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THE EVOLUTION OF CONCH ONTOGENY IN MESOZOIC OPEN SEA GASTROPODS

(EWOLUCJA ONTOGENEZY MUSZLI MEZOZOICZNYCH
ŚLIMAKÓW OTWARTEGO MORZA)

by

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Data on embryonic, larval, and postlarval morphology of the gastropod conchs from the Mid Jurassic to Early Cretaceous black clays from Poland are used to improve their taxonomy. The phylogenetic relationships of the fossil gastropod taxa to their Recent relatives are traced. The results show that most of the Recent groups were already present in the Mid Jurassic. The vetigastropods are apparently conservative and shells of some groups have not changed significantly for at least 160 Ma. The most primitive extant caenogastropods (e.g., Cerithioidea and Ampullospiridae) most probably have originated from the branches which diverged already in the Late Paleozoic. The other caenogastropods have undergone significant radiation in the Triassic. Then the Caenogastropoda had a period of relative stagnation. The significant exception is emergence and rapid radiation of Neogastropoda during the Cretaceous. The most diversified Mesozoic family of Heterostropha, the Mathildidae, had its acme from the Late Triassic to the Early Cretaceous. Later the family gradually declines and nowadays it is a relic group. The oldest cephalaspidean opisthobranchians are known since the Early Triassic but the significant radiation has taken place in the Mid Jurassic. The siphonariids, the marine pulmonates, are recognized from the Early Cretaceous. 135 species (54 of them new) and two new genera (*Dzikella* and *Gnaszynium*) are described.

Key words: Gastropoda, evolution, phylogeny, taxonomy, Jurassic, Cretaceous, Poland.

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INTRODUCTION

After the milestone studies of Cossmann (1895–1924), Thiele (1925–26) and Wenz (1938–44), there was a long period of lessened activity at the field of gastropod taxonomy. This was mainly the result of the limitations of the research techniques available at that time. The introduction of the scanning electron microscope (SEM) to the gastropod studies, and somewhat later that of molecular analysis, offered new instruments for reconstructing gastropod phylogeny. The SEM photographs especially contributed greatly to the subject as a source of much information, which introduced some order into the taxonomy of fossil gastropods. Such detailed studies of the conch ontogeny and shell microstructure were virtually impossible earlier. Thiriot-Quiévreux (1972) was the first to apply the SEM to the study of the early development of extant gastropods, while Bandel (1982) was the first to apply it to the study of the development of fossil ones. These studies showed that the morphology of larval shells is much more stable and significant in the high level taxa than the morphology of teleoconch. Since those pioneering works, the amount of data concerning the early ontogeny of gastropods rapidly increases year by year.

The new evidence stimulated the zoologists' attempts to construct a general phylogeny of the group (e.g., Ponder and Lindberg 1997; Winnepenninckx *et al.* 1998; Colgan *et al.* 2000, 2003). These analyses were based mainly on the anatomical and molecular data, not available for fossils. Despite their obvious limitations, the fossils are indispensable in offering an additional dimension of the deep geological time. Owing to it, the shell characters of fossil gastropods can be used for independent tests of zoological phylogenetic trees. The tracing of particular lineages to the Mesozoic times, when most of the gastropods were significantly different from the extant ones but higher rank taxonomic affiliations are still easily detectable (especially those from deep-water), has appeared to be the most efficient approach to resolve taxonomic and phylogenetic problems.

The present paper is aimed at extracting information on the early ontogeny of extinct gastropods from exellently preserved, aragonitic shells from the Jurassic and Cretaceous of Poland. The new information is merged with data on the shell ontogeny of Recent gastropods to construct a taxonomy applicable both to fossils and living gastropods. Once a well-supported phylogeny of Mesozoic to Recent gastropods is obtained, the research should be extended backwards in time to the root of "modern" gastropods that are contained within the much more troublesome Palaeozoic taxa.

The material is housed at the Institute of Paleobiology, Polish Academy of Sciences (PAS) in Warsaw (abbreviated ZPAL) and the Museum of the Earth PAS in Warsaw (abbreviated MZ).

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FOSSIL LOCALITIES

Most of the gastropods studied come from clayey facies of more or less open sea environment. The gastropods described herein are derived from numerous Bajocian–Bathonian localities of the Częstochowa region and from single localities in other regions of Poland. The black/gray clay and silt of the latest Bajocian to Bathonian crop out in the Częstochowa region (often also called the Polish Jura Chain). Large blocks of Upper Callovian black clay were once accessible at Łuków (Podlasie region) in glacial drift. Oxfordian shallow water high-energy sand (Cedro 1999) crops out near Kłęby (Pomerania in northwestern Poland). Gastropods of the early to late Valanginian were obtained from the black clay exposed at Wąwał near Tomaszów Mazowiecki, Central Poland. The sampled localities are briefly described in alphabetical order.

Blanowice. — This is a brick-pit located in the northeast suburb of Zawiercie (Fig. 1B). The section exposes black clays of the Bathonian, most probably the *Morrisiceras morrisi* Zone (Różycki 1953). The gastropod specimens I examined were collected in the 1960's by S. Dąbrowski and deposited at the Museum of the Earth PAS in Warsaw.

Faustianka. — This is a brick-pit located in the eastern part of the village Faustianka (Fig. 1B, F). The section exposes about 8 meters of black to gray clays with layers of ironstone nodules. Three gastropod yielding samples representing *Procerites progracilis* Zone of the Mid Bathonian (Matyja and Wierzbowski 2000) were taken from the upper part of the section. The samples (5 kg each) show the homogenous composition of the assemblage throughout the sampled unit.

Gnaszyn. — The locality was referred to as Gnaszyn Dolny by Majewski (1997) and Gnaszyn II by Majewski (2000). This is a large brick-pit on the western rim of Częstochowa (Fig. 1B, G). The main part of the section exposes the *Morrisiceras morrisi* Zone of the Mid Bathonian (Majewski 1997). The uppermost part most probably belongs to the Late Bathonian (Majewski 1997). The gastropod-bearing sample (about 100 kg) came from a block of clay containing a large log of wood encrusted by numerous individuals of benthic fauna. The sample collected from the surface of this log yielded a rich assemblage of mollusks (gastropods, bivalves, scaphopods, and chitons) and other fossils. This assemblage might be interpreted as "the sunken-wood association" known from the Recent seas (e.g., Marshall 1988; Warén and Carrozza 1990; Hasegawa 1997; Sirenko 1998).

Kawodrza-Kawodrzanka. — The locality was referred to as Kawodrza Dolna (outcrop 3) by Majewski (1997). This is a large brick-pit on the western rim of Częstochowa (Fig. 1B). The section exposes clay of *Morrisiceras morrisi*, *Procerites hodsoni*, and *Oxycerites orbis* Zones of the Mid to Late Bathonian (Majewski 1997). I collected two samples (5 kg each) in the *Morrisiceras morrisi* Zone of Mid Bathonian. The samples yielded very few specimens of gastropods, and of those only two were possible to identify (*Eucycloscala* sp. 3 and *Azyga* sp.).

Kawodrza-Sowa. — The locality was referred to as Gnaszyn Górny by Majewski (1997). This is a brick-pit located on the western rim of Częstochowa (Fig. 1B). The section exposes about six meters of gray silty clay. These are the Bajocian–Bathonian boundary strata (Matyja and Wierzbowski 2000). The gastropods described here come from two samples taken from the upper part of the section, representing the uppermost *Parkinsonia bomfordi* Subzone of Late Bajocian, just below the "D" ironstone layer of Wierzbowski and Matyja (2000). The samples (5 kg each) show the homogenous composition of the gastropod assemblage.

Kłęby outcrop. — The outcrop is located close to village the Kłęby (Klemmen before 1945) on the left bank of the Zielonka Stream (Fig. 1C). The gastropod-bearing strata are currently (1999) covered by soil and hardly visible on the surface. The strata, developed as shell-supported coquinas with a sandy-clayey matrix, were dated by Schmidt (1905) as the Late Oxfordian, based on ammonites. According to Cedro (1999) they were deposited in the shallow water, high-energy environment.

The gastropods from this outcrop were previously studied by Schmidt (1905) and Dmoch (1971). The material I examined comes from the collection of J. Dzik and from rock samples provided by M. Gruszczyński (both of the Institute of Paleobiology PAS).

It is worth noting that the numerous papers of Gründel (1973, 1974b, 1975a, b, 1977, 1997a, b, 1998a, b, 1999a, c, d, e, f, 2000a, b, 2001b) on the Bathonian and Callovian gastropods were based on a borehole drilled in 1938 in the vicinity of Kłęby but not on the outcrop.

Kłobuck borehole 22. — The Kłobuck borehole 22 (Fig. 1B) reached silt and clay of the Bajocian and Bathonian (Garbowska *et al.* 1978). The samples I received from B. Łącka (Institute of Geological Sciences, Warsaw) partially lack information as to the exact position in the geological section. I estimated the age of the gastropod-bearing samples as Bathonian on the basis of lithologic premises.

Korwinów. — This is an abandoned brick-pit on the southern rim of Częstochowa (Fig. 1B). The section exposed black clay which is attributed by J. Dzik (unpublished data) to the *Zigzagiceras zigzag* Zone of the Early Bathonian. The gastropod collection I examined was collected in 1971 by J. Dzik and is housed at the Institute of Paleobiology PAS, Warsaw.

Łuków. — This is an abandoned brick-pit at Łapiguz, a suburb in the southern part of Łuków (Fig. 1D), exploiting large blocks of glacial drift. The outcrop exposed the Late Callovian black clay with limestone concretions (see review of Olempska and Błaszyk 2001) containing rich ammonite fauna. The concretions are dated by Dzik (1990) as the *Quenstedtoceras henrici* Subzone of the *Quenstedtoceras lamberti* Zone. The rocks at Łuków are foreign to the area. The autochthonous Late Callovian strata reached by deep boreholes in the Łuków area were deposited in carbonate facies (Dayczak-Calikowska and Kopik 1976). The source of the Callovian clay is probably the bottom of the Baltic Sea, northward from Gdańsk (Olempska and Błaszyk 2001).

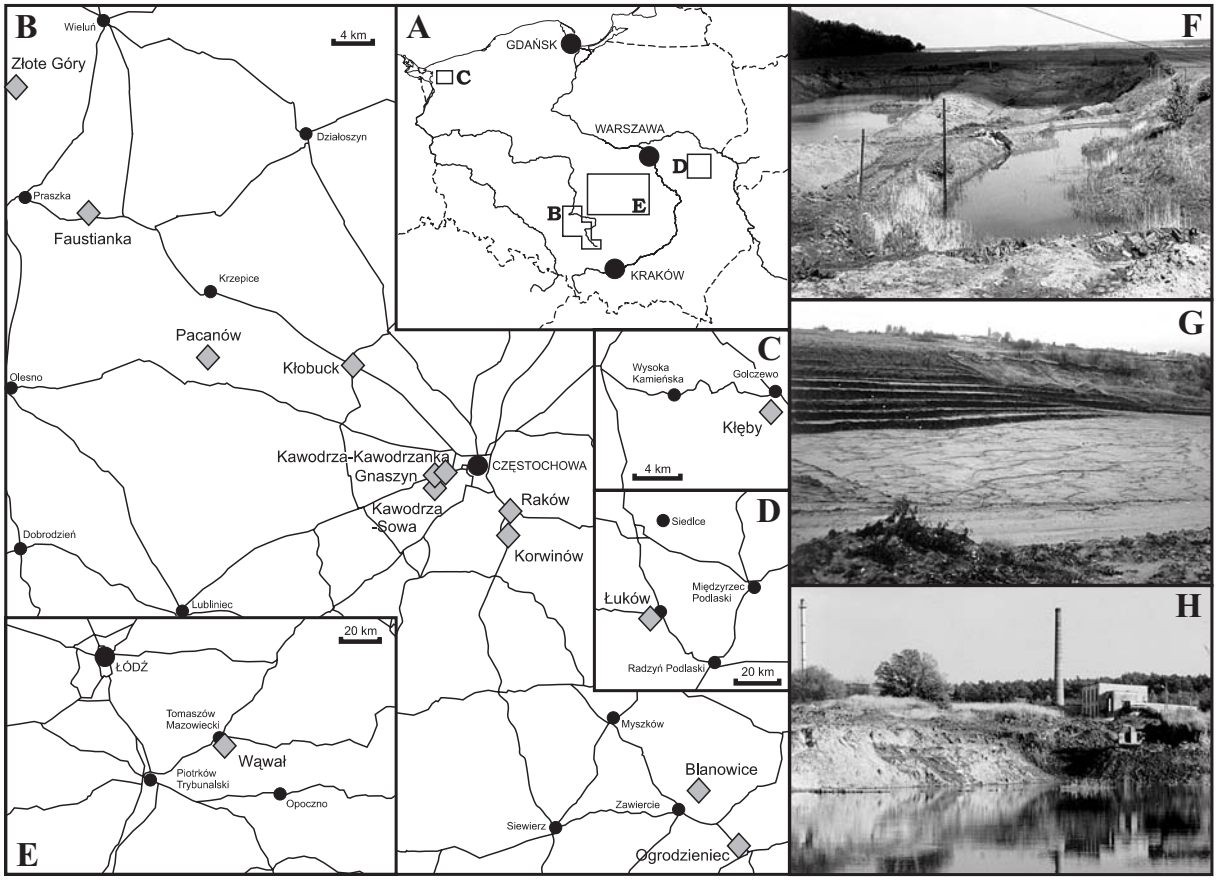


Fig. 1. Sketch maps with the localities mentioned in the text (as gray diamonds), main cities (as black circles), and main roads. **A**. Location of the particular areas in Poland. **B**. Localities in the Częstochowa region. **C**. The locality of Kłęby in Western Pomerania. **D**. The locality of Łuków in the Podlasie region. **E**. The locality of Wąwał in the Łódź region. **F**. View of the brick-pit Faustianka in May 1999. **G**. View of the brick-pit Gnaszyn in November 2002. **H**. View of the brick-pit Wąwał in October 1995.

The gastropods of Łuków were partially described by Makowski (1952) and Schröder (1995). The collection I examined comes from several sources. The largest part was collected by G. Jakubowski (1958–1966) and deposited at the Museum of the Earth PAS in Warsaw. I received additional material from J. Błaszyk, J. Dzik, and M. Machalski, the staff of the Institute of Paleobiology in Warsaw.

Ogrodzieniec. — The locality was referred to as Ogrodzieniec-Wiek by Różycki (1953). These are two brick-pits close to one another and situated between Fugasówka and Ogrodzieniec (Fig. 1B). In 1953 the sections had exposed black clay, which according to Różycki (1953) ranged from the Early Bajocian to the Late Bathonian. Most probably only the middle part of the section is exposed now (1995–2002) and can be attributed to the time span from the latest Bajocian to the Mid Bathonian. The gastropod-yielding samples come from the upper part of the exposed section that most probably represents the Mid Bathonian. The ten samples (5 kg each) show the homogenous composition of the assemblage throughout the sampled unit.

Pacanów. — This is a small outcrop of brickyard situated southward of Krzepice in the Częstochowa region (Fig. 1B). The section exposes about three meters of intercalated gray and black clay. According to the dinoflagellate stratigraphy of Poulsen (1998), the strata at Pacanów correspond to the *Parkinsonia acris–Parkinsonia densicosta* Subzones of the Late Bajocian. I have taken two samples (5 kg each), one from the upper and the other from the lower part of the section. Both samples have similar gastropod content.

Raków. — The locality was referred to as Częstochowa-Bugaj by Majewski (1997, 2000). This is a large brick-pit in the southern part of Częstochowa (Fig. 1B). The section exposes clay and silty clay of the Bathonian. Różycki (1953) found Late Bathonian ammonites in Raków. Regrettably it is not certain whether the outcrop of Różycki (1953) is the same one which was sampled for gastropods. Majewski (1997) did not find any index ammonites but, based on the lithology, he estimated the age of the strata as Late or possibly

Mid Bathonian. The single sample (10 kg) I collected yielded small number of badly preserved gastropods, mainly *Cryptaulax* spp.

Wąwał. — The brick-pit at the village Wąwał (Fig. 1E, H) abandoned in 2002, located two kilometers east of Tomaszów Mazowiecki, exposed a rock section of the Early- and part of the Late Valanginian (Kutek *et al.* 1989).

In the Wąwał section, a single transgressive/regressive cycle is recorded (Kaim 2001, 2002). The faunal assemblages suggest shallow water conditions near the photic zone in the lower and upper parts of the section and a deeper water conditions in the middle part (Kaim 2001).

The 37 rock samples (2.5 kg each) show significant changes in gastropod composition throughout the section. The detailed analysis of this section in presented by Kaim (2001). The numbers of the samples referred to are those of Kaim (2001).

Złote Góry. — This is a newly opened (1999) brick-pit located southwest of Wieluń (Fig. 1B). In 1999 the section of about one meter of black clay was exposed. I collected a single sample (5 kg). The ostracod content of the sample suggests a similar age to that of Pacanów (Janusz Błaszyk, personal communication 2002).

METHODS

Most of the gastropods from the Częstochowa region and Wąwał described herein were obtained from rock samples collected over the period 1995–2002. The samples from Wąwał were taken bed by bed. Those from the other localities have rather a reconnaissance nature and their detailed description and faunistic analysis is in progress.

The clay/silt rock samples were placed for 24 hours into a container filled with water and detergent. The samples were then washed with hot water and sieved (diameter 0.05 and 0.375 mm). Supplementary large specimens from the same localities were manually picked from the weathered rock surfaces.

The specimens were mounted on stubs and coated with platinum for SEM examination. The SEM photographs were recorded in high resolution TIFF files, which were used to prepare the figures using Adobe Photoshop 5.5 and CorelDraw 8.0 software.

The conchological terminology follows after the glossaries of Cox (1960) and Arnold (1965); the protoconch terminology was summarized by Jablonski and Lutz (1980).

The meaning of some of the terms is here narrowed. These are as follows:

Shell: the whole gastropod shell including the teleoconch and protoconch.

Protoconch: the whole protoconch including protoconch 1 and 2 or the protoconch with undemarcated developmental stages.

Protoconch 1: the first, initial portion of the protoconch if clearly demarcated from protoconch 2; it usually corresponds to the embryonic stage.

Protoconch 2: the second portion of the protoconch, which usually corresponds to the veliger stage.

Teleoconch: the part of the shell produced after metamorphosis.

In measuring the number of the protoconch whorls, I followed the Taylor method (Jablonski and Lutz 1980: fig. 4 therein).

To estimate the degree of heterostrophy the Average Line Box Method is used (Cipriani and Bieler 2001) whenever measurements were possible. If not, I used only the descriptive terms of Schröder (1995; transaxial, medioaxial, coaxial).

TAXONOMY

The modern gastropod taxonomy is based mainly on the soft body and radula characters (see e.g., Ponder and Lindberg 1997) which are inaccessible in the fossil record. The shell characters are believed to be only of minor importance to the zoological taxonomy although the analysis by Schander and Sundberg (2002) shows that both shell and soft-body characters are equally homoplastic (but see also Wagner 2001). The most efficient approach to resolve the taxonomic and phylogenetic problems of Mesozoic gastropods is by comparing them with extant forms. This requires focusing on the similarities between particular taxa, not on the differences.

This approach prevents the excessive splitting of taxa, common in paleontological papers. The general rule accepted here is to make the taxonomy of the Mesozoic gastropods (especially at the generic level) as concise as possible and comparable to the taxonomy of extant gastropods. The genera based on tenuous differences are rejected. The range of shell morphologies of fossil gastropods is compared with such a variation in closest extant genera. It appears that many of the fossil species can be easily classified in extant genera (especially vetigastropods) and some of the fossil genera are redundant. Some other fossil gastropods (e.g., turritellids) cannot be classified generically with acceptable credibility, as the available shell characters are useless even for extant members of the family. High level fossil taxa are used only if the species cannot be placed in extant taxa.

This chapter summarizes the taxonomic information about Mid Jurassic to Early Cretaceous gastropods extracted from clayish rocks of Poland. Several contributions to the taxonomy of Mid Jurassic gastropods of northwest Poland (Pomerania) have been already published by Gründel (1973, 1974b, 1975a, b, 1977, 1997a, b, 1998a, b, 1999a, c, d, e, f, 2000a, b, 2001b). Schröder (1995) and Kaim (2001, 2002) contributed to the knowledge of Early Cretaceous gastropods from Wąwał in central Poland. Most of the taxa published in these papers are revised here and appropriately illustrated.

The chapter contains descriptions and illustrations of 135 species (54 new) of 61genera (2 new). Eight species are left without generic assessment. As most of the taxa are not widely known, the diagnoses or emended diagnoses are given here. The diagnoses of extant taxa refer only to the shell characters. The descriptions are as concise as possible, only to supplement to the high-resolution photographic illustrations. The "remarks" section contains a short discussion of the particular taxon and its relationship to the other taxa.

Phylum **MOLLUSCA** Linné, 1758
Class **GASTROPODA** Cuvier, 1797
Subclass **PROSOBRANCHIA** Milne Edwards, 1848
Order **Archaeogastropoda** Thiele, 1925
Suborder **Vetigastropoda** Salvini-Plawen *et* Haszprunar, 1987
Superfamily **Trochoidea** Rafinesque, 1815
Family **Skeneidae** Clark, 1851

Genus *Eudaronia* Cotton, 1945
(*Levihelix* Gründel, 2000)

Type species: *Cyclostrema* (*Daronia*) *jaffaensis* Verco, 1909; original designation. Recent, deep waters off of South Australia.

Emended diagnosis. — Small shell, planispiral, with carinating cords on lateral flanks, suture impressed, aperture trapezoidal, ovate to reniform, peristome simple. Umbilicus very wide and perspective (modified after Cotton 1945).

Remarks. — Cotton (1945) included this genus in the family Liotiidae. Warén (1991) reexamined the type species and suggested that *Eudaronia* can be placed into the Skeneidae.

Recently Gründel (2000a) described shells from the Bathonian (Mid Jurassic) of Northwest Poland, closely similar in shell characters and dimensions to the shell of *Eudaronia*, as *Levihelix pusilla* Gründel, 2000 included his new genus into the family Discohelicidae Schröder, 1995. The type species of *Discohelix*, *D. calculiformis* Dunker, 1847 appears to be unrelated to *Eudaronia* (and *Adeuomphalus*, see below, Fig. 3). This large archaeogastropod (40 to 50 mm in diameter) may be related to the liottids or turbinids instead (A. Warén, personal communication; compare Fig. 2D and 2E herein).

Range. — Mid Bathonian (Mid Jurassic) to Recent.

Eudaronia pusilla (Gründel, 2000)
(Fig. 2B, C)

1975. *Discohelix calculiformis* Dunker, 1848?; Gründel 1975b: 777, pl. 1: 17 (non *Discohelix calculiformis* sp. n.; Dunker 1847: 132).

2000. *Levihelix pusilla* sp. n.; Gründel 2000a: 211, pl. 2: 7–12.

Holotype: Gründel 2000a: pl. 2: 7–10.

Type horizon: Late Bathonian (Mid Jurassic).

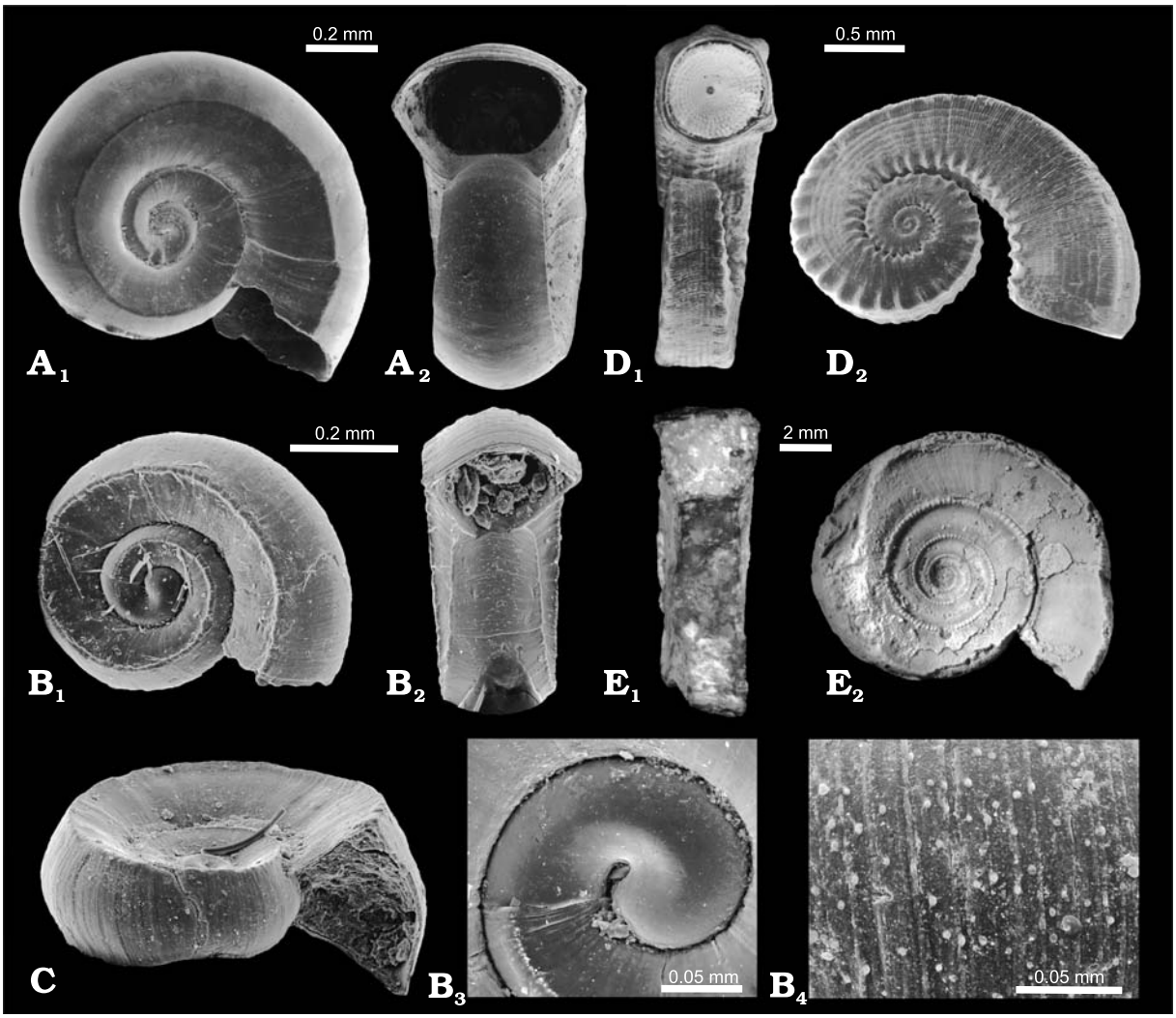


Fig. 2. Possible relationship of Recent and fossil vetigastropods with semiplanispiral shells. Note close resemblance of fossil and Recent *Eudaronia*. The *Discohelix* is more similar to *Delphinula* than to *Eudaronia*. **A**. *Eudaronia jaffaensis* (Verco, 1909), Recent, North Atlantic (courtesy of A. Warén); A_1 apical view, A_2 lateral view. **B**. *Eudaronia pusilla* (Gründel, 2000), ZPAL Ga. 9/104 from Łuków (block in glacial drift), Podlasie, Poland, Callovian (Mid Jurassic); B_1 apical view, B_2 lateral view, B_3 close-up of the protoconch, B_4 details of lateral surface ornamentation consists of growth lines and fine pustules. **C**. *Eudaronia pusilla* (Gründel, 2000), ZPAL Ga. 9/103 from Faustianka, Częstochowa region, Bathonian (Mid Jurassic), latero-apical view. **D**. *Angaria evoluta* (Reeve, 1843), Recent, Indo-Pacific (courtesy of A. Warén); D_1 lateral view, D_2 apical view. **E**. *Discohelix calculiformis* Dunker, 1847, Late Triassic of Germany (courtesy of A. Warén); E_1 lateral view, E_2 apical view.

Type locality: Borehole Kłęby 1/37, West Pomerania, Poland.

Material. — Two well-preserved juvenile shells: one from Faustianka (ZPAL Ga.9/103), the other from Łuków (ZPAL Ga.9/104), both in Poland.

Measurements. — The holotype with three whorls measures 0.9 mm in width and 0.35 mm in height. The protoconch has a width of 0.15 mm (after Gründel 2000a).

Occurrences. — West Pomerania (Poland), northeastern Germany: many localities of Early Bajocian to the Mid Callovian age (see Gründel 2000a). Częstochowa region (Poland): Faustianka, Mid Bathonian. Podlasie (Poland): Łuków (block in glacial drift), Late Callovian.

Emended diagnosis. — Protoconch with no sculpture. Keels on teleoconch distinct and flat-topped. Aperture of juveniles trapezoidal, later in ontogeny ovate.

Description. — The protoconch is smooth and it consists of 0.75 of the whorl. Distinct, orthocline growth lines cross the keels with interruptions in some places. The abaxial surface of the shell is covered by small, scarce pustules.

Remarks. — The fossil species differs from the Recent ones in having more distinct spiral keels. The whorls are more angulated what results in the trapezoidal shape of the aperture. Moreover, the protoconch of the Recent species is ornamented with three to four spiral lirae.

Genus *Adeuomphalus* Seguenza, 1876

Type species: *Adeuomphalus ammoniformis* Seguenza, 1876; original designation. Late Pliocene to Early Pleistocene, Sicily.

Emended diagnosis. — Small, planispiral shell with concave superior and umbilical faces. Former more concave than latter. Aperture quadrangular and teleoconch ornamented with two, more or less distinct keels on lateral flanks and distinct axial ribs (modified after Seguenza 1876 and Nofroni and Sciubba 1985).

Discussion. — The holotype is a fossil shell. Living animals were later found in the Mediterranean at depths of 300–900 m south of the Sardinia (Nofroni and Sciubba 1985). Seguenza (1876) suggested a relationship between *Adeuomphalus* and the hyperstrophic architectonicids. Nofroni and Sciubba (1985) found that the protoconch of the type species is orthostrophic and typical of archaeogastropods. Moreover, they suggested establishing a new family for the genus. Warén (1991) admitted the similarity to the genus *Eudaronia* and suggested a relationship of both genera to the skeneids.

Bandel (1988) and Schröder (1995) found planispirally coiled shells in the Valanginian of central Poland. Schröder (1995) established a new species for them and assigned it to the genus *Discohelix*. This assigment seems to be unjustified (see discussion section in the genus *Eudaronia*) and I propose the inclusion of this species in the genus *Adeuomphalus*.

Range. — Valanginian (Early Cretaceous) to Recent.

Adeuomphalus bandeli (Schröder, 1995)
(Fig. 3C, D)

1988. *Discohelix* sp.; Bandel 1988: 13, pl. 2: 6, pl. 7: 4.
1995. *Discohelix bandeli* sp. n.; Schröder 1995: 11, pl. 1: 1–4, pl. 13: 17.

Holotype: Schröder 1995; Pl. 1: 2, 4.
Type horizon: Valanginian (Early Cretaceous).
Type locality: Wąwał, southern Mazowsze, Poland.

Material. — Two well-preserved juvenile shells from Wąwał (ZPAL Ga.9/105–106).

Measurements. — The holotype with one whorl of teleoconch is 0.53 mm wide and 0.21 mm high. Protoconch has one whorl and a width of 0.22 mm (after Schröder 1995).

Occurrences. — Type locality only.

Emended diagnosis. — Protoconch without ornamentation, apart from growth lines at terminal part. Keels determine a well-pronounced angulation of the shell that makes the shape of aperture angulate and trapezoidal. Intersections between spiral keels and axial ribs with blunt nodes. Delicate lirae present between axial ribs.

Description. — Small, planispiral shells have two distinct spiral keels on the lateral flanks of the shell and almost orthocline axial ribs. The umbilical face is more concave than the superior face.

Remarks. — The other species of this genus lack spiral lirae and nodes. Moreover, *A. bandeli* has a more angulated shape of aperture. The type of species of *Adeuomphalus* has a protoconch with a granular pattern on the surface of the shell.

Genus *Aequispirella* Finlay, 1924

Type species: *Scalaria corulum* Hutton 1885; original designation. Late Pleistocene, Wanganui, New Zealand.

Emended diagnosis. — Minute conispiral shell. Raised protoconch bearing granulate pattern and two weak spiral lirae. Teleoconch with axial ribs and spiral lirae. Aperture circular to elipsoidal and umbilicus deep (modified after Finlay 1924).

Remarks. — The holotype was found in Late Pleistocene strata of New Zealand, but later it was also discovered in shallow waters around New Zealand (Powell 1979). Finlay (1924) clasified *Aequispirella* as a subgenus of the genus *Brookula*. Comparison of the type species *Aequispirella* and *Brookula* leads to the conlusion that these genera may not have been very closely related (Anders Warén, personal communication

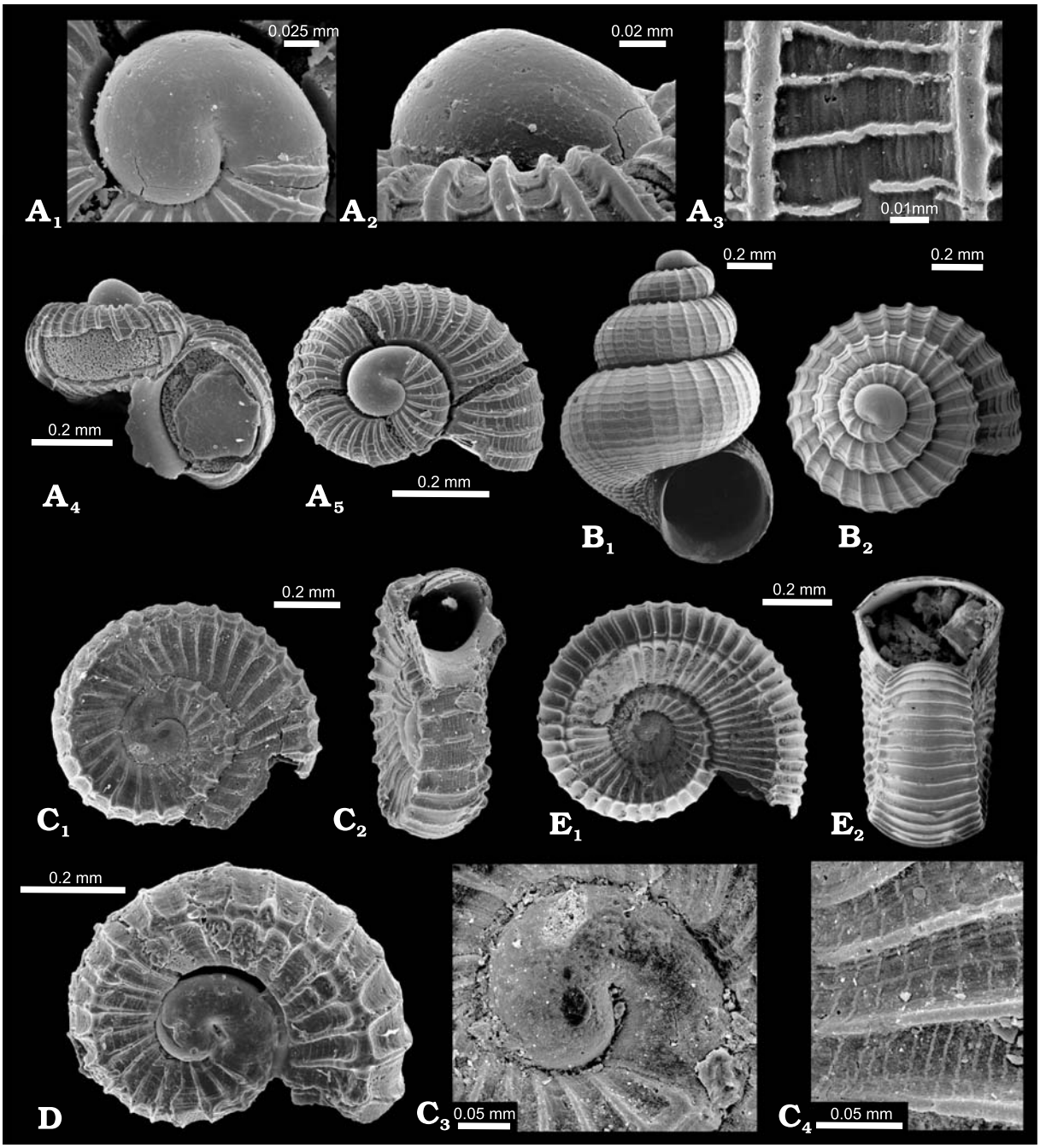


Fig. 3. The skeneids *Aequispirella jurassica* sp. n., *Adeuomphalus bandeli* (Schröder, 1995), and their Recent counterparts. **A**. *Aequispirella jurassica* sp. n., ZPAL Ga. 9/107 (holotype) from Łuków (block in glacial drift), Podlasie, Poland, Callovian, Mid Jurassic); A_1 close-up of the protoconch, A_2 lateral view of the protoconch, A_3 details of teleoconch ornamentation, A_4 lateral view, A_5 apical view. **B**. *Aequispirella corulum* (Hutton, 1885), Recent, of New Zealand (courtesy of A. Warén); B_1 apical view, B_2 lateral view. **C**, **D**. *Adeuomphalus bandeli* (Schröder, 1995). **C**. ZPAL Ga. 9/105 from sample B1 of Wąwał, souther Mazowsze, Valanginian (Early Cretaceous); C_1 apical view, C_2 lateral view, C_3 close-up of the protoconch, C_4 details of teleoconch ornamentation. **D**. ZPAL Ga. 9/106 from sample E1 apical view. **E**. *Adeuomphalus ammoniformis* Seguenza, 1876, Recent, Mediterranean (courtesy of A. Warén); E_1 apical view, E_2 lateral view.

2002). Also, the family level classification remains unclear because the soft body of the genus has never been examined. Here, I classify *Aequispirella* in the traditional way among the skeneids but this relationship has to be supported by studies of the soft body.

Range. — Valanginian (Early Cretaceous) to Recent.

Aequispirella jurassica sp. n.
(Fig. 3A)

Holotype: ZPAL Ga.9/107, Fig. 3A.
Type horizon: *Quenstedtoceras lamberti* Zone, Late Callovian (Mid Jurassic).
Type locality: Łuków (block in glacial drift), Podlasie, Poland.
Derivation of the name: After Jurassic.

Material. — One juvenile shell.

Measurements. — The holotype with 1.25 whorls of teleoconch is 0.55 mm in width and 0.48 mm in height. The protoconch consists of 0.75 whorls is 0.17 mm wide.

Occurrences. — Type locality only.

Diagnosis. — Small shell, broadly conical, sculptured by prominent prosocline axial ribs and spiral lirae. Spiral lirae in some places not continuous.

Description. — The protoconch is ornamented by two weak spiral lirae and its surface bears remnants of the granular pattern. The preserved part of the teleoconch consists of 1.25 whorls. The aperture is elipsoidal and the umbilicus is wide and deep. Growth lines are well-visible and prosocline.

Remarks. — The proposed species differs from Recent and Tertiary species of the genus by a broader shape of the shell, prosocline axial ribs, and discontinuous spiral lirae. It may represent a subgenus of *Aequispirella* or even a distinct, closely related genus. Adult shells have to be found to clear up this uncertainty.

Family **Turbinidae** Rafinesque, 1815
Subfamily **Turbininae** Rafinesque, 1815
Genus *Torallochus* Kiel *et* Bandel, 2002

Type species: *Torallochus trempensis* Kiel *et* Bandel, 2002; original designation. Campanian (Late Cretaceous), Torallola, Spain.

Diagnosis. — Small shell, discoid to pupoid, early whorls planispirally coiled and sculptured with strong axial ribs, thickened at periphery. Later, whorls angular, keeled. Axial ribs may turn into blunt spines (after Kiel and Bandel 2002).

Remarks. — The first juvenile shell of *Torallochus* from Łuków was identified by Schröder (1995) as *Discohelix* sp. Later, Kiel and Bandel (2002) established the genus *Torallochus* and placed three newly found species within it. The juvenile whorls of *Torallochus* are very similar to juvenile whorls of some Recent turbinids (*Bolma*, *Astraea*) which justifies including them with the Turbinidae (compare Fig. 4).

Range. — Mid Bathonian to Late Callovian.

Torallochus lukovensis sp. n.
(Fig. 4A, B)

1995. *Discohelix* sp.; Schröder 1995: 12, pl. 1: 5–8, pl. 13: 18.

Holotype: ZPAL Ga.9/108, Fig. 4A.
Type horizon: *Quenstedtoceras lamberti* Zone, Late Callovian (Mid Jurassic).
Type locality: Łuków (block in glacial drift), Podlasie, Poland.
Derivation of the name: After the type locality.

Material. — One well-preserved adult shell and three juveniles.

Measurements. — The holotype has 3.75 whorls of teleoconch and is 1.46 mm in width and 1.95 mm in height. The protoconch consists of one whorl and is 0.22 mm wide.

Occurrences. — Type locality only.

Diagnosis. — First 2.5 teleoconch whorls with angulation close to abapical suture and rest whorls of protoconch with angulation in middle part of visible whorl surface. Angulation there bears undulation of weak carinae. Third whorl of teleoconch wider than fourth.

Description. — The protoconch consists of one whorl and is ornamented by one weak spiral lira. The surface of the protoconch is covered by remnants of the granular pattern. Third and fourth whorls are ornamented with one spiral cord close to the adapical suture.

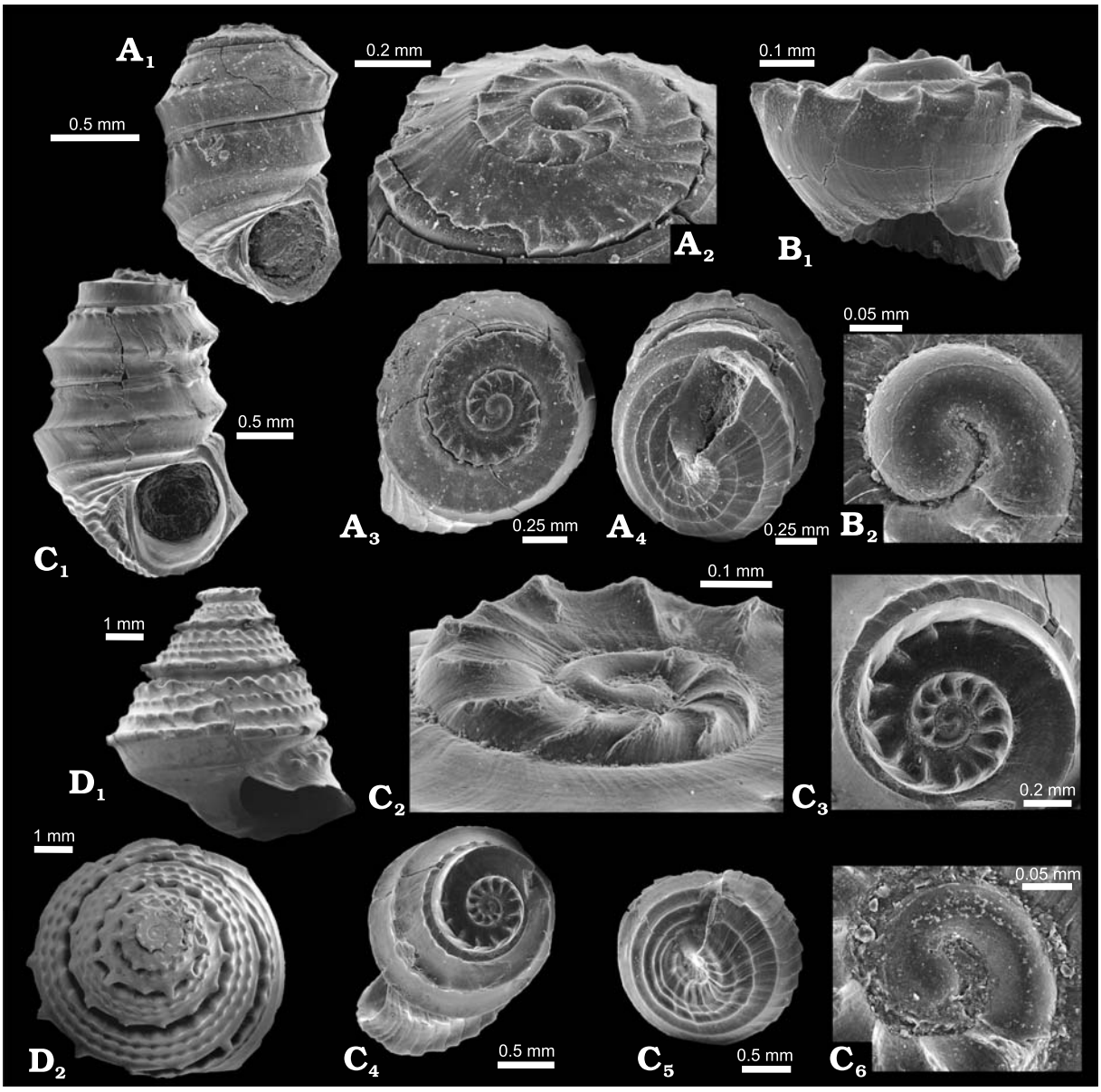


Fig. 4. Fossil and Recent turbinids. Note characteristically flattened early whorls. **A**, **B**. *Torallochus lukovensis* sp. n., ZPAL Ga. 9/108 (holotype; A) and 9/110 (B) from Łuków (block in glacial drift), Podlasie, Poland, Callovian (Mid Jurassic); A_1 lateral view, A_2 details of juvenile whorls, A_3 apical view, A_4 umbilical view; B_1 lateral view, B_2 close-up of the protoconch. **C**. *Torallochus faustiankensis* sp. n., ZPAL Ga. 9/112 (holotype) from Faustianka, Częstochowa region, Bathonian (Mid Jurassic); C_1 lateral view, C_2, C_3 details of juvenile whorls, C_4 apical view, C_5 umbilical view, C_6 close-up of the protoconch. **D**. Unnamed turbinid from off of New Caledonia, Recent (courtesy of A. Warén).

Remarks. — The species differs from the other in the situation of the angulation at the first two whorls of the teleoconch and with its delicate undulation. Moreover the third whorl is wider than the fourth. The two shells from Łuków described by Schröder (1995) as *Discohelix* sp. belong to *T. lukovensis*.

Torallochus faustiankensis sp. n.
(Fig. 4C)

Holotype: ZPAL Ga.9/112, Fig. 4C.

Type horizon: *Procerites progracilis* Zone, Mid Bathonian (Mid Jurassic).

Type locality: Faustianka, Częstochowa region, Poland.

Derivation of the name: After the type locality.

Material. — One well-preserved adult shell.

Measurements. — The holotype consists of four teleoconch whorls and it is 1.61 mm wide and 2.05 mm high. Protoconch has one whorl and a width of 0.21 mm.

Occurrences. — Type locality only.

Diagnosis. — Teleconch with angulation close to the middle part of visible whorl surface. Angulation there bears no undulation. Third whorl narrower than fourth.

Description. — The protoconch has one whorl, is ornamented by one weak spiral lira and its surface bears remnants of the granular pattern. The third and fourth whorl are ornamented with one spiral cord close to the adapical suture.

Remarks. — The species differs from the preceding one in having the angulation situated at the first two whorls of the teleoconch and with no undulation on it. Moreover, the third whorl is narrower than fourth.

Family **Trochidae** Rafinesque, 1815
Subfamily **Eucyclinae** Koken, 1896
Tribe Eucyclini Koken, 1897

Remarks. — Hickman and McLean (1990) divided the Eucyclinae into three tribes. At least two of them, Eucyclini Koken, 1897 and Calliotropini Hickman *et* McLean, 1990, seem to be closely related. The diagnoses given by Hickmann and McLean (1990) are based on the ontogenetic change from an interrupted peristome in the juvenile stage to a closed one in the adult stage and on the thickness of the shell wall. I agree with Kiel and Bandel (2001), that these differences are too weak to justify this division. The members of both tribes have almost identical juvenile whorls and I treat them jointly here.

McLean (1982) showed that some of the living trochacean gastropods lack an afferent membrane along the greater length of the ctenidium. This feature is developed in the liottiids, angariids and some trochids (e.g., *Calliotropis*, *Turcica*, *Bathybembix*, *Cidarina*, *Danilia*, and *Euchelus*) and was regarded by McLean (1982) as a primitive state. Here I include some Jurassic trochids into the Recent genera *Calliotropis* and *Turcica* to emphasize their close resemblance. Although it is difficult to prove their biological relationship, I suggest keeping them together until a more exhaustive work on the fossil and living trochids is done.

Genus *Eucycloscala* Cossmann, 1895

Type species: *Trochus binodosus* Münster, 1841; subsequent designation by Cox in Knight *et al.* 1960: 267. Late Triassic, Alps, Italy.

Diagnosis. — Conical shell with inner nacreous layer present. Protoconch with one whorl, subplanispiral. Aperture round; peristome complete. Teleoconch with strong axial ribs crossed by a few finer spiral cords. Base with some, usually three, spiral cords with or without umbilicus (after Bandel 1993b).

Discussion. — In the original paper by Cossmann (1895a) the author did not give a type species for the genus *Eucycloscala* and stated only that both *Scalaria limatula* Ammon, 1893 and *Scalaria binodosa* (Münster, 1841) had to be included in the genus. In a following paper, Cossmann (1912) designated another species *Scalaria cretacea* Boury (year not given), as the type species, but this designation cannot be accepted because this species was not mentioned in the original description. Cox (in Knight *et al.* 1960) made choice of *Trochus binodosus* Münster, 1841, one of the two Cossmann originally included in the genus, as the type species and this was used by later authors.

Bandel (1993b) classified the genus in his informal group described as: "Trochospiral forms with strong axial ribs on the first whorl of the first whorl of the teleoconch like among modern Eucyclinae or Palaeozoic Microdomatidae." The shape and sculpture of the juvenile whorls seems to be typical of Eucyclini. The assesment of the genus by Wenz (1938) and Knight *et al.* (1960) into Liotiinae Gray, 1850 is inconsistent with the shape and sculpture of liotiid's juvenile whorls, which are typically ornamented with a dense set of axial lamellae (Fig. 6C).

Range. — Mid Triassic to Late Cretaceous.

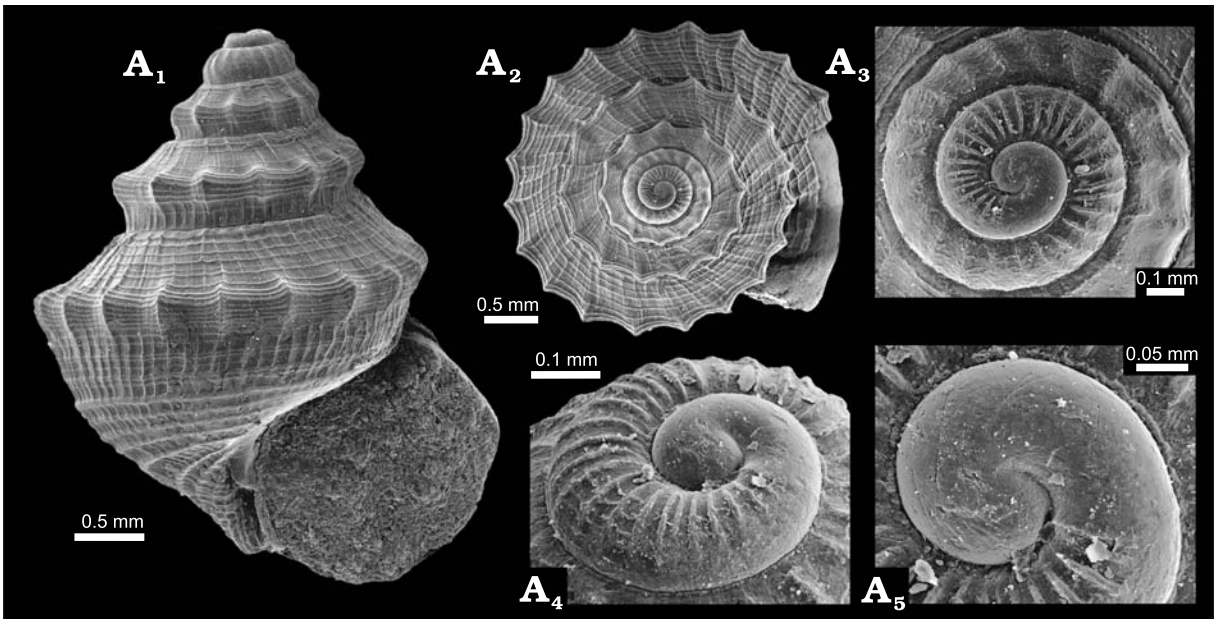


Fig. 5. The eucyclinid *Eucycloscala izabellae* sp. n. from Faustianka, Częstochowa region, Bathonian (Mid Jurassic). **A**. ZPAL Ga.9/214 (holotype); A_1 lateral view, A_2 apical view, A_3, A_4 details of juvenile whorls, A_5 close-up of the protoconch.

Eucycloscala izabellae sp. n.
(Fig. 5)

Holotype: ZPAL Ga.9/214, Fig. 5.
Type horizon: *Procerites progracilis* Zone, Mid Bathonian (Mid Jurassic).
Type locality: Faustianka, Częstochowa region, Poland.
Derivation of name: After my daughter Izabella.

Material. — Ten well-preserved shells from the type locality.

Measurements. — The holotype with six whorls of teleoconch is 3.29 mm in width and 4.11 mm in height. The protoconch has one whorl and width of 0.27 mm.

Occurrences. — Type locality only.

Diagnosis. — First teleoconch whorls rounded with numerous tubercules. Later whorls with nodose keel composed of numerous, densely spaced spiral ribs. Surface of teleoconch covered with a net of spiral and axial lirae

Description. — The protoconch is smooth, composed of one whorl. Early teleoconch whorls has distinct axial ribs. The keel has about 15 nodes per whorl. Base has 7–8 spiral ribs, which are crossed by numerous axial lirae.

Remarks. — The species is most similar to *E. verrucosa* Gründel, 2000 from the Mid Bathonian of Germany but it differs in having a dense net of axial and spiral ornamentation covering the surface of the teleoconch.

Eucycloscala sp. 1
(Fig. 6A, B)

Material. — Four well preserved-juvenile shells (ZPAL Ga.9/113–116) from Łuków (block in glacial drift), Podlasie, Poland, Late Callovian (Mid Jurassic).

Measurements. — The shell with 4.5 whorls is 1.97 mm in width and 2.34 mm in height. A shell with four whorls (ZPAL Ga.9/114) measures 1.50 mm in width and 1.74 mm in height. The protoconch has 0.75 of the whorl and width of 0.23 mm.

Description. — The first whorl of the trochospiral teleoconch is ornamented only with distinct axial ribs and on the following whorls two spiral cords are developed. At the intersection of the spiral and the axial

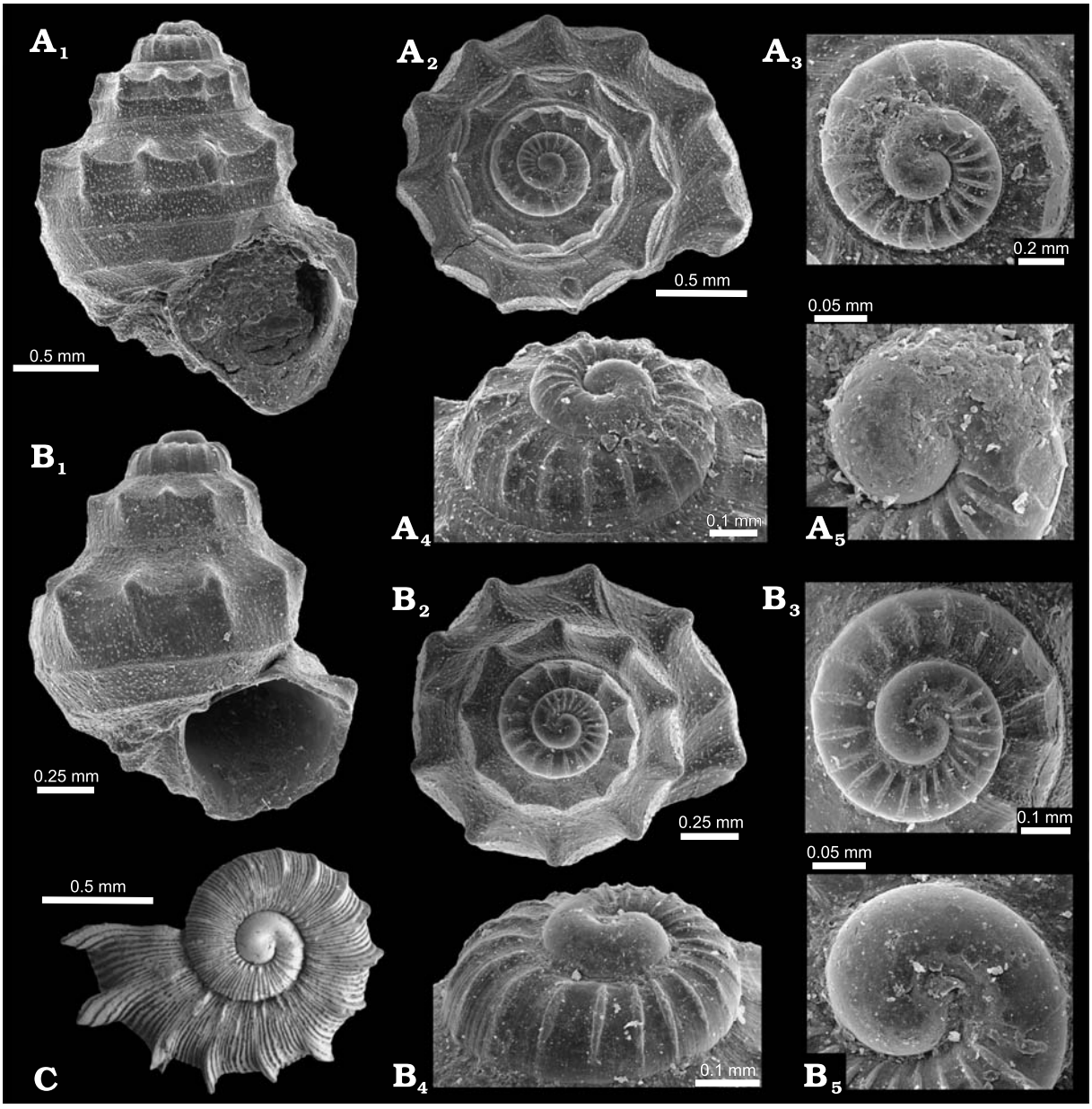


Fig. 6. Fossil eucyclinids and Recent juvenile liottid. Note the different shape and sculpture, especially the densely packed, band-like axial ribs of the liottid. **A**, **B**. *Eucycloscala* sp. 1, ZPAL Ga. 9/113 from Łuków (block in glacial drift), Podlasie, Poland, Callovian (Mid Jurassic); A_1 lateral view, A_2 apical view, A_3, A_4 details of juvenile whorls, A_5 close-up of the protoconch. **B**. *Eucycloscala* sp. 2, ZPAL Ga. 9/114 from Łuków (block in glacial drift), Podlasie, Poland, Callovian (Mid Jurassic); B_1 lateral view, B_2 apical view, B_3, B_4 details of juvenile whorls, B_5 close-up of the protoconch. **C**. Juvenile liottid, Recent, Swan Reef, off of Australia (courtesy of A. Warén).

sculptures, blunt nodes appear. The surface of the teleconch covered by small tubercles. One specimen (ZPAL Ga.9/113) shows more prominent spiral sculpture than others.

Remarks. — The protoconch and the shape of teleoconch is typical of the genus *Eucycloscala* but absence of adult whorls induces me to leave it in open nomenclature.

Eucycloscala sp. 2
(Fig. 7A, B)

Material. — Two well-preserved juvenile shells (ZPAL Ga.9/117–118) from Faustianka, Częstochowa region, Poland, Mid Bathonian (Mid Jurassic).

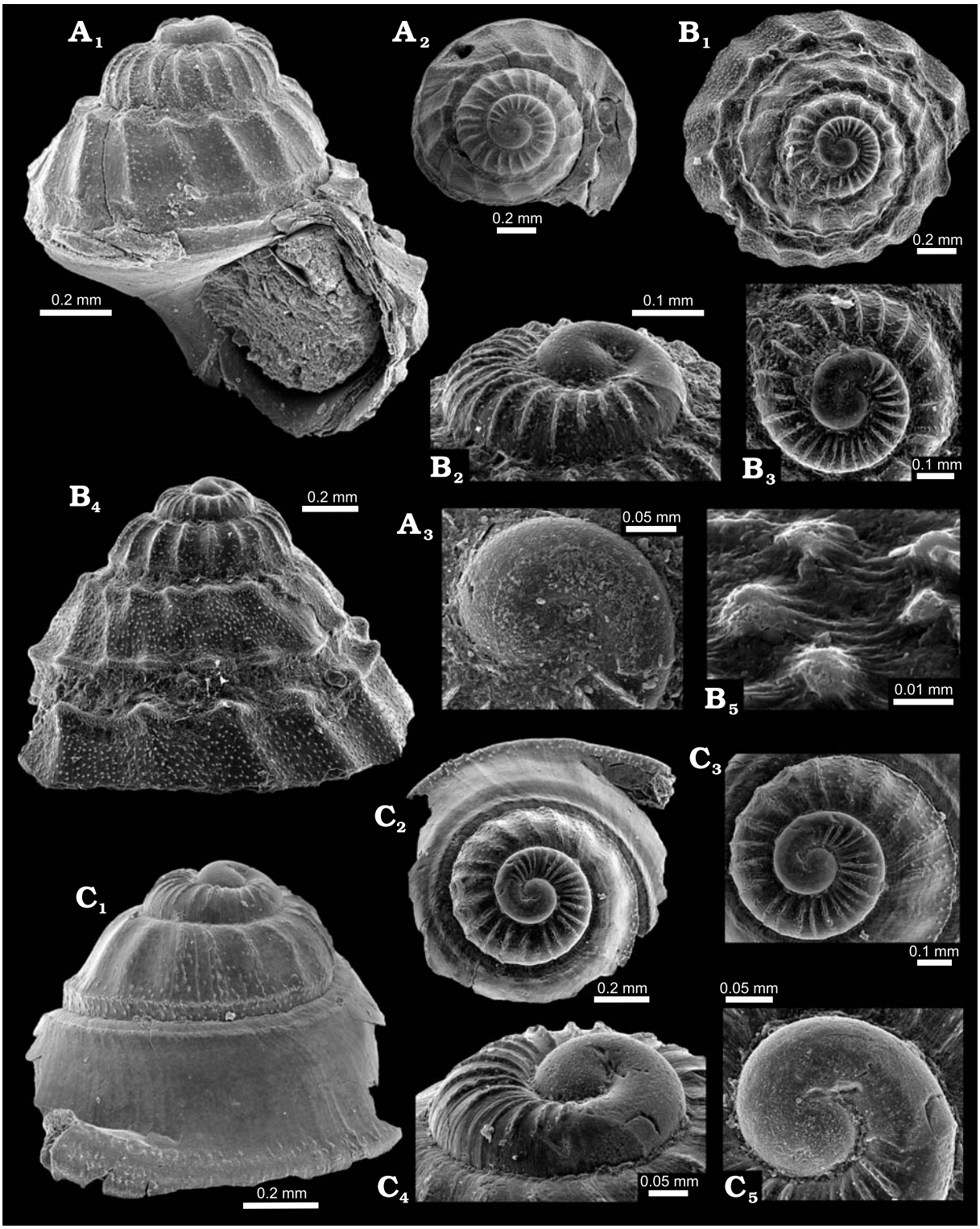


Fig. 7. The eucyclinids *Eucycloscala* from the Mid Jurassic of Częstochowa region. **A**, **B**. *Eucycloscala* sp. 2, ZPAL Ga. 9/118 (A) and 9/117 (B) from Faustianka, Bathonian; A_1 lateral view, A_2 apical view, A_3 close-up of the protoconch; B_1 apical view; B_2, B_3 details of juvenile whorls, B_4 lateral view, B_5 close-up of the teleoconch pustules. **C**. *Eucycloscala* sp. 3, ZPAL Ga. 9/128 from Pacanów, Late Bajocian; C_1 lateral view, C_2 apical view, C_3, C_4 details of juvenile whorls, C_5 close-up of the protoconch.

Measurements. — The shell with 4.25 whorls is 1.49 mm in width and 1.18 mm in height. The protoconch consists of 0.75 whorls and it is 0.21 mm wide.

Description. — The planispiral protoconch consists of 0.75 whorls. The first 1.25 whorls of the broadly conical teleoconch are ornamented only with distinct axial ribs, and on the following whorls two spiral cords are developed, the first close to the adapical suture and the latter close to the abapical suture. At the intersection of the spiral and the axial sculpture blunt nodes appear. The surface of the teleconch is covered by small tubercles.

Remarks. — The species differs from *Eucycloscala* sp. 1 in the conical shape of the shell.

Eucycloscala sp. 3
(Fig. 7C)

Material. — Ten juvenile individuals, three from Pacanów, six from Złote Góry (both Late Bajocian), and one from Kawodrza-Kawodrzanka (Mid Bathonian).

Measurements. — Shell (ZPAL Ga.9/128) with 3.25 whorls of teleoconch is 1.15 mm in width and 0.92 mm in height. Larval shell has one whorl and width of 0.24 mm.

Description. — The protoconch is ornamented by one weak spiral lira. The surface of the protoconch is covered by remnants of the granular pattern. The first whorl of teleoconch is ornamented with distinct axial ribs. On the following quarter of the whorl, the ribs are still present but they are much weaker and in the last section they disappear completely. Simultaneously, close to the abapical suture, a spiral rib appears. On the third whorl another rib close to the adapical suture can be observed. The surface of the teleoconch is abapically covered by small tubercules. Similar tubercules can also be observed along the axial ribs.

Remarks. — The protoconch and first whorl of the teleoconch are very close to that of *Eucycloscala* sp. 3. Similar forms were illustrated by Gründel (1975a, 2000a) as "*Riselloidea*? sp." and "Eucyclidae gen. inc. 2, sp. 1" respectively. These and even *Parvitomella exigua* Gründel, 2000 might be potentially regarded as species of *Eucycloscala* with reduced ornamentation of the late teleoconch.

Genus *Parvitomella* Gründel, 2000

Type species: *Parvitomella exigua* Gründel, 2000; monotypy. Late Batonian (Mid Jurassic), Kłęby borehole 1/37, West Pomerania, Poland.

Emended diagnosis. — Conical shell with convex, rounded whorls. Protoconch of one whorl, subplanispiral. Early teleoconch with axial ribs, further in ontogeny ribs reduced. Rounded base, ornamented with spirals. Umbilicus small. Peristome broadly oval, complete with no callus (modified after Gründel 2000a).

Discussion. — The protoconch and early whorls of the teleoconch are similar to those of *Eucycloscala* shells (see e.g., Fig. 6) but the shell differs in regard to the reduction of the teleoconch ornamentation. *Parvitomella* might be a synonym of *Eucycloscala*.

Range. — Mid to Late Bathonian (Mid Jurassic).

Parvitomella gofasi sp. n.
(Fig. 8)

Holotype: ZPAL Ga.9/289, Fig. 8.

Type horizon: *Procerites progracilis* Zone, Mid Bathonian (Mid Jurassic).

Type locality: Faustianka, Częstochowa region, Poland.

Derivation of the name: In honour of Serge Gofas.

Material. — One well-preserved shell.

Measurements. — The holotype with 3.25 whorls of teleoconch is 1.54 mm in width and 1.67 mm in height. Larval shell has one whorl and width of 0.21 mm.

Occurrences. — Type locality only.

Diagnosis. — Initially teleoconch whorl with axial ribs, otherwise the teleoconch smooth. Shell rounded, the subsutural ramp absent.

Description. — The protoconch is smooth. The early teleoconch whorls are ornamented with distinct axial ribs, which are reduced later in ontogeny. The base is rounded and ornamented with numerous spiral ribs. The peristome is broadly oval and complete.

Remarks. — The species is similar to *P. exigua* Gründel, 2000 but differs from it in the earlier disappearance of the axial ribs and the lack of the subsutural ramp.

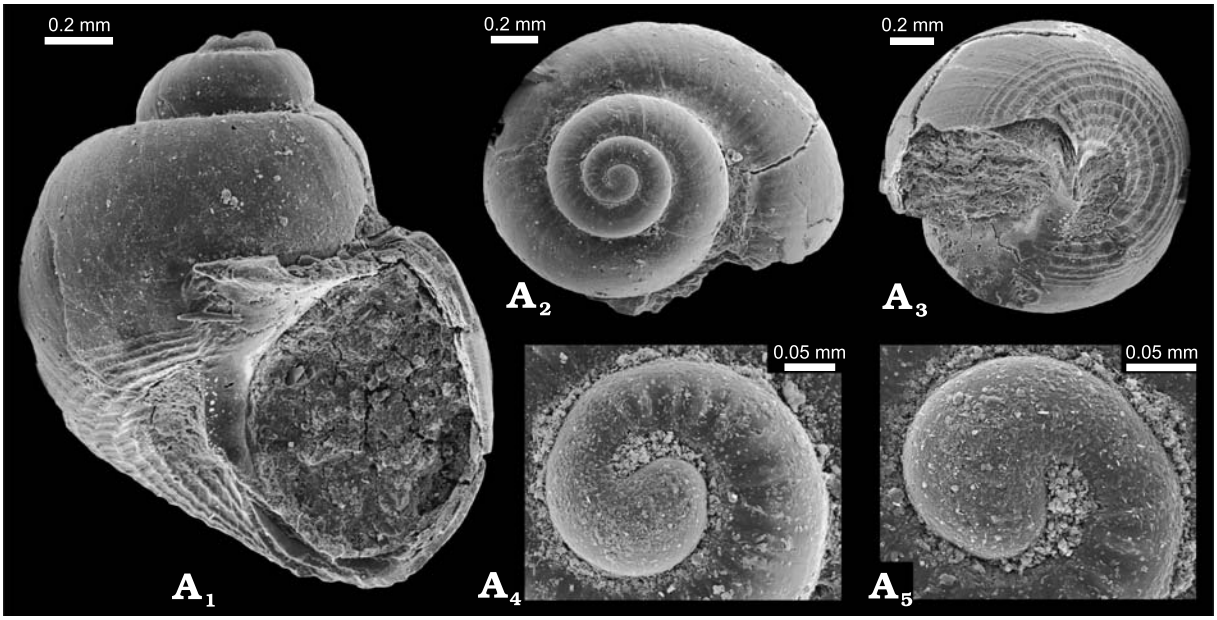


Fig. 8. The eucyclinid *Parvitomella gofasi* sp. n. from Faustianka, Częstochowa region, Bathonian (Mid Jurassic). **A**. ZPAL Ga. 9/289 (holotype); A_1 lateral view, A_2 apical view, A_3 umbilical view, A_4 details of the juvenile whorls, A_5 close-up of the protoconch.

Genus *Calliotropis* Seguenza, 1902
(*Riselloidea* Cossmann, 1909)

Type species: *Trochus ottoi* Philippi, 1844; original designation. Pleistocene, Sicily, Italy.

Emended diagnosis. — Shell conical with convex whorls. Teleoconch is sculptured with axial and spiral ribs. Nodes appearing at intersections of ribs. Oblique aperture, angular; peristome complete. Base with some, usually four nodose spiral cords, with or without umbilicus (modified after Philippi 1844; Seguenza 1902; and Kiel and Bandel 2001).

Discussion. — The only difference between Recent forms of *Calliotropis* and those from Mid and Late Jurassic is an absence of the umbilicus among the latter ones (Fig. 9). The Jurassic species of *Calliotropis* are usually described under the generic name *Riselloidea* Cossmann, 1909 (see e.g., Gründel 1975a, 1990b, 1997c, 2000a). The systematic position of *Risellopsis subdisjuncta* (Cossmann, 1908), the type species of *Riselloidea*, is not clear. It differs from the species of *Calliotropis* in absence of nodose ornamentation. Nevertheless, I propose treating the genus *Riselloidea* Cossmann, 1909 as a junior synonym of the genus *Calliotropis* Seguenza, 1902 until the type material of *Risellopsis subdisjuncta* Cossmann, 1908 is re-examined.

Range. — Late Triassic to Recent.

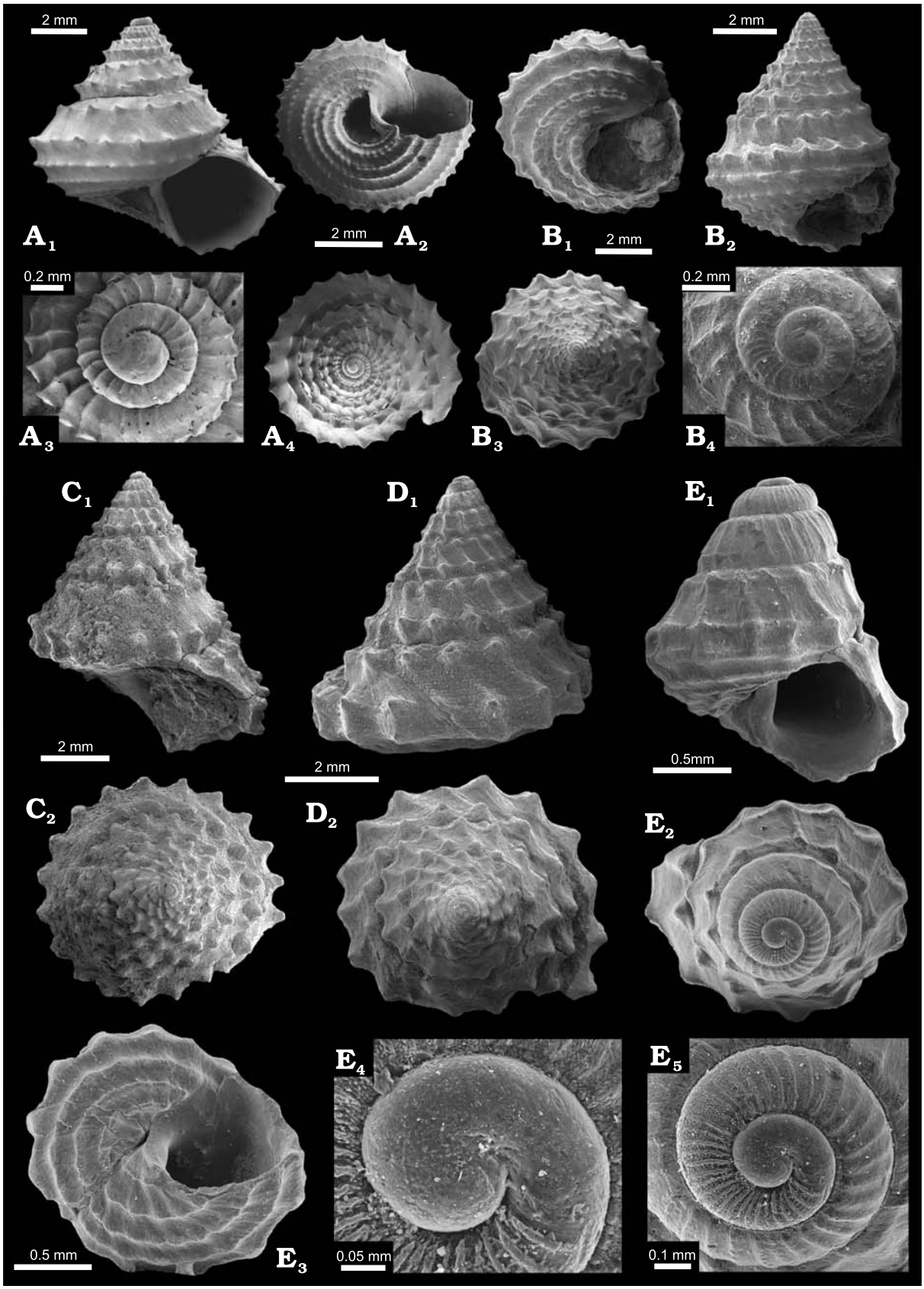
Calliotropis biarmata (Münster, 1844)
(Fig. 9B–E)

1844. *Trochus biarmatus* sp. n.; Münster 1844: 55, pl. 170: 2.

1860. *Trochus bitorquatus* sp. n.; Hébert and Eudes-Deslongchamps 1860: 213, pl. 2: 6.

1924. *Riselloidea bitorquata* (Hébert *et* Eudes-Deslongchamps, 1860); Cossmann 1924: 13, pl. 2: 30–32, pl. 6: 6.

Fig. 9. Fossil and Recent eucyclinids; Recent *Calliotropis ottoi* (Philippi, 1844) and Jurassic *Calliotropis biarmata* (Münster, 1844). Note a close resemblance in the shell shape and ornamentation of both forms. **A**. *Calliotropis ottoi* (Philippi, 1844), Recent, Mediterranean (courtesy of A. Warén); A_1 lateral view, A_2 umbilical view, A_3 close-up of the apex in an umbilical view, A_4 apical view. **B**. *Calliotropis biarmata* (Münster, 1844), MZ VIII Mg 4223/1 from Blanowice, Częstochowa region, Poland, Bathonian (Mid Jurassic); B_1 umbilical view, B_2 lateral view, B_3 apical view, B_4 close-up of the apex in an umbilical view. **C**. *Calliotropis biarmata* (Münster, 1844), ZPAL Ga. 9/124 from Kawodrza Sowa, Częstochowa region, Poland, Late Bajocian (Mid Jurassic); C_1 lateral view, C_2 apical view. **D**. *Calliotropis biarmata* (Münster, 1844), ZPAL Ga. 9/119 from Ogrodzieniec, →



Częstochowa region, Poland, Bathonian (Mid Jurassic); D_1 lateral view, D_2 apical view. **E**. *Calliotropis biarmata* (Münster, 1844), ZPAL Ga. 9/210 from Gnaszyn, Częstochowa region, Poland, Bathonian (Mid Jurassic); E_1 lateral view, E_2 apical view, E_3 umbilical view, E_4 details of juvenile whorls, E_5 close-up of the protoconch.

1975. *Riselloidea biarmata* (Münster, 1844); Gründel 1975a: 245: figs 7, 8, pl. 1: 17–19.
1990. *Riselloidea bitorquata* (Hébert *et* Eudes-Deslongchamps, 1860); Gründel 1990b: 1141, pl. 2: 4, 5.
2000. *Riselloidea biarmata* (Münster, 1844); Gründel 2000a: 229, pl. 7: 1–3.

Type material: Münster 1844: pl. 170: 2.
Type horizon: Lower Oolite of Thurnau, Mid Jurassic.
Type locality: Thurnau, Germany.

Material. — Thirty shells from Kawodrza-Sowa (Late Bajocian), twenty shells from Blanowice (Bathonian), six shells from Ogrodzieniec (Bathonian), one juvenile shell from Gnaszyn (Bathonian), and two juveniles from Kłobuck borehole 21 (?Bathonian), all Częstochowa region, Poland.

Measurements. — The shell ZPAL Ga.9/119 from Ogrodzieniec with 6.5 whorls is 6.70 mm in width and 7.58 mm in height. The protoconch consists of about 0.75 whorls and it is 0.24 mm wide.

Occurrences. — Mid and Late Jurassic of Europe.

Diagnosis. — Teleoconch conical. First juvenile whorl of teleoconch ornamented with weak axial ribs. Later in ontogeny whorls angulated at two keels, which are close to suture on both whorl sides. Keels ornamented with short spines. Each spine from upper keel connected with another one from lower keel by oblique rib-like folds. Base sculptured with strong ribs. Umbilicus absent (modified after Münster 1844).

Description. — The protoconch is smooth. The axial ribs on teleoconch become more and more prosocline during the ontogeny. On the subadult whorls the ribs change into rib-like folds and almost disappear on some shells. In the two best-preserved, juvenile *Calliotropis* shells from Ogrodzieniec (ZPAL Ga.9/120–121) additional irregular spiral lirae are visible on the first whorl of the teleoconch. Detailed description of the species is also provided by Gründel (1975a, 1990b, 1997c, 2000a).

Remarks. — According to Gründel (2000a), *Calliotropis biarmata* (Münster, 1844) and *Calliotropis bitorquata* (Hébert *et* Eudes-Deslongchamps, 1860), and most probably even *Calliotropis sauvagei* (Cossmann, 1895), may represent varieties of one highly variable species.

Calliotropis sp.
(Fig. 10)

Material. — One shell (MZ VIII Mg 4232/1) from Łuków (block in glacial drift), Podlasie, Poland, Late Callovian (Mid Jurassic).

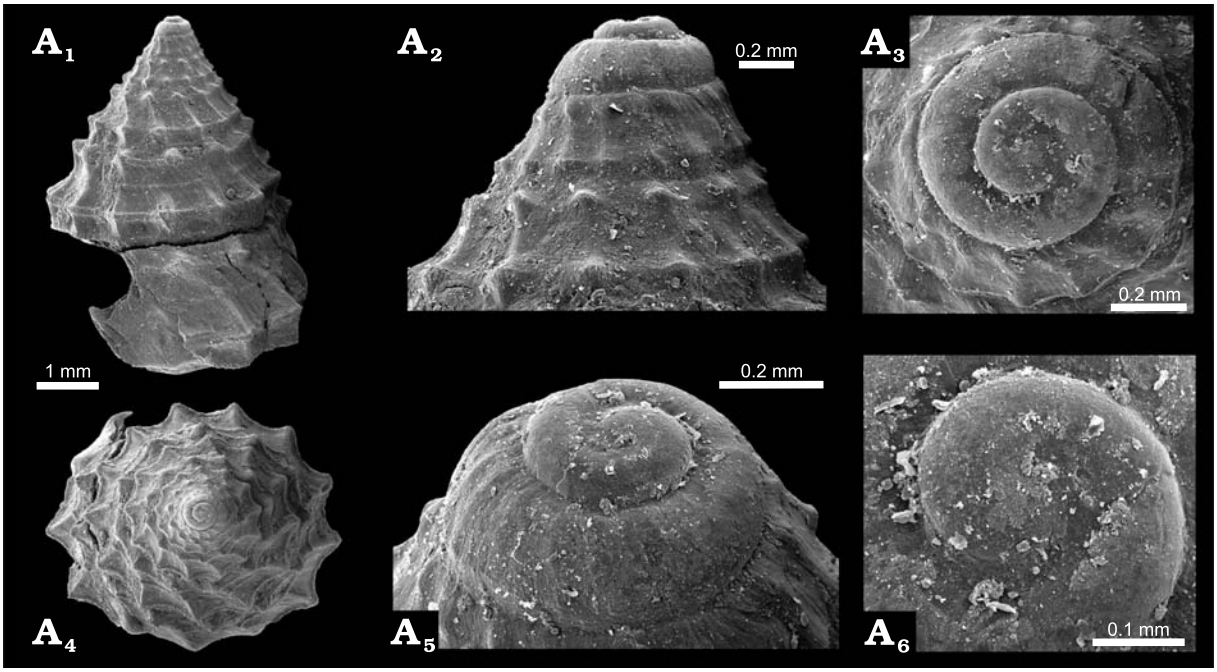


Fig. 10. The eucyclinid *Calliotropis* sp. from Łuków (block in glacial drift), Podlasie, Poland, Callovian (Mid Jurassic). **A**. MZ VIII Mg 4232/1; A_1 lateral view, A_2, A_3, A_5 details of juvenile whorls, A_4 apical view, A_6 close-up of the protoconch.

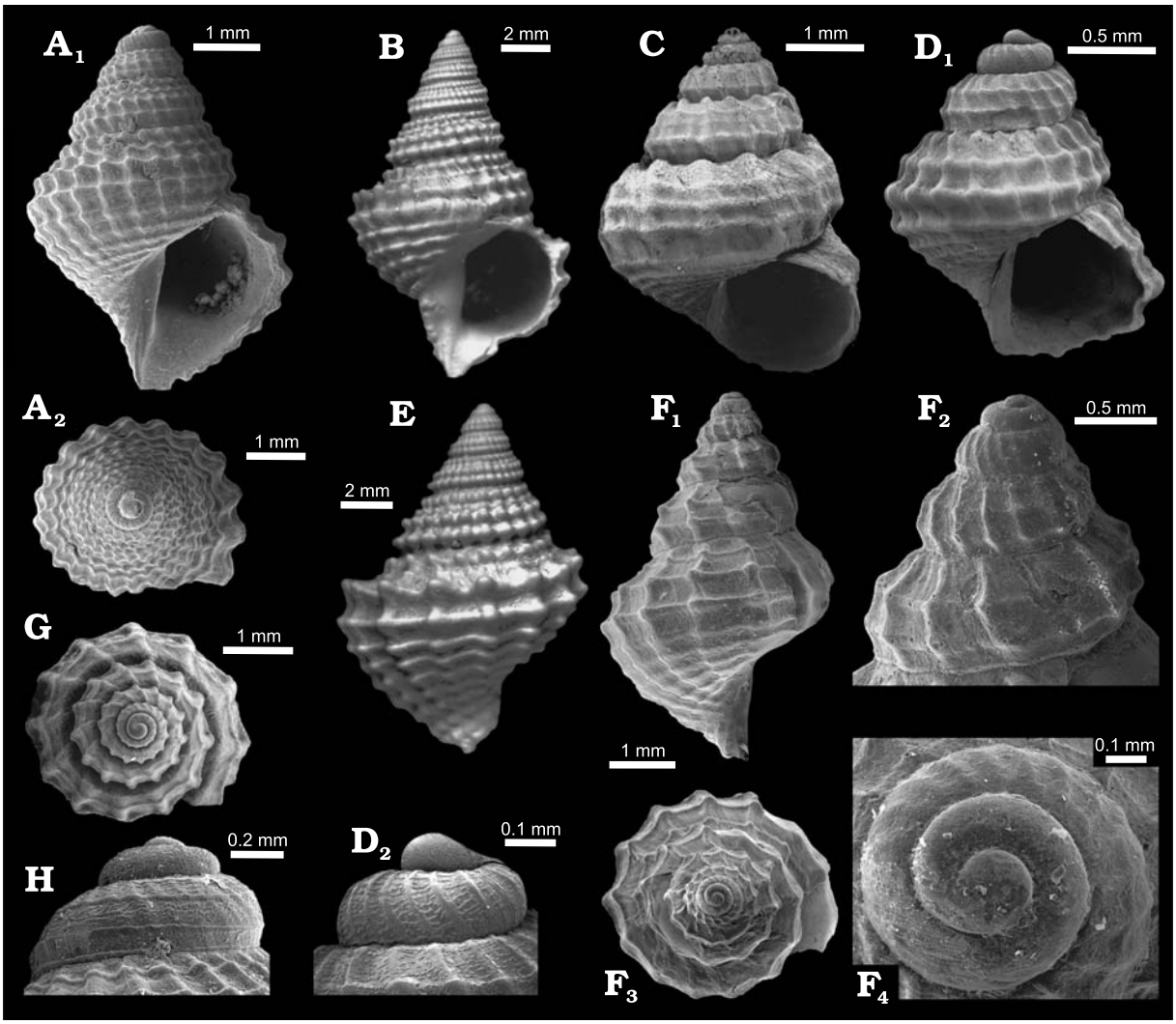


Fig. 11. Possible relationship of Recent eucyclinid *Turcica* to its fossil counterparts. Note the close resemblance of the Jurassic *T. wareni* (H, Fig. 13) and Recent *T. admirabilis* (D) expressed especially by similar ornamentation of the early whorls and the shape of the peristome; also the similarity of Jurassic *T. ogrodzieniecensis* (F) to Recent unnamed *Turcica* (C, G) seems significant. **A**. *Turcica clathrata* (Lahusen, 1883), juvenile individual (ZPAL Ga.10/10) from Moscow-Mnieviniki, Russia, Oxfordian (Late Jurassic); A_1 lateral view, A_2 apical view. **B**, **E**. *Turcica clathrata* (Lahusen, 1883), adult individuals from Kamushki and Novoselki respectively (both in central Russia) illustrated by Gerasimov (1992), Early Oxfordian (Late Jurassic); courtesy of V. Mitta: lateral views. **C**, **G**. Unnamed Recent *Turcica* off of New Caledonia; courtesy of A. Warén; C lateral view, G apical view. **D**. *Turcica admirabilis* Berry, 1969, Recent, locality LACM 77-33, 100 m depth, off of Sonora, Mexico; courtesy of A. Warén; D_1 lateral view, D_2 details of juvenile whorl. **F**. *Turcica ogrodzieniecensis* sp. n., ZPAL Ga.9/132 (holotype) from Ogrodzieniec, Częstochowa region, Poland, Bathonian (Mid Jurassic); F_1 lateral view, F_2, F_4 details of juvenile whorls, F_3 apical view. **H**. *Turcica wareni* sp. n., ZPAL Ga.9/137 from Gnaszyn, Częstochowa region, Poland, Bathonian (Mid Jurassic).

Measurements. — The shell with 6.5 whorls is 4.48 mm in width and 5.86 mm in height. Protoconch consists of one whorl and it is 0.28 mm wide.

Description. — The protoconch is planispiral with no ornamentation visible. The first whorl of the trochospiral teleoconch has hardly visible axial ribs. On the second whorl of the teleoconch weak spiral ribs appear and the axial ribs become more distinct. At the intersection of the spiral and the axial ribs, distinct nodes appear. In the central part of the fifth whorl of the teleoconch, an additional spiral rib without a nodose sculpture appears.

Remarks. — The relative size of the teleoconch studied is smaller than that of *Calliotropis biarmata*. Also, ornamentation differs in having an additional rib on the fifth and later whorls. Nevertheless, both forms are closely similar to each other.

Genus *Turcica* Adams *et* Adams, 1854

Type species: *Turcica monilifera* A. Adams, 1854; original designation. Recent off of Australia.

Emended diagnosis. — Conoidal shell, whorls with spiral ribs ornamented by distinct tubercules (modified after Adams and Adams 1854).

Discussion. — There is a close resemblance between the Recent species of *Turcica* and some species of the fossil genera *Metriomphalus* Cossmann, 1915 and *Ooliticia* Cossmann, 1894. Also the shells classified by Gerasimov (1992) to the genus *Petersia* seem to be very similar to the Recent *Turcica* (compare Fig. 11). The genus *Petersia*, with type species *Petersia costata* Gemmellaro, 1879, is believed to belong to the Cerithioidea. It differ by an expanded, terminal aperture (see e.g., Cossmann 1906). The protoconch of *Petersia* is unknown so far. Moreover, some of the species (at least: *E. pseudoarmiger*, *E. gjelensis*, and *E. verrucatus*) classified by Gerasimov (1992) as the genus *Eucyclus* Eudes-Deslongchamps, 1860 are much more similar to *Turcica* than to *Eucyclus*. In my opinion many of the Jurassic "littorinids" should be included in the genus *Turcica* (see e.g., Hudleston 1892: pl. 23 and Fig. 11 herein).

Range. — Middle Jurassic to Recent.

Turcica gerasimovi sp. n.
(Fig. 12)

Holotype: MZ VIII Mg 4233/1; Fig. 12.

Type horizon: *Quenstedtoceras lamberti* Zone, Late Callovian (Mid Jurassic).

Type locality: Łuków (block in glacial drift), Podlasie, Poland.

Derivation of the name: In honour of late Prof. Petr A. Gerasimov.

Material. — One shell (MZ VIII Mg 4233/1) from Łuków (block in glacial drift), Podlasie, Poland, Late Callovian (Mid Jurassic), one shell (ZPAL Ga.9/131) from Gnaszyn, Częstochowa region, Poland, Mid Bathonian (Mid Jurassic), and one shell (MZ VIII Mg 4224/1) from Blanowice, Częstochowa region, Poland, Bathonian (Mid Jurassic).

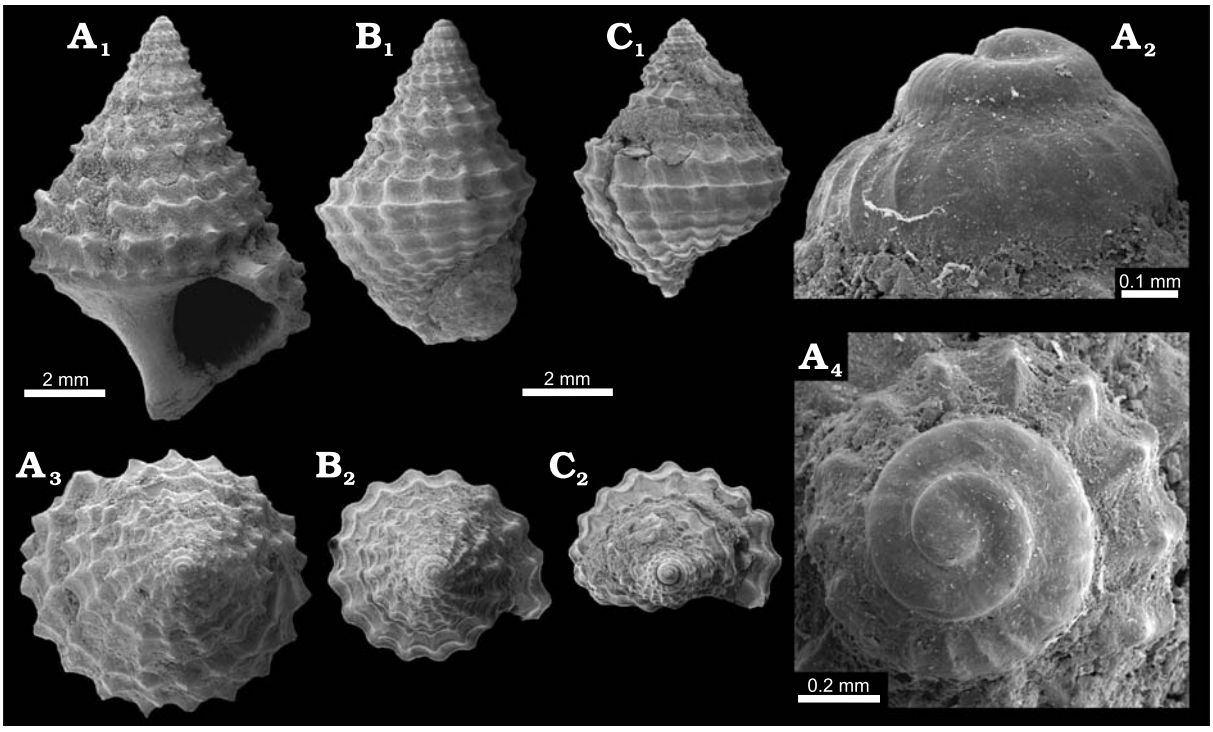


Fig. 12. The eucyclinid *Turcica gerasimovi* sp. n. from the Mid Jurassic of Poland. **A**. MZ VIII Mg 4233/1 (holotype) from Łuków (block in glacial drift), Podlasie, Late Callovian; A_1 lateral view, A_2, A_4 details of juvenile whorls, A_3 apical view. **B**. MZ VIII Mg 4224/1 from Blanowice, Częstochowa region, Bathonian; B_1 lateral view, B_2 apical view. **C**. ZPAL Ga.9/131 from Gnaszyn, Mid Bathonian; C_1 lateral view, C_2 apical view.

Measurements. — The holotype with seven whorls is 7.22 mm in width and 10.22 mm in height. The larval shell has about one whorl and a width of 0.28 mm.

Occurrences. — Bathonian to Callovian (Mid Jurassic) of Poland.

Diagnosis. — Conoidal shell. Juvenile whorls ornamented with weak axial ribs. On second whorl of teleoconch axial ribs becoming stronger; three spiral ribs appearing. Lowermost rib strongest. At intersection of spiral and axial ribs, thorn-like nodes appear.

Description. — The protoconch is badly preserved, planispiral with no ornamentation visible. The peristome is not preserved on the specimens available.

Remarks. — A similar species, *Turcica clathrata* (Lahusen, 1883), was placed by Gerasimov (1992) in the genus *Petersia* Gemmelaro, 1879 which belongs to the Cerithioidea (see discussion under genus *Turcica*). The latter species differs in having less thorn-like nodes and an expanded, angulated body whorl.

Turcica ogrodzieniecensis sp. n.
(Fig. 11F)

Holotype: ZPAL Ga.9/132; Fig. 11F.
Type horizon: Bathonian (Mid Jurassic).
Type locality: Ogrodzieniec, Częstochowa region, Poland.
Derivation of the name: After type locality.

Material. — Holotype only.

Measurements. — Holotype with four whorls of teleoconch is 3.59 mm wide and 5.86 mm high.

Occurrences. — Type locality only.

Diagnosis. — Highly cyrtoconoid shell. First whorl of teleoconch smooth after which weak axial ribs appearing. A little further three spiral ribs can be observed. Two of them distinct, third one weak and situated close to the adapical suture. At intersection of spiral and axial ribs blunt nodes appearing.

Description. — The protoconch is badly preserved, planispiral with no ornamentation visible.

Remarks. — The teleoconch ornamentation of this species is much weaker than observed among other members of the genus, but the ornamentation of the juvenile whorls is very similar to that of other species of *Turcica* and *Calliotropis*. *T. ogrodzieniecensis* is most similar to an undescribed Recent calliotropid species found near New Caledonia (Fig. 11C, G).

Turcica wareni sp. n.
(Fig. 13)

Holotype: ZPAL Ga.9/133; Figs 11H, 13.
Type horizon: *Morrisiceras morrisi* Zone, Mid Bathonian (Mid Jurassic).
Type locality: Gnaszyn, Częstochowa region, Poland.
Derivation of the name: In honour of Anders Warén.

Material. — Over fifty shells from the type locality.

Measurements. — Holotype with six whorls of teleoconch is 4.81 mm in width and 7.26 mm in height. Protoconch consists of one whorl and it is 0.28 mm wide.

Occurrence. — Type locality only.

Diagnosis. — Cyrtoconoid shell. Early whorls ornamented with zigzag pattern. Later in ontogeny, whorls ornamented with prosocline axial ribs and spiral ribs appearing. At intersections blunt, delicate nodes appearing.

Description. — The protoconch bears remnants of a granulate pattern. The first whorl of the teleoconch is ornamented with a zigzag pattern. On the second whorl of teleoconch, four spiral ribs and weak axial ribs appear. Later on, the zigzag pattern becomes weaker and the ribs increase in strength. A narrow callus at the columellar lip is developed.

Remarks. — The shells described above are similar to some Recent calliotropids, especially from the genera *Turcica* and *Cidarina*. I found the closest resemblance to *Turcica admirabilis* Berry, 1969. It has similar shape and sculpture of the teleoconch and aperture (Fig. 11D). The ornamentation of the juvenile protoconch of *T. wareni* resembles to some degree the teleoconch ornamentation of some species of the Re-

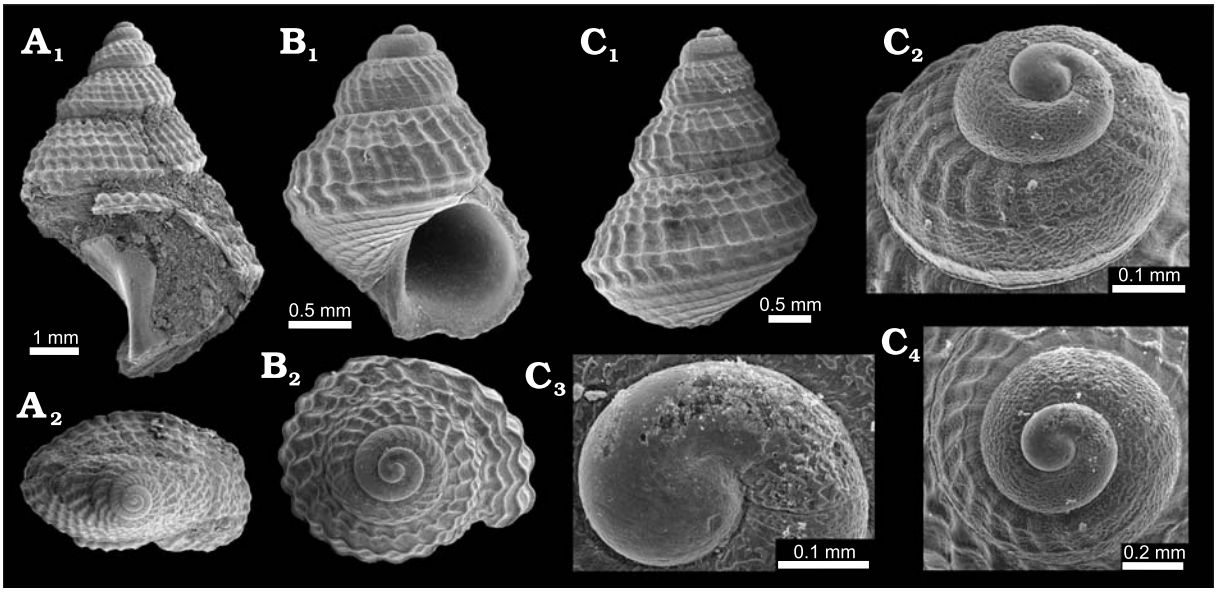


Fig. 13. The eucyclinid *Turcica wareni* sp. n. from Gnaszyn, Częstochowa region, Poland, Mid Bathonian, Mid Jurassic). **A**. ZPAL Ga.9/133 (holotype); A_1 lateral view, A_2 Apical view. **B**. ZPAL Ga.9/137; B_1 lateral view, B_2 apical view. **C**. ZPAL Ga.9/134; C_1 Lateral view, C_2, C_4 details of juvenile whorls, C_3 close-up of the protoconch.

cent *Granigyra* (a group of deep water vetigastropods; see Warén 1992, 1996) but their adult shells lack the axial and spiral ornamentation that is typical of *Turcica*.

Family **Ataphridae** Cossmann, 1918

Genus *Ataphrus* Gabb, 1869

(*Plocostylus* Gemmelaro, 1878)

Type species: *Ataphrus crassus* Gabb, 1858; original designation. Late Cretaceous, Martinez, California, USA.

Diagnosis. — Trochiform, non-umbilicate shell with rounded sides, subcircular to ovate aperture, and generally smooth exterior, protoconch of less than one whorl (after Dockery 1993).

Discussion. — The Mesozoic genus *Ataphrus* and family Ataphridae is similar to the Tertiary and Recent members of the family Trochaclididae Thiele, 1929 (Anders Warén, personal communication 2002; see also Marshall 1995) but a more systematic approach is needed to confirm this relationship. The similar genus *Plocostylus* Gemmelaro, 1878 is synonymized with *Ataphrus* Gabb, 1869 by Monari *et al.* (1996) although the species of *Plocostylus* differ by having a tooth on the inner lip. The type species of *Ataphrus* has no teeth on its inner lip (Gabb 1869: fig. 54).

Range. — Early Jurassic to Late Cretaceous: Dockery (1993).

Ataphrus wawalensis sp. n.

(Fig. 14)

Holotype: ZPAL Ga.9/199; Fig. 14.

Type locality: Wąwał, southern Mazowsze, Poland.

Type horizon: Sample R1, *Tirnovella pertransiens* Zone, Early Valanginian (Early Cretaceous).

Derivation of the name: After the type locality.

Material. — One shell from the type locality.

Measurements. — Holotype with 3.75 whorls is 3.04 mm in diameter and 2.19 mm high. Protoconch consists of about 0.75 whorls and it is 0.20 mm in diameter.

Occurrences. — Type locality only.

Diagnosis. — Turbiniform shell , thick, smooth, shiny. Peristome circular with large, blunt tooth on inner lip. Umbilicus absent.

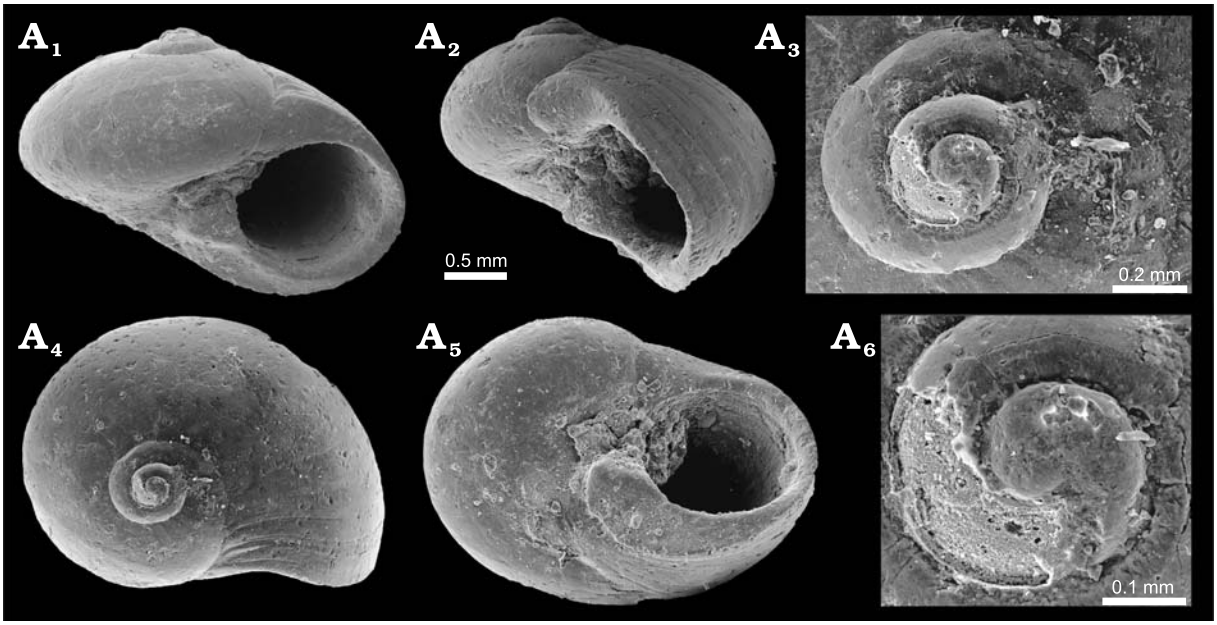


Fig. 14. The ataphrid *Ataphrus wawalensis* sp. n. from sample R1 of Wąwał (Early Valanginian, Early Cretaceous). **A**. ZPAL Ga.9/199 (holotype); A_1, A_2 lateral view, A_3 details of juvenile whorls, A_4 apical view, A_5 umbilical view, A_6 close-up of the protoconch.

Description. — The protoconch is badly preserved with no ornamentation visible. The teleoconch has no ornamentation apart from growth lines that are best visible at the terminal part of the shell.

Remarks. — The species under consideration is most similar to *Ataphrus typus* (Gemmelaro, 1878), the type species of *Plocostylus* Gemmelaro, 1878 (see above) but it differs in having larger teeth on the inner lip.

Family **uncertain**

Genus *Striatoconulus* Gründel, 2000

Type species: *Striatoconulus latus* Gründel, 2000; monotypy. Early/Mid Callovian, Kłęby borehole 1/37, West Pomerania, Poland.

Diagnosis. — Convex flanks of whorls, distinct suture. First whorls of teleoconch smooth. Later whorls including the base, covered by spirals. No axial ribs developed. Base moderately convex, angulate, with small umbilicus. Aperture with columellar callus and a halfmoon-shaped cavity on columella (after Gründel 2000a).

Discussion. — The diagnosis presented above is in agreement with that of the subfamilies Proconulinae and Gibbulinae by Knight *et al.* (1960). The most similar extant genera are *Trochus* and *Gibbula*.

Range. — Mid Bathonian to Mid Callovian (Mid Jurassic).

Striatoconulus latus Gründel, 2000
(Fig. 15)

Holotype: Gründel, 2000; pl. 6: 12–15.

Type horizon: Early/Mid Callovian (Mid Jurassic).

Type locality: Kłęby borehole 1/37, West Pomerania, Poland.

Material. — Three juvenile shells from Gnaszyn, Częstochowa region, Poland, Mid Bathonian (Mid Jurassic).

Measurements. — The shell ZPAL Ga.9/140 with five whorls is 5.54 mm in width and 4.46 mm in height. The protoconch of the shell ZPAL Ga.9/138 has about 0.75 of the whorl and width of 0.22 mm.

Occurrences. — Mid Bathonian to Mid Callovian (Mid Jurassic) of Poland.

Diagnosis. — Shell very broadly conical. Flanks of the whorls convex; sutures distinct. First teleoconch whorl smooth, following whorl with broad spiral ribs. Base also covered with ribs. Axial ribs not present.

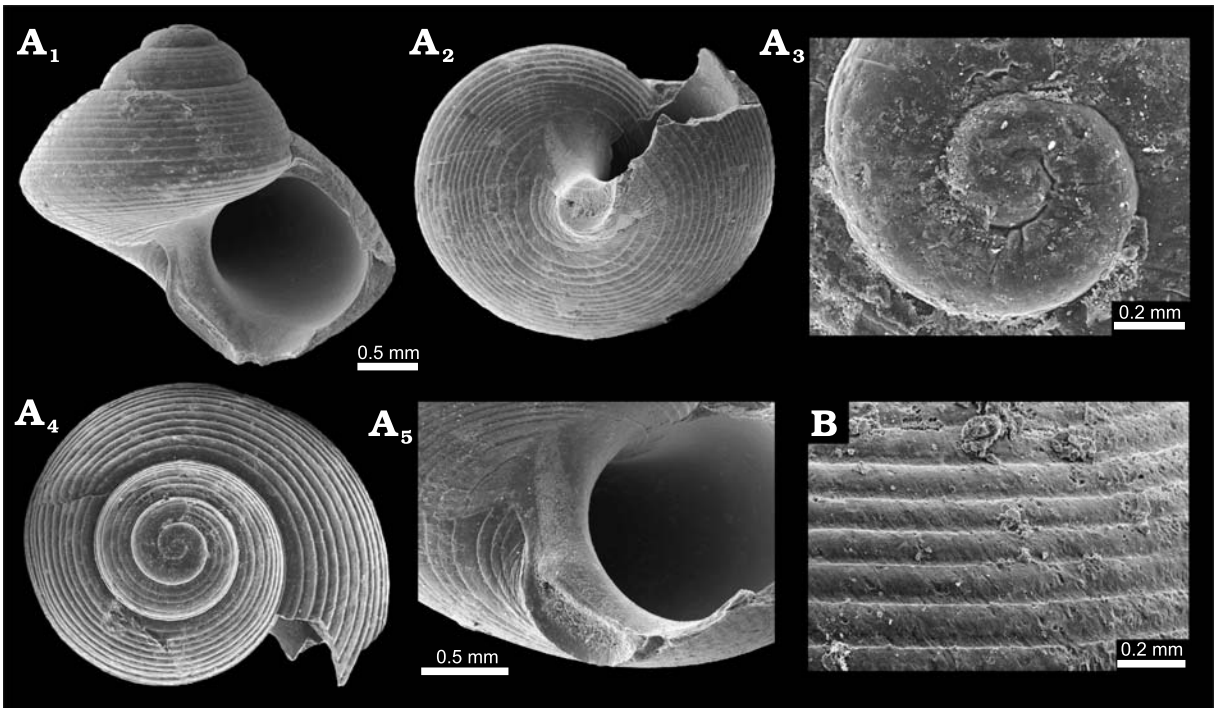


Fig. 15. The trochoid *Striatoconulus latus* Gründel, 2000 from Gnaszyn, Częstochowa region, Mid Bathonian (Mid Jurassic). **A**. ZPAL Ga.9/211; A_1 lateral view, A_2 umbilical view, A_3 details of juvenile whorls, A_4 apical view, A_5 close-up of the umbilical area. **B**. ZPAL Ga.9/140; details of the shell surface.

Base slightly convex. Zone between flanks of whorls and base continuous, rounded. Aperture broadly oval. Inner lip with broad callus and a halfmoon-shaped cavity on columella (after Gründel 2000a).

Description. — The growth lines are strongly prosocline above the periphery and opisthocyrtic on the base. Detailed description is provided by Gründel (2000a).

Remarks. — The shells from Gnaszyn are very similar to the type material described by Gründel (2000a).

Genus ?*Crossostoma* Morris *et* Lycett, 1851

Type species: *Crossostoma pratti* Morris *et* Lycett, 1851; original designation. Inferior Oolite (Mid Jurassic), England.

Diagnosis. — Thick, turbinate depressed shell with deep umbilicus closed by thickened glaze of inner lip. Adult whorls smooth. Fully grown shell having thickened apertural margin. Aperture round (after Bandel *et al.* 2000).

Discussion. — The genus *Crossostoma* Morris *et* Lycett, 1851 and family Crossostomatidae Cox, 1960 is based on the type species *C. pratti* Morris *et* Lycett, 1851 which has the outer lip strongly thickened externally, a feature that is typical for Vitrinellidae (Rissooidea), often misplaced into Vetigastropoda because of similar teleoconch morphology (Warén 1992). To be sure that *Crossotoma* really is a genus of Vetigastropoda, the protoconch and/or shell structure of the type material has to be reexamined.

Range. — Early to Mid Jurassic.

?*Crossostoma* sp.
(Fig. 16)

Material. — One juvenile shell (ZPAL Ga.9/141) from Ogrodzieniec, Częstochowa region, Poland, Bathonian (Mid Jurassic).

Measurements. — The shell with 2.25 of the whorl is 0.79 mm in width and 0.49 mm in height. Larval shell has one whorl and width of 0.25 mm.

Description. — The protoconch is planispiral with one smooth whorl. The widely trochospiral teleoconch starts without ornamentation. A little later four spiral lirae appear on the abapical part of the whorl and one lira close to the adapical suture. On the second whorl of teleoconch, the adapical lira is sunken under the preceding whorl. Delicate axial striae appear between the spiral lirae.

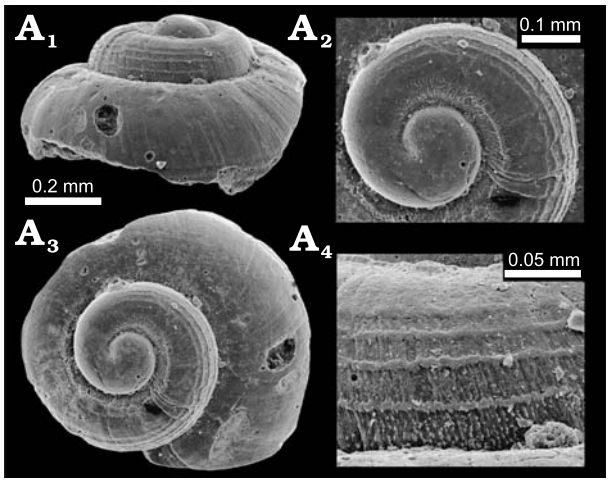


Fig. 16. The trochoid ?*Crossostoma* sp. **A**. ZPAL Ga.9/141 from Ogrodzieniec (Bathonian, Mid Jurassic): A_1 lateral view, A_2 details of juvenile whorls, A_3 apical view, A_4 details of the shell surface.

Remarks. — The shell described here is similar to a newly described species, *Crossostoma spirata* Bandel *et al.*, 2000, from Early/Mid Jurassic of New Zealand. The species described by Bandel *et al.* (2000) differs in having the spiral lirae on the whole surface of the juvenile whorl and a much more flattened apex. Moreover, in having axial lamellae on the whorls which is common in the genus *Solariella* to some degree, the shell resembles, some species of Recent *Solariella*.

Order **Caenogastropoda** Cox, 1959
Superfamily **Cerithioidea** Férrusac, 1822
Family **Cerithiidae** Férrusac, 1822

Remarks. — Traditionally the Jurassic and Cretaceous species of cerithiid-like gastropods have been placed into the family Procerithiidae Cossmann, 1906. Gründel (1976b) pointed out the close resemblance of the Mesozoic cerithiid shells (especially *Cryptaulax* Tate, 1869) to the shells of Recent *Varicopeza* Gründel, 1976 and *Argyropeza* Melvill *et* Standen, 1901. On the basis of this similarity Gründel (1976b) considered *Varicopeza* and *Argyropeza* as living representatives of the family Procerithiidae. He divided the Procerithiidae into two subfamilies: Cryptaulacinae Gründel, 1976 (*Argyropeza*, *Varicopeza*, and *Cryptaulax*) and Procerithiinae Cossmann, 1906 (*Procerithium* and *Bittium*) and considered both subfamilies to have developed independently since Middle Jurassic. Houbrick (1993) assigned *Argyropeza* and *Varicopeza* tentatively to the subfamily Bittiinae Cossmann, 1906 on the basis of both soft parts anatomy and shell characters. Simultaneously Houbrick (1993) questioned the relationship of Jurassic and Recent taxa as, in his opinion, the evidence based solely on the shell characters are, at best, tenuous. Moreover, he stated that the derivation of the *Bittium*-group from the *Procerithium*-group is largely speculative and cannot be proven. The new paleontological data support this hypothesis, however. It has been shown that "Jurassic" taxa were present in the Early Cretaceous also (Schröder 1995, and herein) and that similar forms occurred also in Late Cretaceous (Bandel 1993a). On the other hand, Gründel's (1976b) hypothesis that the *Argyropeza*/*Varicopeza* group and the *Bittium* group have developed independently since Jurassic has not been adequately documented. Here I tentantively include the Jurassic and the Cretaceous species in the family Cerithiidae, without subdivision on subfamily level.

Genus *Cryptaulax* Tate, 1869
(*Xystrella* Cossmann, 1906)

Type species: *Cerithium tortile* Hébert *et* Eudes-Deslongchamps, 1860, non *Cerithium tortile* Eudes-Deslongchamps, 1842; original designation Tate 1869: 418. Callovian (Mid Jurassic), Montreuil-Bellay, France.

Emended diagnosis. — Protoconch with two spiral keels. Demarcation between protoconch and teleoconch sinusoidal. Teleoconch *Bittium*-like with slightly or deeply incised sutures. Ornament of teleoconch starting with distinctly straight axial ribs and weaker spiral ribs which becoming stronger during ontogeny. Intersections of the ribs more or less nodose.

Discussion. — The protoconch of the type species is not known. The species I examined (see below) have a characteristic protoconch with two spiral keels. The genus *Cryptaulax* is defined here rather broadly, and includes several species classified previously in genera *Cryptaulax* Tate, 1869, *Xystrella* Cossmann, 1906, and some species of *Procerithium* Cossmann, 1902 and *Rhabdocolpus* Cossmann, 1906. *Cryptaulax* and *Xystrella* are most probably synonymous (see discussion in Gründel 1974b) with the older name being *Cryptaulax* Tate, 1869. The type species of *Procerithium* Cossmann, 1902, *P. quinquegranosum* Cossmann, 1902, was reexamined and refigured by Gründel (1997c) but its relation to the genus *Cryptaulax* and other species of *Procerithium* remains unclear. The taxonomic status of *Rhabdocolpus* Cossmann, 1906 is also questionable and its type species, "*Melania*" *scalariformis* Eudes-Deslongchamps, 1842, has to be reexamined. *Rhabdocolpus* and *Procerithium* can probably be conveniently treated as subgenera, as originally designated by Cossmann (1906). Moreover, some intermediate forms between species occur in my material. They may represent evolutionary transitions between species of different age, or clinal variability between different localities. This is not surprising as the Recent cerithioidean gastropods are known to be highly variable in shell shape on the species level (Houbrick 1992, 1993). Here I accept most of the widely used specific names for gastropods of the genus *Cryptaulax*, although their actual taxonomical status has to be better constituted by statistical studies. The exception is *C. donosum* Gründel, 1974 which seems conspecific with *C. quenstedti* (Walther, 1951).

Range. — Early Jurassic (e.g., Goldfuss 1843) to Early Cretaceous.

Cryptaulax muricata (Sowerby, 1825)
(Fig. 17)

1825. *Turritella muricata* sp. n.; Sowerby 1825: 159, pl. 499: 1, 2.
1889. *Cerithium muricatum* (Sowerby, 1825); Hudleston 1889: 146, pl. 8: 2, 3.

Type material: Sowerby 1825: 159, pl. 499: 1, 2.
Type horizon: Unspecified Mid Jurassic.
Type locality: unspecified locality in Yorkshire, England.

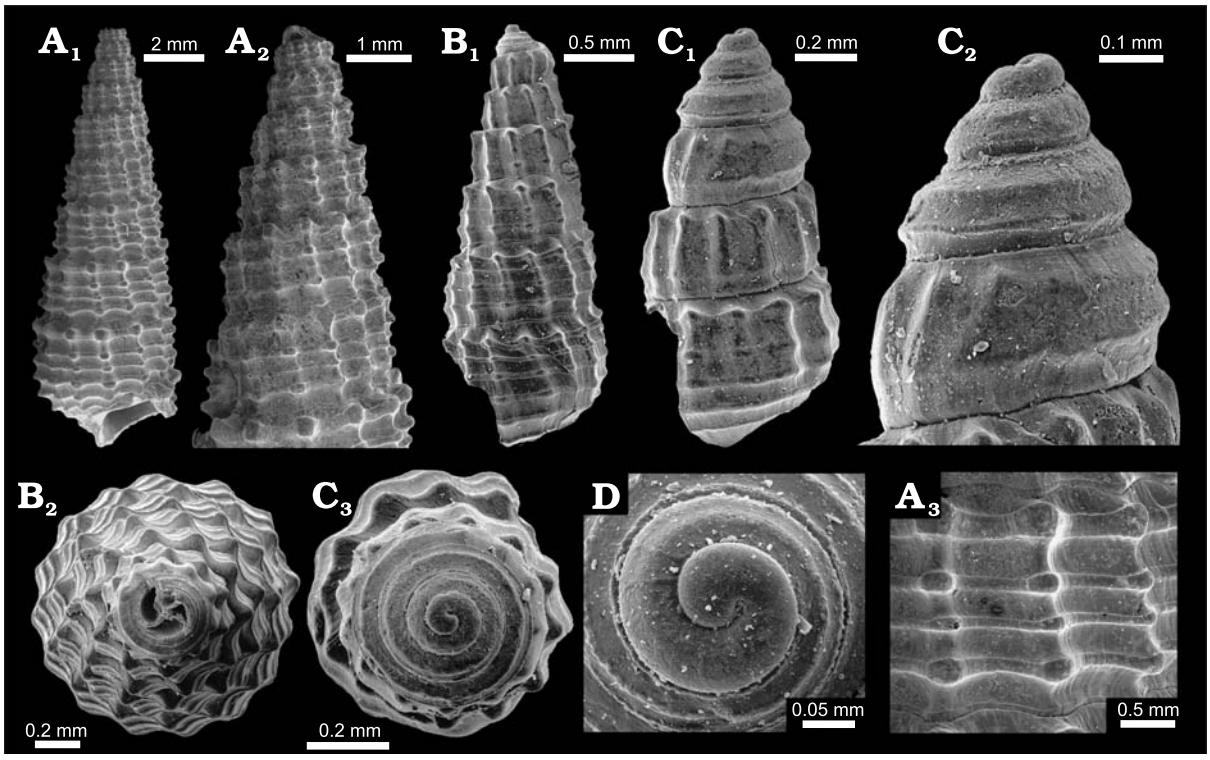


Fig. 17. The cerithiid *Cryptaulax muricata* (Sowerby, 1825) from Łuków (block in glacial drift), Podlasie, Poland, Late Callovian (Mid Jurassic). **A**. ZPAL Ga.9/142; A_1 lateral view, A_2 details of juvenile whorls, A_3 details of ornamentation. **B**. MZ VIII Mg 4234/1; B_1 lateral view, B_2 apical view. **C**. Juvenile ZPAL Ga.9/143; C_1 lateral view, C_2 close-up of the protoconch, C_3 apical view. **D**. ZPAL Ga.9/144; close-up of the protoconch 1.

Material. — Three incomplete adult shells and two juvenile ones from Łuków (block in glacial drift) (block in glacial drift), Podlasie, Poland, Late Callovian (Mid Jurassic).

Measurements. — The protoconch (ZPAL Ga.9/143) of four whorls is 0.56 mm high and 0.44 mm in diameter. The protoconch 1 is about one whorl and it is 0.14 mm in diameter. The largest shell I found (ZPAL Ga.9/142) with nine whorls preserved, is 13 mm high and 5 mm in diameter.

Occurrences. — Mid to Late Jurassic of Europe.

Emended diagnosis. — Elongate shell, 2.6 times as high as broad. Suture incised. Ornament consisting of four granulated spiral ribs and weakly prosocline axial ribs (modified after Hudleston 1889).

Description. — Protoconch 1 is ornamented with a granular pattern. Protoconch 2 is ornamented with two spiral ribs sculptured by small pustules. Growth lines are sinusoidal at the demarcation between the protoconch and the teleoconch. On the first teleoconch whorl, only strong axial ribs are visible. On the second teleoconch whorl, two weak spiral ribs appear. On the third teleoconch whorl the two ribs become pronounced and third additional medial rib appears. The fourth spiral rib appears on the fifth whorl of the teleoconch. The nodes or spinuous granulations occuring at the points of intersection with weakly prosocline axial ribs (usually 10–11 per whorl) are somewhat stronger at the most adapical rib. Peristome is not known in complete condition.

Remarks. — The name of the species has been often misused (see e.g., Brösamlen 1909; Makowski 1952) in the case of the shells of *Cryptaulax undulata* (Eudes-Deslongchamps, 1842) which have five spiral ribs and opisthocyrtic axial ribs (see below). The shell described by Hudleston (1889) as *Cerithium muricatum* var. *trilineatum* most probably represents another species as it was already admitted by Hudleston (1889) himself. Also the shells described as *Procerithium* (*Rhabdocolpus*) *muricatum* by Gründel (1974b) seem to represent another species as they are more rounded and have wider whorls.

Cryptaulax undulata (Eudes-Deslongchamps, 1842)
(Fig. 18)

1842. *Melania undulata* sp. n.; Eudes-Deslongchamps 1842: 217, pl. 5: 24.
1906. *Procerithium* (*Rhabdocolpus*) *undulatum* (Eudes-Deslongchamps, 1842); Cossmann 1906: 29, pl. 5: 24.

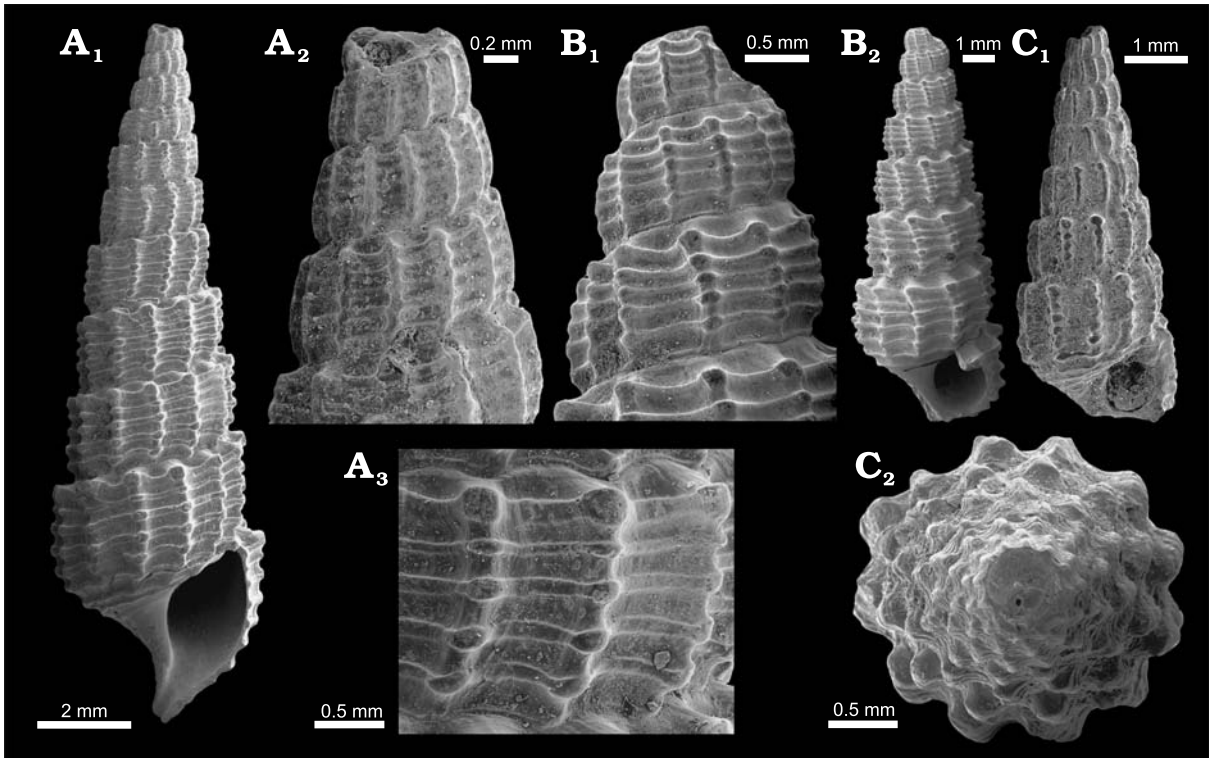


Fig. 18. The cerithiid *Cryptaulax undulata* (Eudes-Deslongchamps, 1842) from Łuków (block in glacial drift), Podlasie, Poland, Late Callovian (Mid Jurassic). **A**. ZPAL Ga.9/145; A_1 lateral view, A_2 details of juvenile whorls, A_3 details of ornamentation. **B**. ZPAL Ga.9/146; B_1 lateral view, B_2 details of juvenile whorls. **C**. Juvenile ZPAL Ga.9/143; C_1 lateral view, C_2 apical view.

1909. *Cerithium muricatum*; Brösamlen 1909: 295, pl. 21: 36–39 [non *Cerithium muricatum* Sowerby, 1825 — *Cryptaulax muricata* (Sowerby, 1825)].

1952. *Cerithium muricatum*; Makowski 1952: 21, pl. 2: 5 [non *Cerithium muricatum* Sowerby, 1825 — *Cryptaulax muricata* (Sowerby, 1825)].

Type material: Eudes-Deslongchamps 1842: 217, pl. 5: 24.

Type horizon: Pliensbachian (Early Jurassic).

Type locality: Fontaine–Etoupefour, France.

Material. — Over fifty incomplete specimens from Łuków (block in glacial drift), Late Callovian (Mid Jurassic).

Measurements. — The largest specimen has eleven whorls and is 15 mm high and 4.7 mm in diameter.

Occurrences. — Early to Late Jurassic of Europe.

Emended diagnosis. — Shell elongate, three times as high as broad. Suture incised. Ornament consisting of about 13–15 axial ribs per whorl and about five sharp spiral cords together forming distinct net of elongate meshes with distinct tubercules at intersections.

Description. — The protoconch is unknown. The earliest known teleoconch whorl (MZ VIII Mg 4235/2) bears distinct axial ribs and five weak spiral ribs. The peristome has an anteriorly directed siphonal canal.

Remarks. — The shells of this species were often confused with *C. muricata* (Sowerby, 1825); see above.

Cryptaulax sp. 1
(Fig. 19C, D)

Material. — One incomplete shell (ZPAL Ga.9/147) from Faustianka, and one shell (ZPAL Ga.9/148) from Raków, Częstochowa region, Poland, Bathonian (Mid Jurassic).

Measurements. — Protoconch of four whorls is 0.39 mm in diameter and 0.47 mm high. The shell ZPAL Ga.9/147 of ten whorls preserved, is 13.28 mm high and 3.56 mm in diameter.

Description. — The protoconch of four whorls is ornamented with two spiral keels. The first teleoconch whorl has distinct axial ribs (ten ribs per whorl) and three spiral ribs. On the sixth teleoconch whorl, a fourth, weak spiral rib appears. On the tenth teleoconch whorl, an additional fifth, weak spiral rib appears. The peristome is unknown.

Remarks. — *Cryptaulax* sp. 1 is a morphologically-intermediate form between *C. muricata* (Sowerby, 1825), *C. shiptonensis* (Cox *et* Arkell, 1950), and *C. quenstedti* (Walther, 1951). *Cryptaulax* sp. 2 differs from *Cryptaulax* sp. 1 by the later appearance of the fourth rib. Moreover the rib becomes strong on the next whorl whereas in *Cryptaulax* sp. 1, the rib remains weak during the whole ontogeny.

Cryptaulax sp. 2
(Fig. 19A, B)

Material. — Two incomplete shells (ZPAL Ga.9/149–150) from Faustianka, Częstochowa region, Poland, Mid Bathonian (Mid Jurassic).

Measurements. — The shell ZPAL Ga.9/150 of ten whorls preserved is 12.00 mm high and 3.78 mm in diameter.

Description. — The protoconch is unknown. The earliest preserved (probably the second) teleoconch whorl has distinct axial ribs (ten ribs per whorl) and three spiral ribs. On the ninth teleoconch whorl, a fourth spiral rib appears. On the tenth teleoconch whorl, an additional fifth, weak spiral rib appears. The peristome is unknown.

Remarks. — See remarks on *Cryptaulax* sp. 1.

Cryptaulax shiptonensis (Cox *et* Arkell, 1950)
(Fig. 20)

1860. *Cerithium tortile* sp. n.; Hébert and Eudes-Deslongchamps 1860; partim: 191, pl. 6: 1a, b, e [non fig. 1c, d — *Cryptalaux tortilis* (Hébert *et* Eudes-Deslongchamps, 1860); non *Cerithium tortile* Eudes-Deslongchamps, 1842 — *Gordenella tortilis* (Eudes-Deslongchamps, 1842)].

1905. *Cryptaulax tortilis* (Hébert *et* Eudes-Deslongchamps, 1860); Blake 1905: 69, pl. 7: 12, 13.

1950. *Procerithium* (*Xystrella*) *shiptonense* sp. n.; Cox and Arkell 1950: 73, not illustrated.

1974. *Cryptaulax* (*Cryptaulax*) *shiptonense* (Cox *et* Arkell, 1950); Gründel 1974b: 844, pl. 1: 12, 13.

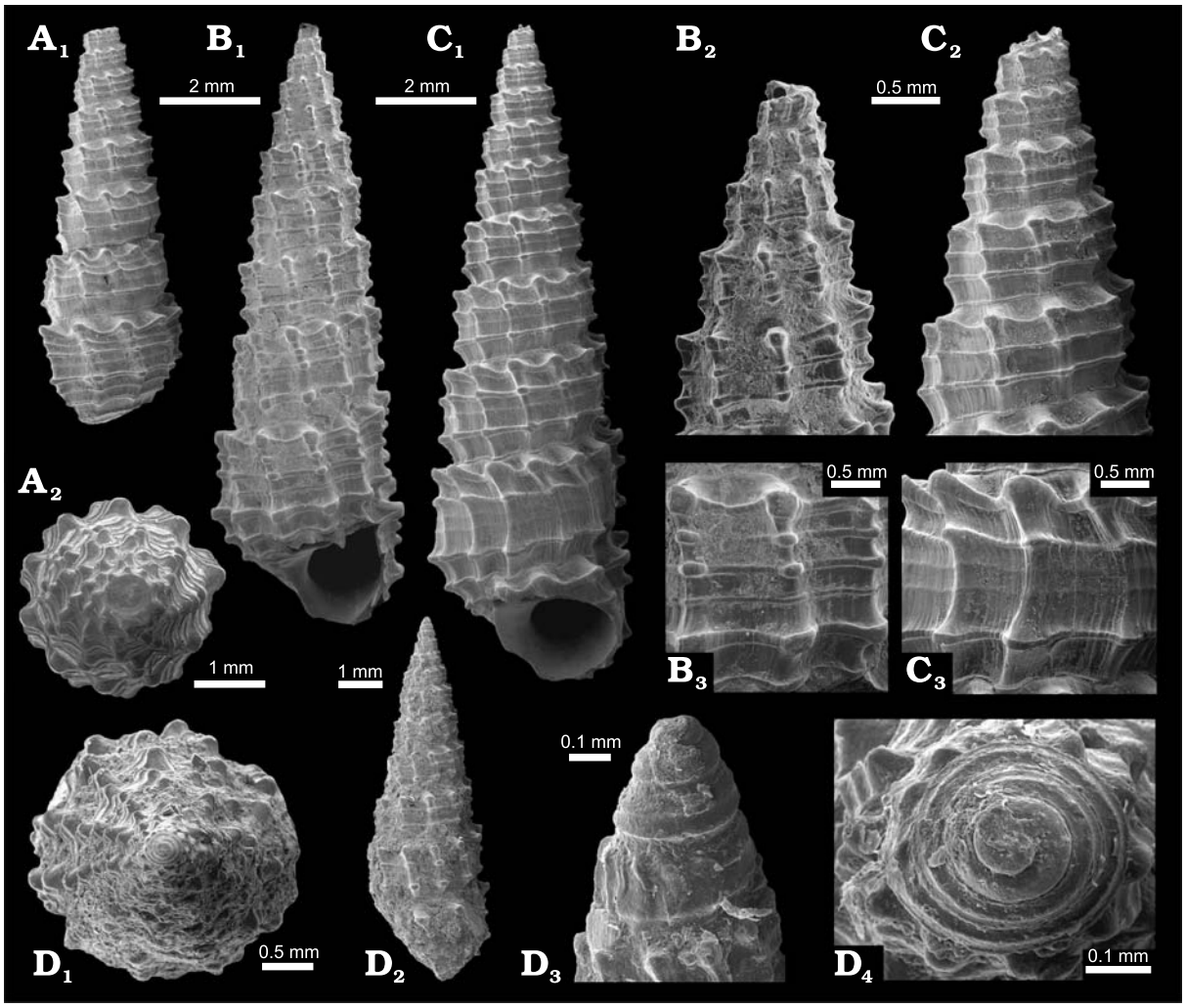


Fig. 19. Mid Jurassic cerithiids *Cryptaulax* from Częstochowa region, Poland. **A**, **B**. *Cryptaulax* sp. 2, ZPAL Ga.9/149 (A) and 9/150 (B) from Faustianka, Mid Bathonian; A_1 lateral view, A_2 apical view; B_1 lateral view, B_2 details of juvenile whorls, B_3 details of ornamentation. **C**, **D**. *Cryptaulax* sp. 1., ZPAL Ga.9/147 from Faustianka, Mid Bathonian (C) and 9/148 from Raków, Bathonian (D); C_1 lateral view, C_2 details of juvenile whorls, C_3 details of ornamentation; D_1 apical view, D_2 lateral view, D_3, D_4 protoconch.

Holotype: Blake, 1905: pl. 7: 12.

Type horizon: Great Oolite (Mid Jurassic).

Type locality: Cornbrash, England.

Material. — One incomplete subadult shell and five juvenile ones from Ogrodzieniec, Bathonian (Middle Jurassic).

Measurements. — Protoconch 1 of one whorl is 0.13 mm. Protoconch of 3.5 of the whorl is 0.36 in diameter and 0.44 high. The largest shell I found (ZPAL Ga.9/102) of nine whorls preserved is 3.14 mm in diameter and 8 mm high.

Occurrences. — Middle to Late Jurassic of Europe.

Emended diagnosis. — Shell elongate, 2.5 times as high as broad. Suture incised. Teleoconch ornament consisting of granulated spiral ribs (two strong and one or two weak) and straight axial ribs (usually 9–10 per whorl) together forming distinct net of elongate meshes with blunt tubercules at intersections.

Description. — Protoconch 1 is not visibly ornamented. Protoconch 2 consists of 3.5 whorls, which are ornamented with two spiral keels. The first whorl of the teleoconch and the keels are ornamented with small pustules. Demarcation between the protoconch and the teleoconch is sinusoidal. The first teleoconch whorl is ornamented with distinct axial ribs and two weak spiral ribs. On the fourth or fifth teleoconch whorl, two ad-

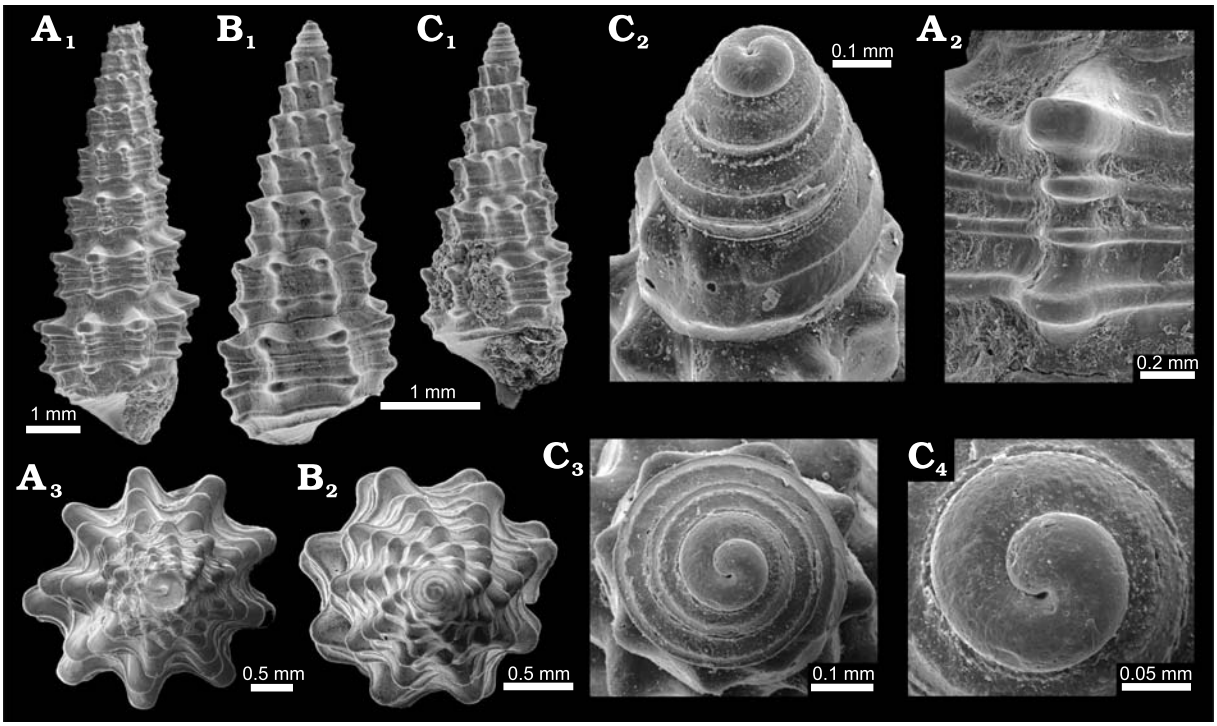


Fig. 20. The cerithiid *Cryptaulax shiptonensis* (Cox *et* Arkell, 1950) from Ogrodzieniec, Częstochowa region, Poland, Bathonian (Mid Jurassic). **A**. ZPAL Ga.9/102; A_1 lateral view, A_2 details of ornamentation, A_3 apical view. **B**. ZPAL Ga.9/152; B_1 lateral view, B_2 apical view. **C**. ZPAL Ga.9/151; C_1 lateral view, C_2, C_3 protoconch, C_4 close-up of the protoconch 1.

ditional, weak medial ribs appear.The peristome is not known. In some cases only one medial spiral rib is developed.

Remarks. This is an intermediate species between *C. muricata* and *C. quenstedti*. The morphotype with one medial rib is especially close to *C. quenstedti* but it differs in having broader tubercles. It differs from *C. muricata* in having much weaker medial spiral ribs. The latter species has the ribs of the same, or almost the same, strength.

Cryptaulax quenstedti (Walther, 1951)
(Fig. 21)

1851. *Turritella echinata* Buch, 1831; Quenstedt 1851: 372 [non *Turritella echinata* Buch, 1831 — *Cryptaulax echinata* (Buch, 1831)].

1884. *Cerithium echinatum* (Buch, 1831); Quenstedt 1884: 515, pl. 205: 33–36.

1951. *Procerithium* (*Xystrella*) *quenstedti* sp. n.; Walther 1951: 81, pl. 4: 8.

1974. *Cryptaulax* (*Xystrella*) *quenstedti* (Walther, 1951); Gründel 1974b: 842, pl. 2: 9–15.

1974. *Cryptaulax* (*Xystrella*) *donosum* sp. n.; Gründel 1974b: 841, pl. 2: 4.

Type material: Originals of Quenstedt (1851) according to Walther (1951) lost. Lectotype designated by Walther (1951): 81, from the collection of Quenstedt (1884; pl. 205: 34) is housed at the Geologisch-Paläontologischen Institut of the University of Tübingen.

Type horizon: Dogger ε (Middle Jurassic).

Type locality: Eningen near Reutlingen, Germany.

Material. — Many specimens of different Bathonian localities in the Częstochowa region (Faustianka, Ogrodzieniec, Korwinów, the Kłobuck borehole) and many specimens of the Callovian in Łuków (block in glacial drift), Podlasie, Poland.

Measurements. — Protoconch 1 consists of one whorl that is 0.12 mm wide. Protoconch 2 has 3.5 whorls and it is 0.40 mm in diameter and 0.53 mm high. The complete shell (ZPAL Ga.9/156) with 8.5 whorls is 2.00 mm in diameter and 6.57 mm high.

Occurrences. — Mid and Late Jurassic of Europe.

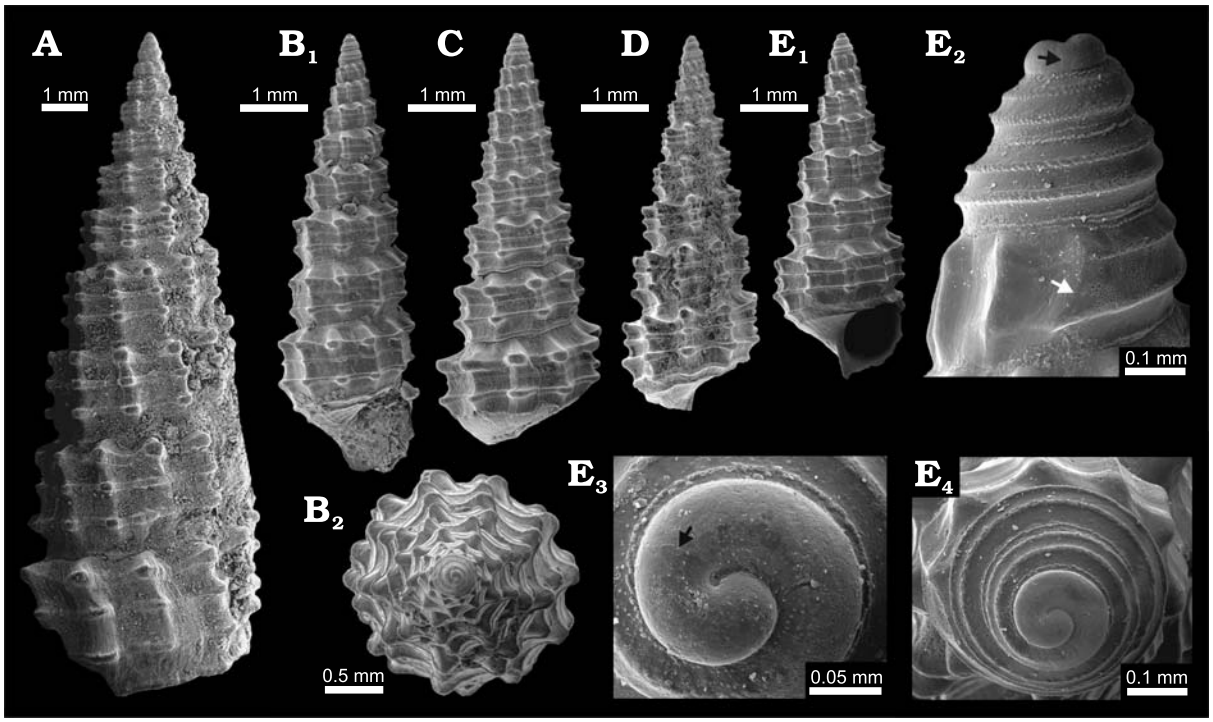


Fig. 21. The cerithiid *Cryptaulax quenstedti* (Walther, 1951) from Mid Jurassic of Poland. **A**. ZPAL MZ VIII Mg 4236/1 from Łuków (block in glacial drift), Podlasie, Late Callovian; lateral view. **B**. ZPAL Ga.9/156 from the Kłobuck borehole, Częstochowa region, Mid Bathonian; B_1 lateral view, B_2 apical view. **C**. ZPAL Ga.9/158 from Ogrodzieniec, Częstochowa region, Bathonian; lateral view. **D**. ZPAL Ga.9/161 from Korwinów, Częstochowa region, Bathonian; lateral view. **E**. ZPAL Ga.9/157 from Faustianka, Częstochowa region, Mid Bathonian; E_1 lateral view, E_2, E_4 protoconch, E_3 close-up of protoconch 1. Black arrows indicate demarcation between protoconch 1 and protoconch 2; white arrow indicates demarcation between protoconch and teleoconch.

Emended diagnosis. — Shell elongate, about three times as high as broad. Suture incised. First teleoconch whorl ornamented with distinct axial ribs (9–10 ribs per whorl) and two or three weak spiral ribs together forming distinct net of elongate meshes with blunt tubercules at intersections. On third and further whorls of teleoconch third spiral rib well-developed.

Description. — Protoconch 1 is not visibly ornamented. Protoconch 2 consists of 3.5 whorls, which are ornamented with two spiral keels. The first whorl of the teleoconch and the keels are ornamented with small pustules. Close to both adapical and abapical sutures, rows of small pustules are developed. The demarcation between the protoconch and the teleoconch is sinusoidal. The third spiral rib is weaker or of the same strength as the two others. Aperture is drop-like and peristome is continuous.

Remarks. — Gründel (1974b) used the specific name *C. quenstedti* for the forms of slender shells with the medial spiral rib weaker than the two others. Based on the broader shell form and the ribs of the same strength, he considered it a new species *C. donosum* Gründel, 1974. In my material, I found a series of shells that show continuous changes both in shell shape and in rib strength and I regard these species as synonyms with the older specific name *Cryptaulax quenstedti* (Walther, 1851).

Cryptaulax armata (Goldfuss, 1843)
(Fig. 22)

1843. *Cerithium armatum* sp. n.; Goldfuss 1843: 31, pl. 173: 7.
1913. *Procerithium* (*Xystrella*) *armatum* (Goldfuss, 1843); Cossmann 1913: 85, pl. 4: 45–49 and 51–53.
1997. *Xystrella armatum* (Goldfuss, 1843); Gründel 1997c: 96, pl. 6: 6–9.

Type material: Type material of Goldfuss (1843) according to Gründel (1997c) lost.
Type horizon: Toarcian (Early Jurassic).
Type locality: Vicinity of Banz and Pretzfeld, northern Germany.

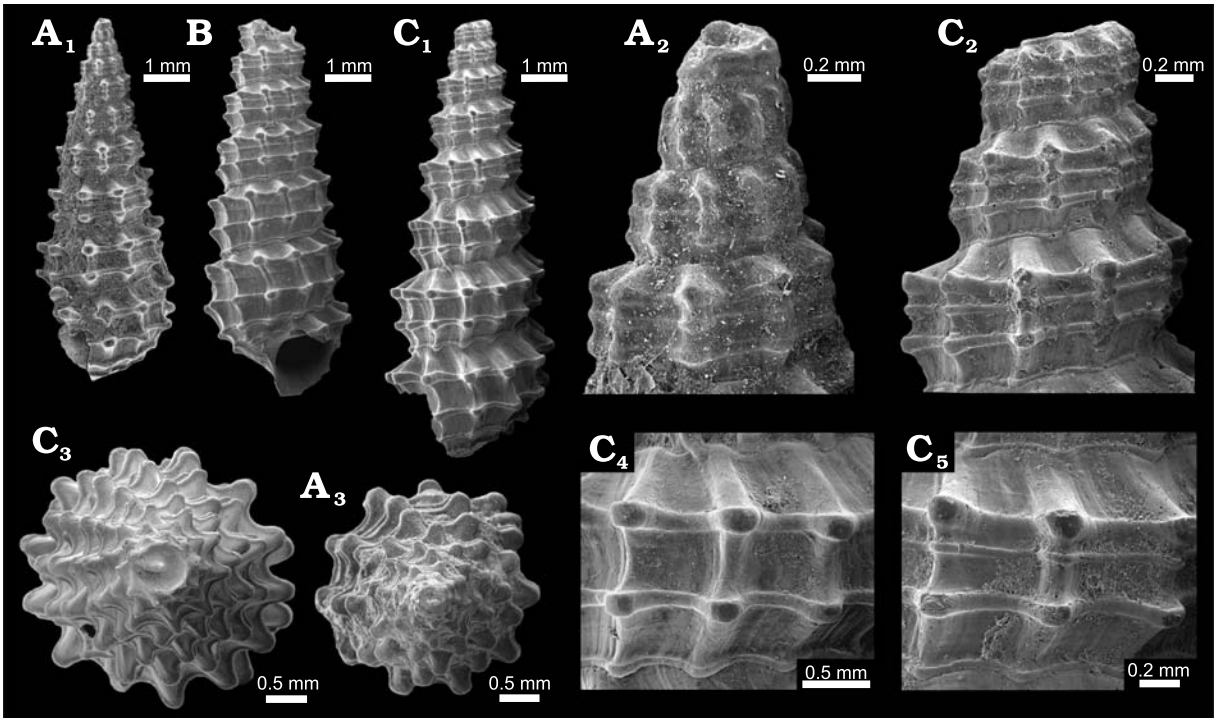


Fig. 22. Mid Jurassic cerithiid *Cryptaulax armata* (Goldfuss, 1843) from Częstochowa region, Poland. **A**. MZ VIII Mg 4222/1 (morphotype 1) from Blanowice, Bathonian; A_1 lateral view, A_2 details of juvenile whorls, A_3 apical view. **B**. ZPAL Ga.9/165 (morphotype 2) from Faustianka, Mid Bathonian; lateral view. **C**. ZPAL Ga.9/164 (morphotype 2) from Faustianka, Bathonian; C_1 lateral view, C_2 details of juvenile whorls, C_3 apical view, C_4 details of ornamentation on late whorls, C_5 details of ornamentation on early whorls.

Material. — Five incomplete shells of morphotype 1 from Blanowice, Częstochowa region, Poland, Bathonian (Mid Jurassic). Two incomplete shells of morphotype 2 from Faustianka, Częstochowa region, Mid Bathonian (Mid Jurassic).

Measurements. — Morphotype 1: The largest shell (MZ VIII Mg 4222/1) with nine whorls preserved is 7.67 mm high and 3.10 mm in diameter. Morphotype 2: The largest shell (ZPAL Ga.9/164) with eight whorls preserved is 9.5 mm high and 3.7 mm in diameter.

Occurrences. — Early to Late Jurassic of Europe.

Emended diagnosis. — Shell elongate, about 2.5 times as high as broad. Suture weakly to deeply incised. Ornament consisting of, three granulated spiral cords, and straight axial ribs (9–12 ribs per whorl) together forming distinct net of elongate meshes with distinct tubercles at intersections. Later in ontogeny medial rib reduced.

Description. — The protoconch is unknown. The first teleoconch whorl has distinct axial ribs and three spiral ribs. The medial spiral rib is reduced on the eighth (Morphotype 1) or the seventh (Morphotype 2) teleoconch whorl. The suture is deeply to weakly incised. The peristome is unknown.

Remarks. — *C. armata* is morphologically intermediate between *C. quenstedti* (Walther, 1951) and *C. echinata* (Buch, 1831). It differs from *C. quenstedti* by the reduction of the third, medial rib during ontogeny and from *C. echinata* in having the medial rib on the juvenile whorls. Morphotype 1 differs from morphotype 2 in having broader whorls of teleoconch and weakly incised sutures.

Cryptaulax echinata (Buch, 1831)
(Fig. 23)

1831. *Turritella echinata* sp. n.; Buch 1831: no pagination, pl. 7: 1.
1909. *Cryptaulax echinata* (Buch, 1831); Brösamlen 1909: 292, pl. 21: 30.
1974. *Cryptaulax* (*Xystrella*) *echinatum* (Buch, 1831); Gründel 1974b: 842, pl. 2: 5–8.

Type material: Buch 1831: pl. 7: 1.

Type horizon: ?Dogger ε (≅ Bathonian, Mid Jurassic).

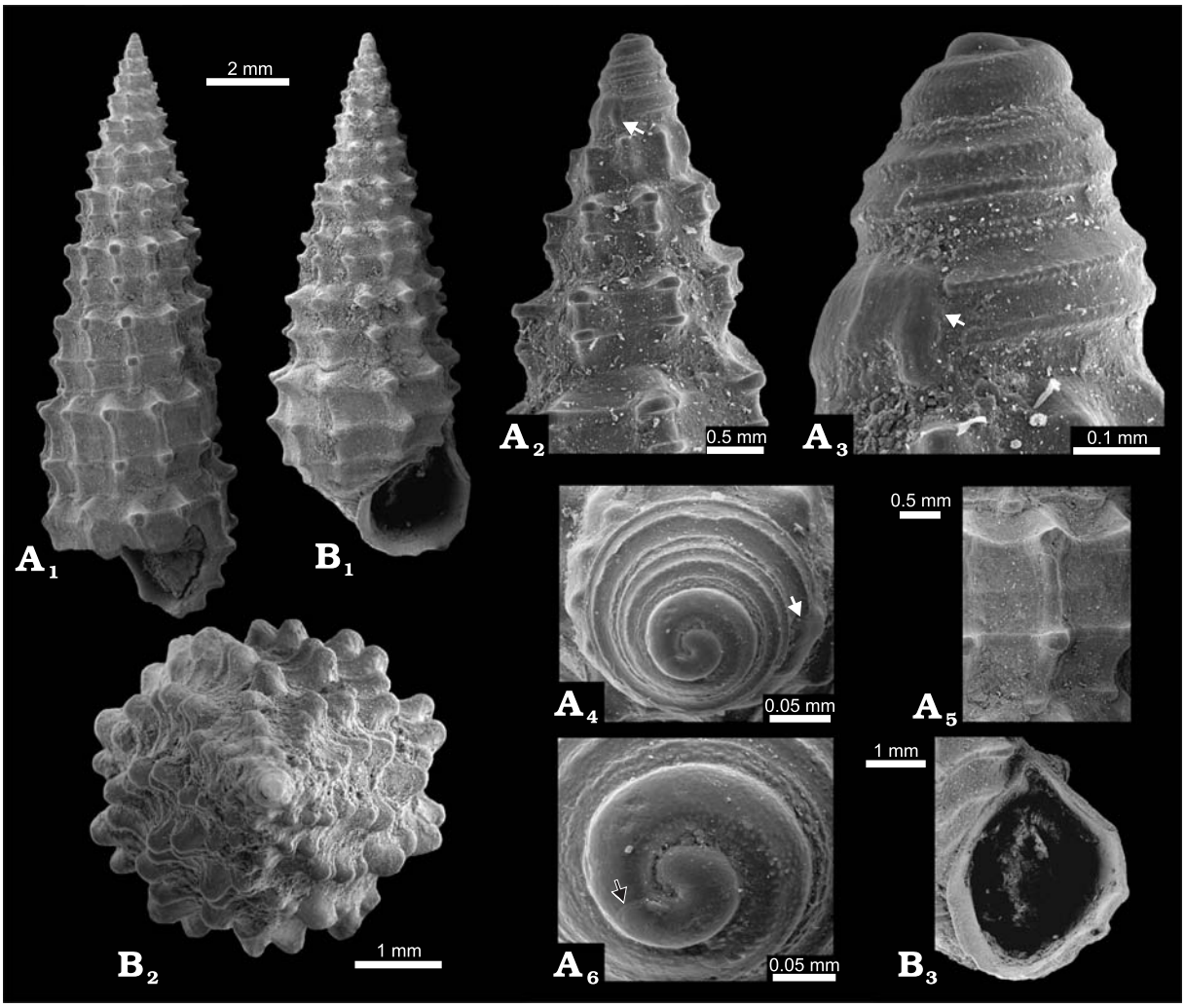


Fig. 23. The cerithiid *Cryptaulax echinata* (Buch, 1831) from Łuków (block in glacial drift), Podlasie, Poland, Late Callovian (Mid Jurassic). **A**. MZ VIII Mg 4231/1; A_1 lateral view, A_2 details of juvenile whorls, A_3, A_4 protoconch, A_5 details of ornamentation, A_6 close-up of protoconch 1. **B**. MZ VIII Mg 4231/3; B_1 lateral view, B_2 apical view, B_3 close-up of the peristome. Black arrow indicates demarcation between protoconch 1 and protoconch 2; white arrows indicate demarcation between protoconch and teleoconch.

Type region: Banz near Bamberg, Germany.

Material. — Many specimens from Łuków (block in glacial drift), Podlasie, Poland, Late Callovian (Mid Jurassic) and five specimens from Ogrodzieniec, Częstochowa region, Bathonian (Mid Jurassic).

Measurements. — Protoconch 1 of one whorl is 0.11 mm. Protoconch 2 of 3.25 whorls is 0.39 in diameter and 0.41 high. The shell (MZ VIII Mg 4231/1) with fourteen whorls is 4.77 mm in diameter and 14.15 mm high.

Occurrences. — Mid to Late Jurassic of Europe.

Emended diagnosis. — Shell elongate, three times as high as broad. Suture incised. Ornament consists of two sharp, granulated spiral cords, and about 8–9 straight axial ribs, together forming distinct net of elongate meshes with distinct tubercles at intersections.

Description. — Protoconch 1 is not visibly ornamented. Protoconch 2 of 3.25 whorls are ornamented with two spiral keels. The first whorl of the teleoconch and the keels is ornamented with small pustules. Rows of small pustules develop close to both the adapical and the abapical sutures. The demarcation between the protoconch and teleoconch is sinusoidal. The spiral cords are either close to each other or with a wide, flat space in between. In the latter case, a very weak third medial cord is visible. The peristome is drop-like, with a well developed anal canal.

Remarks. — This species resembles *C. armata* and *C. quenstedti* but differs from them in having only two sharp spiral cords.

Cryptaulax wawalensis sp. n.
(Fig. 24)

2001. *Xystrella* sp.; Kaim 2001: tab. 2, fig. 5.

Holotype: ZPAL Ga.9/95, Fig. 24B.
Type horizon: Sample D2, *Saynoceras verrucosum* Zone, Late Valanginian (Early Cretaceous).
Type locality: Wąwał, southern Mazowsze, Poland.
Derivation of the name: After the type locality.

Material. — Over 400 shells from Wąwał, southern Mazowsze, Poland.

Measurements. Protoconch 1 of 0.75 whorls is 0.09 mm wide. Protoconch of three whorls is 0.37 mm in diameter and 0.43 mm high. The shell (ZPAL Ga.9/96) of ten whorls is 1.50 mm in diameter and 3.63 mm high.

Occurrences. — Type locality only.

Diagnosis. — Shell elongate, about 2.4 as high as broad. Suture incised. Ornament consisting of three granulated, strong spiral ribs, and about ten axial ribs per whorl, together forming distinct net of elongate meshes with distinct tubercles at intersections. Spiral keels of protoconch present only on last half of protoconch 2. Spiral cords of teleoconch ornamented with small pustules.

Description. — Protoconch 1 is not visibly ornamented. The first 2.5 whorls of protoconch 2 are smooth. The demarcation between the protoconch and the teleoconch is sinusoidal. The teleoconch starts with two spiral ribs. The medial rib appears on the second whorl. On the ninth and tenth whorls of the shell additional spiral ribs appear. The axial ribs are prosocline to orthocline. The peristome is drop-like, not completely preserved.

Remarks. — The species has a slightly different protoconch 2 in comparison to other members of the genus. The spiral keels are present only on the last whorl of protoconch 2, which is smooth otherwise. Still the keels ornamenting protoconch 2 are diagnostic of the genus *Cryptaulax*.

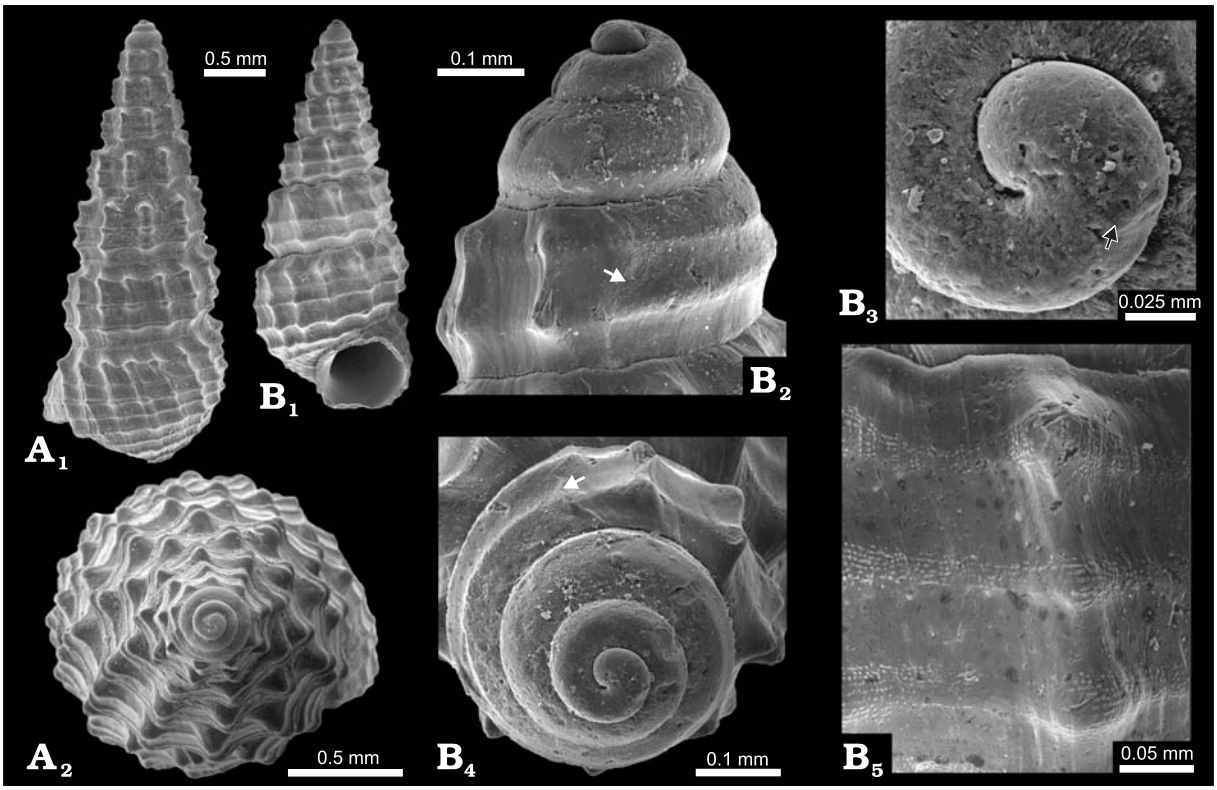


Fig. 24. The cerithiid *Cryptaulax wawalensis* sp. n. from sample D2 of Wąwał, southern Mazowsze, Poland, Late Valanginian (Early Cretaceous). **A**. ZPAL Ga.9/96); A_1 lateral view, A_2 apical view. **B**. ZPAL Ga.9/95 (holotype); B_1 lateral view, B_2, B_4 protoconch, B_3 close-up of protoconch 1, B_5 details of ornamentation.Black arrow indicates demarcation between protoconch 1 and protoconch 2; white arrows indicate demarcation between protoconch and teleoconch.

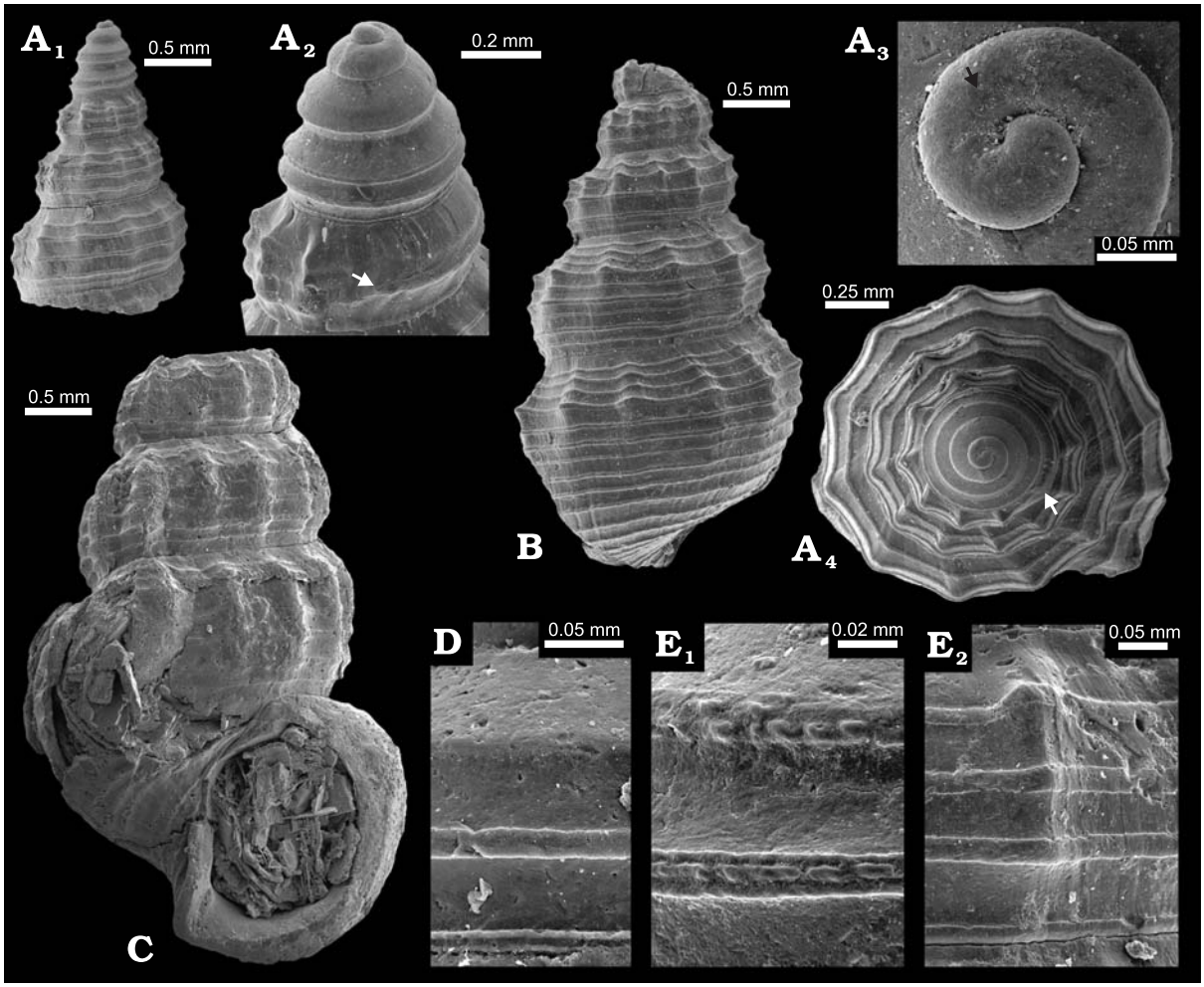


Fig. 25. The cerithiid *Cryptaulax kulickii* (Schröder, 1995) from Wąwał, southern Mazowsze, Poland, Early Valanginian (Early Cretaceous). **A**. ZPAL Ga.9/68 from sample C1; A_1 lateral view, A_2 protoconch, A_3 close-up of protoconch 1, A_4 apical view. **B**. ZPAL Ga.9/67 from sample C1; lateral view. **C**. ZPAL Ga.9/71 from sample H1; lateral view of the largest specimen known. **D**. ZPAL Ga.9/70 from sample G1; details of ornamentation on the second whorl of the protoconch. **E**. ZPAL Ga.9/69 from sample N1; E_1 details of ornamentation on the fourth whorl of the protoconch, E_2 details of teleoconch ornamentation. Black arrow indicates demarcation between protoconch 1 and protoconch 2; white arrows indicate demarcation between protoconch and teleoconch.

Cryptaulax kulickii (Schröder, 1995)
(Fig. 25)

1995. *Procerithium kulickii* sp. n.; Schröder 1995: 21, pl. 3: 9–13 and pl. 14: 7.

Holotype: Schröder 1995: 21, pl. 3: 10.

Type horizon: Valanginian (Lower Cretaceous). Bed by bed sampling by Kaim (2001) shows that *C. kulickii* is present in the type locality in the *Tirnovella pertransiens* and *Busnardoides campylotoxus* Zones of Early Valanginian.

Type locality: Wąwał, southern Mazowsze, Poland.

Material. — Over 7300 shells from Early Valanginian of Wąwał.

Measurements. — Protoconch 1 consists of 0.75 whorls and it is 0.12 mm wide. Protoconch of 4.25 whorls is 0.55 mm in diameter and 0.62 mm high. The shell (ZPAL Ga.9/68) of 7.5 of the whorl is 1.36 mm in diameter and 2.61 mm high.

Occurrences. — Type locality only.

Emended diagnosis. — Protoconch ornamented with two keels. Teleoconch with convex whorls, starting with distinct axial ribs (about 11–12 per whorl) which becoming weaker during ontogeny. Teleoconch ornament starting with distinct axial ribs which becoming increasingly weaker during ontogeny. First whorl

of teleoconch ornamented with three distinct, non-nodose spiral ribs. Number of spiral ribs increasing during ontogeny.

Description. — Protoconch 1 is not visibly ornamented. Protoconch 2 of about 4.25 of the whorl is smooth on the first whorl while on the second whorl two keels appear. The adapical keel is weaker than the abapical keel. Later on the keels are of the same dimensions and bear dash-like pustules. Peristome with weak anterior and anal canals.

Remarks. — Both *C. kulickii* and *C. tricuspis* (see below) are more similar to each other than to any other member of the genus. They possibly represent a derived lineage evolved from *Cryptaulax* stem. Although they still seem to belong to the genus but the shell morphology becomes similar to the Tertiary and Recent bittiinid-like gastropods, e.g. the shell illustrated by Cossmann (1906) as *Cerithidium submamillatus* (Rayneval *et* Ponzi, 1854).

Cryptaulax tricuspis (Schröder, 1995)
(Fig. 26)

1995. *Procerithium tricuspis* sp. n.; Schröder 1995: 22, pl. 3: 14–16 and pl. 14: 8.

Holotype: Schröder 1995: 22, pl. 3: 14.

Type horizon: Valanginian (Early Cretaceous). Bed by bed sampling by Kaim (2001) shows that *C. tricuspis* is present in the type locality in the *Dichotomites* beds, which correspond to the upper part of *Saynoceras verrucosum* Zone of the Late Valanginian.

Type locality: Wąwał, southern Mazowsze, Poland.

Material. — Over 5700 shells from the Late Valanginian of Wąwał.

Measurements. — Protoconch 1 of 0.75 whorls is 0.11 mm wide. Protoconch of five whorls is 0.62 mm in diameter and 0.85 mm high. The shell (ZPAL Ga.9/73) consisting of 7.5 whorls is 1.88 mm in diameter and 3.06 mm high.

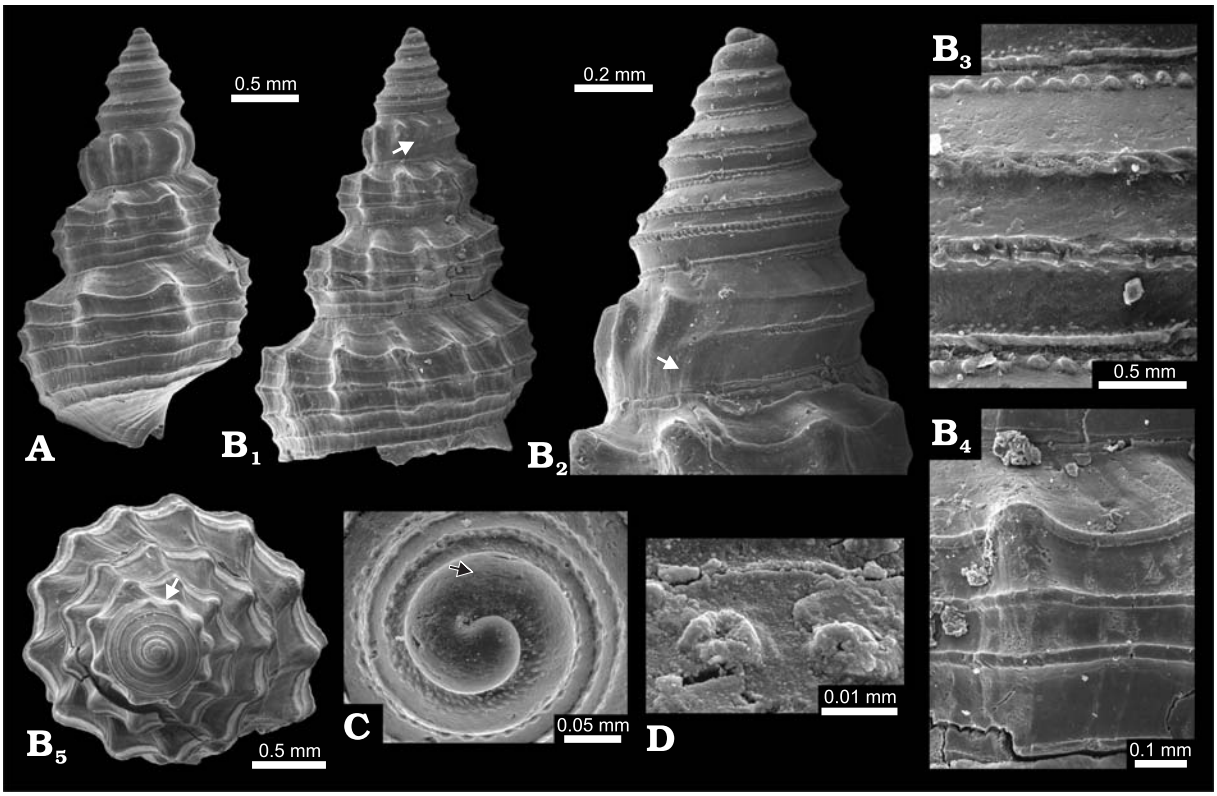


Fig. 26. The cerithiid *Cryptaulax tricuspis* (Schröder, 1995) from Wąwał, southern Mazowsze, Poland, Late Valanginian (Early Cretaceous). **A**. ZPAL Ga.9/73; lateral view. **B**. ZPAL Ga.9/72; B_1 lateral view, B_2 protoconch, B_3 details of protoconch ornamentation, B_4 details of teleoconch ornamentation, B_5 apical view. **C**. ZPAL Ga.9/77; close-up of protoconch 1. **D**. ZPAL Ga.9/74 from sample F3; close-up of the pustules forming subsutural row on protoconch 2. Black arrow indicates demarcation between protoconch 1 and protoconch 2; white arrows indicate demarcation between protoconch and teleoconch.

Occurrences. — Type locality only.

Emended diagnosis. — Protoconch ornamented with two keels and adapical row of pustules. Teleoconch of convex whorls, with distinct axial ribs (12–13 per whorl). On first teleoconch whorl, three, distinct spiral ribs appearing. Adapical spiral rib with weak nodes at intersections with axial ribs. Number of ribs increasing during ontogeny.

Description. — Protoconch 1 of about 0.75 whorls is not visibly ornamented. Protoconch 2 of about five whorls has pustulose ornamentation on the first whorl of the teleoconch. On the second whorl, an adapical row of pustules and two keels appear. The keels bear dash-like pustules. A well-preserved peristome is unknown.

Remarks. — See remarks to *C. kulickii*.

Cryptaulax sp. 3
(Fig. 27)

Material. — One juvenile shell (ZPAL Ga.9/167) from Łuków (block in glacial drift), Podlasie, Poland, Late Callovian (Mid Jurassic).

Measurements. — Protoconch 1 consisting of 0.75 whorls is 0.09 mm wide. Protoconch of five whorls is 0.42 mm in diameter. The shell (ZPAL Ga.9/167) of seven of whorls is 0.8 mm in diameter and 1.88 mm high.

Description. — Protoconch 1, consisting of 0.75 whorls, is ornamented with a granulate pattern. Protoconch 2 of 3.25 whorls is ornamented with two spiral keels. At the adapical suture, a row of dash-like pustules is visible. The first whorl of protoconch 2 and the keel are ornamented with small pustules. The first teleoconch whorl is ornamented with distinct axial ribs (about nine ribs per whorl) and two indistinct spiral ribs. On the third teleoconch whorl, the spiral ribs are more visible and occupy the adapical and abapical part of the whorl respectively. Between the two ribs, the surface of the whorl is almost flat. The well preserved peristome is unknown.

Remarks. — I could not assign this juvenile shell to any known *Cryptaulax* species and therefore I leave it unnamed.

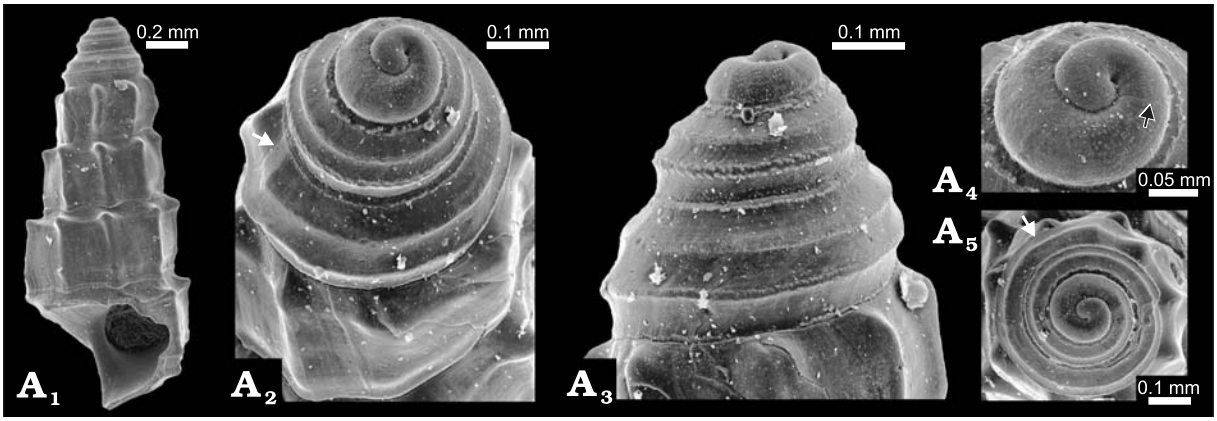


Fig. 27. The cerithiid *Cryptaulax* sp. 3. from Łuków (block in glacial drift), Podlasie, Poland, Late Callovian (Mid Jurassic) **A**. ZPAL Ga.9/167; A_1 lateral view, A_2, A_3, A_5 protoconch, A_4 close-up of protoconch 1. Black arrow indicates demarcation between protoconch 1 and protoconch 2; white arrows indicate demarcation between protoconch and teleoconch.

?*Cryptaulax mutabilis* (Gerasimov, 1955)
(Fig. 28)

1912. *Pseudomelania variabilis* (Morris *et* Lycett, 1850); Riabinin 1912: 255, pl. 12: 8–10 [non *Chemnitzia variabilis* sp. n.; Morris and Lycett 1850: 51, pl. 8: 7 — *Rhabdocolpus variabile* (Morris *et* Lycett, 1850)].

1955. *Pseudomelania* (?) *mutabilis* sp. n.; Gerasimov 1955: 186, pl. 40: 15–17.

1992. *Cryptaulax* (*Neocryptaulax*) *mutabilis* (Gerasimov, 1955); Gerasimov 1992: 84, pl. 22: 1–21.

Holotype: Gerasimov 1955: 186, pl. 40: 15.

Type horizon: Mid Callovian (Mid Jurassic).

Type locality: Unspecified borehole near Lyudinovo, Kaluzhskaya oblast', Russia.

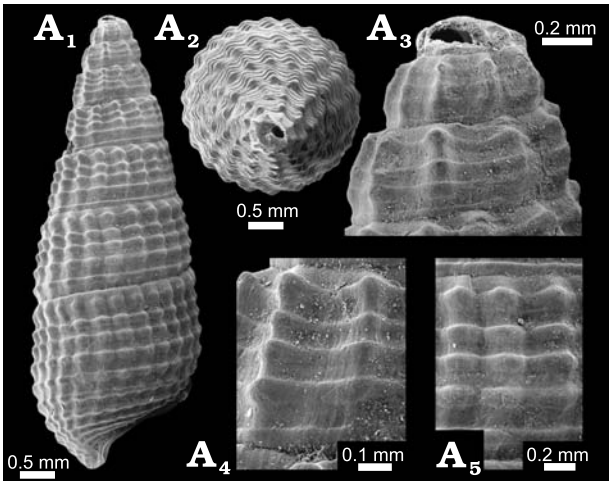


Fig. 28. The *Bittium*-like cerithiid ?*Cryptaulax mutabilis* (Gerasimov, 1955) from Łuków (block in glacial drift), Podlasie, Poland, Late Callovian (Mid Jurassic). **A**. ZPAL Ga.9/168; A_1 lateral view, A_2 apical view, A_3 details of juvenile whorls, A_4 details of ornamentation on early whorls, A_5 details of ornamentation on later whorls.

Material. — One incomplete shell from Łuków (block in glacial drift), Podlasie, Poland, Late Callovian (Mid Jurassic).

Measurements. — The shell ZPAL Ga.9/168 of seven whorls is 6.57 mm high and 2.55 mm in diameter.

Occurrences. — Callovian of Lithuania, Poland, Russia, and Ukraine.

Emended diagnosis. — Small shell, *Bittium*-like, of about eleven nearly flat whorls. Suture weakly incised. Teleoconch ornamentation with axial (12–13 per whorl) and 4–5 spiral ribs. At the intersections, blunt nodes appearing. In early ontogeny, axial ribs stronger than spiral ribs and later both of similar dimensions. Peristome drop-like with weak siphonal canal (modified after Riabinin 1912; Gerasimov 1955, 1992).

Description. — The protoconch is unknown. The earliest ontogenetically known teleoconch whorl is ornamented with distinct axial ribs and three weak spiral ribs. The number of spiral ribs increases during ontogeny.

Remarks. — The early whorls of the teleoconch are typical of the genus *Cryptaulax*. Later whorls are more similar to the extant *Bittium*-like gastropods and differ significantly from the other known members of the genus *Cryptaulax* in having nearly flat whorl flanks and weakly incised suture. Gerasimov (1992) has established a subgenus *Neocryptaulax* for this species. I leave the species as a *Cryptaulax* but with a question mark, until shells with the protoconch preserved are found.

Genus *Schroederium* Kowalke, 1998

Type species: *Bittium valanginense* Schröder, 1995. Valanginian, Wąwał, southern Mazowsze, Poland; original designation by Kowalke 1998: 8.

Diagnosis. — Small slender, tall tower-like shell with weakly globose, suturally constricted whorls. Sculpture of early teleoconch consisting of orthocline growth lines and of two rows of thorns which are connected by weak or indistinct spiral ribs. Number of rows increasing during ontogeny. Shape of peristome round and narrowed at edge, somewhat flattened at base. Protoconch of three to five whorls conical and orhostrophic. Protoconch 1 weakly rounded or flat. Sculpture of protoconch 2 consisting of tuberculate spiral keels medially and basally arranged. Transition to teleoconch demarcated by lamella-like thickening of growth lines (after Kowalke 1998).

Discussion. — Surprisingly Kowalke (1998) designated *Bittium valanginense* Schröder, 1995 for the type species of *Schroederium*, which is known only from juvenile shells. The second species of *Schroederium*, originally *Potamides cowickeensis* Sohl, 1964, is known from fully grown shells (Dockery 1993) and part of Kowalke's (1998) diagnosis is apparently based on this species.

The genus *Schroederium* is very similar to the genus *Cryptaulax* in morphology of the protoconch and early whorls of the teleoconch. This may indicate a relationship between these genera. The teleoconch of *Schroederium cowickense* (Sohl, 1964) is very similar to that of *Cosmocerithium nysti* (d'Archiac, 1843), the type species of *Cosmocerithium*, as illustrated by Gründel (1997c). According to Guzhov (2002b) this genus (and species) belongs to the family Cerithiopsidae (see pp. 56, 57).

Range. — Valanginian (Schröder 1995; Kowalke 1998; and herein) to Campanian (Dockery 1993 and Kowalke 1998), Cretaceous.

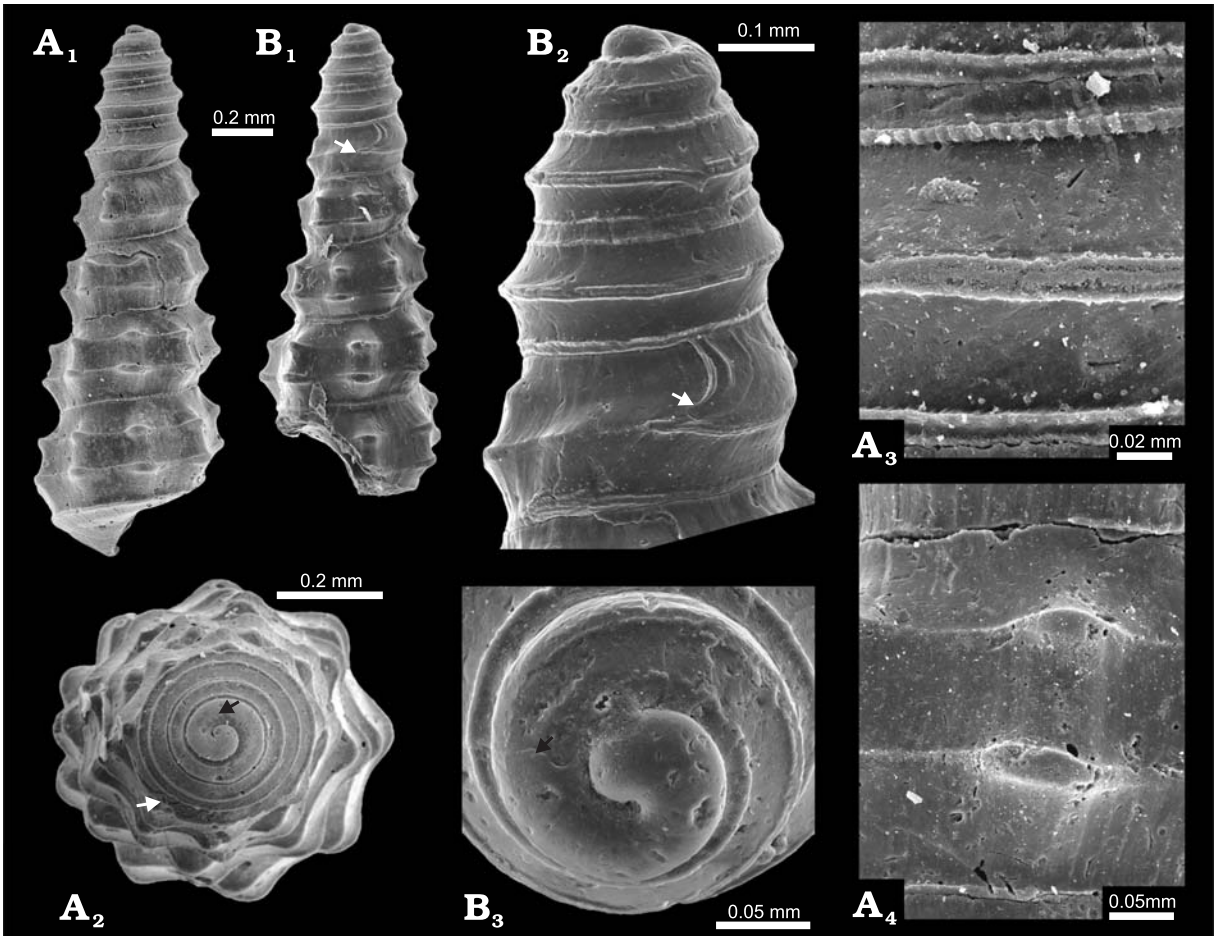


Fig. 29. The cerithiid *Schroederium valanginense* (Schröder, 1995) from Wąwał, southern Mazowsze, Poland, Early Valanginian (Early Cretaceous). **A**. ZPAL Ga.9/65 from sample B1; A_1 lateral view, A_2 apical view, A_3 details of protoconch ornamentation, A_4 details of teleoconch ornamentation. **B**. ZPAL Ga.9/66 from sample B1; B_1 lateral view, B_2 protoconch, B_3 close-up of protoconch 1. Black arrows indicate demarcation between protoconch 1 and protoconch 2; white arrows indicate demarcation between protoconch and teleoconch.

Schroederium valanginense (Schröder, 1995)
(Fig. 29)

1995. *Bittium valanginense* sp. n.; Schröder 1995: 23, pl. 3: 17, 18 and pl. 14: 9.
1998. *Schroederium valanginense* (Schröder, 1995); Kowalke 1998: 9, fig. 1.

Holotype: Schröder 1995: 23, pl. 3: 17.

Type horizon: Valanginian (Early Cretaceous). Bed by bed sampling by Kaim (2001) shows that *S. valanginense* is present in the type locality in the *Busnardoides campylotoxus* Zone of Early Valanginian.

Type locality: Wąwał, southern Mazowsze, Poland.

Material. — 197 shells from the Early Valanginian of Wąwał.

Measurements. — Protoconch 1 of 0.75 of the whorl is 0.11 mm. Protoconch of 4.5 whorls is 0.36 mm in diameter and 1.00 mm high. The shell (ZPAL Ga.9/65) of nine whorls is 0.65 mm in diameter and 1.73 mm high.

Occurrences. — Type locality only.

Emended diagnosis. — Small slender shell with incised sutures. Protoconch 2 of 4.5 whorls, angulated with one spiral keel and two spiral ribs. Keel and ribs starting at second whorl of protoconch 2, keel situated medially and ribs situated laterally. Sinusigera lip well developed at peristome of protoconch 2 . Teleoconch ornamented with wide weak axial ribs and two spiral ribs. Distinct nodes appearing at intersections. Axial ribs of teleoconch orthocline.

Description. — Protoconch 1 is not visibly ornamented. The ribs of protoconch 2 are ornamented with small pustules.

Remarks. — This species is known from juvenile (or micromorphic?) shells only. The second known species, *Schroederium cowickeense* (Sohl, 1964), comes from the Campanian of the United States. This species is also known from adult shells (10.9 mm high). The protoconch and the juvenile whorls of the teleoconch are very similar in both species.

Genus *Rhynchocerithium* Cossmann, 1906

Type species: *Cerithium fusiforme* Hébert *et* Eudes-Deslongchamps, 1860; original designation by Cossmann 1906: 49. Callovian, Montreuil-Bellay, France.

Emended diagnosis. — Small bucciniform shell ornamented by axial and spiral ribs with nodes at intersections. Ornamentation is attenuated at base. Body whorl weakly inflated. Peristome oval, subrhomboidal with small siphonal notch. Narrow callus on the columellar lip developed (modified after Cossmann 1906).

Discussion. — Apart from the shape of the shell and the distinct siphonal notch, the genus is very similar to *Cryptaulax*. The protoconch and early teleoconch of the type species illustrated by Gründel (1997c) support this relationship.

Range. — Bathonian (Mid Jurassic) to Neocomian (Early Cretaceous).

Rhynchocerithium sp.
(Fig. 30)

Material. — One incomplete juvenile shell (ZPAL Ga.9/169) from Kłęby outcrop, West Pomerania, Poland, Oxfordian (Late Jurassic).

Measurements. — The shell with seven whorls preserved is 2.93 mm high and 1.69 mm in diameter.

Description. — Only the last badly preserved whorl of protoconch 2 is visible. The first teleoconch whorl is ornamented with distinct axial ribs (numer of ribs increases in ontogeny from 11 to 16) and four weak spiral ribs. At the intersections, blunt nodes appear. The peristome is ovate with a well-developed siphonal canal. The columellar lip has a narrow callus extended onto the parietal lip.

Remarks. — The juvenile shell under consideration is similar to the shells of *Rhynchocerithium fusiforme* (Hébert *et* Eudes-Deslongchamps, 1860) illustrated by Gründel (1997c) but its nodes are more blunt than those of the latter.

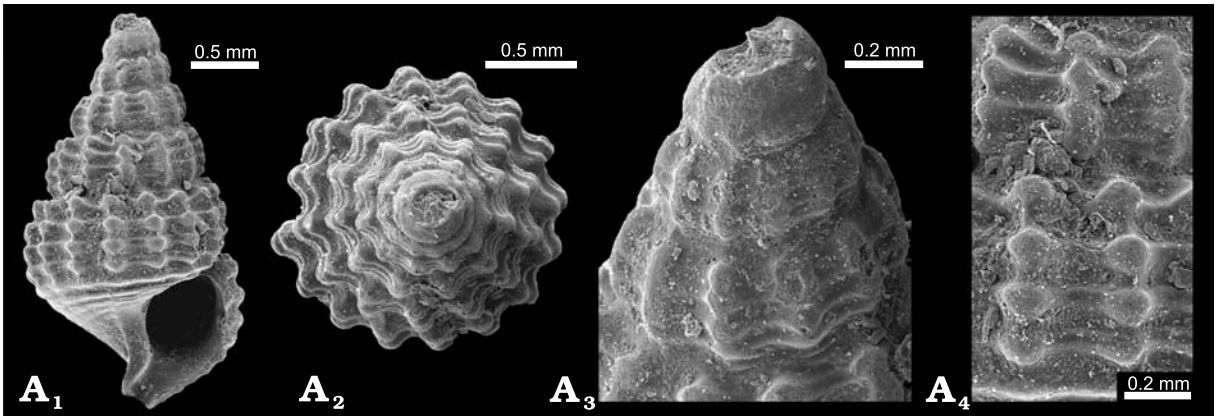


Fig. 30. The cerithiid *Rhynchocerithium* sp. from Kłęby, West Pomerania, Poland, Oxfordian (Late Jurassic). **A**. ZPAL Ga.9/169; A_1 lateral view, A_2 apical view, A_3 juvenile whorls, A_4 details of ornamentation.

Genus *Exelissa* Piette, 1860

Type species: *Exelissa strangulata* (d'Archiac, 1840); original designation by Piette 1860: 15. Bathonian (Mid Jurassic), d'Eparcy, l'Aisne, France.

Emended diagnosis. — Slender pupiform shell. Suture narrow and shallow. Whorls slightly convex. Sculpture with wide, blunt axial ribs and much weaker, band-like spiral ribs. Number of spiral ribs increases

during ontogeny. Spirals swollen when traversing axial ribs. Base ornamented with spiral ribs. Peristome small and round, angled in adapical part, with an indistinct canal in the abapical part (based on Cossmann 1906; and Gründel 1997c, 1999d).

Discussion. — The type material is probably lost (Gründel 1997c). The neotype designated by Cossmann (1913) was reexamined and refigured by Gründel (1997c). The known protoconchs of *Exelissa* species (Gründel 1999d) have about three sturdy whorls with no ornamentation visible. They are similar in this respect to the protoconch of *Cryptaulax wawalensis* sp. n. (see above) and possibly reflect short planktotrophic or lecithotrophic development.

Range. — Hettangian (Early Jurassic) to Portlandian (Late Jurassic/Early Cretaceous) after Cossmann (1906).

Exelissa distans Cossmann, 1913
(Fig. 31)

1913. *Exelissa distans* sp. n.; Cossmann 1913: 122, pl. 5: 63–65.
1971. *Exelissa distans* Cossmann, 1913; Dmoch 1971: 24, pl. 3: 2, 4, 6.

Type material: Cossmann 1913: 122, pl. 5: 63–65.
Type horizon: Oxfordian (Late Jurassic).
Type locality: Cordebugle, Normandy, France.

Material. — Two shells from the Kłęby outcrop, West Pomerania, Oxfordian (Upper Jurassic).

Measurements. — The shell (ZPAL Ga.9/65) consisting of five whorls is 2.00 mm in diameter and 4.83 mm in height.

Occurrences. — Oxfordian (Late Jurassic) of Europe.

Emended diagnosis. — Shell pupiform, with very weakly convex whorls. Teleoconch ornamentation with wide, blunt axial ribs and flat-topped, band-like spiral ribs. Later in ontogeny axial ribs disappearing.

Description. — The protoconch and peristome are unknown. The early whorls of teleoconch are badly preserved. The number of axial ribs per whorl is stable (eight ribs per whorl) but the axial ribs get weaker during ontogeny and finally disappear.

Remarks. — The protoconch of this species is unknown, and thus its status remains unclear as does the status of the whole genus.

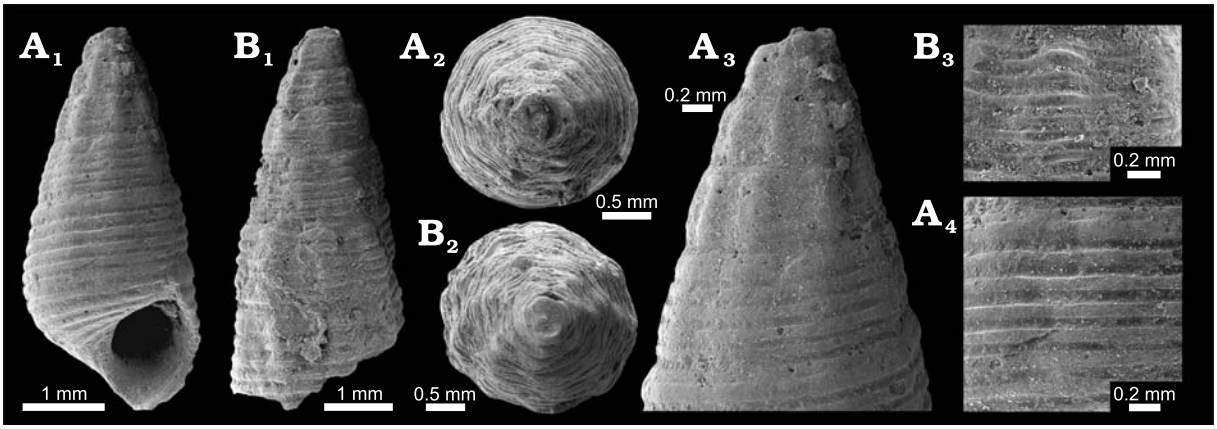


Fig. 31. The cerithiid *Exelissa distans* Cossmann, 1913 from Kłęby, West Pomerania, Poland, Oxfordian (Late Jurassic). **A**. ZPAL Ga.9/170; A_1 lateral view, A_2 apical view, A_3 juvenile whorls, A_4 details of teleoconch ornamentation on the late whorls. **B**. ZPAL Ga.9/171; B_1 lateral view, B_2 apical view, B_3 details of teleoconch ornamentation on the early whorls.

Cerithiidae gen et sp. indent.
(Fig. 32)

2001. *Rhabdocolpus* sp.; Kaim 2001: fig. 7.

Material. — Many juvenile shells from Wąwał, southern Mazowsze, Poland, Early to Late Valanginian (Early Cretaceous).

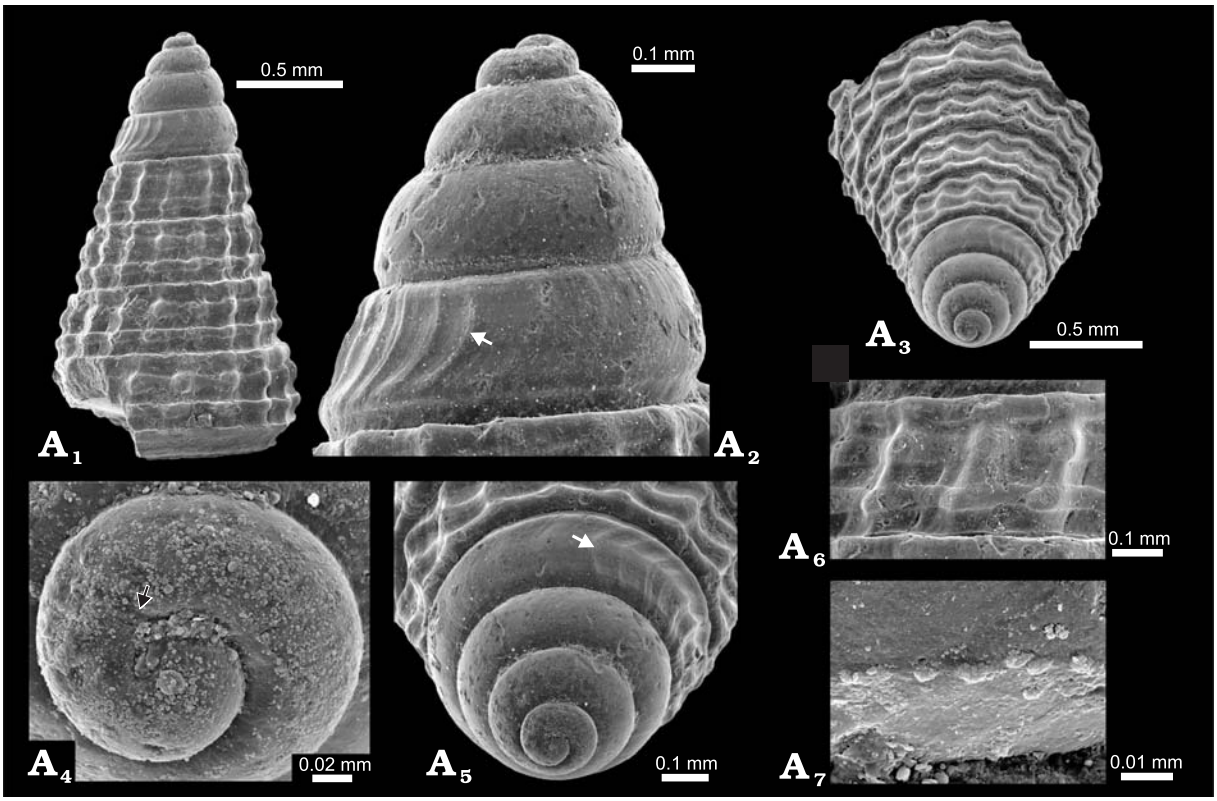


Fig. 32. Cerithiidae gen. et sp. indet. from Wąwał (Valanginian, Early Cretaceous). **A**. ZPAL Ga.9/101; A_1 lateral view, A_2, A_5 protoconch, A_3 latero-apical view, A_4 close-up of the protoconch 1, A_6 details of teleoconch ornamentation, A_7 details of protoconch ornamentation. Black arrow indicates demarcation between protoconch 1 and protoconch 2; white arrows indicate demarcation between protoconch and teleoconch.

Measurements. — Protoconch 1 of 0.75 whorls is 0.12 mm wide. Protoconch of 3.75 whorls is 0.54 mm in diameter and 0.73 mm high. The shell (ZPAL Ga.9/172) of 9.5 whorls is 1.43 mm in diameter and 2.43 mm in height.

Description. — The highly conical shell with flat flanks has a suture which is almost not incised. Protoconch 1 is not visibly ornamented. Protoconch 2, consisting of 3.75 weakly convex whorls, is ornamented only on the last whorl, with a row of very small nodes situated close to the abapical suture. The shell is angulated at this row. The demarcation to the teleoconch is not clearly visible. The growth lines at the supposed demarcation are opisthocyrtic. The teleconch starts with three spiral ribs among which the abapical one is the strongest. There is also ornamention of axial ribs, which get weaker during ontogeny until finally they are visible only as blunt nodes on the spiral ribs. The well preserved peristome is unknown.

Remarks. — The juvenile shells under consideration are similar in shape to the shells of many cerithiid species belonging to different genera. The protoconch is rather characterless and similar ones can be found among many different taxa. Given situation I leave these shells in open nomenclature.

Family **Turritellidae** Lovén, 1847

Genus *Turritella* Lamarck, 1799

Type species: *Turbo terebra* Linné, 1758. Recent, Indo-Pacific.

Emended diagnosis. — Usually long, multispiral shell and in most cases sculptured with spiral ribs or keels.

Discussion. — No well-established diagnosis that is based on Recent material has been provided yet. According to recent investigations (Anders Warén, personal communication 2002) the shell characters cannot be of use for taxonomic purposes above the species level. Species of very similar shell morphology have different soft-body characters of supraspecific importance and some others, which differ significantly in shell

characters can be placed into *Turritella* on the basis of soft-body, radula, and operculum characters (Anders Warén, personal communication 2002). In summary, most of the paleontological supraspecific classification based on the shell characters has potentially parataxonomic value. For practical reasons, I present here a very broad, provisional diagnosis until the neontological review is published.

Range. — Valanginian to Recent.

Turritella polonica (Schröder, 1995)
(Fig. 33)

1995. *Haustator polonicus* sp. n.; Schröder 1995: 25, pl. 4: 12–16 and pl. 14: 13.
2001. *Haustator polonicus* Schröder, 1995; Kaim 2001: fig. 7.

Holotype: Schröder 1995: 25: pl. 4: 13, 16.
Type horizon: Valanginian (Early Cretaceous).
Type locality: Wąwał, southern Mazowsze, Poland.

Material. — 113 shells from Early to Late Valanginian of Wąwał.

Measurements. — Protoconch 1 of one whorl measures 0.12 mm in diameter. Protoconch of 5.5 whorls is 0.62 mm in diameter and 0.8 mm high. The largest known shell has eighteen whorls of teleoconch and is 18 mm high.

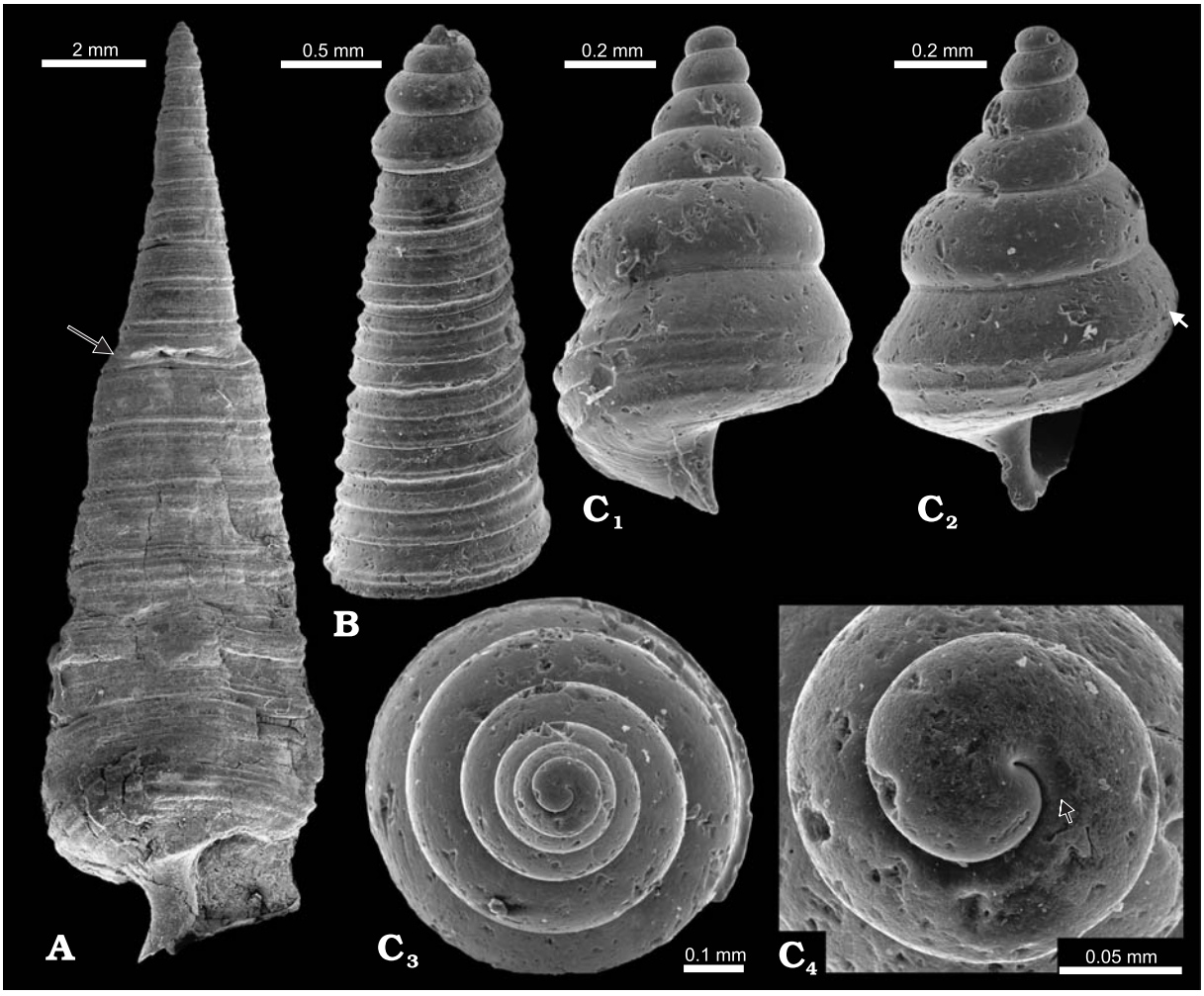


Fig. 33. *Turritella polonica* (Schröder, 1995) from Wąwał, southern Mazowsze, Poland, Early Valanginian (Early Cretaceous). **A**. ZPAL Ga.9/86; lateral view of the largest shell known, after the large black arrow the shell is diagenetically flattened. **B**. ZPAL Ga.9/88; lateral view. **C**. ZPAL Ga.9/87 juvenile from sample B5; C_1, C_2 lateral view, C_3 apical view, C_4 close-up of protoconch 1. Small black arrow indicates demarcation between protoconch 1 and protoconch 2; white arrow indicates demarcation between protoconch and teleoconch.

Occurrences. — Type locality only.

Emended diagnosis. — Protoconch 2 tear-drop-shaped with convex whorls. Suture of protoconch 2 deeply incised. Ornamentation starting on the last whorl of protoconch 2 with two spiral ribs situated abapically and passing gradually onto teleoconch. Protoconch demarcated from teleoconch only by densification of opisthocyrtic, sinusoidal growth lines. Adapical third spiral rib appearing on third teleoconch whorl. Additional weak spiral rib appearing on the fourth whorl. Later in ontogeny, only two strong spiral ribs situated abapically and adapically, distinct with much weaker secondary ribs inbetween.

Description. — Protoconch 1 is not well demarcated from the teleoconch. The surface of protoconch 1 is not visibly ornamented. The protoconch has 5.5 whorls.

Remarks. — This species was originally described by Schröder (1995) as *Haustator polonicus*. I doubt in the taxonomical validity of the genus *Haustator* for the same reason as in case of *Turritella*. In any cases the species under consideration does not fit the diagnosis of *Haustator* emended by Allmon (1996). In such a situation, the best choice is to return to the generic name *Turritella*, in a broad sense.

Family **uncertain**

Genus *Tomaszoviella* Kaim, 2001

Type species: *Tomaszoviella polonica* Kaim, 2001; monotypy. Valanginian, Wąwał, southern Mazowsze, Poland.

Diagnosis. — Protoconch 2 with spiral keels on the last whorl. Lower keel distinct and upper keel weak. Ornamentation of teleoconch with broad axial ribs. Body whorl deviated from helix axis (after Kaim 2001).

Discussion. — The protoconch of this genus is similar to those observed among species of *Cryptaulax*, especially that of *Cryptaulax wawalensis* (see above), which possibly had a short planktotrophic development (Kaim 2001). The teleoconch characters, especially the deviating body whorl, are of unknown type among bittiinid gastropods.

Range. — Valanginian (Early Cretaceous).

Tomaszoviella polonica Kaim, 2001
(Fig. 34)

2001. *Tomaszoviella polonica* sp. n.; Kaim 2001: 337, fig. 2.

Holotype: Kaim 2001: 337, fig. 2.

Type horizon: Early Valanginian (Early Cretaceous).

Type locality: Wąwał, southern Mazowsze, Poland.

Material. — 199 shells from Early Valanginian of Wąwał.

Measurements. — Protoconch 1 consisting of 0.75 whorls is 0.10 mm wide. Protoconch of three whorls is 0.30 mm in diameter and 0.33 mm high. The fully grown shell has four whorls of teleoconch and is 1.4 mm high and 0.54 mm in diameter.

Occurrences. — Type locality only.

Diagnosis. — Micromorphic gastropod with adult shell height of about 1.4 mm. Protoconch 2 high-spired with three whorls. Demarcation between protoconch and teleoconch clearly visible with large apertural projection of outer lip. Teleoconch possessing four whorls with broad axial ribs. Ribs on the third whorl ornamented with two blunt nodes on the adapical and abapical rib parts (after Kaim 2001).

Description. — Protoconch 1 is not visibly ornamented. The last uncoiled whorl has no sculpture, except for dense growth lines.

Genus *Diatrypesis* Tomlin, 1929b
(*Terebrella* Andreae, 1887 non Maltzan, 1886; *Trypetes* Tomlin, 1929a non Schenck, 1859)

Type species: *Cerithium guerrei* Hébert *et* Deslongchamps, 1860; original designation by Tomlin 1929a: 256. Callovian, Mountreil-Bellay, Maine-et-Loire, France.

Emended diagnosis. — Slender shell, highly conical with weakly convex or flat whorls. Adapical part of whorls notched or ornamented with adsutural row of nodes. Peristome rhomboidal, outer lip thin. Columella delicately twisted, columellar lip indistict (modified after Cossmann 1906 and Wenz 1940).

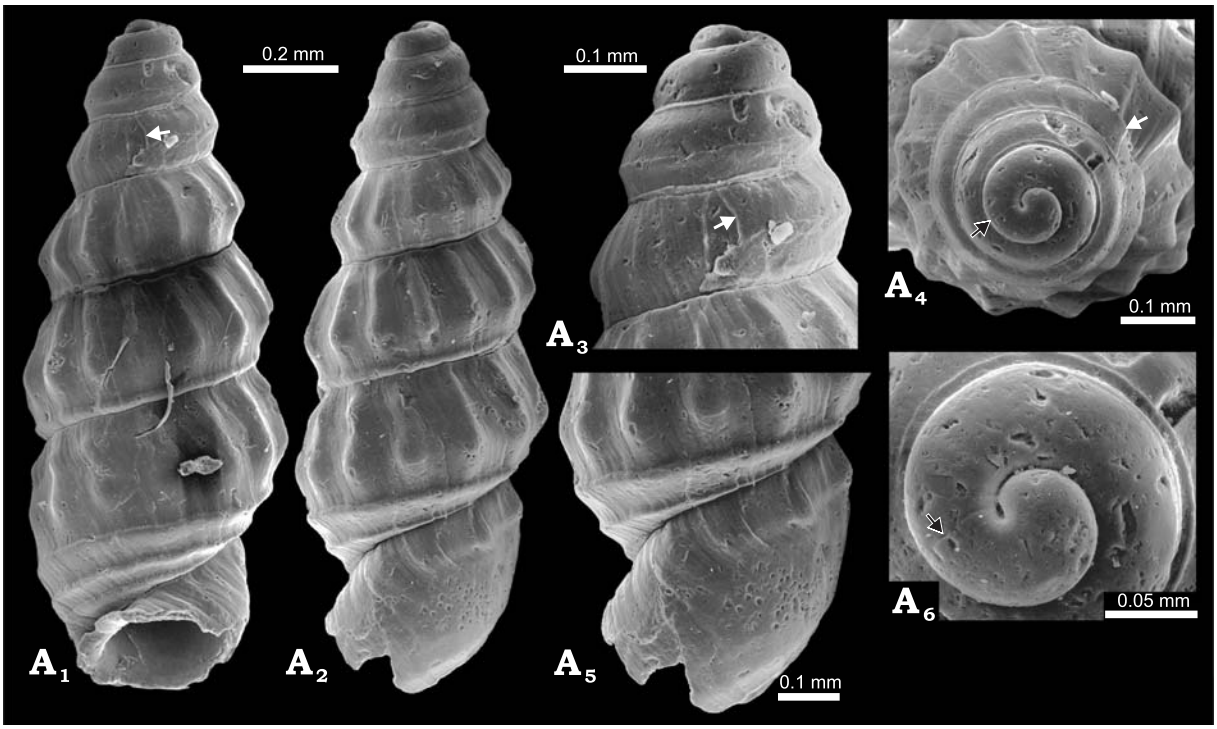


Fig. 34. The cerithioid *Tomaszoviella polonica* Kaim, 2001 from Wąwał, southern Mazowsze, Poland, Early Valanginian (Early Cretaceous). **A**. ZPAL Ga.9/1 (holotype) from sample I1; A_1, A_2 lateral view, A_3, A_4 protoconch, A_5 close-up of the body whorl, A_6 close-up of the protoconch 1. Black arrows indicate demarcation between protoconch 1 and protoconch 2; white arrows indicate demarcation between protoconch and teleoconch.

Discussion. — This genus was previously included in the family Procerithiidae. The protoconch and the early whorls of the teleoconch do not support this classification. In such a situation, I leave the genus under the heading: family uncertain. The shells of *Diatrypesis* are similar to those of the genus *Cimolithium* Cossmann, 1906 (also Procerithiidae) and may be congeneric. To support this hypothesis, a survey of an early ontogenetic shell of this genus is needed. There is also some resemblance in the protoconch and early teleoconch of *Diatrypesis* to the members of family Terebridae (Neogastropoda), especialy to the Miocene *Subula* (*Oxymeris*) *plicaria* (Basterot, 1825) reported by Bałuk (1997).

Range. — Toarcian (Early Jurassic) to Aptian (Early Cretaceous).

Diatrypesis kurushini sp. n.
(Fig. 35)

2001. *Cimolithium* sp.; Kaim 2001: fig. 7.

Holotype: ZPAL Ga.9/75, Fig. 35A.

Type horizon: *Busnardoides campylotoxus* Zone, Early Valanginian (Early Cretaceous).

Type locality: Wąwał, southern Mazowsze, Poland.

Derivation of the name: In honour of late Nikolai I. Kurushin.

Material. — 21 shells from Early to Late Valanginian of Wąwał.

Measurements. — Protoconch of 2.25 whorls is 0.34 mm in diameter and 0.30 mm high. Height of the holotype consisting of 6.75 whorls is 2.61 mm high. The width of the shell has not been measured because of lateral deformation.

Occurrences. — Type locality only.

Diagnosis. — Protoconch having 2.25 smooth, low spired whorls. Protoconch demarcated from teleoconch with thickened outer lip. Teleoconch higly conical with spiral rib ornamented by broad nodes situated close to the adapical suture. Nodose rib forming narrow adsutural platform.

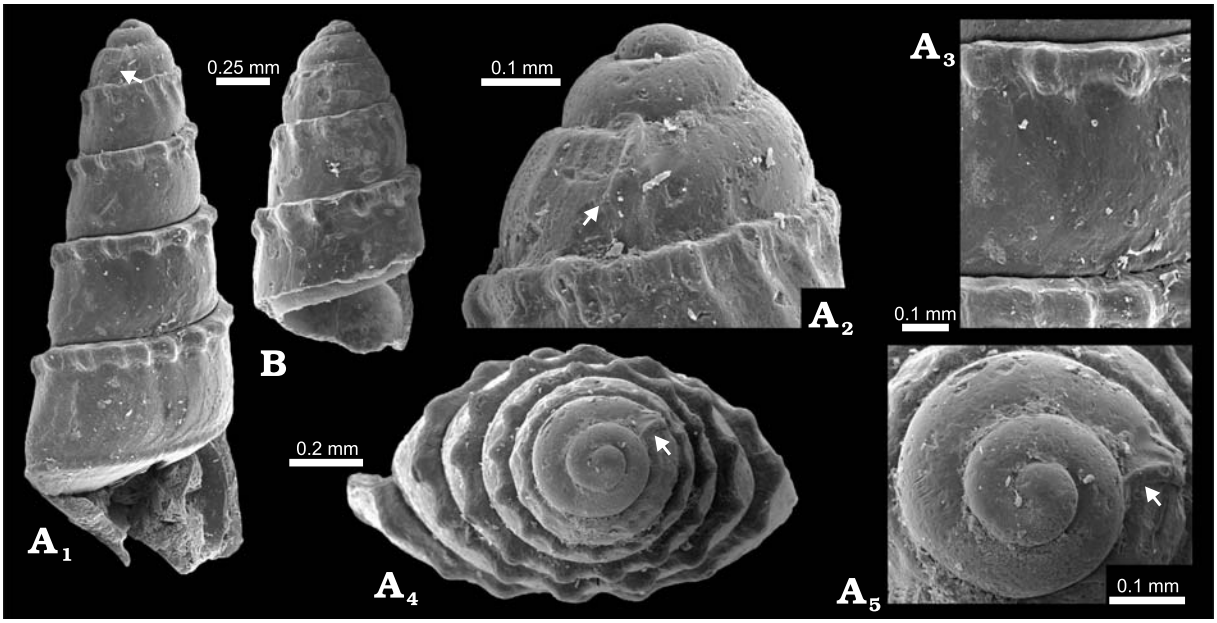


Fig. 35. Possible cerithioid *Diatrypesis kurushini* sp. n. from Wąwał, southern Mazowsze, Poland, Early Valanginian (Early Cretaceous). **A**. ZPAL Ga.9/75 (holotype) from G1; A_1 lateral view, A_2, A_5 protoconch, A_3 details of the teleoconch ornamentation, A_4 apical view. **B**. ZPAL Ga.9/76 from sample A5; lateral view. White arrows indicate demarcation between protoconch and teleoconch.

Description. — Protoconch 1 is not visibly ornamented and not clearly demarcated from protoconch 2. Peristome is unknown.

Remarks. — The species under consideration is similar to *Diatrypesis guerrei* (Hébert *et* Eudes-Deslongchamps, 1860) but the latter differs in having opisthocyrtic axial ribs. Also, some species of *Cimolithium* are very similar to *D. kurushini*. This especially concerns *Cimolithium eleanorae* Allison, 1955 and *Cimolithium* aff. *eleanorae* Allison, 1995 described by Abbass (1973).

Superfamily **uncertain**

Family **uncertain**

Genus *Dzikella* gen. n.

Type species: *Dzikella trammeri* sp. n. Late Valanginian (Early Cretaceous), Wąwał, Poland.

Derivation of the name: In honour of Jerzy Dzik.

Diagnosis. — Shell slender. Protoconch of about 2–2.5 rounded whorls with delicate, pustulose ornamentation. Demarcation between protoconch and teleoconch with thickened opisthocline outer lip. Teleoconch ornamented with strong axial ribs and weak spiral lirae.

Discussion. — The protoconch is similar to that of *Diatrypesis kurushini* but the latter is more dome-shaped. There is also some resemblance to certain rissoinid protoconchs. The teleoconch ornamentation is also a little similar to that of the rissoinids, but the said pattern of ornamentation can be observed in many groups (e.g., some pseudozygopleurids, see below). *Dzikella* also resembles a Late Cretaceous epitoniid genus *Aciculiscala*, especially *Aciculiscala coffea* Dockery, 1993 illustrated by Nützel (1998) but the former has a smooth protoconch with a thickened outer lip.

Range. — Late Valanginian (Early Cretaceous).

Dzikella trammeri sp. n.

(Fig. 36)

Holotype: ZPAL Ga.9/2, Fig. 36.

Type horizon: *Saynoceras verrucosum* Zone, Late Valanginian (Early Cretaceous).

Type locality: Wąwał, southern Mazowsze, Poland.

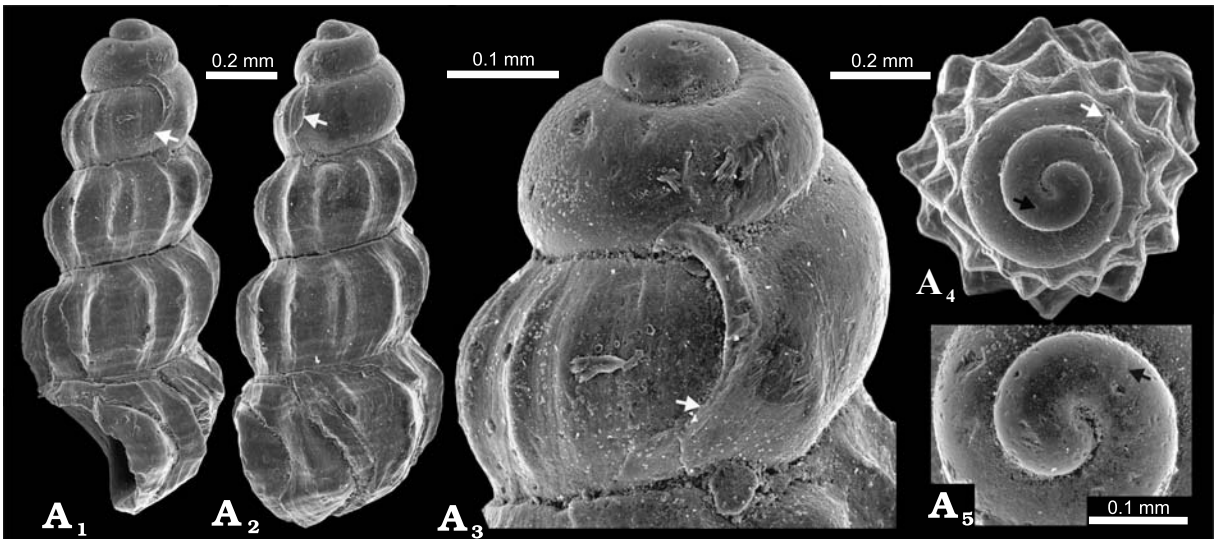


Fig. 36. The caenogastropod *Dzikella trammeri* gen. et sp. n. from Wąwał, southern Mazowsze, Poland, Early Valanginian (Early Cretaceous). **A**. ZPAL Ga.9/2 (holotype) from sample H3; A_1, A_2 lateral view, A_3 protoconch, A_4 apical view, A_5 close-up of the protoconch 1. Black arrows indicate demarcation between protoconch 1 and protoconch 2; white arrows indicate demarcation between protoconch and teleoconch.

Derivation of the name: In honour of Jerzy Trammer.

Material. — One well-preserved shell.

Measurements. — Protoconch 1 consists of 1.25 whorls and is 0.21 mm in diameter. Protoconch of 2.25 whorls is 0.41 mm high and 0.37 mm in diameter. The shell with 5.25 whorls is 1.48 mm high and 0.64 mm in diameter.

Occurrences. — Type locality only.

Diagnosis. — Shell slender 2.3 times as high as broad. Protoconch 2 whorls rounded and ornamented with pustules. Demarcation between protoconch and teleoconch with thickened outer lip. Teleoconch whorls rounded and ornamented with strong axial ribs and weak spiral lirae.

Description. — Protoconch 1 is large and convex. The axial ribs of teleoconch are opisthocline. Shell has many irregularities in growth. Peristome not preserved.

Remarks. — See discussion under the genus *Dzikella*.

Suborder **Ptenoglossa** Gray, 1853
Superfamily **Triphoroidea** Gray, 1847
Family **Eumetulidae** Golikov *et* Starobogatov, 1975
Genus *Vatopsis* Gründel, 1980

Type species: *Cerithium bimoniliferum* Sandberger, 1858; original designation. Late Oligocene, Grube Höllkopf near Glimmerode, Germany.

Diagnosis. — Teleoconch with reticulate ornament. Protoconchs of species with planktotrophic development ornamented with collabral axial ribs and one or two medial spiral ribbons. Axial ribs mostly ended on or above spiral ribbons. Ribs rarely crossing spirals. Adapical spiral ribbon representing upper edge of larval outer lip. Larger or smaller abapical portion of protoconch 2 whorls ornamented with fine, non-collabral ribs (after Nützel 1998).

Discussion. — This genus contains species with reticulate teleoconch and collabral axial ribs on the protoconch. A spiral ribbon of the protoconch is also characteristic. As the genus is known only from the fossil record thus far, its systematic position is not well constituted. Nützel (1998) placed *Vatopsis* into Eumetulidae and I follow this interpretation here.

Range. — Mid Jurassic (Gründel 1980, 2001) to Miocene (Nützel 1998).

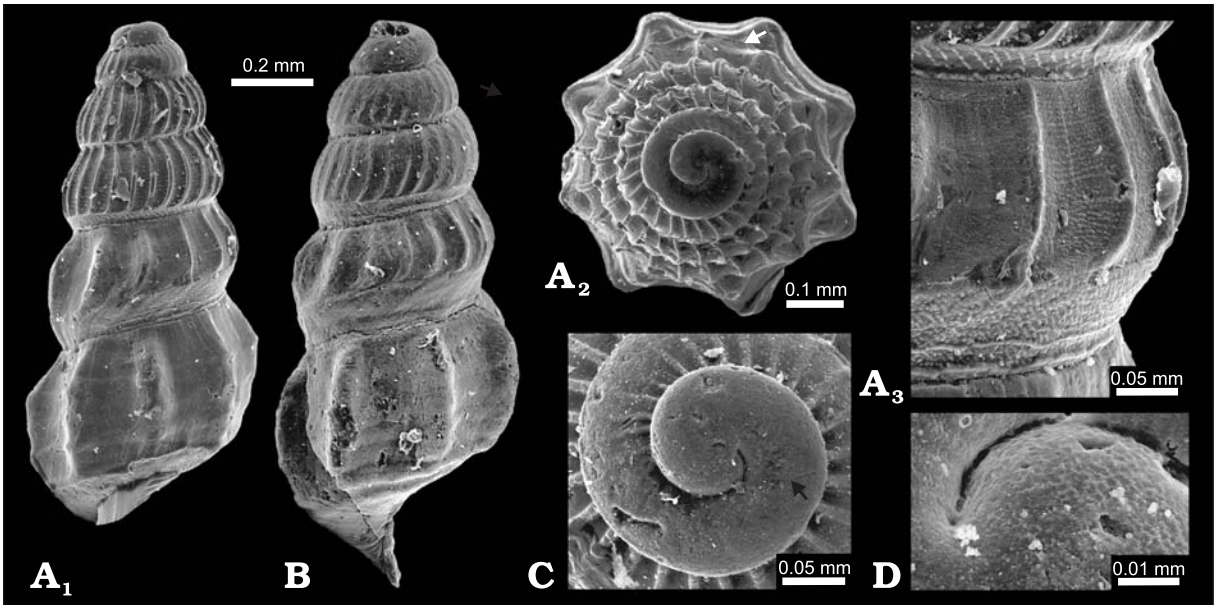


Fig. 37. The eumetulid *Vatopsis nuetzeli* sp. n. from Wąwał, southern Mazowsze, Poland, Late Valanginan (Early Cretaceous). **A**. ZPAL Ga.9/188 (holotype) from sample B5; A_1 lateral view, A_2 apical view, A_3 details of the protoconch ornamentation at the demarcation from the teleoconch. **B**. ZPAL Ga.9/190 from sample G1; lateral view. **C**. ZPAL Ga.9/191 from sample B1; close-up of the protoconch 1. **D**. ZPAL Ga.9/189 from sample C1; close-up of the protoconch 1 ornamentation.

Vatopsis nuetzeli sp. n.
(Fig. 37)

1995. PROT.1; Schröder 1995: 16, pl. 2: 1–7.
1998. "PROT.1"; Nützel 1998: 132: pl. 19: M–O.

Holotype: ZPAL Ga.9/188, Fig. 37A.
Type horizon: Sample B5, *Saynoceras verrucosum* Zone, Late Valanginian (Early Cretaceous).
Type locality: Wąwał, southern Mazowsze, Poland.
Derivation of the name: In honour of Alexander Nützel.

Material. — Five shells from the type locality.

Measurements. — Protoconch 1 consists of 0.75 whorls and is 0.14 mm in diameter. The complete protoconch of 4.5 whorls is 0.44 mm in diameter and 0.74 mm high. The shell with 1.5 of the teleoconch whorl is 1.26 mm high and 0.55 mm in diameter.

Occurrences. — Type locality only.

Diagnosis. — First 1.25 whorls without ornamentation. Rest of protoconch ornamented with weakly opisthocyrtic axial ribs. Whorls weakly angulated close to abapical suture. Angulation ornamented with weak spiral ribbon. Demarcation between protoconch and teleoconch having some intermediate zone sinusoidal in shape. Teleoconch ornamented with strong axial ribs and weak axial ribs.

Description. — Protoconch 1 of 0.75 of the whorl is not ornamented. Protoconch 2 bears remnants of spiral lirae expressed by weak spiral threads. The surface of the protoconch under the angulation is covered by short, oblique threads. The intermediate zone between protoconch and teleoconch bears pustulose ornamentation. Peristome not preserved.

Remarks. — The ornamentation of both the protoconch and the teleoconch fits the diagnosis of the genus *Vatopsis* by Nützel (1998) although the spiral ribs of the teleoconch are much weaker than the ones observed among the Tertiary species of the genus.

Vatopsis ewae sp. n.
(Fig. 38)

Holotype: ZPAL Ga.9/63, Fig. 38A.
Type horizon: *Saynoceras verrucosum* Zone, LateValanginian (Early Cretaceous).

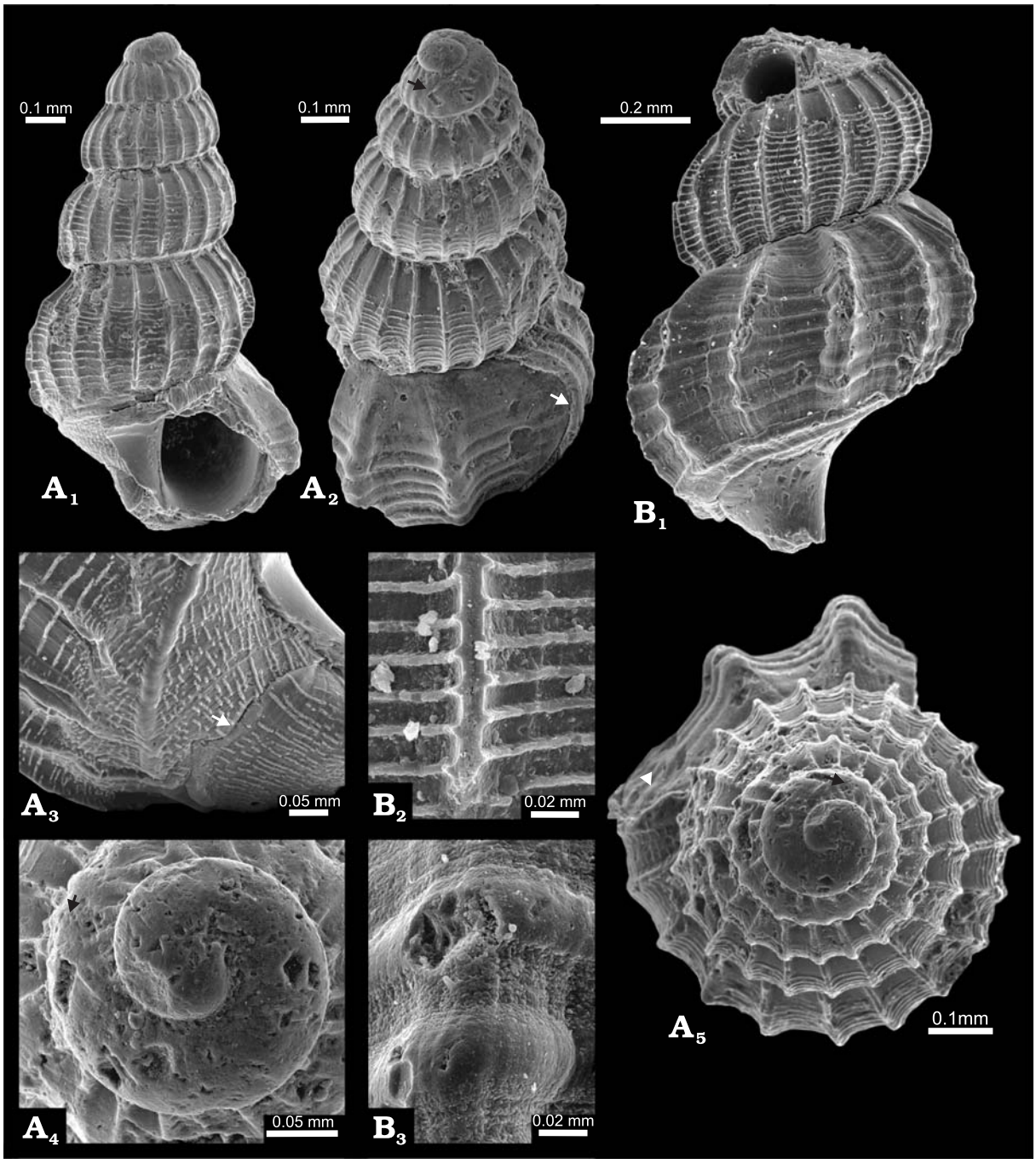


Fig. 38. The eumetulid *Vatopsis ewae* sp. n. from Wąwał, southern Mazowsze, Poland, Late Valanginan (Early Cretaceous). **A**. ZPAL Ga.9/63 (holotype); A_1, A_2 lateral view, A_3 details of ornamentation of the base at the demarcation between the protoconch and the teleoconch, A_4 close-up of the protoconch 1, A_5 apical view. **B**. ZPAL Ga.9/64 from sample B3; B_1 lateral view, B_2 details of the protoconch 2 ornamentation, B_3 details of teleoconch ornamentation. Black arrows indicate demarcation between protoconch 1 and protoconch 2; white arrows indicate demarcation between protoconch and teleoconch.

Type locality: Wąwał, southern Mazowsze, Poland.

Derivation of the name: After my wife Ewa.

Material. — Two shells from the type locality.

Measurements. — Protoconch (holotype) of five whorls is 0.63 mm in diameter and 1.28 mm high.

Occurrences. — Type locality only.

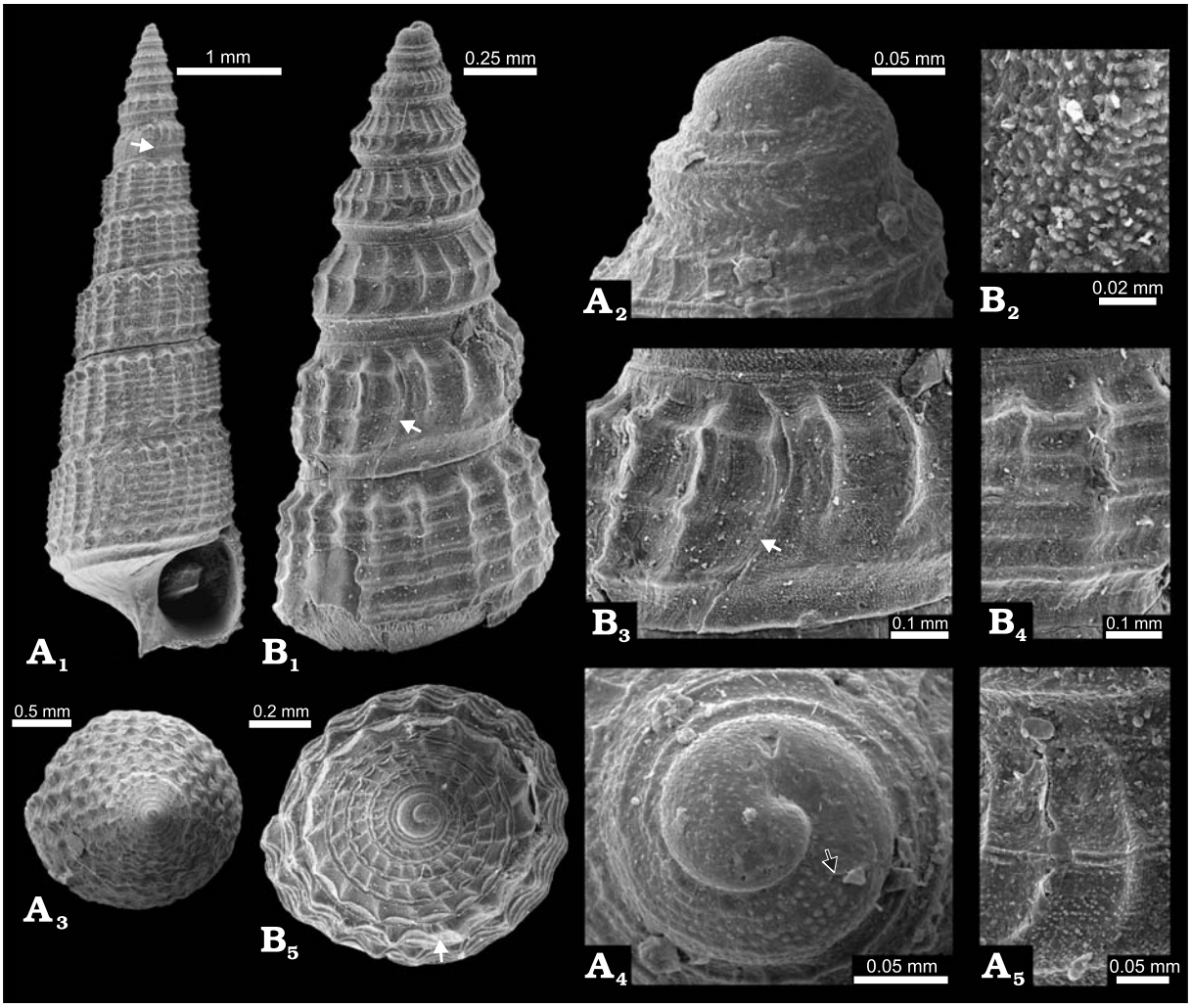


Fig. 39. The eumetulid *Cosmocerithium antiquum* (Gründel, 2001) from Gnaszyn, Częstochowa region, Poland, Mid Bathonian (Mid Jurassic). **A**. ZPAL Ga.9/99; A_1 lateral view, A_2 close-up of the apex (protoconch 1 and the early part of protoconch 2) in lateral view, A_3 apical view, A_4 close-up of protoconch 1, A_5 details of protoconch 2 ornamentation. **B**. ZPAL Ga.9/100; B_1 lateral view, B_2 details of protoconch 1 ornamentation, B_3 demarcation between protoconch and teleoconch, B_4 details of teleoconch ornamentation, B_5 apical view. Black arrow indicates demarcation between protoconch 1 and protoconch 2; white arrows indicate demarcation between protoconch and teleoconch.

Diagnosis. — Protoconch highly conical with first 1.25 whorls not ornamented. Rest of protoconch ornamented with orthocline axial ribs and interstitial spiral lirae. Base of the protoconch demarcated by spiral ribbon and weak angulation of whorl situated a little higher. Demarcation between protoconch and teleoconch clearly visible, truncated. Teleoconch ornamented with strong axial ribs and blunt spiral ribs. Blunt nodes appearing at intersections.

Description. — The demarcation between protoconch 1 and 2 is not visible. The base of the protoconch ornamented by short spiral threads. The peristome is not preserved.

Remarks. — This species has sculpture similar to the teleoconch as found in *Vatopsis* sp. of Gründel (2001) but it differs in having the abapical ribbon of the protoconch hidden under the suture and a clearly visible spiral ornamentation of the protoconch.

Genus *Cosmocerithium* Cossmann, 1906
(*Prisciphora* Schröder, 1992)

Type species: *Cerithium nysti* d'Archiac, 1843; original designation. Bathonian (Mid Jurassic), l'Aisne, France.

Diagnosis. — Orthostrophic protoconch , highly conical, with angular to rounded, convex whorls. Sculpture consisting of network of intersecting spiral and strong axial riblets. Transition to teleoconch abruptly terminated, with varix and basal, subsutural sinuosity of outer lip. Teleoconch turriculate with convex to flattened whorls. Sculpture with axial and spiral costation, intersections nodulated (after Schröder 1992).

Discussion. — From Cossmann (1906) till Gerasimov (1992), the *Cosmocerithium* was classified in Cerithiidae but Guzhov (2002b) interpreted the genus as a member of the family Cerithiopsidae. The independently established synonymous genus *Prisciphora* Schröder, 1992 was included into Triphoridae (Schröder 1992). The same author suggested later (Schröder 1995) that the genus can be classified under Cerithioidea or Triphoridae. Nützel (1998) included *Prisciphora* in the family Eumetulidae as *Prisciphora* has a very similar protoconch to that of *Retilaskeya* Marshall, 1978 [e.g., *Retilaskeya zelandica* Marshall, 1978; see Marshall (1978), fig. 10H].

Range. — Bathonian (Middle Jurassic herein) to Aptian (Early Cretaceous; Schröder 1992, 1995).

Cosmocerithium antiquum (Gründel, 2001)
(Fig. 39)

2001. *Vatopsis antiquus* sp. n.; Gründel 2001: 55, pl. 3: 12–16.

Holotype: Gründel 2001: 55, pl. 3: 15, 16.
Type horizon: Bathonian, Mid Jurassic.
Type locality: Oderin borehole 1/62, Germany.

Material. — Over 100 shells from Bathonian of Gnaszyn, central Poland.

Measurements. — Protoconch 1 of one whorl is 0.13 mm in diameter. The protoconch of 6.75 whorls is 1.42 mm high and 0.77 mm in diameter. The shell of 122 of the whorl is 8.95 mm high and 1.83 mm in diameter.

Occurrences. — Bathonian of Germany and Poland.

Emended diagnosis. — Shell elongate, 4.9 times as high as broad. First half of protoconch 2 whorl ornamented exclusively with pustules. Afterwards three spiral ribs appearing. Axial ribs appearing on second whorl of protoconch 2. Adapicalmost spiral rib disappearing on third whorl. Abapical ribs becoming keel-like. Axial ribs weakly opisthocyrtic. Teleoconch ornamented with net of spiral and axial ribs pointed at intersections. Number of spiral ribs ranging from four at first teleoconch whorl to eight at sixth. Number of axial ribs increasing from 18 to 26 per whorl.

Description. — Protoconch 1 and protoconch 2 is covered by small pustules. The demarcation with teleoconch clearly visible and opisthocytic.

Remarks. — The shells from Gnaszyn differ from the one illustrated by Gründel (2001) in having a larger size of the protoconch and pustulose ornamentation on protoconch 1. Nevertheless I do not find these differences to be enough evidence to designate a new species.

Cosmocerithium kosmai sp. n.
(Fig. 40)

Holotype: MZ VIII M 4244/1, Fig. 40.
Type horizon: *Quenstedtoceras lamberti* Zone, Late Callovian (Mid Jurassic).
Type locality: Łuków (block in glacial drift), Podlasie, Poland.
Derivation of the name: After my son Kosma.

Material. — Twenty shells from the type locality.

Measurements. — Protoconch 1 of one whorl is 0.11 mm in diameter. The protoconch of six whorls is 1.11 mm high and 0.62 mm in diameter. The shell of nine whorls is 3.02 mm high and 1.08 mm in diameter.

Occurrences. — Type locality only.

Diagnosis. — Protoconch with axial ribs and spiral lirae. Teleoconch with very weak, blunt, spiral and axial ribs. Whorls of teleoconch rounded.

Description. — The shell is elongate and 2.7 times as high as broad. Protoconch 1 and first half of the protoconch 2 whorl is not ornamented. Later three spiral ribs appear. Axial ribs appear on the second whorl of protoconch 2. On the third whorl, the adapicalmost spiral rib disappears. Later in ontogeny, the two spiral

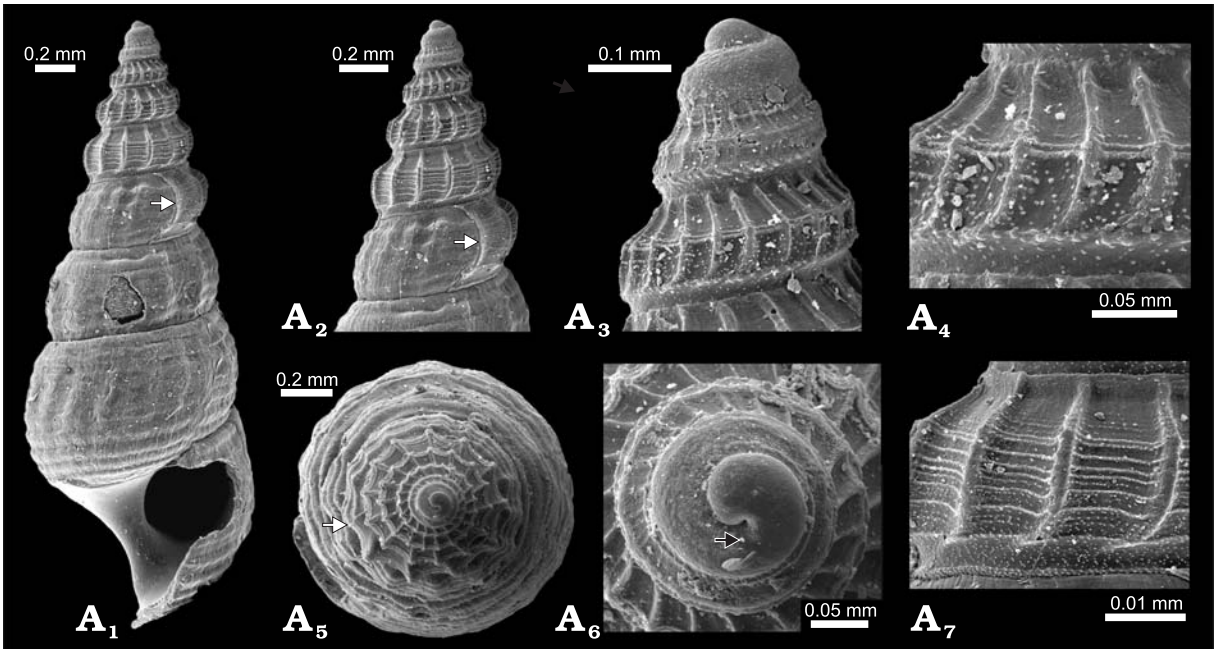


Fig. 40. The eumetulid *Cosmocerithium kosmai* sp. n .from Łuków (block in glacial drift), Podlasie, Poland, Late Callovian (Mid Jurassic). **A**. MZ VIII Mg 4244/1 (holotype); A_1 lateral view, A_2 protoconch, A_3 close-up of the apex (protoconch 1 and early part of protoconch 2), A_4 details of the early protoconch 2 ornamentation, A_5 apical view, A_6 close-up of protoconch 1, A_7 details of the late protoconch 2 ornamentation. Black arrow indicates demarcation between protoconch 1 and protoconch 2; white arrows indicate demarcation between protoconch and teleoconch.

ribs change into lirae and numerous additional lirae appear (there are seventeen lirae on the last whorl of the protoconch). The axial ribs are weakly opisthocyrtic. The surface of protoconch 2 (apart from the first half of the whorl) is covered by small pustules. Demarcation from teleoconch is clearly visible and opisthocytic. Teleoconch is ornamented with a net of very weak, blunt, spiral and axial ribs. The number of spiral ribs ranges from five at the first whorl of teleoconch to nine at the third whorl. The number of axial ribs increases from 15 to 20 per whorl.

Remarks. — The species differs from *C. antiquum* in having numerous spiral lirae on the protoconch and very weak ornamentation on the teleoconch. The protoconch of *C. kosmai* is the most similar among the species of *Cosmocerithium* to that of the Recent *Retilaskeya zelandica* illustrated by Marshall (1978).

Cosmocerithium lukovensis sp. n.
(Fig. 41)

Holotype: MZ VIII Mg 4245/1, Fig. 41.
Type horizon: *Quenstedtoceras lamberti* Zone, Late Callovian (Mid Jurassic).
Type locality: Łuków (block in glacial drift), Podlasie, Poland.
Derivation of the name: After the type locality.

Material. — Eighteen shells from the type locality.

Measurements. — Protoconch 1 of one whorl is 0.10 mm in diameter. The protoconch of 6.25 whorls is 1.15 mm high and 0.64 mm in diameter. The shell with 8.75 whorls is 2.50 mm high and 0.89 mm in diameter.

Occurrences. — Type locality only.

Diagnosis. — Protoconch with inflated axial ribs and weak spiral lirae. First whorl of teleoconch ornamented with strong axial ribs and weaker spiral ribs. Axial ribs disappearing later in ontogeny . Whorls of teleoconch rounded.

Description. — The shell is elongate, 2.8 times as high as broad. Protoconch 1 and first half whorl of protoconch 2 are ornamented only with pustules. Later, three spiral ribs appear. On the second whorl of protoconch 2, axial ribs appear. On the third whorl, the adapicalmost spiral rib disappears. Later in ontogeny the two spiral ribs change into very weak lirae and numerous additional lirae appear. The axial ribs are almost

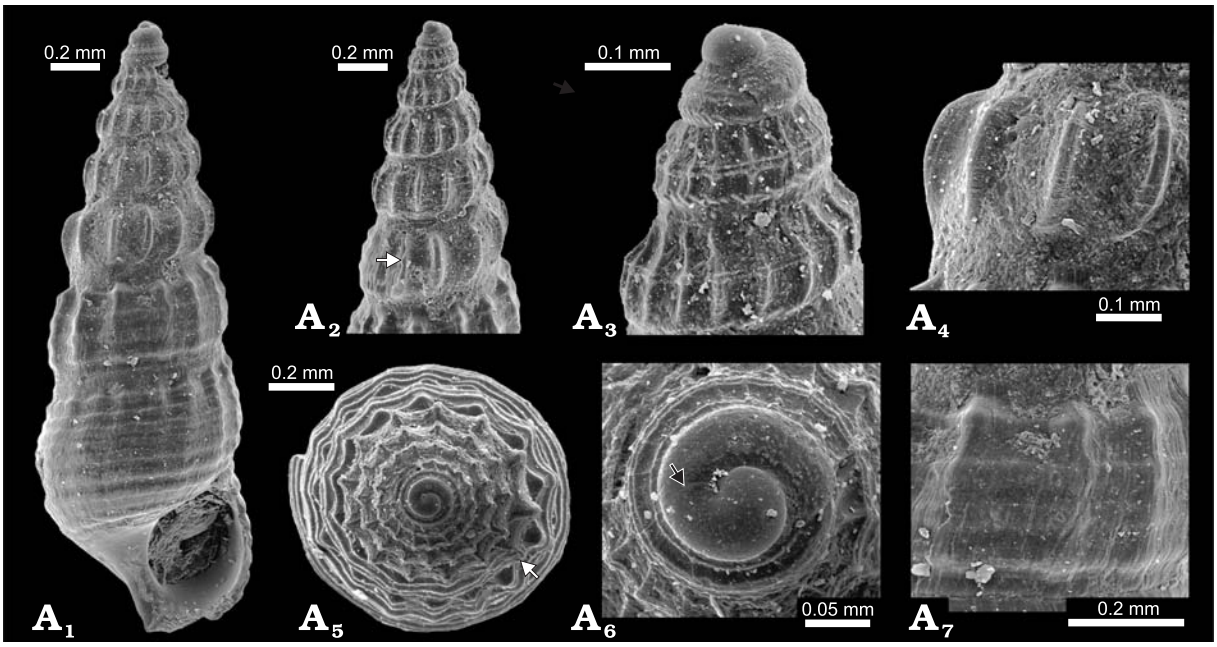


Fig. 41. The eumetulid *Cosmocerithium lukovensis* sp. n. from Łuków (block in glacial drift), Podlasie, Poland, Late Callovian (Mid Jurassic) **A**. MZ VIII Mg 4245/1 (holotype); A_1 lateral view, A_2 protoconch, A_3 close-up of the apex (protoconch 1 and early part of protoconch 2), A_4 details of the protoconch 2 ornamentation, A_5 apical view, A_6 close-up of protoconch 1, A_7 details of the teleoconch ornamentation. Black arrow indicates demarcation between protoconch 1 and protoconch 2; white arrows indicate demarcation between protoconch and teleoconch.

orthocline. The whole surface of protoconch 2 is covered by small pustules. The demarcation from the teleoconch is clearly visible. First whorl of the teleoconch is ornamented with strong axial ribs and weaker spiral ribs. During ontogeny, the axial ribs become increasingly weaker and finally disappear. The number of spiral ribs range from four at the first whorl of teleoconch to seven on the third whorl. The number of axial ribs increases from 13 to 16 per whorl.

Remarks. — The species is similar to *C. kosmai* but differs in having more sturdy ribs of the protoconch and strong axial ribs on the first whorl of the teleoconch. Moreover *C. kosmai* has much stronger spiral lirae on its protoconch.

Cosmocerithium polonicum sp. n.
(Fig. 42)

Holotype: MZ VIII Mg 4246/1, Fig. 42.
Type horizon: *Quenstedtoceras lamberti* Zone, Late Callovian (Mid Jurassic).
Type locality: Łuków (block in glacial drift), Podlasie, Poland.
Derivation of the name: After the latnization of Poland.

Material. — Three shells from the type locality.

Measurements. — Protoconch 1 consisting of one whorl is 0.11 mm in diameter. The protoconch of six whorls is 1.23 mm high and 0.62 mm in diameter. A shell with 9.25 whorls is 3.07 mm high and 1.10 mm in diameter.

Occurrences. — Type locality only.

Diagnosis. — Protoconch ornamented with strong, opisthocyrtic axial ribs and weak spiral lirae. Teleoconch ornamented with opisthocyrtic axial ribs and equally strong spiral ribs. Whorls of teleoconch flattened.

Description. — The shell is elongate, 2.8 times as high as broad. Protoconch 1 and first half whorl of the protoconch 2 are ornamented only with pustules. Later, three spiral ribs appear. On the second whorl of protoconch 2 axial ribs appear. On the third whorl the adapicalmost spiral rib disappears. Later in ontogeny, the two spiral ribs change into very weak lirae and numerous additional lirae appear. The whole surface of protoconch 2 is covered by small pustules. Demarcation with the teleoconch is clearly visible. Teleoconch

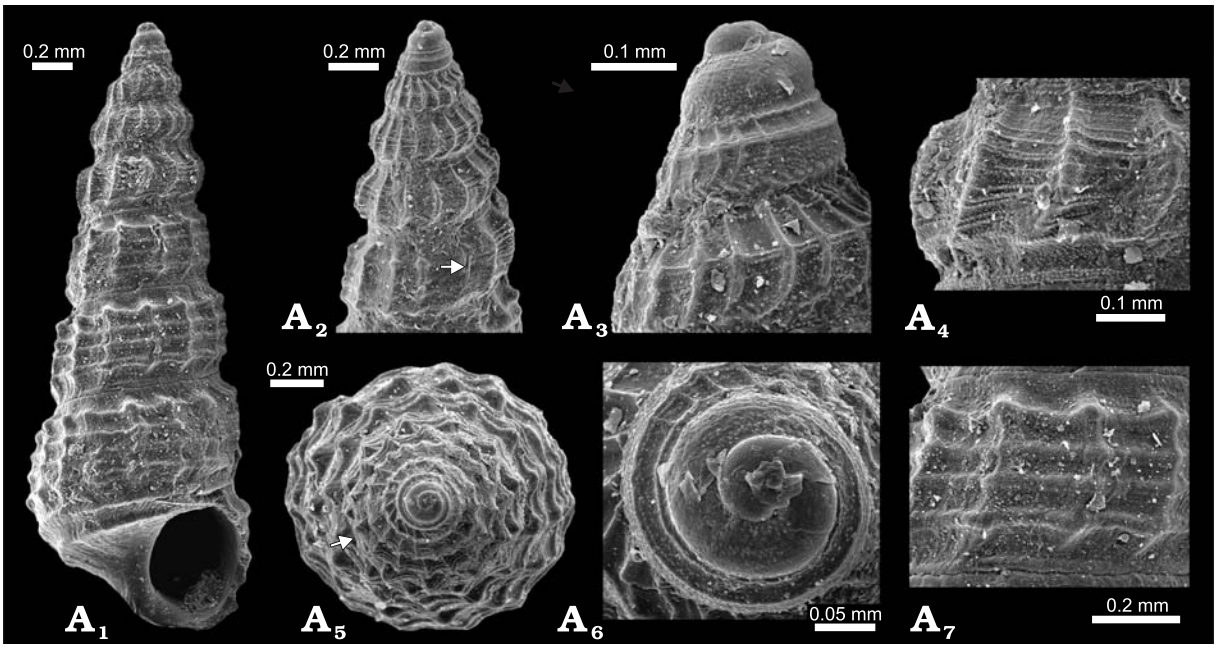


Fig. 42. The eumetulid *Cosmocerithium polonicum* sp. n. from Łuków (block in glacial drift), Podlasie, Poland, Late Callovian (Mid Jurassic). **A**. MZ VIII Mg 4246/1 (holotype); A_1 lateral view, A_2 protoconch, A_3 close-up of the apex (protoconch 1 and the early part of the protoconch 2), A_4 details of protoconch 2 ornamentation, A_5 apical view, A_6 close-up of protoconch 1, A_7 details of the teleoconch ornamentation. White arrows indicate demarcation between protoconch and teleoconch.

ornamented with four spiral ribs and opisthocyrtic axial ribs. The number of axial ribs increases from 13 to 16 per whorl.

Remarks. — The species is most similar to *C. antiquum* but it differs in having the protoconch ornamented with convex axial ribs and spiral lirae. Moreover *C. polonicum* has four spiral ribs on the teleoconch and their number remains stable during ontogeny.

Family **uncertain**

Triphoroidea gen. et sp. indet.

(Fig. 43)

Material. — One shell (ZPAL Ga.9/187) from sample G1 of Wąwał, southern Mazowsze, *Busnardoides campylotoxus* Zone of Early Valanginian (Early Cretaceous).

Measurements. — The protoconch of 5.5 whorls is 0.95 mm high and 0.49 mm in diameter.

Description. — The protoconch is highly conical with the first two whorls not ornamented. The rest of the protoconch is ornamented with opisthocline axial ribs. Spiral lirae are not present. Demarcation from the teleoconch is not well preserved. The teleoconch is worn but remnants of spiral and axial ribs are visible. Peristome is not preserved.

Remarks. — This multispiral protoconch to some degree resembles the specimen identified by Nützel (1998) as *Vatopsis*/*Retaliskeya* sp. but the former differs in lacking the abapical ribbon. To determine more precisely the taxonomic position of this shell, more completely preserved material is needed.

Superfamily **Janthinoidea** Gray, 1853

Family **Epitoniidae** Berry, 1910

Genus *Claviscala* de Boury, 1909

Type species: *Scalaria richardi* Dautzenberg *et* de Boury, 1897; original designation. Recent, North Atlantic.

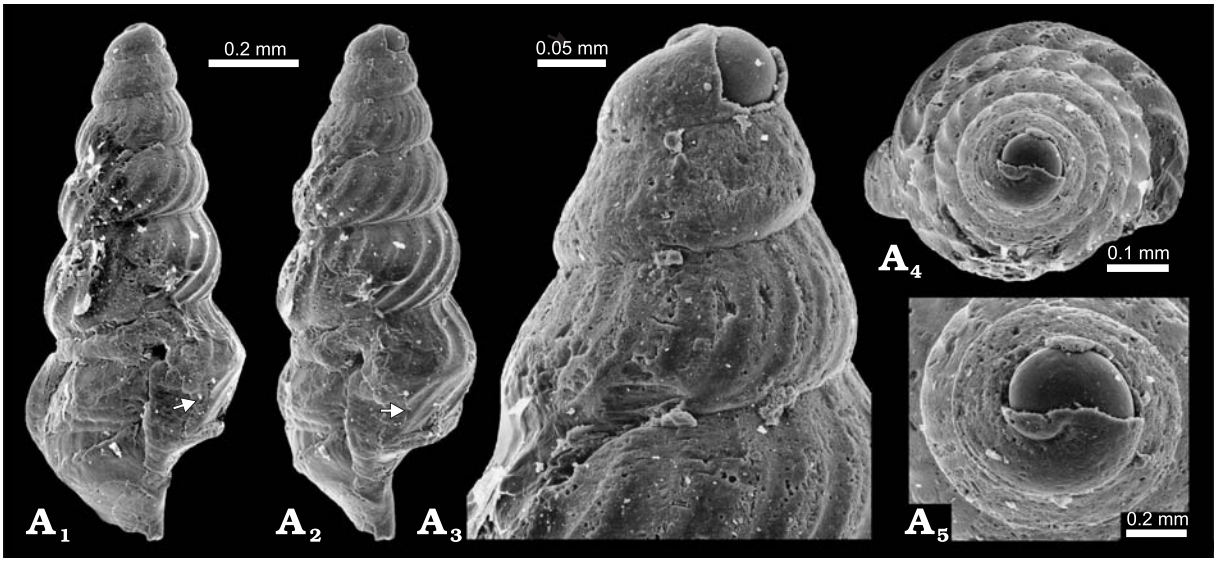


Fig. 43. Triphoroidea gen. et sp. indet. from Wąwał, southern Mazowsze, Poland, Early Valanginian (Early Cretaceous). **A**. ZPAL Ga.9/187 from sample G1; A_1, A_2 lateral views, A_3 close-up of the apex (protoconch 1and early part of protoconch 2), A_4 apical view, A_5 close-up of the protoconch 1. White arrows indicate demarcation between protoconch and teleoconch.

Diagnosis. — Shell medium to large, rather narrow, orthoconic, with strong axial ribs, fine spiral striae, relatively insconspicuous varices; base of body whorl with single cord; aperture ovate-quadrate; without intritacalx (after Kilburn 1985).

Discussion. — This genus was established for Recent species but some Cretaceous species have also been included (see e.g., Cossmann 1912). The relationship of Cretaceous and Recent species remains unclear as the protoconchs of the former has never been illustrated.

Range. — Early Cretaceous (Cossmann 1912 and herein) to Recent (e.g., Kilburn 1985).

Claviscala sp.
(Fig. 44)

Material. — One shell (ZPAL Ga.9/198) from Wąwał, southern Mazowsze, Poland, Late Valanginian (Early Cretaceous).

Measurements. — The incomplete shell of six whorls is 5.17 mm high and 1.6 mm in diameter.

Description. — The protoconch is not preserved. The slender shell is 3.2 times as high as broad with convex whorls ornamented with strong axial ribs (six per whorl) and much weaker spiral ribs (about ten ribs per whorl). Peristome is not preserved.

Remarks. — The shell described here is similar to the Albian (Early Cretaceous) *Claviscala clementina* (Michelin, 1833) illustrated by Cossmann (1912) but because of fragmentary preservation an exact identification is not possible. A similar pattern of the teleoconch ornamentation occurs in a fossil species of *Opaliopsis* described below. Without the protoconch preserved, an exact determination is not possible.

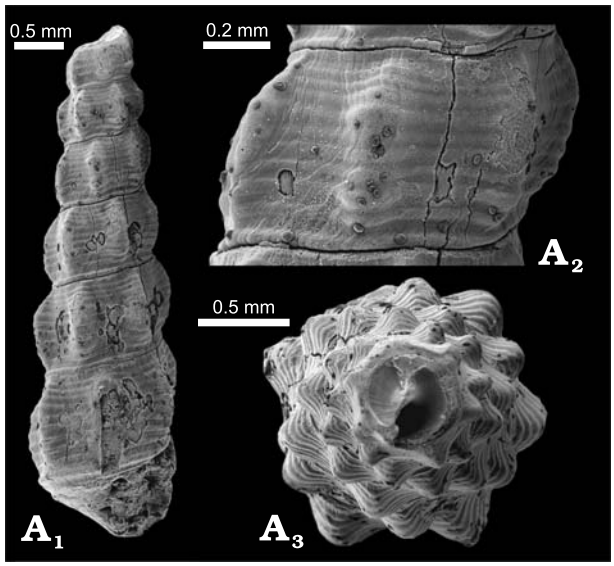


Fig. 44. Possible epitoniid *Claviscala* sp. from Wąwał, southern Mazowsze, Poland, Late Valanginan (Early Cretaceous). **A**. ZPAL Ga.9/198; A_1 lateral view, A_2 details of the teleoconch ornamentation, A_3 apical view.

Family **Nystiellidae** Clench *et* Turner, 1952

Genus *Opaliopsis* Thiele, 1928

(*Nystiella* Clench *et* Turner, 1952; *Plicacerithium* Gerasimov, 1992)

Type species: *Scala elata* Thiele, 1925; original designation. Recent, 1˚40' S, 41˚47' E, 693 m depth.

Diagnosis. — Shell with broad axial ribs (not lamellae); no intritacalx; protoconch conical, usually of 3–4 whorls, with distinct axial ribs and sometimes interstitial spiral lirae (after Kilburn 1985; and Bouchet and Warén 1986).

Discussion. — This genus typically has a protoconch that is set off from the teleoconch and broad axial ribs of the teleoconch (see e.g., Bouchet and Warén 1986). Some fossil species with this kind of protoconch are grouped by Guzhov (2002a) under the genus *Plicacerithium* Gerasimov, 1992 and placed in the family Epitoniidae.

Range. — Oxfordian, Late Jurassic (Guzhov 2002a) to Recent (e.g., Bouchet and Warén 1986). The older species listed by Guzhov (2002a) need revision before they can be transferred to *Opaliopsis*.

Opaliopsis boucheti sp. n.

(Fig. 45)

Holotype: ZPAL Ga.9/186, Fig. 45.

Type horizon: Sample G1, *Busnardoides campylotoxus* Zone, Early Valanginian (Early Cretaceous).

Type locality: Wąwał, southern Mazowsze, Poland.

Derivation of the name: In honour of Philippe Bouchet.

Material. — One shell from the type locality.

Measurements. — The protoconch (holotype) with 4.25 whorls is 0.44 mm in diameter and 0.76 mm high. The shell with 1.25 teleoconch whorls is 1.21 mm high and 0.75 mm in diameter.

Occurrences. — Type locality only.

Diagnosis. — Mammillated protoconch, highly conical, with first 1.5 whorls not ornamented. Rest of protoconch ornamented with opisthocline axial ribs; spiral lirae not present. Demarcation from teleoconch clearly visible, sinusoidal with sinusigera lip. Teleoconch ornamented with strong axial ribs and blunt axial ribs.

Description. — The demarcation between protoconch 1 and 2 is not visible. Spiral ribs cross the axial ribs without breaking. The peristome is not preserved.

Remarks. — This species has a protoconch typical of members of the family Nystiellidae and it may represent the earliest known member of the family. A very similar shell from the Late Cretaceous of North America (fig. 47 therein) was identified by Bandel (1991) as *Acirsa* sp.

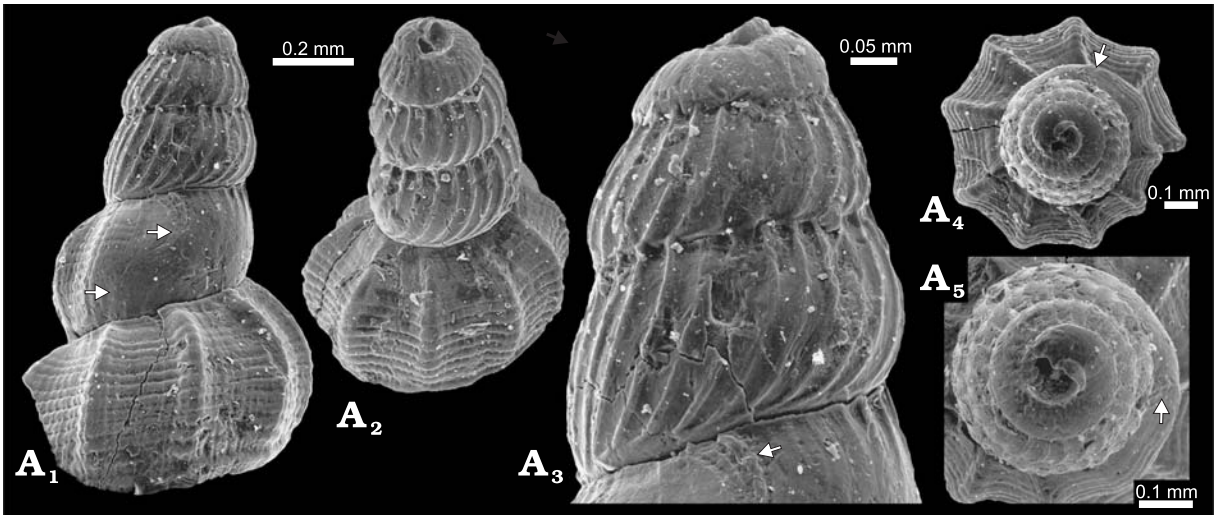


Fig. 45. The nystiellid *Opaliopsis boucheti* sp. n. from Wąwał, southern Mazowsze, Poland, Early Valanginan (Early Cretaceous) **A**. ZPAL Ga.9/186 (holotype) from sample G1; A_1, A_2 lateral views, A_3 close-up of the apex (protoconch 1 and the early part of the protoconch 2), A_4 apical view, A_5 close-up of the protoconch in apical view. White arrows indicate demarcation between protoconch and teleoconch.

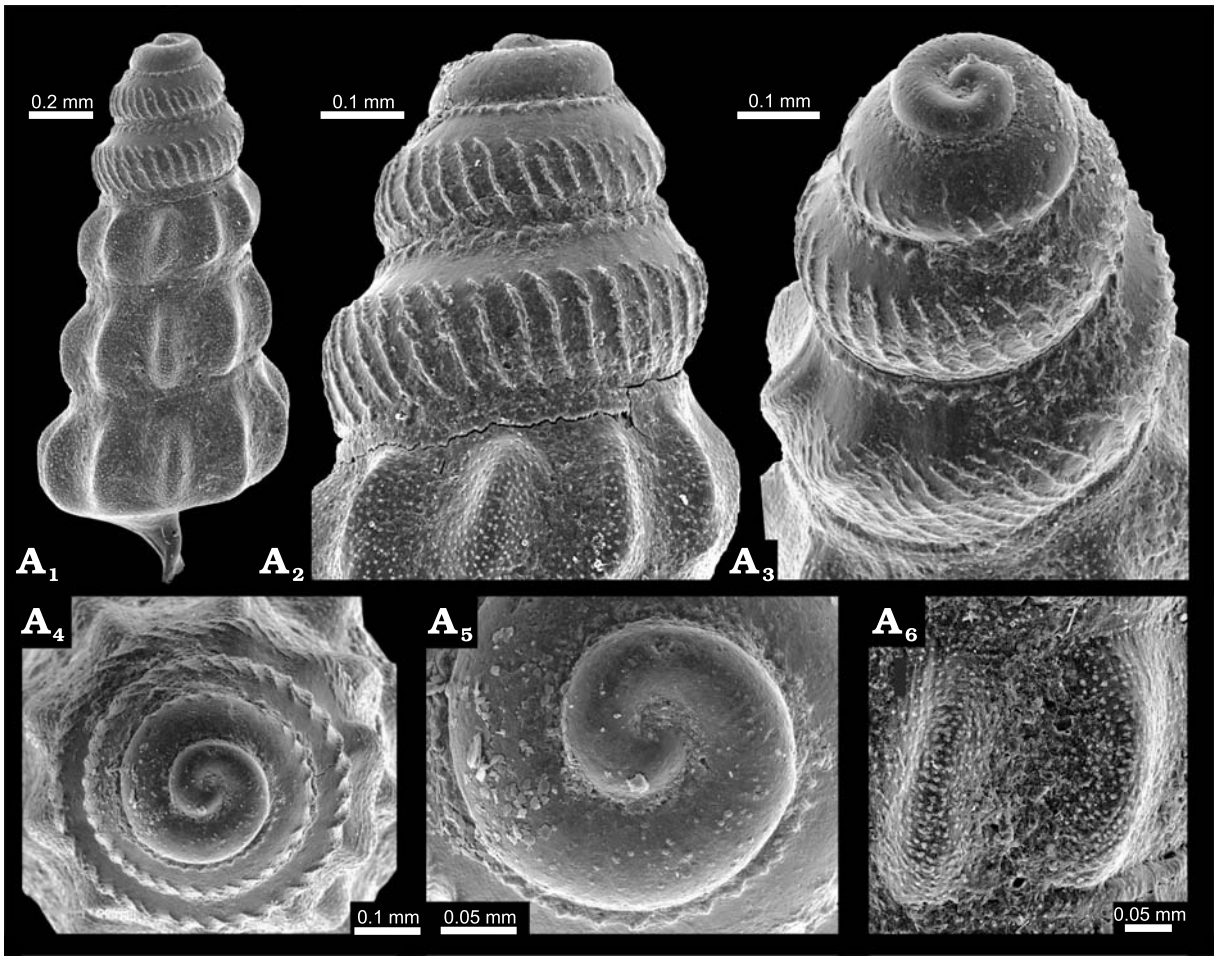


Fig. 46. The polygyrynid *Teutonica verrucosa* Gründel, 1999 from Pacanów, Częstochowa region, Poland, Late Bajocian, Mid Jurassic). **A**. ZPAL Ga.9/61; A_1 lateral view, A_2, A_3 protoconch in lateral view, A_4 protoconch in apical view, A_5 close-up of the protoconch 1, A_6 details of teleoconch ornamentation.

Superfamily **uncertain**

Family **Polygyrynidae** Bandel, 1993

Genus *Teutonica* Schröder, 1992

Type species: *Teutonica grammani* Schröder, 1992; original designation. Bajocian (Mid Jurassic), Osterfeld, Northern Germany.

Emended diagnosis. — Embryonic and larval shell orthostrophic, cylindrical, barrel shaped, convex whorl with impressed sutures. Initial whorls more or less planispirally coiled. Larval shell with adapical spiral row of tubercules and axial, granulated riblets, extending from upper periphery to the abapical suture. Transition to teleoconch with sinuous growth lines and a sudden change in ornamentation. Turriculate teleoconch with numerous, convex whorls. Sculpture consisting of strong, peripheral salient axial ribs and/or faint spiral striae. Peristome rounded with obliquely situated anterior channel (after Schröder 1992; and Gründel 1999a).

Discussion. — Schröder (1992) originally placed the genus *Teutonica* into the family Cerithiopsidae Adams *et* Adams, 1853. Nützel (1998) transferred the genus into the family Zygopleuridae Wenz, 1938. Gründel (1999a) suggested a close resemblance of *Teutonica* to the genus *Polygyrina* Koken, 1892 and placed the former in the family Polygyrinidae that is based on the latter genus. The family Polygyrinidae was established by Bandel (1991) with no diagnosis given. The preliminary diagnosis is accessible in Bandel (1993a) and thereafter in Nützel (1998) and Gründel (1999a). Here I follow the interpretation of Gründel (1999a) although the status of the family still seems to be not clear (see also discussion in Gründel 1999a).

Range. — Bajocian to Callovian (Mid Jurassic; Schröder 1992, 1995; Gründel 1999a, 2001, and herein).

Teutonica verrucosa Gründel, 1999
(Fig. 46)

1977. sp. 5; Gründel 1977: 192, pl. 1: 11, 12.
1999. *Teutonica verrucosa* sp. n.; Gründel 1999: 41, figs 6–9.

Holotype: Gründel 1999a: 41, figs 6–9.
Type horizon: Late Bajocian, Mid Jurassic.
Type locality: Kłęby borehole 1/37, West Pomerania, Poland.

Material. — Five shells from Pacanów and twenty shells from Złote Góry, both Częstochowa region, Poland, Late Bajocian (Mid Jurassic).

Measurements. — Protoconch 1 consisting of one whorl, which is 0.12 mm in diameter. The protoconch with 3.75 whorls is 0.72 mm high and 0.42 mm in diameter. The shell with 6.5 whorls is 1.69 mm high and 0.77 mm wide.

Occurrences. — Late Bajocian (Mid Jurassic) of Poland.

Emended diagnosis. — Protoconch cylindrical with dome-shaped apex ornamented with adapical spiral row of tubercules and axial, prosocline riblets extending from upper periphery to abapical suture. Teleoconch ornamented with strong, weakly opistocline axial ribs. Surface of shell densely covered by pustulose ornamentation.

Description. — Protoconch 1 consists of one whorl with no ornamentation. The demarcation between the protoconch and the teleoconch marked with intermediate zone. Sutures of the teleoconch are weakly incised. The peristome is not preserved.

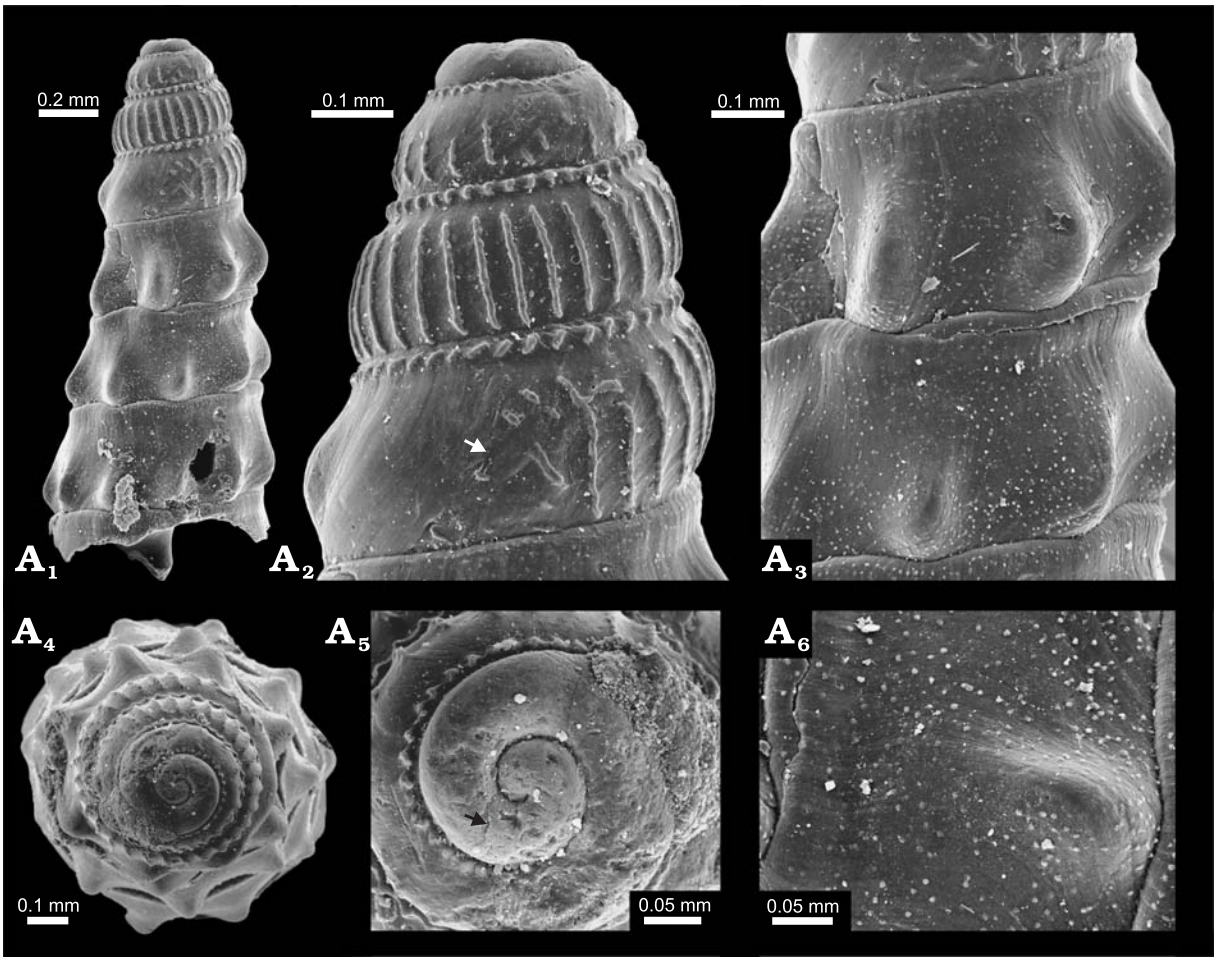


Fig. 47. The polygyrynid *Teutonica calloviana* Gründel, 2001 from Łuków (block in glacial drift), Podlasie, Poland, Late Callovian (Mid Jurassic) **A**. MZ VIII Mg 4226/1; A_1 lateral view, A_2 protoconch in lateral view, A_3 early teleoconch whorls, A_4 apical view, A_5 close-up of the protoconch 1, A_6 details of teleoconch ornamentation. Black arrow indicates demarcation between protoconch 1and protoconch 2; white arrow indicates demarcation between protoconch and teleoconch.

Remarks. — *T. verrucosa* is very similar to *T. procera* Gründel, 1999 and the two can represent end-members within the variability of the species. *T. grammani* Schröder, 1992 differs in absence of the pustulose ornamentation on the teleconch and in having a more distinct demarcation between protoconch and teleoconch. This can nevertheless be a preservational bias. *T. calloviana* and *T. jakubowskii* differ from *T. verrucosa* in having almost orthocline axial ribs of the protoconch and a shorter distance between the adapical row of tubercules and the beginning of the axial ribs on the protoconch.

Teutonica calloviana Gründel, 2001
(Fig. 47)

2001. *Teutonica calloviana* sp. n.; Gründel 2001: 48, pl. 1: 11–14.

Holotype: Gründel 2001: 48, pl. 1: 14.
Type horizon: Late Callovian (Mid Jurassic).
Type locality: Teetz borehole 1/63, Germany.

Material. — Twenty shells from Late Callovian of Łuków (block in glacial drift), Podlasie, Poland.

Measurements. — Protoconch 1 consisting of one whorl is 0.13 mm in diameter. The whole protoconch of four whorls is 0.63 mm high and 0.5 mm in diameter. A shell with 7.25 whorls is 1.86 mm high and 0.79 mm in diameter.

Occurrences. — Late Callovian of Germany and Poland.

Emended diagnosis. — Protoconch cylindrical with dome-shaped apex ornamented with adapical spiral row of tubercules and axial, very weakly prosocline (almost orthocline) riblets, extending from upper periphery to abapical suture. Teleoconch ornamented with strong, orthocline axial ribs, bulbous abapically. Surface of shell scarcely covered by small pustules.

Description. — