Acta Geologica Polonica, Vol. 52 (2002), No. 2, pp. 239-249

Further Archaeogastropoda from the Campanian of Torallola, northern Spain

STEFFEN KIEL & KLAUS BANDEL

Geologisch-Paläontologisches Institut und Museum, Universität Hamburg, Bundesstrasse 55, 20146 Hamburg, Germany.
E-mail: steffen.kiel@gmx.de; bandel@geowiss.uni-hamburg.de

ABSTRACT:

KIEL, S. & BANDEL, K. 2002. Further Archaeogastropoda from the Campanian of Torallola, northern Spain. *Acta Geologica Polonica*, **52** (3), 239-249. Warszawa.

18 archaeogastropod species are described from the Campanian of Torallola in north-eastern Spain, including 13 new species and one new genus. They are assigned to the Liotiinae, Colloniinae, Turbininae, Skeneidae and Cirridae. Our species of the Liotiinae are comparable with Recent as well as Triassic liotiids, the documented colloniids show close relations to modern species. Certain members of the *Angaria-Astraea-Turbo*-relation are difficult if not impossible to distinguish on shell characters alone, although these shells can be traced back into the Triassic. Three skeneiform species are assigned to Recent *Skenea*, but neither fossil nor recent Skeneidae are sufficiently well known, so our treatment remains preliminary. The new genus *Torallochus* is introduced for species having initially planispiral coiling that later changes to turriform coiling, and which are sculptured with strong ribs or spines on the periphery. The systematic position of this genus within the Trochoidea remains uncertain. Among the Cirridae, the genus *Shikamacirrus* is synonymized with the older name *Sensuitrochus*, and the youngest member of this genus is described. The new species are *Pseudoliotina stinnesbecki, Arene mcleani, Homalopoma schroederi, Astraea iredalei, Astraea batalleria, Astraea hickmanae, Astraea*? *sohli, Skenea wareni, Skenea suturata, Skenea torallensis, Torallochus rempensis*, *Torallochus pupiformis*, and *Torallochus discus*.

Key words: Cretaceous, Campanian, Archaeogastropoda, Taxonomy, Northern Spain.

INTRODUCTION

This is the third and last part of a study of Archaeogastropoda from the Campanian marls of Torallola in north-eastern Spain. In the first part (KIEL & BANDEL 2000) slit-bearing species of the Pleurotomariidae SWAINSON, 1840, Temnotropidae COX, 1960, Scissurellidae GRAY, 1847, and Fissurellidae FLEMMING, 1822 were described. The earlier hypothesis that the Haliotidae RAFINESQUE, 1815 derived from the Temnotropidae was supported by the discovery of a Campanian member of *Temnotropis* LAUBE, 1870. The youngest *Temnotropis* was previously only known from the Triassic.

In the second part (KIEL & BANDEL 2001) we gave a brief introduction to the nature of the outcrop and discussed taxonomic and paleogeographic relations of members of the archaeogastropod family Trochidae RAFINESQUE, 1815 found in this locality. It became apparent that the modern trochid subfamilies Tegulinae KURODA, HABE & OYAMA, 1971, Margaritinae STOLICZKA, 1868, and Solariellinae POWELL, 1951 can be traced through the Tertiary into the Late Cretaceous. The members of the Trochinae appeared to be of different character than their modern representatives, those of the Eucyclinae KOKEN, 1897 showed close relations to their modern as well as to their earlier Mesozoic relatives.

This report concerns the remaining 18 archaeogastropod species. The shell structure of several species was investigated by HÄNSEL (1992) in a masterthesis at Hamburg University where nacre in its original aragonitic state could be demonstrated in some cases (see KIEL & BANDEL 2001 for details). All specimens are deposited in the type collection of the Geologisch-Paläontologisches Institut und Museum, University of Hamburg, labelled GPI 3969-3988.

SYSTEMATIC PART

Class Gastropoda CUVIER, 1797
Subclass Archaeogastropoda THIELE, 1925
Order Vetigastropoda SALVINI-PLAWEN, 1980
Superfamily Trochoidea RAFINESQUE, 1815
Family Turbinidae RAFINESQUE, 1815

REMARKS: The family diagnosis presented by HICKMAN & MCLEAN (1990) is based mainly on radula characters and is therefore of little use in the fossil record. These authors as well as WENZ (1938-44) described members of the Turbininae as high-conical to disc-shaped, with an interior nacreous layer and a radial to oblique aperture. Although they live in all latitudes, diversity is highest in tropical environments (HICKMAN & MCLEAN 1990).

Subfamily Liotiinae ADAMS & ADAMS, 1854

REMARKS: Typical shell characters include a nearly radial aperture with an uninterrupted peristome and axial lamellae on the teleoconch (HICKMAN & MCLEAN 1990). The same authors noted a nearly world-wide distribution of the Recent species, exclusive the northeastern Atlantic and the Mediterranean.

Genus *Pseudoliotina* COSSMANN, 1925

TYPE SPECIES: *Liotia sensuyi* VIDAL, 1921 from the Campanian of Torallola, Spain.

DESCRIPTION: The genus includes planispiral shells with angular whorls. Ornament consists of several keels and fine axial lamella. The aperture is circular, thickened and has radial grooves corresponding with the keels of the whorls in fully grown individuals.

REMARKS: The Recent *Cyclostrema* MARRYAT, 1854 is similar but has an oblique aperture which lacks the radial grooves of *Pseudoliotina*. *Liotia* GRAY, 1847 is trochiform rather than planispirally coiled. ABBOTT (1974) considered *Pseudoliotina* and *Mundita* FINLEY, 1926 synonymous, HICKMAN & MCLEAN (1990) regarded *Pseudoliotina* as a valid genus. We follow COSSMANN's (1925) and HICKMAN & MCLEAN's (1990) opinion with the above mentioned diagnostic differences.

Pseudoliotina sensuyi (VIDAL, 1921)
(Pl. 1, Figs 1-2)

1921. *Liotia sensuyi* n.sp.; L.M. VIDAL, p. 99, Pl. 6, Figs 2-3.
1925. *Pseudoliotina sensuyi* (VIDAL); M. COSSMANN, p. 286.
1949. *Liotia sensuyi* VIDAL; J.R. BATALLER, p. 16.

MATERIAL: One specimen (figured: GPI 3969).

DESCRIPTION: The medium sized, planispiral shell has at least three volutions. Its sculpture consists of two jagged spiral cords on the upper side, three on the outer side and two on the base, the second of which is very weak. Growthlines are strong, the aperture is round and the shell is 3 mm high and 11 mm wide.

REMARKS: This species is distinct from *Pseudoliotina stinnesbecki* sp. nov. by its three jagged cords on the outer side.

Pseudoliotina stinnesbecki sp. nov.
(Pl. 1, Figs 3-5)

HOLOTYPE: The specimen illustrated in Pl. 1, Figs 3-5 (GPI 3970).

MATERIAL: Two specimens.

DERIVATION OF NAME: Named after Wolfgang STINNESBECK, Karlsruhe, who is working with Cretaceous molluscs.

DIAGNOSIS: The planispiral shell has two jagged spirals on the upper side and two on the lower side. The aperture has a flaring margin with radial grooves inside.

DESCRIPTION: The planispiral shell is made of three volutions and shows strong growthlines. Its sculpture consists of three spiral cords on the upper side and two on the lower side. The spirals extend in intervalls into gutter-like short spines. The upper side of the shell is little convex, the lower side flat and the outer side is inclined. The aperture is round and reinforced with a flaring

margin that has grooves corresponding with the spiral keels on the shell. The shell is 7 mm high and 18 mm wide.

