. Although the herein presented assemblage comprises only a small collection of shells and few species, it is the first contribution dealing with Paleocene gastropods from northern Iraq.

Geological setting and age of the gastropod assemblage

The study area is located in the northern part of Iraq on the northern Arabian Platform (Fig. 1). Paleogene sediments are exposed in the northern, western and eastern parts of northern Iraq. These deposits are well developed in surface and subsurface sections in northern and northeastern Iraq (Kassab et al. 1986; Al-Qayim et al. 2008; Sharbazheri et al. 2009), separated by thrusts and fault zone systems (Buday 1980) (Fig. 1). Paleocene-Lower Eocene sediments are most widespread and comprise clastic and carbonate sediments. These sediments were first identified by Henson (1951) and Dunnington (1958) who designated a section at Kolosh, north of Koi Sanjak in the High Folded Zone, as the type area of the Kolosh formation (Buday 1980). They described two sedimentary cycles with frequent discontinuous sedimentation in most parts of the basin (Al-Ameri 1996). The Aaliji, Kolosh and Sinjar Limestone Formations belong to the Paleocene-Lower Eocene cycle and the Jaddala Formation belongs to the upper Lower Eocene-Upper Eocene cycle of the Iraqi platform area (Buday 1980).

The herein described gastropods derive from the Kolosh Formation. This is an about 180-m-thick alternation of thin sandstone layers with thick shale interlayers. It is underlain by pelagic marlstone and marly limestone of the Upper Cretaceous Shiranish Formation (Fig. 1). Paleontological evidence indicates the occurrence of a stratigraphic gap that extends from the uppermost Maastrichtian to the Lower Thanetian (Al-Qayim et al. 2008). The Kolosh Formation is overlain by the Sinjar Limestone Formation, which displays some interfingering with the Kolosh Formation in its upper parts (Buday 1980). Its depositional environment is interpreted as marginal marine to shallow marine (Al-Qayim et al. 1988; 2008). The sediments of the Kolosh Formation are known also from other areas of north and northeastern Iraq and are considered to represent a Flysch facies of the Paleogene Foreland Basin (Dunnington 1958; Bellen et al. 1959; Al-Qayim et al. 2008).

The herein studied Zakho section is close to Shiranish village, which is located about 10 km north of Zakho (Fig. 1). It comprises green to yellow shales, irregularly alternating with sandstone beds. The shales are rich in well-preserved calcitic pseudomorphoses of gastropods. These gastropod-bearing strata of the Kolosh Formation

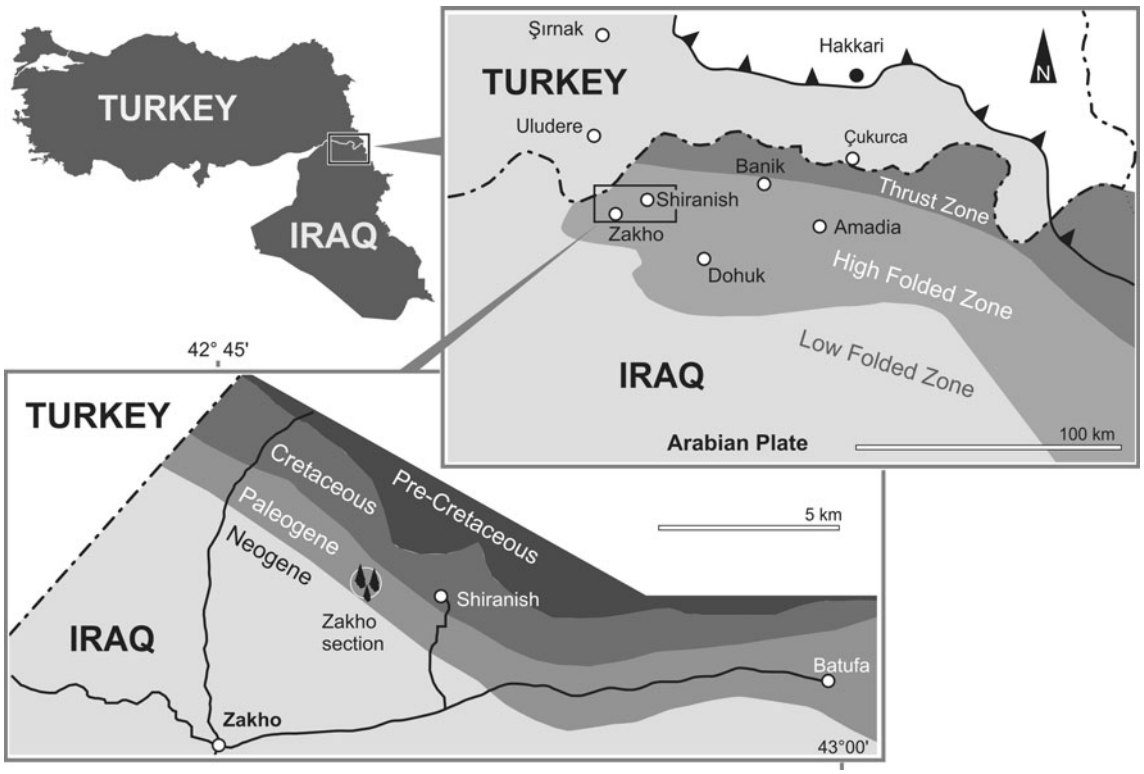


Fig. 1 Geographical and geological setting of the Zakho site (modified from Al-Qayim et al. 2008)

crop out only in the northeastern part of the Zakho area, along a road strip of 1–2 km width (NW Shiranish Village). To the east, towards the basin margin, gastropods become increasingly rare and lithologies gradually change to marginal claystones and sandstones (lower parts of the Kolosh Formation). The gastropods were collected from the uppermost fine-grained siliciclastic units (Fig. 2).

The biostratigraphy of the Kolosh Formation was studied by Kassab (1976, 1978) and Kassab et al. (1986) at the type locality and other locations in the north and northeast of Iraq. Its age is confirmed by the occurrence of planktonic and benthic foraminifers, which indicate a Middle-Late Paleocene age (Bellen et al. 1959; Kassab 1976, 1978; Buday 1980; Kassab et al. 1986; Al-Qayim et al. 2008; Sharbazhari et al. 2009). According to these results, the formation developed mainly during Middle to early Late Paleocene times (Al-Qayim et al. 1988), suggesting a Thanetian age of the gastropod assemblage.

Abbreviations

NHMW Naturhistorisches Museum Wien, Austria
MTA Geological Research Department of General Directorate of Mineral Research and Exploration of Ankara, Turkey

Systematic paleontology

Class Gastropoda Cuvier 1795
Subclass Caenogastropoda Cox 1960
unassigned order
(formerly as Architaenioglossa Haller 1892, which is invalid according to Harasewych et al. 1998)
Superfamily Campaniloidea Douvillé 1904
Family Campanilidae Douvillé 1904
Genus *Campanile* Bayle in Fischer 1884

Type species *Cerithium leve* Quoy & Gaimard 1834 [non Perry 1811] by subsequente designation [=*Cerithium symbolicum* Iredale 1917 nomen novum]. Recent, Australia.

***Campanile zakhoense* nov. sp.** (Fig. 3C, D)

1942 *Cerithium* (*Campanile*) sp.—Erünal: 128, 131, fig. 14
2008 *Campanile tchihatcheffi* d'Archiac 1850.—Okan & Hoşgör: 792, fig. 6c [non *Cerithium Tchihatcheffi* d'Archiac 1866]
2011 *Campanile giganteum* (Lamarck 1804).—İslamoğlu et al.: 312, fig. 5G [non *Cerithium giganteum* Lamarck 1804]

