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New slit-bearing Archaeogastropoda from the Late Cretaceous of Spain

Steffen Kiel & Klaus Bandel

Abstract: Six species of slit-bearing archaeogastopods are described from the Campanian (Upper Cretaceous) of Torallola in north-eastern Spain. They are considered to belong to the Pleurotomariidae, Fissurellidae, Scissurellidae and Temnotropidae. The earlier suggestions that *Temnotropis* may be among the stem-group representatives of the Haliotidae is supported by the discovery of *Temnotropis frýdai* n. sp. which lived simultaneously with the earliest Haliotidae. The new species are Stuorella cretacea, *Temnotropis frýdai*, *Scissurella hispanica*, *Scissurella lleidania* and *Emarginula radiocostata*.

Kurzfassung: Sechs Arten der Schlitzbandschnecken werden aus dem Campan (Oberkreide) von Torallola im Nordosten Spaniens beschrieben und den Pleurotomariidae, Temnotropidae, Scissurellidae und Fissurellidae zugeordnet. Die frühere Vermutung, *Temnotropis* könnte zu den Stammgruppenvertretern der Haliotidae gehören, wird durch die Entdeckung von *Temnotropis frýdai* n. sp. unterstützt, da diese Art zeitgleich mit der ersten Haliotidae lebte. Die neuen Arten sind Stuorella cretacea, *Temnotropis frýdai*, *Scissurella hispanica*, *Scissurella lleidania* und *Emarginula radiocostata*.

Keywords: Cretaceous, Archaeogastropoda, Pleurotomariidae, Fissurellidae, Scissurellidae, Temnotropidae, taxonomy, phylogeny.

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

1. Introduction

Among the living slit-bearing (selenimorph) archaeogastropods, five families can be recognized. Three of them, the Pleurotomariidae Swainson, 1840, the Haliotidae Rafinesque, 1815 and the Seguenziidae Verrill, 1884 have a predominantly nacreous shell (Bandel 1979), while the Fissurellidae Flemming, 1822 and the Scissurellidae Gray, 1847 construct their shell mainly of aragonitic crossed lamella structure (Bandel 1998). Members of the five families are well distinguishable by their radula (Troschel 1856; Thiele 1929-35; Hickman 1981; Marshall 1993) and by shell characters. Relationships between and within these families are still a matter of debate. They have all been raised to superfamilies by various authors, Haszprunar (1988) even regarded the Seguenziidae as an independent archaeogastropod suborder. Batten (1975) considered the Scissurellidae to represent neotenously derived fissurellids, and McLean (1984) suggested a derivation of the Fissurellidae directly from the Bellerophontidae M'Coy, 1851. Both suggestions could not be verified by the fossil record (Bandel 1998).

Most of these families have already existed during the Late Cretaceous (Holzapfel 1888; Sohl 1992). In the case of the Seguenziidae, members have been recognized in the Late Triassic (Bandel 1991) and again from the Eocene to modern time (Marshall 1988), with no record from the Jurassic or Cretaceous. The Pleurotomariidae can be traced to the Triassic and with some probability into the Paleozoic, where selenimorph species with nacreous shell are known for example from the Carboniferous and Devonian (Batten 1972; Bandel & Geldmacher 1996). Pleurotomariids could well be among those groups that lived during the early days of gastropod existence in the lower Ordovician. Among the Haliotidae, the oldest characteristic Haliotis-like species are known from the Late Cretaceous (Anderson 1902; Durham 1979; Sohl 1992; Geiger & Groves 1999). However, there is a gap in the fossil record from Paleocene through Oligocene (Sohl 1992). It was suggested that the Haliotidae relate to the Temnotropidae (Laube 1869; Koken 1897) which used to have their latest known representatives in the Late Triassic (Kittl 1891;

Bandel 1991). The most ancient representative of the Scissurellidae apparently lived in the Late Triassic, and rather "normal" scissurellids are known from the early Jurassic onwards (Bandel 1991, 1998). The Fissurellidae originated apparently at the same time; *Emarginula* Lamarck, 1801 for example was already quite differentiated in the Late Triassic (Zardini 1978; Bandel 1998).

Going back in the fossil record, it usually becomes more and more difficult to connect the species of selenimorph archaeogastropods with living ones. Several selenimorph species from the Triassic can be regarded as possible stem-group representatives of the Recent families. Others were interpreted as independent, now extinct groups with Paleozoic character (Bandel 1991). The selenimorph archaeogastropods had their heydays in the Paleozoic; Wenz (1938) and Knight et al. (1960) listed no less than fifteen Paleozoic pleurotomarioid subfamilies. Unfortunately, many of these taxa can neither be related to any modern group, nor can they be placed in a well defined taxon of extinct species (Bandel & Frýda 1996).