REMARKS: The Puerto Rican *Cyclostrema mcleani* (SOHL, 1998) was considered a member of *Pseudoliotina* (SOHL 1998). But that species shows strong axial ribs instead of lamellae and it has an oblique aperture unlike *P. sensuyi* and *P. stinnesbecki*, and also in size it resembles *Cyclostrema* more closely than *Pseudoliotina*.

Genus *Arene* ADAMS & ADAMS, 1853

TYPE SPECIES: *Arene radiata* (KIENER) according to WENZ (1938-44, fig. 792).

DESCRIPTION: The small and thick, depressed turbinate shell has a rimmed and thickened round aperture. The sculpture consists of spiny spiral cords.

Arene mcleani sp. nov.
(Pl. 1, Figs 6-7)

HOLOTYPE: The specimen illustrated in Pl. 1, Figs 6-7 (GPI 3971).

MATERIAL: One specimen.

DERIVATION OF NAME: Named after James MCLEAN, who contributed greatly to the classification of Archaeogastropoda.

DIAGNOSIS: The low spired shell has an angular body whorl which is sculptured with seven beaded spiral cords. The aperture has small denticles on its base.

DESCRIPTION: The small shell consists of four volutions, its protoconch and first whorl are smooth and planispirally coiled, the body whorl is angular, has seven beaded spiral cords and fine axial lamella. The base is sculptured with three spirals, the umbilical slit is bordered by a beaded ridge. The aperture is round with denticles on the basal side. The shell is 2.1 mm wide and 2.6 mm high.

REMARKS: SOHL (1998) described a related species as *A. truncatosphaera* SOHL, 1998 from the Jamaican Maastrichtian. It has only four spirals on the body whorl but these are stronger than in *A. mcleani*. A similar Recent species is *Arene bairdii* DALL (in ABBOTT 1974, p. 55) from the North American east coast. It shows almost identical sculpture but no apertural denticles and is about three times larger.

Subfamily Colloniinae COSSMANN, 1916

REMARKS: Recent members of this turbinid subfamily live world-wide on gravel and hard substrates from intertidal to bathyal depth (HICKMAN & MCLEAN 1990). Comparing anatomical characters, HICKMAN & MCLEAN (1990) considered the Colloniinae to intermediate between the primitive Liotiinae and Angariinae on one side and more advanced turbinids on the other side.

Genus *Homalopoma* CARPENTER, 1864

TYPE SPECIES: *Turbo sanguineaum* LINNÉ, 1758 living in the Mediterranean (WENZ 1938-44, fig. 798).

DESCRIPTION: This genus comprises small, low spired shells with convex volutions, spiral sculpture, a narrow or closed umbilicus and a roundish aperture.

REMARKS: According to WENZ (1938-44) and HICKMAN & MCLEAN (1990) *Collonia* GRAY, 1850 differs from *Homalopoma* by having an open umbilicus with beaded margin and by being rather smooth. Accordingly, *Homalopoma* has a mostly closed umbilicus and spiral sculpture. Although WENZ (1938-44) treated *Boutilliera* COSSMANN, 1888 as a subgenus of *Homalopoma*, there is almost no difference in their respective diagnosises, and HICKMAN & MCLEAN (1990) considered *Boutilliera* closely related to *Homalopoma* s.s. Due to the absence of any obvious differences between *Boutilliera* and *Homalopoma* and due to the lack of a throughout revision of the subfamily, we assign our two species to *Homalopoma*.

Homalopoma minuta (QUINTERO & REVILLA, 1966)
(Pl. 1, Fig. 11)

1966. *Turbo minutum* n.sp.; I. QUINTERO & J. REVILLA, p. 48, Pl. 7, Fig. 7.
1966. *Turbo minutum* QUINTERO & REVILLA; J. REVILLA & I. QUINTERO, p. 20, pl. 2, fig. 7.

MATERIAL: One specimen (figured: GPI 3972).

DESCRIPTION: The small, relatively high spired turbiform shell has whorls with numerous spiral cords. The whorl-sides are straight above the strong fifth cord, and

are convex below. It has a round aperture and an umbilicate, concave base with spiral cords. The shell is 4 mm high and wide.

REMARKS: *Homalopoma schroederi* n.sp. has a larger last whorl and a flat-topped spire, *Collonia wollemanni* SCHRÖDER, 1995 from the Aptian/Albian of northern Germany shows a much lower spire, a wider umbilicus and its whorls are more rounded.

Homalopoma schroederi sp. nov.
(Pl. 1, Fig. 8)

HOLOTYPE: The specimen illustrated in Pl. 1, Fig. 8 (GPI 3973).

MATERIAL: One specimen.

DERIVATION OF NAME: Named after Michael SCHRÖDER, Hamburg, who worked on Jurassic and Cretaceous gastropods.

DIAGNOSIS: This nearly flat-topped species of *Homalopoma* has well rounded whorls and two denticles in the aperture.

DESCRIPTION: The small, roundish shell with four convex volutions and deep sutures is sculptured with fine spiral lirae. The first two whorls are almost flat-topped. The rounded base is spirally sculptured and has a narrow umbilical slit. The circular aperture shows two denticles. The shell is 5 mm high and wide.

REMARKS: Of almost identical shape is the Recent *Homalopoma baculum* (CARPENTER) from California (HICKMAN & MCLEAN 1990, fig. 17B) but it differs in having incised spirals rather than spiral cords like *Homalopoma schroederi* sp. nov.

Subfamily Turbininae RAFINESQUE, 1815

REMARKS: Members of the Turbininae today live in all tropical and subtropical seas from the intertidal to bathyal depth. Shells can be relatively large, are cone-shaped, and the apertural inclination is highly variable (WENZ 1938-44, HICKMAN & MCLEAN 1990). The latter authors proposed that the bicarinate early shell represents an apomorphy of this subfamily.

Genus *Barbotella* COSSMANN, 1918

TYPE SPECIES: *Turbo hoernesi* (BARBOT), from the Russian Miocene (WENZ 1938-44, fig. 834).

DESCRIPTION: Shells are of moderate size, their volutions are convex with deep sutures and sculptured with strong, irregular axial ribs.

Barbotella maestrichtiensis (QUINTERO & REVILLA, 1966)
(Pl. 1, Figs 9-10)

1966. *Delphinula maestrichtiensis* n.sp.; I. QUINTERO & J. REVILLA, p. 48, Pl. 7, Fig. 6.
1966. *Delphinula maestrichtiensis* QUINTERO & REVILLA; J. REVILLA & I. QUINTERO, p. 21-22, Pl. 3, Figs 2-3
1992. *Delphinula maestrichtiensis* QUINTERO & REVILLA; K.N. HÄNSEL, p. 81, Pl. 4, Fig. 22.

MATERIAL: Three specimens (figured: GPI 3974 and 3987).

DESCRIPTION: A relatively high spired turbiform shell with at least seven convex volutions and deep sutures. The early whorls show fine spiral lirae, later they are ornamented with irregularly deformed axial to oblique ribs which are crossed by spiral cords. The aperture is round, its inner lip is a little reinforced and there is no umbilicus. The shell is 40 mm high and 33 mm wide. Nacre is still demonstrable in its original aragonitic state in some specimens (HÄNSEL 1992).

REMARKS: This species is higher spired and a little stronger ornamented than the type species. Similar ornament is found on the Jurassic *Barbotella crispicans* (LORIOL, 1886) but that species also has a lower spire than *Barbotella maestrichtiensis*. Additionally, the axial ribs of *B. crispicans* are arranged upon the spire as to form continuous ridges along its whole length.

Genus *Marmorostoma* SWAINSON, 1829

TYPE SPECIES: *Turbo crysostomus* (LINNÉ), that lives around the Philippines (WENZ 1938-44, fig. 822).

DESCRIPTION: The large, conical shells have rounded to angular whorls with denticulate or spiny spiral cords and deep sutures.

Marmorostoma sensuyi (BATALLER, 1949)
(Pl. 2, Figs 1-3)

1924. *Delphinula* sp.; L.M. VIDAL *in* CAZURRO, SAN MIGUEL & PARDILLO, p. 42.
1949. *Delphinula sensuyi* n.sp.; J.R. BATALLER, p. 16.
1966. *Delphinula sensuyi* J.R. BATALLER, J. REVILLA & I. QUINTERO, p. 21, Pl. 3, Fig. 1.
1992. *Delphinula sensuyi* VIDAL; K.N. HÄNSEL, p. 77, Pl. 4, Fig. 20.

MATERIAL: 21 specimens and fragments (figured: GPI 3975 and 3988).

DESCRIPTION: The embryonic part measures 0.21 mm across, is smooth and separated from the teleoconch by a weak varix. The first teleoconch whorl is almost planispirally, ornamentation starts with two ridges on the outer side of the whorl and one close to the inner suture. After one volution, three minor ridges appear between the strong inner and outer ones. The adult shell is turbiform with four to five convex volutions and the sculpture turns into numerous jagged spiral cords. The spines of the first three cords are of equal size, those of the fourth are quite large, those of the fifth resemble the first three, are slightly larger on the sixth cord and then again of similar size as the first three from the seventh cord onwards. The aperture is round and reinforced and the umbilicus small with a beaded margin. The largest shell is 35 mm high and 39 mm wide. Nacre is still demonstrable in its original aragonitic state in some specimens (HÄNSEL 1992).

REMARKS: The Eocene *Delphinula lima* LAMARCK (see COSSMANN 1915, pl. 9, figs 13-14) is similar but its whorls are more angular. The same applies to the Jurassic *Turbo bonjouri* ÉTALLON (see LORIOL 1886-1888, pl. 19, figs 1-4). Further Late Cretaceous species include *Turbo goupilianus* D'ORBIGNY, 1842, *Solarium kirsteni* GEINITZ, 1874, and *Turbo leonhardi* GEINITZ, 1871 from the Cenomanian or Turonian of Saxony in Germany (GEINITZ 1871-75).

Similar species were described by SOHL (1998) from the Caribbean Campanian-Maastrichtian. He assigned them to *Metriomphalus* Cossmann, 1916 which he considered to represent a genus of the Colloniinae. The type species of *Metriomphalus* is of mid-Jurassic age, that of *Marmorostoma* is recent. Thus, both are about 80 million years away from the Campanian species concerned here.

Genus *Astraea* RÖDING, 1798

TYPE SPECIES: *Astraea helitropium* (MARTYN), Recent, New Zealand (WENZ 1938-44, fig. 837)

DESCRIPTION: Recent members of this genus have a low conical shell, whorls with denticulate or spiny keels, and a wide or callus-covered umbilicus.

Astraea iredalei sp. nov.
(Pl. 2, Figs 7-9)

HOLOTYPE: The specimen illustrated in Pl. 2, Figs 7-9 (GPI 3976).

MATERIAL: Two specimens.

DERIVATION OF NAME: In honour of TOM IREDALE who contributed to our knowledge of Australian gastropods.

DIAGNOSIS: This *Astraea* has shouldered whorls with strong spines at the periphery and sculpture of beaded spirals on the whorl's shoulder, flank and on the umbilicate base.

DESCRIPTION: The low spired shell has at least three volutions, which are strongly shouldered to almost rectangular. Sculpture consists of two nodose cords on the upper side and spines on the periphery, and the outer side shows nodose cords of increasing number towards later whorls. On the body whorl appear fine axial lirae and the spines are very strong. The spiral cords continue on the base and into the umbilicus. The shell is 13 mm high and 17 mm wide.

REMARKS: "*Delphinula*" *pelossei* ROMAN & MAZERAN, 1913 from the French Turonian shows very similarly angulated whorls, but shows two prominent tuberculate cords on its flank, while there are numerous fine ones on *Astraea iredalei* sp. nov. From the two species of *Astraea* described below *A. iredalei* differs mainly by its angular and shouldered whorls having the spines on the periphery, while in *Astraea batalleria* sp. nov. and *Astraea hickmanae* sp. nov. the whorls are not shouldered and the strong spines develop near the lower suture.

Astraea batalleria sp. nov.
(Pl. 2, Figs 4-6)

1966 *Astraea* (*Delphinula*) aff. *guerini* BATALLER; J. REVILLA & I. QUINTERO, p. 21, pl. 2, figs. 8-9.
1992 *Delphinula guerini* BATALLER; K.N. HÄNSEL, p. 79, Pl. 4, Fig. 21.

HOLOTYPE: The specimen figured in Pl. 2, Figs. 4-6 (GPI 3977).

MATERIAL: 13 specimens.

DERIVATION OF NAME: Named in honour of J.R.

BATALLER who was working on Spanish Cretaceous gastropods.

DIAGNOSIS: This *Astraea* is characterized by deep sutures, a beaded subsutural rim, and a coarsely sculptured, well-rounded base.

DESCRIPTION: The low spired shell with four to five volutions has rather deep sutures and whorls that are jagged at the sutures. These small spines above the suture attain enormous size on the body whorl. The shell is otherwise ornamented with spiral cords which are continuous into the umbilicus. The last whorls are often loosely coiled. This species shows a broad variability in the height of its spire. Its aperture is round and not inclined, the shell is 16 mm high and 25 mm wide. Nacre is still demonstrable in its original aragonitic state in some specimens (HÄNSEL 1992).

REMARKS: The Spanish *Astraea guerini* BATALLER, 1945 (see BATALLER 1949, p. 17, fig. 463) is similar but differs by having a wider umbilicus and smaller spines. *Astraea hickmanae* sp. nov. described below differs from *Astraea batalleria* by lacking the strong spiral sculpture on the base and having a tuberculated umbilical margin. A very similarly ornamented species occurs in the Trichinopoly Formation in southern India (BANDEL 2000) but has a more rounded base. The Jurassic *Delphinula stellata* BURIGNIER (in LORIOL 1893) shows deep sutures and a smooth surface. Similar although with less but larger spines is the Anisian (Middle Triassic) *Asperilla mayfensis* COSSMANN, 1915.

Astraea hickmanae sp. nov.
(Pl. 2, Figs 10-11)

HOLOTYPE: The specimen illustrated in Pl. 2, Figs 10-11 (GPI 3978).

MATERIAL: Nine specimens.

DERIVATION OF NAME: Named after Carole S. HICKMAN, who contributed very much to the knowledge of the gastropods.

DIAGNOSIS: This *Astraea* has a spire with irregularly tuberculated spirals and its base well-rounded and smooth except for the strongly beaded umbilical margin.

DESCRIPTION: A low spired shell with four whorls that are denticulate at the upper suture and develop broad spines on the periphery of the body whorl. The aperture is round with a little notch in the outer lip, formed by the broad spines. The umbilical margin is broadly dented. The shell is 9 mm high and 15 mm wide.

Astraea? *sohli* sp. nov.
(Pl. 2, Figs 12-14)

HOLOTYPE: The specimen illustrated in Pl. 2, Figs 12-14 (GPI 3979).

MATERIAL: One specimen (figured: GPI 3979).

DERIVATION OF NAME: Named in honour of Norman F. SOHL, who contributed much to the knowledge of Cretaceous gastropods.

DIAGNOSIS: The almost flat shell has carinate whorls, a wide umbilicus, and rounded, widely spaced spiral ribs on its last whorl.

DESCRIPTION: The medium sized, almost flat shell has more than three volutions. The initial two are smooth and convex, later whorls are ornamented with strong axial ribs. The base is convex and the umbilicus has a dented margin. The shell is 7 mm high and 17 mm wide.

REMARKS: It is not totally save to include this species within *Astraea* because neither protoconch nor shell structure are known.

Family Skeneidae CLARK, 1851

REMARKS: Numerous small shelled archaeogastropods living today are unified in this family. FRETTER & GRAHAM (1977) indicated that the Skeneidae are detrivours.

Genus *Skenea* FLEMING, 1825

TYPE SPECIES: *Skenea serpuloides* (MONTAGU), living off England (WENZ 1938-44, fig. 745).

DESCRIPTION: The small, globular shells have convex volutions, a round aperture, and a narrow or wide umbilicus.

REMARKS: *Skenea* is treated here in a wide sense for small and globular archaeogastropods. The type species of *Skenea* shows spiral sculpture, absent from the species described below. However, WARÉN (1993) docu-

mented the variability of Recent *Skenea basistriata* (JEFFREYS) which exhibits transitions from strongly spirally sculptured specimens to some with an almost smooth shell. Several small shells of similar shape from the Jurassic and Cretaceous have been assigned to *Ataphrus* GABB, 1869 (DOCKERY 1993, GRÜNDEL 2000). The type species of *Ataphrus* from the Californian Cretaceous is only poorly documented (STEWARD 1927, pl. 24, fig. 12) and neither protoconch nor shell structure are known (BANDEL & GELDMACHER 1996). According to DOCKERY (1993) the shells are non-umbilicate, which excludes the species described below from that genus. A similar genus from the Jurassic is *Crossostoma* MORRIS & LYCETT, 1851. But members of that genus differ from *Skenea* and *Ataphrus* in having a wide umbilicus which is closed by a callus-pad that extends from the inner lip of the aperture (BANDEL *& al*. 2000).

Skenea wareni sp. nov.
(Pl. 2, Fig. 15)

HOLOTYPE: The specimen illustrated in Pl. 2, Fig. 15 (GPI 3980).

MATERIAL: One specimen.

DERIVATION OF NAME: Named for our Swedish colleague Anders WARÉN, who contributed much to our knowledge of skeneid gastropods.

DIAGNOSIS: The turbiform shell is smooth, is about as wide as high, its body whorl is large, the aperture is reinforced, and the umbilicus is bordered by a smooth ridge.

DESCRIPTION: The embryonic part measures 0.2 mm across, the adult shell is composed of three smooth volutions, has a round and reinforced aperture that is weakly inclined. The umbilicus is small and its margin is marked by a ridge. The shell is 1.7 mm high.

REMARKS: Due to the apertural thickening this species probably is fully grown. *Skenea suturata* sp. nov. has a higher spire while *Skenea torallensis* sp. nov. has a lower spire. A similar Recent species is *Skenea trochoides* (FRIELE see WARÉN 1991, fig. 3G). From the Jurassic of Poland GRÜNDEL (2000) described a similar specimen as *Ataphrus* sp. 1, which differs only marginally by having a slightly broader base.

Skenea suturata sp. nov.
(Pl. 2, Fig. 16)

HOLOTYPE: The specimen illustrated in Pl. 2, Fig. 16 (GPI 3981).

MATERIAL: One specimen.

DERIVATION OF NAME: Named after its subsutural groove.

DIAGNOSIS: This *Skenea* is higher than wide, its whorls show a subsutural groove, and the small umbilicus has a beaded margin.

DESCRIPTION: The embryonic part measures 0.25 mm across, the teleoconch is made of four smooth and convex volutions with a subsutural groove. The aperture is round and strongly inclined, and the small umbilicus has a beaded margin. The shell is 1.8 mm wide and 2.2 mm high.

Skenea torallensis sp. nov.
(Pl. 3, Fig. 1)

HOLOTYPE: The specimen illustrated in Pl. 3, Fig. 1 (GPI 3982).

MATERIAL: One specimen.

DERIVATION OF NAME: Named after the village of Toralla, to the north of the outcrops where this new species was found.

DIAGNOSIS: This *Skenea* has rimmed sutures, an umbilical slit with beaded margin, and an oblique aperture.

DESCRIPTION: The small, low spired and umbilical shell consists of two and a half smooth volutions. The sutures are little incised and show a weak rim below. The aperture is roundish, oblique and a little reinforced. The base has an umbilical slit rimmed by a beaded margin. The embryonic shell measures 0.2 mm across, the whole shell is 2.1 mm wide and 1.5 mm high.

Family uncertain
Genus *Torallochus* gen. nov.

TYPE SPECIES: *Torallochus trempensis* gen. nov. sp. nov. from the Campanian of Torallola, Spain.

DIAGNOSIS: The shell is small, discoid to pupoid, the early whorls are planispirally coiled and are sculptured with strong axial ribs, thickened at the periphery. Later whorls are angular, keeled, and the axial ribs may turn into blunt spines.

DERIVATION OF NAME: A *Trochus*-like shell from Torallola, Spain.

INCLUDED SPECIES: *Torallochus trempensis* sp.nov., *Torallochus pupiformis* sp.nov., and *Torallochus discus* sp.nov. described below from the Campanian of Torallola in northern Spain, and possibly *Discohelix* sp. described by SCHRÖDER (1995) from the Jurassic (Callovian) of Poland.

REMARKS: Among the Archaeogastropoda the shell shape as seen in *Torallochus* n.gen. is rather unusual by having an almost flat initial whorl, an *Astraea*-like juvenile shell with up to four whorls, and from there on an elongate pupoid shell. Similarly elongate late shells are known from the Triassic *Eucycloscala*-relation (see BANDEL 1993a) and the extant umboniid tribe Bankiviini HICKMAN & MCLEAN, 1990, but these groups differ strongly from *Torallochus* regarding shell ornament.

Torallochus trempensis gen. nov. sp. nov.
(Pl. 3, Figs 4-6)

HOLOTYPE: The specimen illustrated in Pl. 3, Figs 4-6 (GPI 3983).

MATERIAL: One specimen.

DERIVATION OF NAME: Named after the Tremp basin in northern Spain, where Torallola is located and this species was found.

DIAGNOSIS: As for the genus.

DESCRIPTION: The protoconch measures about 0.25 mm across and is made of about three quarters of a whorl. The teleoconch consists of six whorls which are initially planispiral, but the last three whorls are turriform; the last whorls has, if at all, a very slow increase in diameter. The first teleoconch whorl has about ten spiny ribs on the periphery, later whorls are angular and have a spiny median keel and a subsutural row of tubercles. The base is rounded and smooth and the shell is about 5 mm high and 4 mm wide.