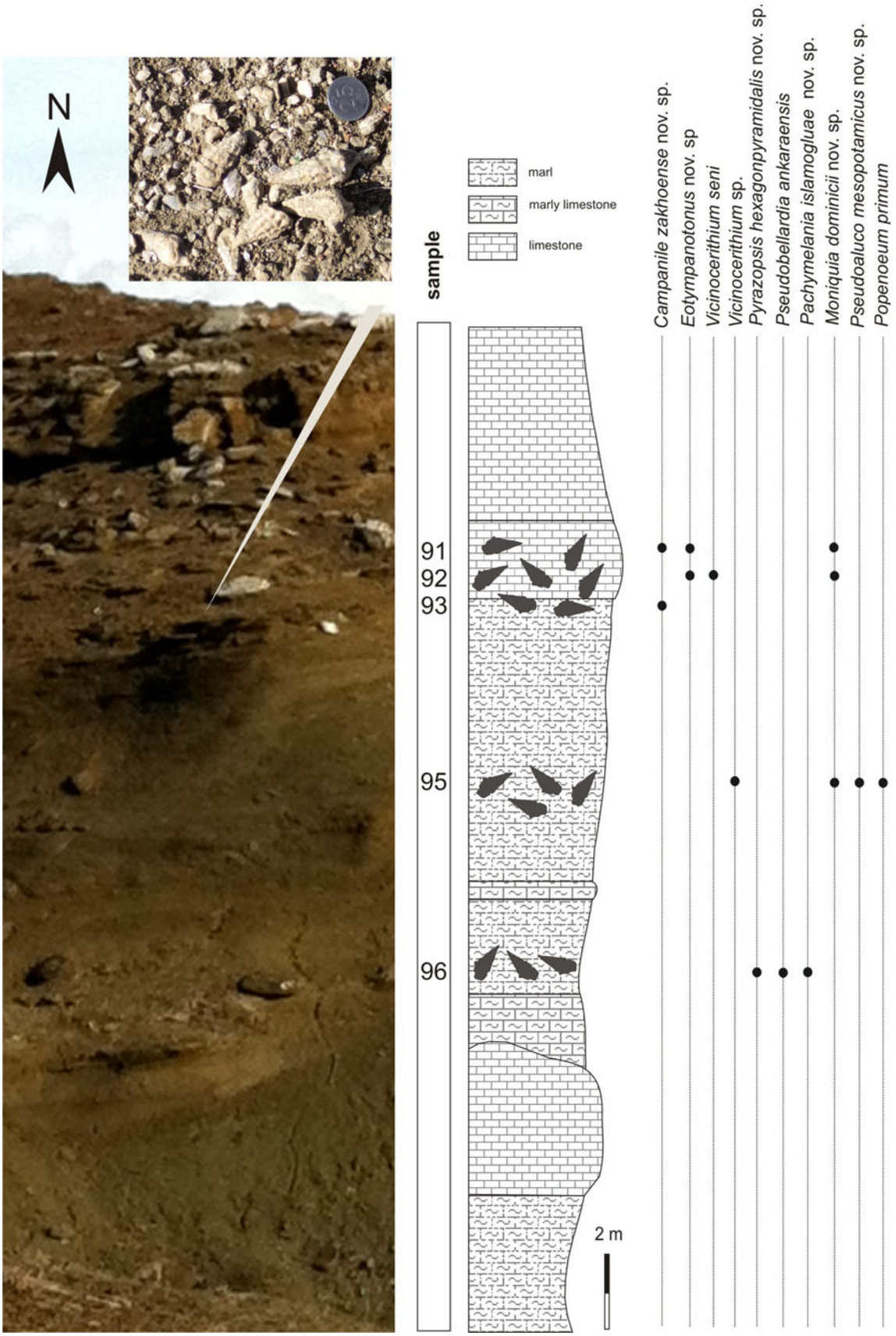


Fig. 2 Position of the studied samples within the Zakho section

Holotype NHM 2012/0103/0001, (Fig. 3d): height: 112 mm, width: 70 mm, sample 93.

Paratype NHM 2012/0103/0002 (Fig. 3c): 1: height: 75 mm, width: 47 mm, sample 91.

Etymology Referring to the Zakho area, Iraq.

Type locality Northeastern Zakho area, Zakho section, Iraq.

Type horizon Green-grey shale and mudstone of the Kolosh Formation.

Age Thanetian

Other material Early Ypresian of Macunköy, Turkey (MTA-Y-2007-19).

Description Stout conical shell with a spire angle of ca. 35°. The teleoconch whorls are broad and very low, causing a slightly gradate outline. Early spire whorls are weakly convex whilst the last 2–3 whorls are nearly flat sided. Indistinct axial swellings on early whorls develop into axially elongate nodes on later whorls. These nodes are most prominent at the upper suture and fade out in the middle part of the whorls. The much weaker spiral sculpture consists of numerous, slightly wavy, delicate spiral grooves also crossing the axial sculpture. This spiral sculpture becomes obsolete on the last whorls. The sigmoidal growth lines are well developed on the last whorl and consist of an opisthocline upper part and a steeply prosocyrt lower part. These prosocyrt growth lines cover the base and coincide with the margin of the outer lip. The aperture is low, moderately wide; the inner lip forms a thin callus; no columellar fold is visible in the preserved part of the aperture but might be present inside; all other parts have been destroyed.

Remarks The two available shells from Iraq and the specimen from Macunköy in Turkey (illustrated in İslamoğlu et al. 2011) represent a new, moderately sized species. It is characterised by the broad and very low teleoconch whorls and the slightly gradate outline. Boussac (1912: pl. 9, fig. 6) illustrated specimens of *Campanile auvertianum* (d'Orbigny 1850) from the Bartonian of France with a gradate spire, barrel-shaped last whorl and nodes at the upper suture. Aside from the considerable stratigraphic gap between both taxa, the Bartonian species differs in its strongly reduced sculpture on the last teleoconch whorls, the then even more gradate outline and the more elongate shell. *Campanile defrenatum* (de Gregorio 1896), from the Bartonian of Roncà (Italy), differs from the Iraqi species in its extraordinary low spire whorls. The Lutetian *Campanile cornucopiae cornucopiae* (Sowerby, J. 1818) from Cotentin (France) and *Campanile cornucopiae benechi* (Bayan 1870b) from the Paris Basin (see Boussac 1912: pl. 4, fig. 3 and pl. 7, fig. 2) have a comparable spiral sculpture and the axial nodes may occur along the upper suture in early stages of growth. They are clearly distinguished from the Iraqi species by the convexity of the last two whorls. The otherwise comparable *Campanile lachesis* (Bayan 1870a) differs mainly in the position of the nodes, which appear in a more median position in *C. lachesis* and not at the suture. *Campanile vicetinum* (Bayan 1870a), which has a comparable sculpture, is also more slender and its whorls are slightly scalate (see Bayan 1870b and Oppenheim 1896/97). *Campanile leymeriei* (d'Archiac 1850), from the Eocene of Safranbolu in northern Anatolia and Hasanfaki in NW Turkey (Güngör 1975), is also very similar concerning the shell outline. This species is known so far only from internal casts but seems to be characterised by a keel-like adsutural swelling of the last whorl and thus is clearly distinguished from the Iraqi species.

Distribution Only known so far from the Thanetian of Northern Iraq and the Late Thanetian to Early Ypresian of Macunköy in the Haymana-Polatlı Basin in Turkey.

Order Sorbeoconcha Ponder & Lindberg 1997
Superfamily Cerithioidea Fleming 1822
Family Potamididae H. & A. Adams 1854
Genus *Eotympanotonus* Chavan 1952

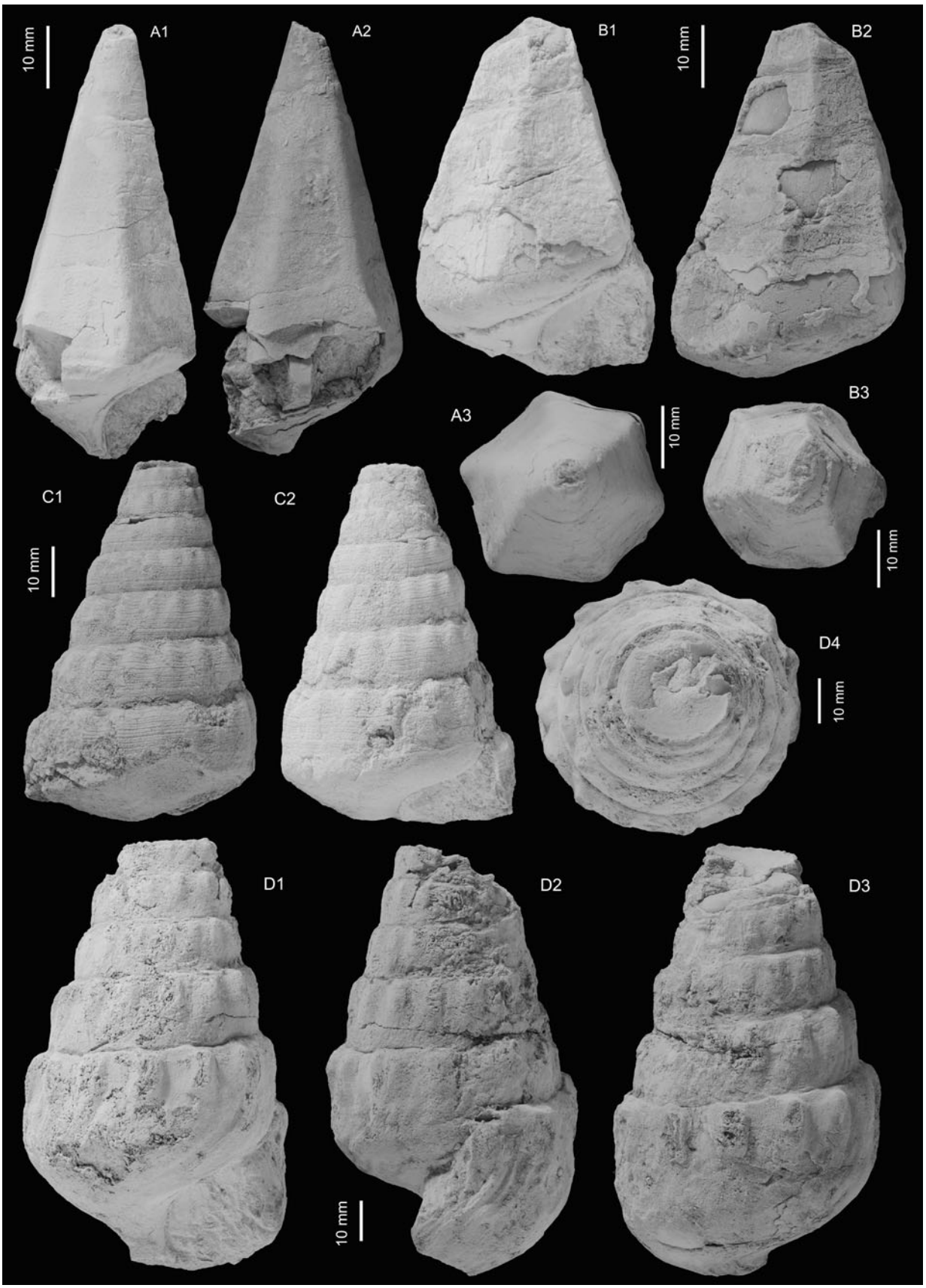
Type species *Cerithium conarium* Bayan 1873 (=*Cerithium trochiforme* Deshayes 1824 non Lamarck 1804). Eocene, France.

Eotympanotonus is treated as subgenus of *Potamides* Brongniart 1810 by Reid et al. (2008) and as subgenus of *Tympanotonos* Schumacher 1817 by Le Renard & Pacaud (1995). Herein, we treat this taxon as a full genus, which is well represented by numerous species during the Paleocene-Eocene of Eurasia.

***Eotympanotonus* nov. sp.** (Fig. 4A, B)

Material Two shells from samples 92 and 91 (NHMW 2012/0103/0003); height: 42 mm; width: 17 mm.

Description A rather slender shell consisting of >8 teleoconch whorls with an apical angle of 27°. Early spire whorls are high and barrel-shaped, slightly gradate and bear four prominent spiral cords, separated by narrow and deep grooves. The one at the upper suture bears small nodes; the one below has weaker and spirally elongate nodes, whilst the lower two cords are smooth. Within the third and fourth (preserved) whorl, the interspace between the two adapical cords becomes wider and the nodes on the second cord increase in strength. Subsequently, these nodes become most prominent and the outline of the whorl is slightly convex with the maximum diameter coinciding with this spiral cord. Simultaneously, the adsutural nodes



◀**Fig. 3** Thanetian gastropods from Zakho (Iraq). **A**, **B**: *Pyrazopsis hexagonpyramidalis* nov. sp., **A**: holotype (NHM 2012/0103/0006), **B**: paratype: NHM 2012/0103/0007). **C**, **D**; *Campanile zakhoense* nov. sp., **C**: paratype (NHM 2012/0103/0002), **D**: holotype (NHM 2012/0103/0001). *Scale bar* corresponds to 10 mm

become weaker and the separating interspace grades into a wide and smooth concavity. The last whorl is moderately convex with a rather straight-sided lower part, which passes rapidly into the convex base. A weak posterior notch coincides with the second spiral cord, which now forms a weak angulation. Aperture largely destroyed; columella concave; inner lip poorly demarcated from the base.

Remarks The early spire whorls, with the beaded adsutural upper spiral cord and the smooth lower spiral cords, are reminiscent of the French Early Eocene *Eotympanotonus funatus rillyensis* (Cossmann 1889) and *E. turris* (Deshayes 1833). The ontogenetic change from the adsutural spiral cord to the second spiral cord as the main spiral element is a unique feature of the Iraqi species and distinguishes it from all French Eocene species described by Cossmann and Pissarro (1911) and others. A specimen from the Late Thanetian to Early Ypresian of Macunköy in the Haymana-Potatlı Basin in Turkey, described as *Batillaria diacanthina* Cossmann 1898 by Okan and Hoşgör (2008), might be conspecific with the Iraqi species.

Distribution Only known from the Thanetian of northern Iraq.

Family Batillariidae Thiele 1929
Genus *Vicinocerithium* Wood 1910

Type species *Vicinocerithium parallelum* Wood 1910 (=*Cerithium bouei* Deshayes 1833). Eocene, Paris Basin.

***Vicinocerithium seni* İslamoğlu, Dominici & Kowalke 2011**. (Fig. 4D–H)

*2011 *Vicinocerithium seni* n. sp.—İslamoğlu et al.: 322, figs 7E, G, I

Material Six shells from sample 92 (NHMW 2012/0103/0004); maximum height: 42 mm, diameter: 21 mm.

Description Conical shells with an apical angle of ca. 30°. The early 4–5 teleoconch whorls bear wide spaced, blunt, axial ribs, roughly aligned on successive whorls. On later whorls, the axial sculpture of each whorl has a slight offset in respect to the preceding whorl. On the last four teleoconch whorls, these axial ribs disintegrate into axially arranged nodes. A weaker row of nodes appears near the upper suture, adjoined by a more prominent row of pointed and spirally elongate nodes in the middle of the whorls. This row forms the periphery of the whorls and is separated from the upper one by a deep concavity on the last whorl. The densely spaced spiral cords override the axial ribs on early whorls. Later, the spiral cords become weak in the upper half of the whorls and form 4–5 prominent cords in the lower part below the middle row of nodes. The suture is moderately incised and wavy because of the adsutural nodes. The last whorl is somewhat allometric, slightly broader than the spire whorls; it contracts rapidly into the short and convex base. Inner lip well developed, glossy and well demarcated from the base. Outer lip and siphonal canal are destroyed.

Remarks The full generic rank of *Vicinocerithium* was proposed by Pacaud (2007) and Ozawa et al. (2009) and is followed herein. Although formerly intermingled with *Batillaria*, a purely Indo-West Pacific (IWP) genus, Ozawa et al. (2009) pointed out that the indeterminate growth allows a clear separation of both taxa. The Early Eocene French *Vicinocerithium subacutum* (d'Orbigny 1850) bears some resemblance to the Turkish-Iraqi species. Especially the two spiral rows of spiny nodes and the broad concavity between them appear in both species. A clear difference is the much broader apical angle and the prominent axial ribs on early spire whorls of *V. seni*.

The Lutetian-Bartonian *Vicinocerithium calcitrapoides britannum* (Vasseur 1881) is comparable in shape and also develops relatively broad shells but lacks the conspicuous adsutural row of nodes. The wide concavity between the adapical suture and the prominent spiral row of nodes in the middle of the last whorl is also developed by the Eocene *Vicinocerithium sieberi* (Kochansky-Devidé 1956). This Croatian species, however, is very slender and lacks spiral cords.

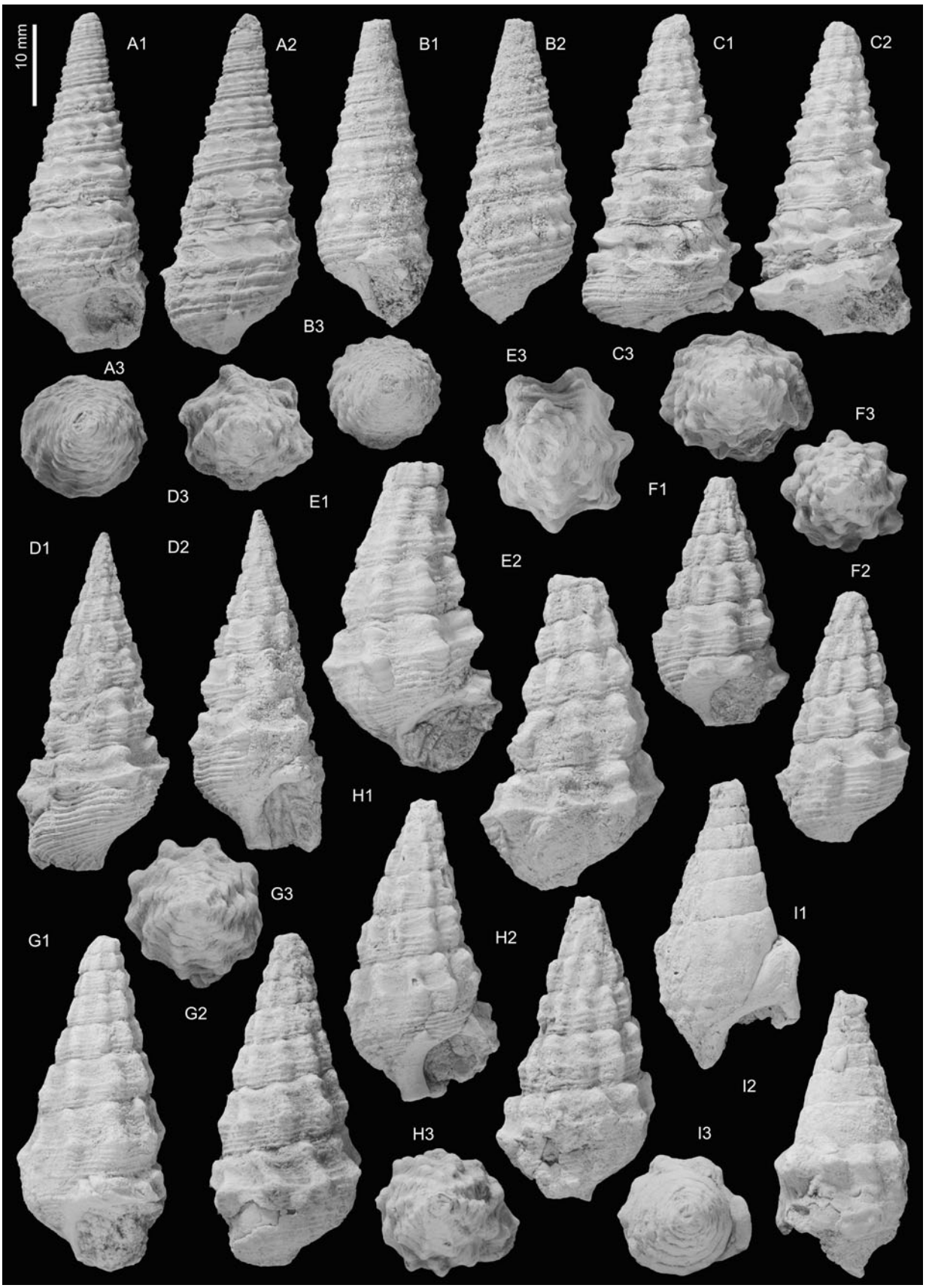
Distribution This species was recently described from the Ypresian of the Ankara region in Turkey.