2. Material

The gastropods described in this study were obtained from grey marls in a valley system around Torallola, Toralla and Sensui in the Tremp basin of the Spanish Pyrenees. Stratigraphically, the sediments belong to the Puimanyons Olisthostrom of the Valcarga Formation which are, according to Rossell Sanuy et al. (1972), of Campanian age. The material was collected by the authors and many of our colleagues from Hamburg University during the last ten years. Fossils from this locality were previously described by Vidal (1921), Bataller (1949), Quintero & Revilla (1966) and Baron-Szabo (1998). All specimens are deposited in the collection of the Geologisch-Paläontologisches Institut und Museum, Universität Hamburg, labelled GPI 3960-3968.

3. Taxonomy

Class Gastropoda Cuvier, 1797
Subclass Archaeogastropoda Thiele, 1925
Order Vetigastropoda Salvini-Plawen, 1980
Family Pleurotomariidae Swainson, 1840

Genus *Perotrochus* Fischer, 1885

Type species: *Perotrochus quoyana* Fischer & Bernardi, 1885 which lives on deep reef slopes in the Caribbean Sea and the Gulf of Mexico (Abbott 1974: Fig. 1).

Description: The moderate to low-spired, conical shell has whorls which may be shouldered and are sculptured with fine spiral and axial lines. The slit is situated in about the centre of the whorl, its base is umbilicate, and the aperture is of rhomboid shape.

Remarks: *Perotrochus* differs from *Pleurotomaria* Sowerby, 1821 by having convex or angular whorls, whereas they are straight or concave in the later. Stuorella Kittl, 1891 differs by having a small, straight-sided shell with indistinct sutures.

Perotrochus cf. *distincta* (Goldfuss, 1841)
(Pl. 1, Figs. 1-2)

1841 *Pleurotomaria distincta* - Goldfuss, p. 71, pl.187, fig. 6.

1888 *Pleurotomaria distincta* Goldfuss - Holzapfel, p. 176, pl. 20, fig. 6.

Material: Seven specimens.

Description: The protoconch is globular and smooth, and measures about 0.4 mm across. The first 2-2.5 volutions of the teleoconch are smooth and well rounded, afterwards an ornamentation of fine transverse cords and spiral cords begins as well as the slit. The teleoconch is large and trochiform, consists of six angular whorls with the slit at the periphery. The base is ornamented with spiral lirae that continue into the deep and large umbilicus. The largest specimen is 25 mm high and 43 mm wide.

Genus *Stuorella* Kittl, 1891

Type species: *Trochus subconcava* Münster, 1841 from the Middle Triassic of the St. Cassian Formation (Bandel 1991: Pl. 9, figs. 7,8; pl. 10, figs. 1-5, 7).

Description: The small, conical shell has straight sides and indistinct sutures. The slit is situated in the lower half of the whorl, the aperture trapezoid and the base concave (Bandel 1991: 25).

Stuorella cretacea n. sp.

(Pl. 1, Figs. 3-4)

Derivatio nominis: This is the first species of *Stuorella* from the Cretaceous.

Holotype: GPI 3962, pl. 1, figs. 3-4.

Locus typicus: The valley system around Torallola, Toralla and Sensui near Pobla de Segur in the Tremp basin of the Spanish Pyrenees.

Stratum typicum: The Puimanyons Olistho-strom (Campanian) of the Valcarga Formation.

Material: One specimen.

Diagnosis: A small *Stuorella* with backward sloping lirae on the upper half and lower quarter of the whorls and a trapezoid aperture.

Description: The small, conical shell consists of seven to eight volutions. Its whorls are sculptured with fine, backward sloping lirae on the upper half and on the lower quarter, the slit is situated between these. The base is concave and sculptured with fine spiral lirae. The aperture is of trapezoid shape. The shell is 7 mm high and 8 mm wide.

Remarks: *Stuorella costalaricensis* Zardini, 1978 from the Triassic of the St. Cassian Formation has a very similar shell that differs only marginally in having straighter sides (Bandel 1991). It is quite surprising to find Stuorella on the coast of the Tethys Ocean in the Campanian, almost unchanged since the Triassic.

Family Temnotropidae Cox, 1960

Genus *Temnotropis* Laube, 1870

Type species: *T. carinata* (Münster, 1841) from the St. Cassian Triassic of the Italian Alps.

Description: The low, ear-shaped shells consist of few, fast-growing volutions. The slit is situated at the upper flank, the base is concave and the aperture oblique.

Remarks: Examining the type material and additional specimens, Bandel (1991) was unable to distinguish *T. carinata* and *T. bicarinata* Laube, 1869 and considered them to represent the same species.

Temnotropis frýdai n. sp.

(Pl. 1, Figs. 5-7)

Derivatio nominis: Named in honour of the Czech paleontologist Jiri Frýda and his contribution to our knowledge of paleozoic gastropods.

Holotype: GPI 3964, pl. 1, figs. 6-7.

Paratype: GPI 3963, pl. 1, fig. 5.

Locus typicus: The valley system around Torallola, Toralla and Sensui near Pobla de Segur in the Tremp basin of the Spanish Pyrenees.

Stratum typicum: The Puimanyons Olistho-strom (Campanian) of the Valcarga Formation.

Material: Two specimens.

Diagnosis: This *Temnotropis* has rounded early whorls, an umbilicus and a narrow, lenticular aperture.

Description: The low conical shell has flat but convex whorls which increase fast in size. The first 1 ½ whorls are convex and smooth and without slit. Afterwards, the whorl's upper side is sculptured with 15 spirals and the slit appears near the outer margin. The base is concave, umbilicate and shows four spirals on the outer side; the aperture is flatly lenticular. The shell's largest diameter measures 3.3 mm.

Remarks: This new species is distinct from the Triassic type by its narrower aperture, its lower lying slit and the presence of an umbilicus. In shape, it very closely resembles

Haliotis antillesensis Sohl, 1992 from the Maastrichtian of Puerto Rico.

Family Scissurellidae Gray, 1847

Genus *Scissurella* d'Orbigny, 1823

Type species: *Scissurella costata* d'Orbigny, 1823, living in the Mediterranean (Wenz 1938: Fig. 269).

Description: The shell is low-turbiniform, the slit is situated above the peripheral margin and the apex is flattened.

Remarks: According to Bandel (1998) *Anatoma* Woodward, 1859 differs by its higher spire, and *Maxwellella* Bandel, 1998 is planispirally coiled and its whorl cross-section increases slower than in the case of *Scissurella*.

Scissurella hispanica n. sp.
(Pl. 1, Figs. 8-9)

Derivatio nominis: Named after Spain, the country of its occurrence.

Holotype: GPI 3965, pl. 1, figs. 8-9.

Locus typicus: The valley system around Torallola, Toralla and Sensui near Pobla de Segur in the Tremp basin of the Spanish Pyrenees.

Stratum typicum: The Puimanyons Olisthostrom (Campanian) of the Valcarga Formation.

Material: One specimen.

Diagnosis: This low spired *Scissurella* has strong but short axial ribs. The slit starts after 1.25 teleoconch whorls.

Description: The nearly disc-shaped scissurellid shell has its protoconch and the first ¼ volution imbedded in the following whorl. Sculpture consists of four opisthocline ribs on the last ¼ volution before the onset of the slit. Afterwards, they are restricted to the inner half of the upper whorl-side. The slit starts after 1.25 teleoconch-whorls and is in prove with the high marginal rim. About half of the height of the whorl's outer side is occupied by a smooth constriction below the slit, the lower half is ornamented with strong transverse ribs. The aperture is oval and almost twice as wide as high. The shell is 0.6 mm high and 1 mm wide.

Differences: This new species is distinct from *Scissurella lleidania* n. sp. by its low shape and strong ribs, which are finer and more numerous on the former. Similar ornament can be seen on *Scissurella peyrerensis* Lozouet, 1986 from the French Oligocene (Bandel 1998: Pl. 4, fig. 8; pl. 5, figs. 1-3) but that species is higher and the slit starts about half a volutions later than on *Scissurella hispanica* n. sp.

Scissurella lleidania n. sp.
(Pl. 1, Figs. 10-11)

Derivatio nominis: After the province of Lleida, to which the locality of Torallola belongs.

Holotype: GPI 3966, pl. 1, fig. 10.

Paratype: GPI 3967, pl. 1, fig. 11.

Locus typicus: The valley system around Torallola, Toralla and Sensui near Pobla de Segur in the Tremp basin of the Spanish Pyrenees.

Stratum typicum: The Puimanyons Olisthostrom (Campanian) of the Valcarga Formation.

Material: Three specimens.

Diagnosis: The first volution including the protoconch is imbedded in the following whorl. The shell is sculptured with transverse ribs and the aperture shows a straight inner and a concave outer side.

Description: This scissurellid shell has a small and low spire and a large last whorl. Its protoconch and the first ¼ volution of the teleoconch are imbedded in the succeeding whorl. The slit starts after 1.25 volutions of the teleoconch and is situated at the periphery. Below the slit is a smooth constriction followed by the convex outer side of the whorl that is sculptured with numerous axial to transverse ribs. The umbilicus is widely open, axially ribbed inside and shows two spiral cords. The large aperture shows a straight columellar lip and a broadly convex outer lip. The shell is 1 mm high and 1.5 mm wide.

Remarks: Very closely related and distinct only by its convex columellar lip is *Scissurella marchmontensis* Sohl, 1992 from the Caribbean Maastrichtian. *Scissurella hispanica* n.

sp. described above is flatter, and possesses less but stronger axial ornament. Similar recent shells include *Scissurella hoernesi* Semper, 1965, *Scissurella reticulata* Philippi, 1853 and *Scissurella koeneni* Semper, 1865 (see Bandel 1998) but they possess spiral ornament also, absent from *Scissurella lleidania* n. sp.

Family Fissurellidae Flemming, 1822

Genus *Emarginula* Lamarck, 1801

Type species: *Patella fissura* Linné, 1758, Recent, from the North Sea (Wenz 1938: Fig. 276).

Description: The patelliform shell has the elongated and narrow slit at its anterior margin between two radial ribs.

Emarginula radiocostata n. sp.
(Pl. 1, Figs. 12-14)

Derivatio nominis: This species shows radial costae only.

Holotype: GPI 3968, pl. 1, figs. 12-14.

Locus typicus: The valley system around Torallola, Toralla and Sensui near Pobla de Segur in the Tremp basin of the Spanish Pyrenees.

Stratum typicum: The Puimanyons Olistho-strom (Campanian) of the Valcarga Formation.

Material: One specimen.

Diagnosis: This *Emarginula* is a little wider than high, possesses a downward-pointing, slightly twisted apex, and strong radial sculpture.

Description: The slightly twisted, limpet-like shell has a downward-pointing apex and is sculptured with 14 radial ridges and fine lines in between. The aperture is rounded rectangular and the slit is situated on the dorsal side between the two strongest ribs. The aperture is 7 mm long, 4.5 mm wide, and the shell is 5 mm high.

Remarks: Sohl (1992) described three species of *Emarginula* from the Upper Cretaceous of the Caribbean, but they all show strong concentric sculpture in addition to the radial ribs. The same applies to the numerous species of *Emarginula* described by Kaunhowen (1897) from Maastricht.

4. Conclusions

The selenimorph group *Stuorella* consists of the Late Triassic genera *Stuorella* and *Codinella* Kittl, 1899 as well as the Permian *Lamellospira* Batten, 1972 and the Carboniferous *Glyptotomaria* Knight, 1945 (Bandel & Geldmacher 1996). A relation to Jurassic Pleurotomariidae has been suggested (Kittl 1891; Wenz 1938; Knight et al. 1960; Bandel 1991; Tracey et al. 1993), which is now further supported by a surviving representative in the Campanian. Modern pleurotomariids like the here redescribed *Perotrochus* cf. *distincta* lived alongside with *Stuorella cretacea*.

Also the earlier proposal that Recent Haliotidae have their ancestors in the Temnotropidae (Laube 1869; Koken 1897; Bandel 1991) may be confirmed by our new data. The latest representative of *Temnotropis* has hitherto been known only from the Late Triassic (Kittl 1891; Bandel 1991). However, the discovery of *Temnotropis frýdai* n. sp. in the Spanish Campanian shows that *Temnotropis* still lived when *Haliotis* Linné, 1758 first appeared.

Only one Cretaceous species of *Scissurella* has hitherto been known, two are added here. One differs only marginally from the one described by Sohl (1992) from the Jamaican Maastrichtian, while the other shows affinities to European species from the Paleogene.

The newly described fissurellid belongs to the well-known genus *Emarginula* but it is quite unique with its slightly twisted shell.

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Plate 1

Figs. 1-2: *Perotrochus* cf. *distincta* (Goldfuss, 1841); 1: adult shell; GPI 3960; greatest width: 43 mm; 2: juvenile shell showing the protoconch and the smooth initial whorls; GPI 3961; width 2.5 mm.

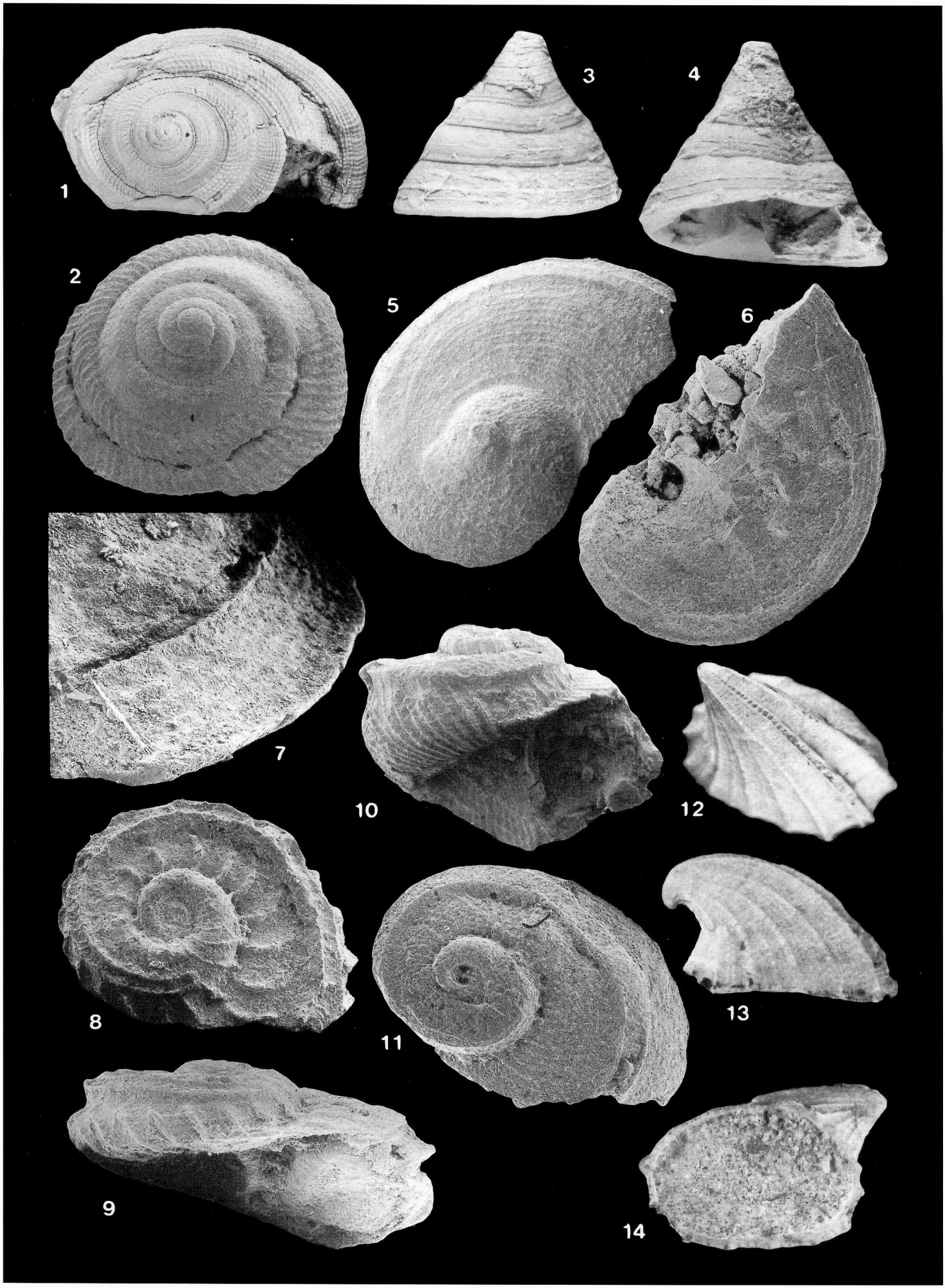
Figs. 3-4: *Stuorella cretacea* n. sp.; GPI 3962; front and back view; height: 7 mm.

Figs. 5-7: *Temnotropis frýdai* n. sp.; 5: paratype showing the transition from the smooth early shell to the sculptured adult shell; GPI 3963; greatest width: 3.1 mm; 6: umbilical view on the holotype; GPI 3964; greatest width 3.3 mm; 7: detail of the holotype showing the slit; width: 0.9 mm.

Figs. 8-9: *Scissurella hispanica* n. sp.; apical and frontal view on the holotype; GPI 3965; width: 1.0 mm.

Figs. 10-11: *Scissurella lleidania* n. sp.; 10: frontal view on the holotype; GPI 3966; height: 1.0 mm; 11: apical view on the paratype; GPI 3967; width: 1.5 mm.

Figs. 12-14: *Emarginula radiocostata* n. sp.; three views on the holotype; GPI 3968; greatest width: 7.0 mm, height: 5.0 mm.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