Torallochus pupiformis gen. nov. sp. nov.
(Pl. 3, Figs 7-8)

HOLOTYPE: The specimen illustrated in Pl. 3, Figs 7-8 (GPI 3984).

MATERIAL: One specimen.

DERIVATION OF NAME: Named after its pupiform shell.

DIAGNOSIS: This small, pupoid *Torallochus* has strong axial ribs which are subsuturally constricted.

DESCRIPTION: Four whorls of the pupiform shell are preserved. They are sculptured with strong axial ribs which are spiny when they cross the median keel and are subsuturally constricted to a row of tubercles. The shell is 1.7 mm high and 1.2 mm wide.

REMARKS: This species is smaller than the type and its axial ribs do not turn into spines on the adult shell.

Torallochus discus gen. nov. sp. nov.
(Pl. 3, Figs 2-3, 11)

HOLOTYPE: The specimen illustrated in Pl. 3, Figs 2-3, 11 (GPI 3985).

MATERIAL: Two specimens.

DERIVATION OF NAME: Named after its discoid shape.

DIAGNOSIS: The discoid shell has 16 radial ribs on the first teleoconch-whorl and the whorl's flanks are convex and smooth.

DESCRIPTION: The protoconch is made of three quarters of a whorl and measures 0.2 mm across. The teleoconch-whorls are flat and smooth on top, have 16 radial ribs on the periphery of the first whorl, and are smooth and convex on the outer flank. Only the last whorl shows turriform coiling. The shell has a diameter of 2.4 mm.

REMARKS: *Torallochus trempensis* differs from *T. discus* not only by its turriform late shell but also in having only about ten ribs on the first whorl, whereas *T. discus* has 16. A discoid shell with similar sculpture and a protoconch of similar shape was described as *Discohelix* sp. by SCHRÖDER (1995) from the Callovian of Poland. That species may belong to *Torallochus* or may represent a disk-shaped ancestral form. However, we doubt its placement within *Discohelix* due to its well-rounded base.

Superfamily Cirroidea COSSMANN, 1916
Family Cirridae COSSMANN, 1916
Subfamily Hesperocirrinae HAAS, 1953

Genus *Sensuitrochus* QUINTERO & REVILLA, 1966

TYPE SPECIES: *Sensuitrochus ferreri* QUINTERO & REVILLA, 1966 from the Campanian of Torallola, Spain.

DESCRIPTION: The high conical shell has flattened whorl flanks and a sharp basal margin. Ornamentation consists of nodes and spiral threads connected to oblique growthlines. The aperture is trapezoid and the base is almost flat or weakly rounded and has no open umbilicus.

REMARKS: *Sensuitrochus* QUINTERO & REVILLA, 1966 was introduced for the sinistrally coiled species described below, and sinistral coiling was the major diagnostic difference which led QUINTERO & REVILLA (1966) to introduced this genus. CALZADA (1989) modified the diagnosis to include a dextrally coiled species from Torallola. This treatment is not accepted here. The additional species of CALZADA (1989) actually represents a member of *Tectus* MONTFORT, 1810 (KIEL & BANDEL 2001). *Shikamacirrus* KASE, 1984 is synonymised with *Sensuitrochus* because the type species *Shikamacirrus nipponicus* KASE, 1984 fits into the diagnosis of *Sensuitrochus*. The Jurassic *Hamusina* GEMMELLARO, 1878 differs from *Sensuitrochus* by having a roundish aperture and a convex base.

We place *Sensuitrochus* within the Cirridae due to its sinistral coiling. However, diagnostic features of the Cirridae are sinistral coiling *and* a dextrally coilded protoconch and possibly early whorls (BANDEL 1993b). This latter character has not yet been proven for *Sensuitrochus*. The only Recent trochoid family with a sinistrally coiled member are the Calliostomatinae (HICKMAN & MCLEAN 1990).

Sensuitrochus ferreri QUINTERO & REVILLA, 1966
(Pl. 3, Figs 9-10)

1966. *Sensuitrochus ferreri* n.sp.; I. QUINTERO & J. REVILLA, p. 51, Pl. 8, Figs 6-7.
1966. *Sensuitrochus ferreri* QUINTERO & REVILLA; J. REVILLA & I. QUINTERO, p. 28, Pl. 5, Figs 6-7.
1989. *Sensuitrochus ferreri* QUINTERO & REVILLA; S. CALZADA, p. 29, Pl. 1, Fig. 2.
1992. *Sensuitrochus ferreri* QUINTERO & REVILLA; K.N. HÄNSEL, p. 63, Pl. 2, Fig. 10.
1993. *Sensuitrochus ferreri* QUINTERO & REVILLA; K. BANDEL, p. 62.

MATERIAL: Ten specimens (figured: GPI 3986).

DESCRIPTION: The sinistrally coiled, trochiform shell is made of eight or more whorls. Its ornament consists of six strong, string-of-pearl-like cords and three weak cords above, between, and below the two strong cords in the middle. The two lowermost cords are a little elevated and form a clear lower margin for the whorl. The aperture is rhomboid, the base is sculptured with numerous weak spiral lines and there is no umbilicus. The figured shell is 15 mm high and 16 mm wide. Nacre is still demonstrable in its original aragonitic state in some specimens (HÄNSEL 1992).

REMARKS: *Sensuitrochus radovesnicensis* (WEINZETTL 1910, pl. 2, figs 31-32) is a very closely related species that possesses only four small tuberculate cords, and the thick collar above the lower suture is not as strongly developed as in *Sensuitrochus ferreri*. Another similar species is *Hamusina nipponicus*, but it has coarser spirals on spire and base.

DISCUSSION

Pseudoliotina was considered a member of the Liotiinae by HICKMAN & MCLEAN (1990). The two species of *Pseudoliotina* documented here are comparable with the Triassic *Woehrmannia* BÖHM, 1895, as well as modern *Cyclostrema*. This group of planispiral liotiids has apparently existed since the Triassic. According to WENZ (1938-44) *Arene* appeared in the Miocene, then SOHL (1998) described a Maastrichtian species from the Caribbean. A similar species from the Campanian is described here.

Among the Colloniinae, our two species of *Homalopoma* closely resemble extant species.

Shells resembling those of Recent *Angaria, Astraea* and *Turbo* can be traced back into the Triassic or even older strata (BANDEL 1993a, YIN & YOCHELSON 1983). For example, *Gizhouia* YIN & YOCHELSON, 1983 from the Chinese Triassic is strikingly similar to modern *Astraea*. Also BANDEL (1993a) connected the Triassic *Coelocentrus* ZITTL, 1882 to Recent forms. When the variability in shell shape documented by BEU & PONDER (1979) for the turbinid genus *Bolma* RISSO, 1826 is considered, it appears to be quite impossible to distinguish *Angaria, Astraea* and *Turbo* from each other in the fossil record. Exceptions may be some direct ancestors of living species in Neogene sediments. We assign our species in question to existing genera and list related forms known from the literature. However, good preservation of gastropods that lived on a rocky shore is rare. Therefore, the fossil record of these groups is too patchy for a truly consistent treatment.

The three small and smooth species resembling

modern skeneids are assigned to *Skenea*, although this taxonomic treatment is far from being save. The modern Skeneidae are not well known and probably represent a polyphyletic group. MARSHALL (1988) described several distinct radulae among the members of this family. WARÉN (1993) indicated anatomical characters diagnostic for *Skenea* to be absent from other skeneid genera. In their revision of Trochoidean gastropods HICKMAN & MCLEAN (1990) summarised problems concerning skeneid classification and considered also their own treatment to be 'highly provisional'. They traced the fossil record of this group back only to the lower Miocene. BANDEL (1993a) illustrated similar shells from the Triassic which would be placed within the Skeneidae if they had lived today.

The new genus *Torallochus* holds archaeogastropods of quite unique, discoid to pupoid shape. We are unable to compare our three species with any extant taxa. A shell resembling *Torallochus*' flat, early whorls was illustrated by SCHRÖDER (1995, pl. 1, figs 5-8) and assigned to *Discohelix*. Due to its rounded base, we doubt this classification, although we cannot offer a better alternative considering available knowledge of these forms.

The here redescribed *Sensuitrochus ferreri* according to BANDEL (1993b) represents the youngest species of the Cirroidea. The same species was also found in presumably Maastrichtian strata near St. Engracia about 5 km south-west of Torallola (own obs.) which is clearly higher up in the stratigraphic section. Thus the Cirroidea apparently reached the end of the Mesozoic era. The genus *Shikamacirrus* KASE, 1980 from the Japanese Aptian/Albian is considered synonymous with *Sensuitrochus*, because its type species fits well into the diagnosis of *Sensuitrochus*.

Acknowledgements

We would like to thank the following persons: Jose M. PONS, Barcelona, for his introduction to the geology of the Tremp basin and the locality of Torallola; Eva VINX, Hamburg for her help in photographing the material; Silke NISSEN, Hamburg, who made the manuscript more readable; Heinz A. KOLLMANN, Vienna and Wacław BAŁUK, Warsaw, for their critical reviews; and all our colleagues who helped to collect these fossils during the numerous field-trips to Spain.

REFERENCES

ABBOTT, T.A. 1974. American Seashells, The marine mollusca of the Atlantic and Pacific Coast of North America, pp. 1-663. *Van Nostrand Reinhold*; New York.

BANDEL, K. 1993a. Trochomorpha (Archaeogastropoda) aus den St.-Cassian-Schichten (Dolomiten, Mittlere Trias). *Annalen des Naturhistorischen Museum Wien,* **95**, 1-99.

— 1993b. Evolutionary history of sinistral archaeogastropods with and without slit (Cirroidea, Vetigastropoda). *Freiberger Forschungsheft*, *Paläontologie C,* **450**, 41-81.

— 2000. Some Gastropods from the Trichinopoly group, Tamil Nadu, India, and their relation to those of the American Gulf Coast. *Memoir Geological Society of India*, **46**, 65-111.

BANDEL, K. & GELDMACHER, W. 1996. The structure of the shell of *Patella crenata* connected with suggestions to the classification and evolution of the Archaeogastropoda. *Freiberger Forschungshefte C,* **464**, 1-71.

BANDEL, K., GRÜNDEL, J. & MAXWELL, P. 2000. Gastropods from the upper Early Jurassic/Middle Jurassic of Kaiwara Valley, North Canterbury, New Zealand. *Freiberger Forschungshefte C,* **490**, 67-132.

BATALLER, J.R. 1949. Sinopsis de las especies nuevas del Cretácico de España. *Anales de la Escuela de Peritos Agrícolas* **8**, 5-148.

BEU, A.G. & PONDER, W.F. 1979. A revision of the species of *Bolma* Risso, 1826 (Gastropoda, Turbinidae). *Records of the Australian Museum*, **32** (1-3), 1-68.

CALZADA, S. 1989. Algunos tróquidos neocretácicos del Prepirineo catalán. *Batalleria*, **3**, 23-36.

COSSMANN, M. 1915. Essais de paléoconchologie comparée 10, pp. 1-292. Privately published; Paris.

— 1925. Essais de paléoconchologie comparée 13, pp. 1-345. Privately published; Paris.

DOCKERY, D.T. 1993. The streptoneuran Gastropods, exclusive of the Stenoglossa, of the Coffee Sand (Campanian) of Northeastern Mississippi. *Mississippi Department of environmental Quality Office of Geology, Bulletin,* **129**, 1-191

FRETTER, V. & GRAHAM, A. 1977. The prosobranch molluscs of Britain and Denmark. Part 2 – Trochacea. *Journal of Molluscan Studies, Supplement,* **3**, 39-100.

GEINITZ, H.B. 1871-1875. Das Elbthalgebirge in Sachsen. *Palaeontographica*, **20** (1), 1-319.

GRÜNDEL, J. 2000. Archaeogastropoda aus dem Dogger Nordeutschlands und des nordwestlichen Polens. *Berliner Geowissenschaftliche Abhandlungen, Reihe E*, **34**, 205-253.

HÄNSEL, K.N. 1992. Geologische Kartierung und Untersuchung der Gastropodenfauna aus dem Campan südwestlich von Pobla de Segur, pp. 1-163. Masterthesis, University of Hamburg (unpubl.).

HICKMAN, C.S. & MCLEAN, J.H. 1990. Systematic revision and suprageneric classification of Trochacean gastropods. *Natural History Museum of Los Angeles County Science Series,* **35,** 1-169.

KASE, T. 1984. Early Cretaceous marine and brackish-water gastropoda from Japan. *National Science Museum*, 1-262.

KIEL, S. & BANDEL, K. 2000. New slit-bearing Archaeo-

gastropoda from the Late Cretaceous of Spain. *Berliner Geowissenschaftliche Abhandlungen, Reihe E*, **34**, 269-277.

— & — 2001. Trochidae (Archaeogastropoda) from the Campanian of Torallola in northern Spain. *Acta Geologica Polonica*, **51** (2), 137-154.

LORIOL, P.DE, 1886-88. Études sur les Molluques des couches Coralligènes de Valfin (Jura). *Abhandlungen der schweizer paläontologischen Gesellschaft*, **13,** 1-120; **14,** 121-224; **15,** 225-369.

— 1893. Description des Mollusques et Brachiopodes des Couches Séquaniennes de Tonnere (Yonne). *Abhandlungen der Schweizer Paläontologischen Gesellschaft*, **20**, 1-213.

MARSHALL, B.A. 1988. Skeneidae, Vitrinellidae and Orbistestellidae (Mollusca: Gastropoda) associated with biogenic substrata from bathyal depth off New Zealand and New south Wales. *Journal of Natural History,* **22**, 949-1004.

QUINTERO, I. & REVILLA, J. 1966. Algunas especies nuevas y otras poco conocidas. *Notas y comunicaciones del Instituto Geologico y Minero de España,* **82,** 27-86.

ROMAN, F. & MAZERAN, P. 1913 [1920]. Monographie paléontologique de la faune du Turonien du Bassin d'Uchaux et de des dépendances. *Archives du Museum d'Historie Naturelle de Lyon,* **12**, 1-133.

SCHRÖDER, M. 1995. Frühontogenetische Schalen jurassischer und unterkretazischer Gastropoden aus Norddeutschland und Polen. *Palaeontographica Abteilung B,* **238** (1), 1-95.

SOHL, N.F. 1998. Upper Cretaceous Trochacean Gastropods from Puerto Rico and Jamaica. *Palaeontographica Americana*, **60,** 1-109.

STEWARD, R.B. 1926. Gabb's California fossil type gastropods. *Proceedings of the Academy of Natural Sciences of Philadelphia,* **78**, 287-447.

VIDAL, L.M. 1921. Segunda nota paleontológica sobre el cretáceo de Cataluña. *Bull. Inst. Cat. Hist. Nat*., **21**, 1-50.

WARÉN, A. 1991. New and little known mollusca from Iceland and Scandinavia. *Sarsia*, **76**, 53-124.

— 1993. New and little known mollusca from Iceland and Scandinavia Part 2. *Sarsia*, **78**, 159-201.

WEINZETTL, V. 1910. Gastropoda Českého Křídového Útvaru. *Palaeontographica Bohemiae,* **8**, 1-56.

WENZ, W. 1938-1944. Gastropoda Teil 1: Allgemeiner Teil und Prosobranchia. *In*: SCHINDEWOLF, H. (*Ed*.), *Handbuch der Paläozoologie,* **6** (1), pp. 1-1639, Berlin.

YIN HONG-FU, & YOCHELSON, E.L. 1983. Middle Triassic Gastropoda from Qingyan, Guizhou Province, China: 2 – Trochacea and Neritacea. *Journal of Paleontology*, **57**, 515-538.

Manuscript submitted: 10th April 2001
Revised version accepted: 15th February 2002

PLATE 1

1-2 – *Pseudoliotina sensuyi* (VIDAL, 1921); × 6.
3-5 – *Pseudoliotina stinnesbecki* sp. nov.; holotype; × 3.8.
6-7 – *Arene mcleani* sp. nov.; holotype; × 21.
8 – *Homalopoma schroederi* sp. nov.; holotype; × 11.4.
9-10 – *Barbotella maestrichtiensis* (QUINTERO & REVILLA, 1966); 9 – adult specimen; × 1.3; 10 – juvenile specimen; × 2.7.
11 – *Homalopoma minuta* (QUINTERO & REVILLA, 1966); × 13.7.

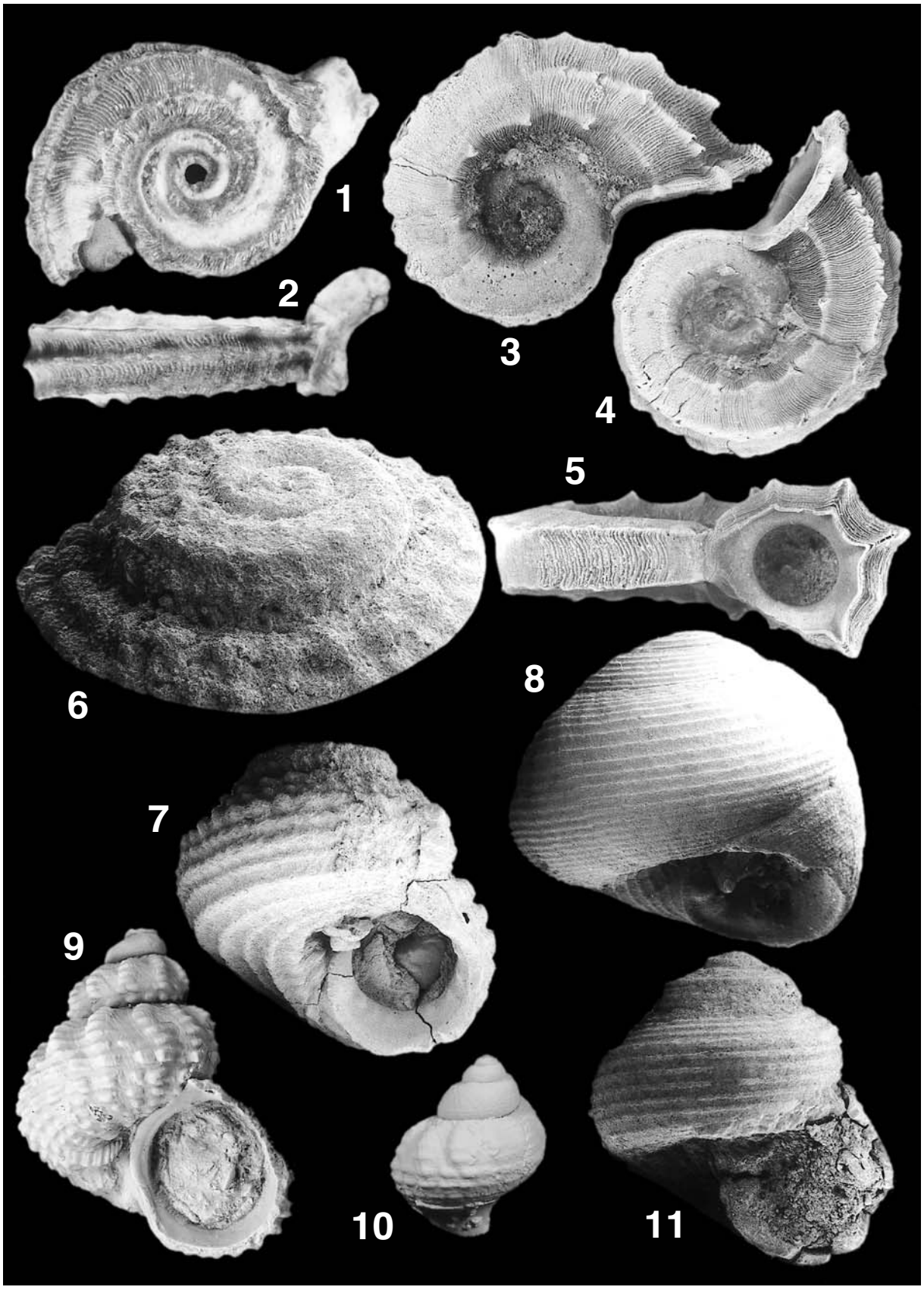

1
2
3
4
5
6
7
8
9
10
11

PLATE 2

1-3 – *Marmorostoma sensuyi* (VIDAL, 1924); 1 – apertural view on an adult specimen; × 2.5; 2 – apical view on the same specimen as Fig. 1; × 2.9; 3 – juvenile specimen showing the protoconch; × 57.

4-6 – *Astraea batalleria* sp. nov.; holotype; × 1.4.

7-9 – *Astraea iredalei* sp. nov.; holotype; × 2.6.

10-11 – *Astraea hickmanae* sp.; holotype; × 2.3.

12-14 – *Astraea sohli* sp.; × 2.7.

15 – *Skenea wareni* sp. nov.; holotype; × 34.

16 – *Skenea suturata* sp. nov.; holotype; × 23.

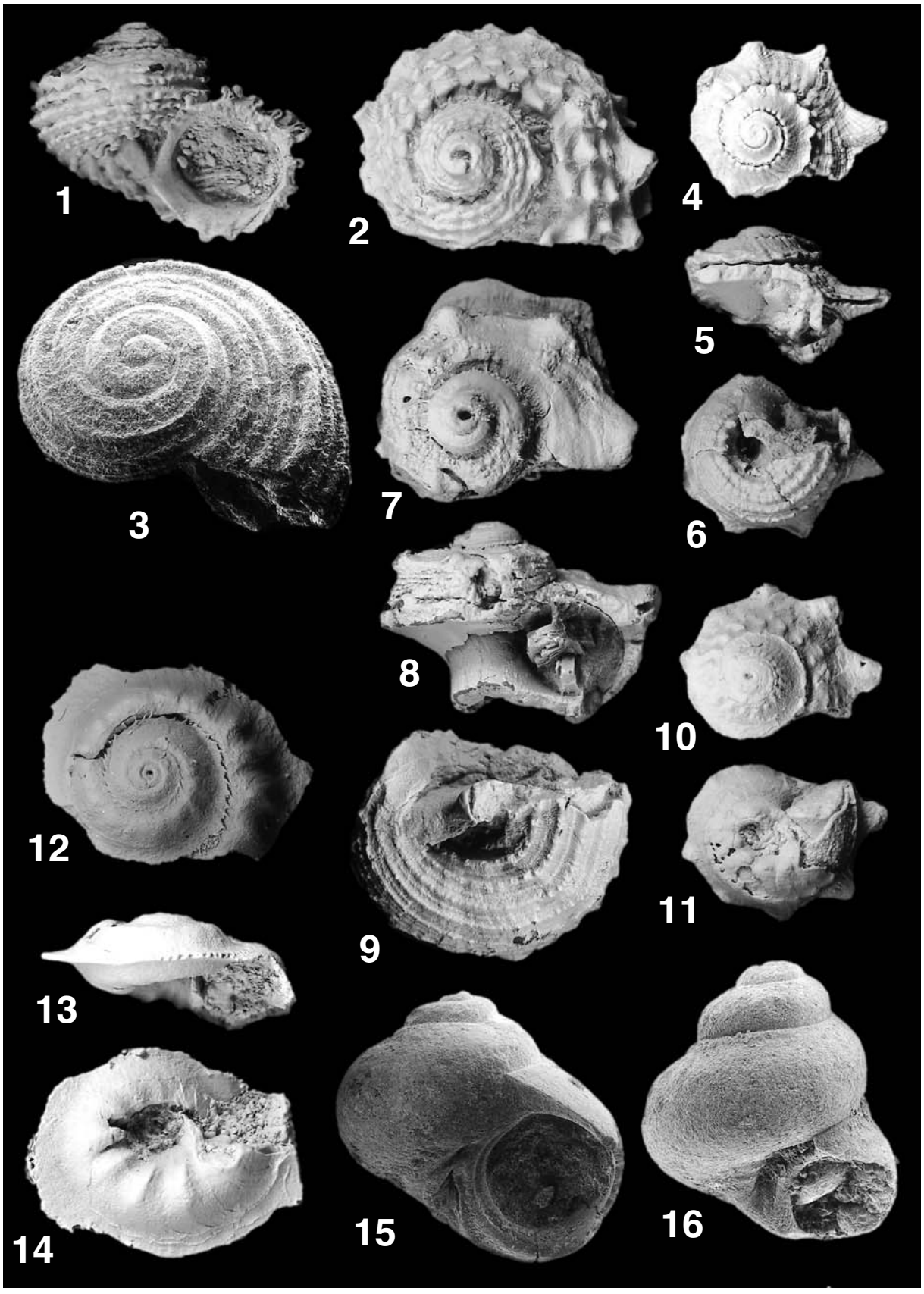

1
2
4
3
7
5
6
8
10
12
9
11
13
14
15
16

PLATE 3

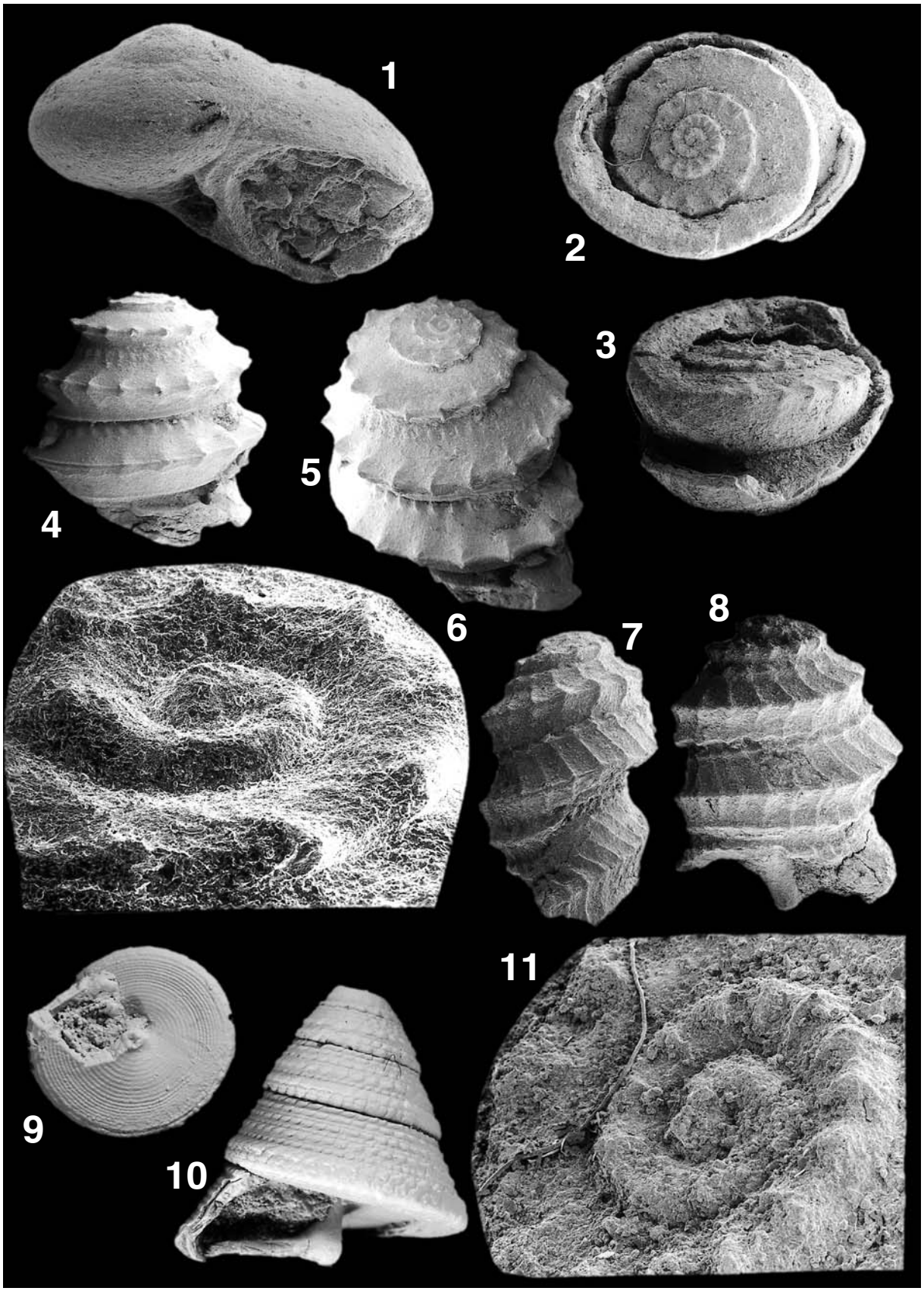
1 – *Skenea torallensis* sp. nov.; holotype; × 34.

2-3, 11 – *Torallochus discus* gen.nov. sp. nov.; holotype; 2-3 – apical and ventral view; × 22; 11 – view on the protoconch; × 125.

4-6 – *Torallochus trempensis* gen.nov. sp. nov.; holotype; 4-5 – two view on the holotype; × 9; 6 – view on the protoconch; × 117.

7-8 – *Torallochus pupiformis* gen. nov. sp. nov.; holotype; × 30.

9-10 – *Sensuitrochus ferreri* QUINTERO & REVILLA, 1966; 9 – basal view; × 2.4; 10 – apertural view; × 3.


1
2
3
4
5
6
7
8
9
10
11