***Vicinocerithium* sp.** (Fig. 4C)

1942 *Batillaria subacuta* d'Orbigny.—Erünal: 128, 131, figs 11–12
1946 *Batillaria subacuta* d'Orbigny.—Stchépinsky: 55, pl. 22, figs 19–20 (non *Cerithium subacutum* d'Orbigny 1850)
2011 *Vicinocerithium* cf. *subacutum* (d'Orbigny 1850).—İslamoğlu et al.: 321, fig. 6B–F (non *Cerithium subacutum* d'Orbigny 1850)

Material One fragmentary specimen from sample 95 (NHMW 2012/0103/0005); diameter: 19.8 mm, height: 39.5 mm.

Description A high conical shell of more than 8 teleoconch whorls and an apical angle of 26°. Juvenile



◀ **Fig. 4** Thanetian gastropods from Zakho (Iraq). **A**, **B**: *Eotympanotonus* nov. sp. (NHMW 2012/0103/0003); **C**: *Vicinocerithium* sp. (NHMW 2012/0103/0005); **D**–**H**: *Vicinocerithium seni* İslamoğlu, Dominici & Kowalke 2011 (NHMW 2012/0103/0004); **I**: *Pseudobellardia ankaraensis* (İslamoğlu, Dominici & Kowalke 2011) (NHMW 2012/0103/0008). *Scale bar* corresponds to 10 mm

teleoconch whorls are moderately convex with incised sutures and low axial ribs. These are crossed by five spiral cords causing a beaded sculpture. After 3–4 whorls the upper two spiral cords become wide spaced and develop spiny nodes. The lower of these spiral rows of nodes becomes most prominent and shifts into the middle of the rather flat whorls. Consequently, the remaining three spiral cords become densely crowded and slightly irregularly wavy. Similarly, the now only weakly incised suture is wavy. The base is very short and covered by about six faintly granulose spiral cords. A moderately deep shoulder sinus coincides with the spiral row of nodes on the last whorl, expressed by strong growth lines on the last three whorls. The aperture is destroyed.

Remarks This species differs from *Vicinocerithium seni*, which is otherwise quite similar, in the flat-sided teleoconch whorls and the indistinct, weakly incised suture. Moreover, early spire whorls lack the predominant axial ribs of *V. seni* and the nodes are spiny instead of rounded. A comparison with the specimens from the Ypresian of the Ankara region, described by İslamoğlu et al. (2011) as *Vicinocerithium* cf. *subacutum* (d'Orbigny 1850), suggests that they are conspecific with the Iraqi shell. Indeed, *Vicinocerithium subacutum* (d'Orbigny 1850) [=*Cerithium acutum* Deshayes 1833 non *Potamides acutus* Sowerby, J. 1822], as illustrated by Cossmann & Pissarro (1911: pl. 29, fig. 152–3), seems to be morphologically related. However, it differs in its higher base and keel-like median spiral cord on early spire whorls. Moreover, the specimen originally described by Deshayes (1833) as *Cerithium acutum* is more slender and lacks the spiny nodes at the suture.

Distribution This species is known from the Thanetian of northern Iraq and from the Ypresian of the Ankara region in Turkey (Stchépinsky 1946; İslamoğlu et al. 2011).

Genus *Pyrazopsis* Akopjan 1972

Type species *Muricites pentagonatus* von Schlotheim 1820, Eocene, Italy.

***Pyrazopsis hexagonpyramidalis* nov. sp.** (Fig. 3A, B)

2008 *Cerithium fodicatum* Bellardi 1852.—Okan & Hoşgör: 792, fig. 6h [non *Cerithium fodicatum* Bellardi 1852]

Holotype NHM 2012/0103/0006, (Fig. 3a): height: 77.2 mm, width: 36.0 mm.

Paratype NHM 2012/0103/0007 (Fig. 3b): 1: height: 61.5 mm, width: 41.0 mm.

Etymology Referring to the shape of a hexagonal pyramid.

Type locality Northeastern Zakho area, Zakho section, Iraq.

Type horizon Green-grey shale and mudstone of the Kolosh Formation.

Age Thanetian

Description A very characteristic shell with a hexagonal cross section consisting of more than eight teleoconch whorls (protoconch and earliest teleoconch are missing). The nearly completely flat whorls form six continuous flanks, separated by weakly rounded edges, which continue along the entire shell; the sutures are indistinct. Only the first ca. 4–5 spire whorls, though also completely flat, lack the hexagonal flanks. On late teleoconch whorls, the flanks tend to become even slightly concave and the angulations are weakly droplet-like and swollen. The apical angle is quite variable, ranging from 30–40°. The transition from flanks into the moderately convex base is abrupt. No additional sculpture is visible because of the preservation. The aperture is largely destroyed, showing a moderately concave columella and narrow inner lip; broad and indistinct spiral cords cover the base. A cross section of one of the specimens revealed a completely smooth columella without folds or twist and an ovoid-subquadratic cross section of the spire whorls.

The Iraqi specimens lack the aperture. This, however, is partly preserved in a specimen from the Late Thanetian or Early Ypresian of Macunköy in Turkey (Okan and Hoşgör 2008). The following additions are based on that specimen: The last whorl has convex flanks and slightly raised axial ribs, which are separated by weakly concave interspaces. The base contracts rapidly and is only slightly convex.

Remarks The unusual shape of a hexagonal pyramid is unique. Nevertheless, without proper information on the aperture, the systematic placement of this strange species remains problematic. The columellar structure fits best to the Batillariidae sensu Ozawa et al. (2009). Among these, only *Pyrazisinus* Heilprin 1887 and *Pyrazopsis* Akopjan 1972 develop comparable morphologies with robust shells and a wide apical angle. *Pyrazisinus* is represented by its type species *P. campanulatus* Heilprin 1887, from the Early Miocene of Florida, and by *P. monstrosus*, from the Oligocene and Early Miocene of France, Italy and Greece (Lesport and Cahuzac 2002; Harzhauser 2004). These species have low and convex spire whorls with numerous,

more or less prominent axial ribs. No tendency to align the ribs on successive whorls is documented from this genus. This feature, however, is observed in some species of *Pyrazopsis* Akopjan 1972 (=*Gantechinobathra* Kowalke 2001, type species: *Muricites pentagonatus* von Schlotheim 1820 is invalid; junior objective synonym). Akopjan (1972) included the French Eocene *Muricites pentagonatus* von Schlotheim 1820 and *Murex angulatus* Solander in Brander 1766 in his new genus and Ozawa et al. (2009) added *Pyrazus expansus* Douvillé 1928 (Paleocene, Pakistan), *Pyrazus khani* Iqbal 1969 (Eocene, Pakistan) and *Pyrazus fresvillensis* (Cossmann & Pissarro 1902) (Eocene, France). *Pyrazus nuttalli* Douvillé 1929 (Paleocene, Pakistan), *Cerithium polygonum* Leymerie 1846, *Cerithium spectabilis* Deshayes 1864, *Pyrazus angustus* Doncieux 1908, *Faunus farinensis* Doncieux 1908, *Pyrazus praeangulatus* Doncieux 1908, *Pyrazus vidali* Doncieux 1908, *Potamides plateaui* Cossmann 1889 and *Cerithium laterostrictum* Boussac 1911, from the Eocene of France, are further species that belong to *Pyrazopsis*. All these species tend to arrange the axial ribs in line on successive whorls. Especially *Pyrazopsis expansus* (Douvillé 1928) is also comparable in respect to the broad apical angle and large size. The strong axial sculpture of all these species clearly differs from the Iraqi species and thus the generic assignment remains doubtful. *Pyrazopsis arapovicensis* (Oppenheim 1909), from the Eocene of Bosnia, has strongly raised axial ribs but is otherwise comparable concerning the strict alignment of the axial elements.

Among the Potamididae, only *Telescopium* Montfort 1810, with the Extant IWP-type species *Telescopium telescopium* (Linnaeus 1758), has a comparable broad conical shell. The strong columellar fold of *Telescopium*, however, excludes an assignment of the Iraqi species to this genus. The morphologically closest species is *Campanile brookamani* Cox 1930 from the Thanetian of Pakistan. It has the same broad apical angle, lacks incised sutures and has no significant sculpture. The circular outline of the whorls, however, is clearly different from the hexagonal one of the Iraqi species. Moreover it develops two columellar folds. The absence of columellar folds is not a strict criterion to exclude this species from the Campaniloidea as the Extant *C. symbolicum* (Iredale 1917) also has a smooth columella (Sälgeback and Savazzi 2006). Nevertheless, as columellar folds are typical in Paleogene representatives of *Campanile*, a closer relation seems unlikely. *Benoistia pyramidata* Cossmann 1906, from the Pyrenean Eocene, is also pyramidal with flat flanks but is very stout, much smaller and develops spiral rows of granules.

Okan and Hoşgör (2008) described this species as *Cerithium fodicatum* from the Late Thanetian or Early Ypresian of the Haymana-Polatlı Basin in Turkey. Whilst the Turkish specimens are undoubtedly conspecific with those from Iraq, they are definitely not comparable with *Cerithium fodicatum* Bellardi 1852 from the Bartonian of Nice in France. The French species is slender and has prominent axial ribs, which are not arranged in line on successive whorls.

Distribution Only known so far from the Thanetian of northern Iraq and the Late Thanetian or Early Ypresian of the Haymana-Polatlı Basin in Turkey.

Family Thiaridae Gill 1871
Genus *Pseudobellardia* Cox 1931
[=*Gantmelanatria* Kowalke 2001]

Type species *Muricites auriculatus* von Schlotheim 1820. Middle Eocene, Northern Italy.

***Pseudobellardia ankaraensis* (İslamoğlu, Dominici & Kowalke 2011) nov. comb.** (Fig. 4I)

* 2011 *Bellatara ankaraensis* n. sp.—İslamoğlu et al.: 316, figs. 6G, S

Material One fragmentary shell from sample 96 (NHMW 2012/0103/0008); maximum diameter: 18.5 mm; height: >37 mm.

Description The specimen consists of a conical spire of >7 weakly convex whorls with an apical angle of 31°. Its sculpture is strongly reduced and comprises very indistinct and low axial swellings, which are most prominent close to the upper and lower sutures. The last whorl is stout, barrel-shaped with subparallel flanks passing via a weak angulation into the short base. A keel-like swelling develops somewhat below the suture on the dorsal side of the last whorl. This swelling bears six spiny nodes that increase in size toward the aperture. About six beaded spiral cords appear below the keel and several weaker spiral cords cover the base. The ovoid aperture is partly destroyed. The posterior part consists of a thick callus, which coincides with the last node of the keel. A narrow slit-like posterior canal is incised into this callus. The inner lip is also thick and is separated by a narrow chink from the base.

Remarks The available specimen agrees well with *Pseudobellardia ankaraensis* from the Ypresian of Turkey. A comparison with type material from Ankara showed that the Turkish specimens form more prominent nodes on the last whorl and well-developed axial ribs on the spire whorls. In respect to the variability of this group, these differences in sculpture might well range within the morphological range of this species. Nevertheless, the identification remains somewhat doubtful unless more Iraqi material is available.

The generic affiliation of the Iraqi and Turkish shells is also questionable as the aperture is only partly known. The Turkish species was originally described as *Bellatara* Strand 1928 by İslamoğlu et al. (2011). All species of this large-sized genus have a superficial similarity with *Pseudobellardia* but lack the thiarid aperture with the callous or deeply incised posterior canal (see Sälgeback and Savazzi 2006) but develop a conspicuous anterior canal (cf. Woodring 1957). Moreover, the dense axial sculpture of the much shorter spire is untypical for all known species of *Bellatara*. *Pseudobellardia auriculata* (von Schlotheim 1820) lacks the prominent callus of the aperture and its last whorl is convex instead of barrel-shaped. *Pseudobellardia manfredi* (Oppenheim 1909), from the Eocene of Bosnia, might be a related species. It has a comparable outline, with a keeled and nodulose last whorl, conical spire and strongly callous adapical part of the aperture. It is distinguished from the Iraqi specimen by its conspicuous axial ribs on the spire whorl and the wider apical angle. *Pseudobellardia delphinus* (Oppenheim 1901), from the Eocene of Bosnia, has a coeloconoid spire and a smooth shell surface.

The type species of *Pseudobellardia* Cox 1931 is *Muricites auriculatus* von Schlotheim 1820 (as illustrated by Oppenheim 1894, Dainelli 1915 and Sälgeback and Savazzi 2006). Kowalke (2001) has chosen the same species as the type for *Gantmelanatria*, which is thus a junior objective synonym.

Distribution *Pseudobellardia ankaraensis* is known from the early Ypresian of western Turkey and the Thanetian of northern Iraq.

Genus *Pachymelania* Smith 1893

Type species *Nerita aurita* Müller 1774; by typification of replaced name (nom. nov. pro *Claviger* Haldeman 1842 non Preyssler 1790 [Insecta]. Recent, Angola.

***Pachymelania islamogluae* nov. sp.** (Fig. 5e–h)

Material Four specimens from sample 96.

Holotype NHM 2012/0103/0009, (Fig. 5E): height: 39.6 mm, width: 19.8 mm.

Paratype NHM 2012/0103/0010, (Fig. 5f): 1: height: 32.8 mm, width: 20.6 mm.

Additional material Two fragments NHM 2012/0103/0011 (Figs 5g, h); the largest fragment suggests a maximum height of ca. 55–60 mm height and has a maximum diameter of 24 mm.

Etymology In honour of the palaeontologist Yesim İslamoğlu (MTA, Ankara).

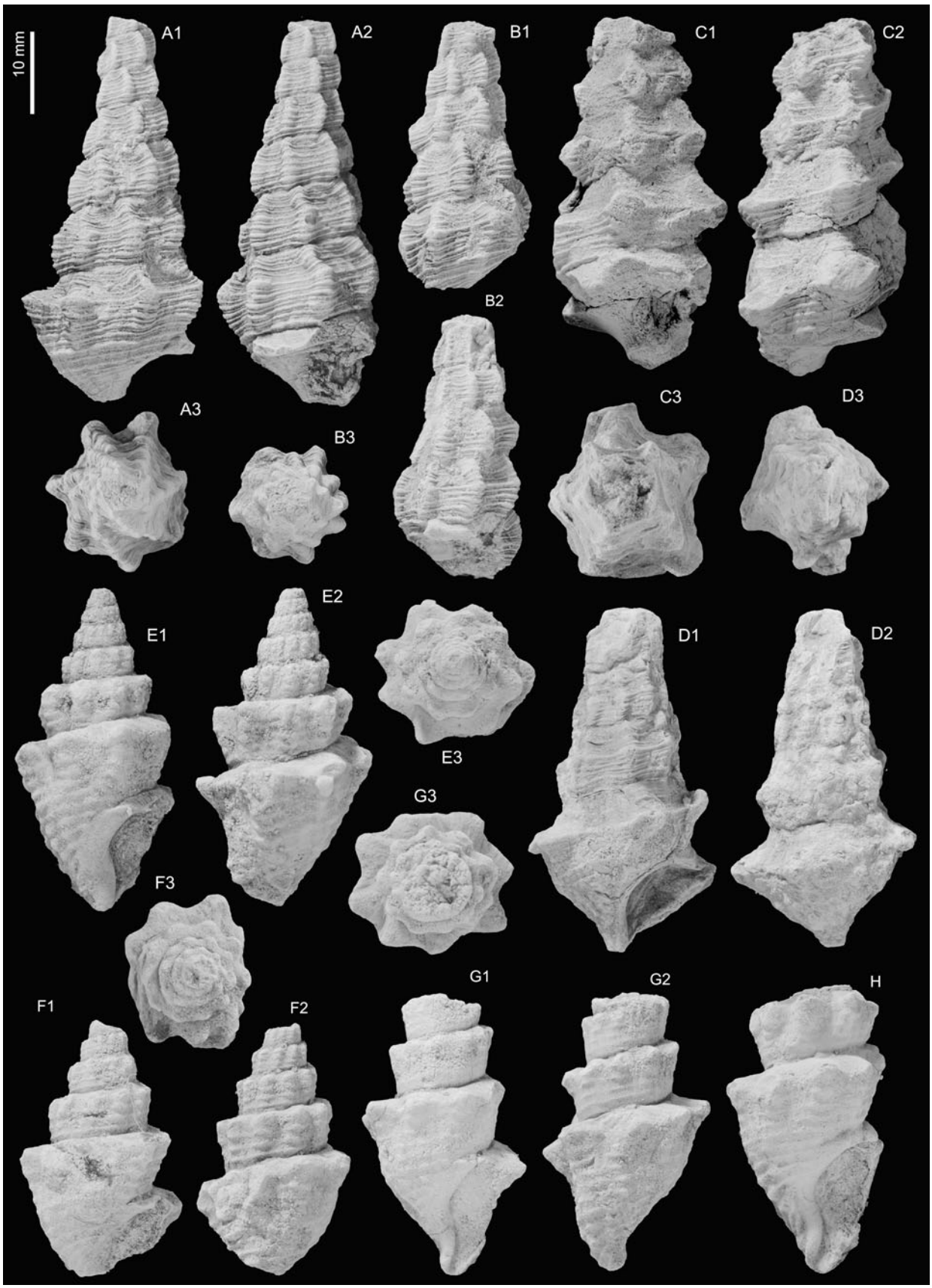
Type locality Northeastern Zakho area, Zakho section, Iraq.

Type horizon Green-grey shale and mudstone of the Kolosh Formation.

Age Thanetian

Description Medium-sized shells with strongly scalate outline (sensu Beu and Maxwell 1990). Early spire whorls (ca. 5) are conical with more or less flat flanks, which are subparallel to the axis. At that stage, the spire is gradate and the whorls bear prominent axial ribs, which are crossed by four spiral cords. The lower three spiral cords form spirally elongate nodes at the intersections with the axial ribs, whilst the upper spiral develops rounded nodes. The last 2–3 whorls become strongly scalate with spiny nodes at the shoulder, which delimits a narrow sutural shelf. Seven to eight of these strongly protruding nodes are developed on the last whorl; the nodes are trigonal in apical view and are oriented perpendicular to the axis. The spiral cords increase in number to 9–10 on the last whorl and are slightly wavy because of the intersections with the now less distinct axial ribs. A weak concavity appears below the shoulder and the weakly convex base contracts slowly into a moderately long, twisted canal. Aperture elongate ovoid with short posterior canal; inner lip well developed; columella strongly concave in the upper half and convex at the transition into the anterior canal. The available specimens suggest some variability concerning the height/width ratio, the height of the whorls and the strength of the spiral sculpture, which may be strongly reduced.

Remarks The change in sculpture and outline from juvenile to adult teleoconchs is comparable with that of the extant *Pachymelania fusca* (Gmelin 1791) from West Africa and the Cretaceous *Pachymelania wyomingensis* (Meek 1873) (see Hartman 1998). The assignment to *Pachymelania* remains questionable as the presence of a distinct siphonal canal is untypical for extant representatives of this genus. Bandel and Kowalke (1999) describe the typical *Pachymelania* aperture as ovate to subangular with a narrow anterior canal and a broad basal notch. This anterior indentation of the aperture is best developed in *P. aurita* (Müller 1774), *P. byronensis* (Wood 1828) and *P. fusca* but never attains the shape of the Thanetian species. Few species with comparably scalate spires and prominent nodes at the shoulder have been described so far from the Eurasian Paleogene. *Melanoides thezanensis* (Doncieux 1903), from the Thanetian of Thézan-des-Corbières in S-France, is comparable but differs clearly in its very slender shell and much higher spire whorls. The systematic placement of this species is unclear as the anterior part of the aperture is unknown (see Doncieux 1903, p. 317, pl. 2, figs 1a–f; Cossmann 1909, p. 128, pl. 2, fig. 24). *Cerithium*



◀**Fig. 5** Thanetian gastropods from Zakho (Iraq). **A–D**: "*Faunus*" *dominicii* nov. sp. (NHMW 2012/0103/0012); **E–H**: *Pachymelania islamogluae* nov. sp., **E**: holotype (NHM 2012/0103/0009), **F**: paratype (NHM 2012/0103/0010), **G–H**: additional material (NHM 2012/0103/0011). *Scale bar* corresponds to 10 mm

puigcercosense sensu İslamoğlu, Dominici & Kowalke 2011 (misidentification) [non Cossmann 1898], from the Ypresian of the Anakara region in Turkey, is morphologically very close to *Melanoides thezanensis* Doncieux 1903 and thus differs from the Iraqi species also in its very slender shell and the long and barrel-shaped last whorl. The Turkish shells, which were considered as conspecific with the Spanish Eocene *Batillaria puigcercosensis* Cossmann 1898 by İslamoğlu et al. (2011), are clearly unrelated with that small, conical Spanish species with its short last whorl (see Cossmann 1898, pl. 8, figs 1–4). It might rather be related to *Cerithium deprati* Oppenheim 1909 from the Eocene of Bosnia, which seems to differ only in the less scalate whorls. *Cerithium jablaui* Oppenheim 1909 from the Eocene of Bosnia might represent a related species but is less gradate. *Terebralia* (*Gravesicerithium*) *labiata* (Deshayes 1833) also displays a change in sculpture from a beaded-granulose subadult shell to a rather smooth adult shell with prominent adsutural spines but lacks the gradate spire and is slender (see Belliard and Gain 2007).

Distribution Known so far only from the Thanetian of northern Iraq.

Family Pachychilidae Fischer & Crosse 1892
Genus *Faunus* auctores non Montfort, 1810
***"Faunus" dominicii* nov. sp.** (Figs. 5A–D, 6)

1964 *Batillaria loparense* Oppenheim.—Čičič: 151, pl. 10, figs. 3–5
2011 "*Cerithiid*" indet.—İslamoğlu et al.: 316, fig. 7H

Holotype NHMW 2008z0310/0004 (Fig. 6): height: 51.6 mm, width: 24.9 mm.

Etymology In honour of the palaeontologist Stefano Dominici. (Museo di Storia Naturale, Università di Firenze).

Type locality Mucanköy, SW Ankara, Turkey

Type horizon Grey siltstone, Kırkkavak Formation

Age Ypresian

Additional material Four fragmentary shells (NHMW 2012/0103/0012) from samples 91, 92 and 95; height: 47 mm, diameter: 26; the largest fragment suggests a total height of more than 70 mm.

Locality Northeastern Zakho area, Zakho section, Iraq.

Horizon Green-grey shale and mudstone of the Kolosh Formation.

Age Thanetian

Description Large, turreted shells with slender early teleoconch and an apical angle of ca. 25°. The early teleoconch whorls are moderately convex with incised sutures. Five very prominent convex axial ribs are crossed by 6–8 sharp and distinct spiral cords. The interspaces between the axial ribs are about two times wider than the axial ribs. The arrangement of the axial ribs may be nearly aligned on successive whorls, forming a slightly oblique line across the entire shell in some specimens. On the last whorls, this arrangement is less strict or completely lost. A secondary spiral cord is intercalated between each pair of primary spiral cords on later whorls, and tertiary threads occur as well. All these spiral cords become very prominent on the last teleoconch whorls and are strongest when intersecting with the axial ribs. The convexity of the whorls increases in late stages of growth and on the last two whorls the axial ribs start to form protuberant nodes in the middle of the whorls. This causes a narrow sutural ramp with a wavy suture. The aperture is wide and ovoid with a wide outer lip and narrow inner lip. The columella is convex and passes into the slightly twisted anterior canal. The angulation of the last whorl, which bears strong nodes, coincides with a deep notch. This is also indicated on earlier parts of the last whorl by a sinus of the growth lines.

Remarks A comparison with the specimen illustrated by İslamoğlu et al. (2011, p. 316, fig. 7H) as "*Cerithiid*" indet., stored in the NHMW collection, suggests that the Iraqi specimens are conspecific with that species. As this species is much better preserved than the Iraqi shells, we propose the Turkish shell as holotype. A difference is the less pronounced spiral sculpture of the Turkish shell, which is only a matter of preservation.

This species is close to a group of Paleogene species, which were usually treated as *Melanatria* Bowdich 1822 (e.g. Pacaud and Le Renard 1995; Pacaud 2007) with *Melania cuvieri* Deshayes 1825 as typical representative. Recently, Köhler and Glaubrecht (2010) documented that the widely used names *Pirena* and *Melanatria* are junior synonyms of *Faunus* Montfort 1810. Neither the Turkish-Iraqi Paleocene-Eocene species nor *Melania cuvieri* Deshayes 1825 can be placed in *Faunus*, which has smooth shells and a conspicuous anterior siphonal notch. Köhler and Glaubrecht (2010) introduced *Madagasikara* as new genus rank name for the Extant species that were traditionally treated as *Melanatria* and showed that this Madagascan lineage did not evolve before Oligocene or even

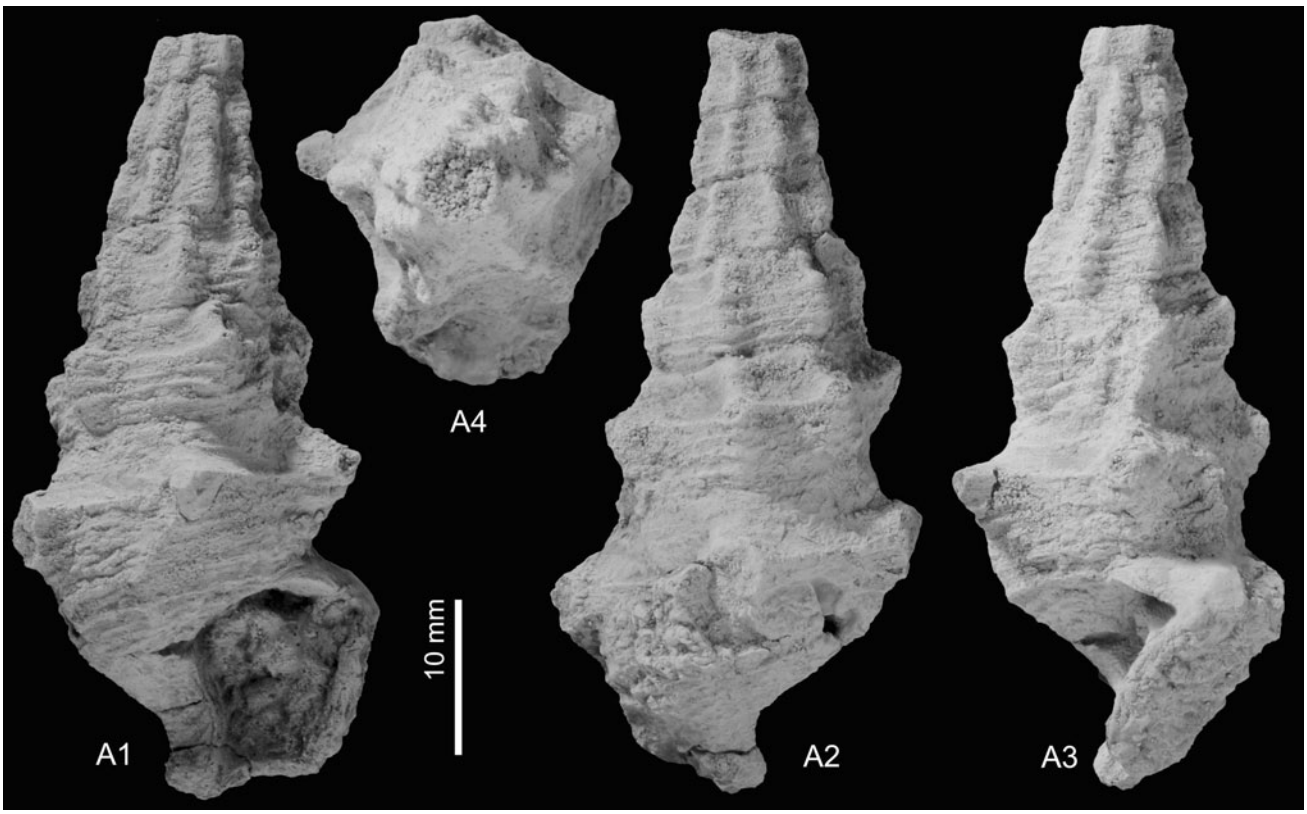


Fig. 6 Holotype of *"Faunus" dominicii* nov. sp., (NHMW 2008z0310/0004) from the Early Ypresian of Mucanköy, SW Ankara, Turkey. *Scale bar* corresponds to 10 mm

Miocene times. Therefore, the much older Eurasian taxa cannot be placed in *Madagasikara* as well. Consequently, Pacaud and Harzhauser (submitted) propose *Moniquia* as a new genus for several Paleocene and Eocene species, such as *Cerithium suzanna* d'Orbigny 1850 and *Cerithium fodicatum* Bellardi 1852. Unfortunately, this paper is still unpublished and the new genus name not yet available. Therefore, we decided to treat the new species provisionally as "*Faunus*".

A characteristic feature of this species is the deep posterior notch at the angulation of the last whorl. This feature also allows a separation of the Asian pachychilid *Brotia* Adams 1866, which was frequently used for European fossil species. A somewhat reminiscent species is "*Faunus*" *vulcanicus* (von Schlotheim 1820) from the Eocene of Italy, which also has prominent nodes on the last whorl (Dainelli 1915; Turco Stella 1976). It differs from "*F.*" *dominicii* in the comparatively more adsutural position and the distinct adapical orientation of the nodes. Moreover, it lacks nodes on the penultimate whorl.

Specimens from the Middle Eocene of Bosnia described by Čičič (1964) as *Batillaria loparense* Oppenheim seem to be conspecific with "*F.*" *dominicii* and agree in outline and sculpture. The preservation of the Bosnian shells, however, is too fragmentary for a clear identification. In any case, they are not conspecific with *Cerithium* (*Batillaria*) *loparense* Oppenheim 1901, which is more slender, has a reduced spiral sculpture and lower whorls. *Cerithium* (*Batillaria*) *loparense* of Oppenheim 1912 is a *Vicinocerithium*, which differs from "*F.*" *dominicii* especially in its angulated early teleoconch whorls and the two spiral cords in the middle of the late teleoconch whorls.

The species is reminiscent of members of the batillariid genus *Pyrazopsis* Akopjan 1972. Many of its species tend to arrange the axial ribs in line on successive whorls and have a wide, flaring aperture with a well-developed siphonal canal. None of them, however, develop a posterior notch at the angulation of the last whorl. A second genus that develops comparable morphologies is the potamidid genus *Exechestoma* Cossmann (1889) with the type species *Cerithium angulosum* Lamarck 1804 from the Eocene of the Paris Basin. This large-sized and usually strongly sculptured genus comprises a large number of Eocene species (see Cossmann 1897; Pacaud and Le Renard 1995; Belliard and Gain 2007). Especially the spiny morphs of *E. angulosum* (Lamarck 1804) and *E. armoricus* (Vasseur 1882) are reminiscent of the Iraqi species. Aside from differences in the sculpture of the early spire whorls, the

circular aperture of *Exechestoma* clearly differs from the Turkish type specimen of "*Faunus*" *dominicii.*

Distribution Only known so far from the Thanetian of northern Iraq and the Early Ypresian of the Ankara region in western Turkey.

A note on *Varicipotamides* Pacaud & Harzhauser nom. nov. pro *Exechestoma* Cossmann (1889) non Brandt (1837)

Exechestoma was introduced by Cossmann (1889) as a new section with *Cerithium angulosum* Lamarck 1804 as type species [*Exechostoma* Cossmann & Pissarro 1911 [non *Exochostoma* Macquart 1842, Insecta] is an incorrect subsequent spelling of *Exechestoma* Cossmann 1889]. The taxon was introduced by Cossmann (1889) to separate a group of species with shells decorated by varicose ribs from *Potamides* (s.str.). The taxon name *Exechestoma*, however, was already preoccupied by Brandt (1837) for a subgenus of the Medusozoa genus *Aequorea*. Therefore, we propose *Varicipotamides* as new name, referring to the typical sculpture of most species of this genus. Sälgeback and Savazzi (2006) treated the type species of *Exechestoma* as *Potamides*. In contrast, Ozawa et al. (2009) accepted the genus-level rank and considered this species group as belonging to the Potamididae based on the presence of spire varices, which contradict a placement in Batillariidae. The type species is *Varicipotamides angulosus* (Lamarck 1804) from the Bartonian of the Paris Basin.

Family Cerithiidae Fleming 1822
Genus *Pseudoaluco* Clark & Durham 1946

Type species *Cerithium jussieui* Mayer-Eymar 1876. Middle Eocene, Paris Basin.

***Pseudoaluco mesopotamicus* nov. sp.** (Fig. 7A, B)

Material Two specimens from sample 95.

Holotype NHM 2012/0103/0013 (Fig. 7a): height: 40.0 mm, width: 14.9 mm.

Paratype NHM 2012/0103/0014 (Fig. 7b): 1: height: 36.0 mm, width: 14.4 mm.

Etymology Referring to ancient Mesoptomia.

Type locality Northeastern Zakho area, Zakho section, Iraq.

Type horizon Green-grey shale and mudstone of the Kolosh Formation.

Age Thanetian.

Description Slender conical shells with an apical angle of 25°. The more than eight teleoconch whorls are flat and separated by weak sutures, causing a slightly gradate outline. Blunt axial ribs with convex backs are the predominant sculpture. Four weaker spiral cords cross the axial ribs on the early teleoconch, forming spirally elongate nodes at the intersections. Within the 4–5th teleoconch whorl, the axial ribs start to develop nodes at the upper suture and two or three weaker nodes below. A broad concavity with indistinct secondary spiral threads is developed between the upper two rows of nodes on the last two whorls. The middle row of nodes becomes more prominent on the last

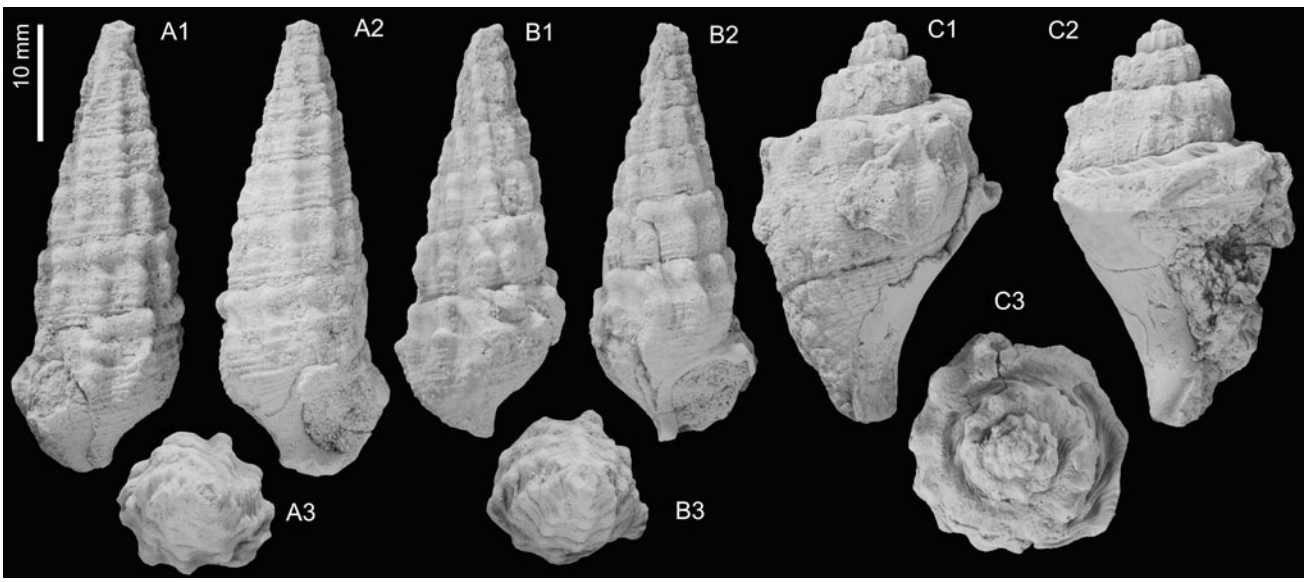


Fig. 7 Thanetian gastropods from Zakho (Iraq). **A**, **B**: *Pseudoaluco mesopotamicus* nov. sp., **A**: holotype (NHM 2012/0103/0013), **B**: paratype (NHM 2012/0103/0014); **C1–3**: *Popenoeum primum* (Defrance 1827) (NHMW 2012/0103/0015). *Scale bar* corresponds to 10 mm

whorl, coinciding with the maximum diameter. Its convex base is covered by numerous spiral cords. The aperture is wide ovoid with a short posterior canal, adjoined by a weak parietal swelling; the columella develops a well-defined inner lip. The outer lip and siphonal canal are destroyed.

Remarks The aperture with the denticle-like parietal swelling supports an assignment to *Pseudoaluco*. The type species *Pseudoaluco jussieui* (Mayer-Eymar 1876) is clearly distinguished from the Iraqi species by its pupoid outline and delicate sculpture (see Cossmann and Pissarro 1911). *Pseudaluco obesus* (Deshayes 1833) as originally described by (Deshayes 1833, p. 378, pl. 56, figs 7–8) is broader; its axial ribs are weaker and fade out within the upper half of the whorls, which develop a weak angulation close below the upper suture. Bouniol (1981) presents a *Pseudoaluco obesus* (Deshayes 1833) from the Thanetian of France, which has an overall comparable shape but is distinguished by its higher last whorl, the more gradate spire and the lack of adsutural nodes. The Paleocene *Pseudoaluco carolinus* (d'Orbigny 1850) of the Paris and Belgian basins is comparable with the Iraqi species concerning the axial sculpture but is more slender and has convex whorls [*Cerithium bellovacinum* Deshayes 1864 is a subjective synonym of *Cerithium carolinus* d'Orbigny 1850].

Distribution Only known so far from the Thanetian of northern Iraq.

Order Caenogastropoda Cox 1960
Superfamily Muricoidea Rafinesque 1815
Family Pseudolividae de Gregorio 1880
Genus *Popenoeum* Squires in Squires, Zinsmeister & Paredes-Mejia 1989

Type species *Popenoeum maritimus* Squires, Zinsmeister & Paredes-Mejia 1989. Paleocene, California.

***Popenoeum primum* (Defrance 1827).** (Fig 7C)

* 1827 *Struthiolaria prima* Defrance: 158
1911 *Pseudoliva prima* Defrance.—Cossmann & Pissarro, pl. 37, fig. 177–4
1970 *Pseudoliva prima* (Defrance).— Villatte: 23, pl. 1, figs 1–10 (cum syn.)
1998 *Popenoeum primum* (Defrance 1827).— Pacaud: 19, fig. 14
1999 *Popenoeum primum* (Defrance 1827).— Pacaud & Schnetler: 56
2009 *Popenoeum primum* (Defrance 1827).— Pacaud: 6

Material One fragmentary shell from sample 95 (NHMW 2012/0103/0015); diameter: >22 mm, height: >35 mm.

Description Medium sized, ovoid shell. The early spire whorls are gradate and flat sided; the flanks are subparallel to the shell axis. Prominent, rather sharp axial ribs form the sculpture, crossed by much weaker spiral threads. Rounded nodes appear on the adapical tips of the axial ribs on the last spire whorl and a second weak row of nodes appears close to the lower suture. On the last whorl, these nodes become very prominent whilst the axial ribs between the nodes are weak and finally obsolete. The upper row of nodes coincides with a strong shoulder that delimitates a canaliculate sutural shelf. This bears strong, prosocline axial ledges, which amalgamate into regularly spaced ribs close to the aperture. The flank is moderately convex; only the area between the shoulder nodes and the lower row of nodes is slightly concave. A deep mid-whorl spiral groove, as typical for many pseudolivids, marks the transition from the flank into the slowly contracting, weakly convex base. A dense spiral pattern of slightly wavy spiral threads covers the last whorl. The aperture is largely destroyed; the columella is weakly convex and passes into a slightly twisted siphonal canal; the inner lip develops a thin, sheet-like callus that covers parts of the base.

Remarks Villatte (1970), Pacaud (1998; 2009) and Pacaud and Schnetler (1999) describe this species as quite variable in shape and sculpture. The specimen from Iraq differs from most of the western European specimens in its less slender shape, the very prominent nodes and the well-developed second row of nodes. Therefore, it might represent a spiny eastern subspecies or even species. The fragmentary preservation and the lack of any apertural features, however, do not allow clarifying this problem. *Popenoeum lacunosum* Pacaud & Schnetler 1999 from the Paleocene of West Greenland differs in its ovoid shape and conical spire. It lacks nodes and has a prominent spiral sculpture. *Popenoeum bajaensis* Squires, Zinsmeister & Paredes-Mejia 1989 from the Thanetian of California has a comparable outline with a gradate spire but has blunt and slightly sigmoidal axial ribs without nodes.

Distribution *Popenoeum primum* is a widespread species during the Danian and Thanetian. Along the northern Tethys coast it is recorded from France, Austria, Poland and Russia (Villatte 1970). Pacaud (1998) also mentioned occurrences from Morocco and Libya as occurrences from the southern Tethys coast.

Discussion and conclusions

The small assemblage of only ten species is the first record of Thanetian gastropods from the Mesopotamian High Folded Zone. All species suggest a littoral to shallow sublittoral depositional environment. Especially the extant

species of the Batillaridae and Potamididae prefer sandy mudflats in warm-temperate to tropical regions (Ozawa et al. 2009; Sälgeback & Savazzi 2006). The Recent *Campanile symbolicum* is also typically found on sandy bottoms in the shallow sublittoral zone (Houbrick 1984). Its fossil congeners seem to have preferred comparable environments (Sälgeback and Savazzi 2006). Modern species of *Pachymelania* are found in mangrove habitats and estuaries, where they can stand strong fluctuations in salinity (Bandel and Kowalke 1999). Similarly, Kowalke (2004) interpreted the preferred habitat of the extinct *Pseudobellardia* (=*Gantmelanatria*) as a calm coastal swamp/lagoon facies.

Eight of the species have been documented from other localities. These are *Campanile zakhoense* nov. sp., *Vicinocerithium seni* İslamoğlu, Dominici & Kowalke 2011, *Vicinocerithium* sp., *Pseudobellardia ankaraensis* (İslamoğlu, Dominici & Kowalke 2011), *Pyrazopsis hexagonpyramidalis* nov. sp., "*Faunus*" *dominicii* nov. sp. and maybe *Eotympanotonus* sp., which are also known from coeval Thanetian or slightly younger Ypresian deposits of western Turkey. *Popenoeum primum* (Defrance 1827) is a widespread species during Paleocene times in the entire (western) Tethys Sea and the North Sea. The other species are so far known only from the Thanetian of the Zakhos region. Hence, the biogeographic relation toward the west, e.g. with the assemblages from the Paris Basin or the Veneto in Italy, is very poor. Interestingly, the younger Eocene assemblages of the Balkans, as described by Oppenheim (1901; 1909; 1912), bear morphologically similar but not con-specific taxa, which might point to some evolutionary relationships. Even less contact is evident with eastern assemblages from India and Pakistan. These Paleocene and Eocene faunas, described by Cossmann and Pissarro (1909), Douvillé (1928; 1929) and Cox (1930; 1931), comprise ecologically comparable taxa but have no species in common with the Iraqi assemblage. This pattern contradicts a homogenous biogeography along the northern coasts of the Paleocene and Early Eocene Tethys. Popov (1993) suggested a biogeographic separation of the Eocene Tethys Realm (sensu Harzhauser et al. 2002) in western Eurasia into an Indo-African Region and a Mediterranean Region. This was based on the similarities of the southern Tethyan bivalve faunas of Egypt, Somalia and India compared to those from the northern Tethyan ones from Italy and southeastern France. The herein discussed Turkish and Iraqi assemblages were not known at that time and consequently were not incorporated in the concept. The similarities between the assemblage from western Turkey (Okan and Hoşgör 2008; İslamoğlu et al. 2011) and the Iraqi one and their dissimilarity with neighbouring areas suggest the existence of an *Anatolian Province* within Popov's *Mediterranean Region* during Thanetian and early Ypresian times. Modern descriptions of assemblages from the eastern Mediterranean and Balkans areas in the west and from the Arabian Platform in the east are completely missing to date. Thus, a formal definition of this new biogeographic entity, including designations of a type area and a type assemblage and the definition of exact palaeogeographic boundaries toward adjoining entities, is impossible to date.

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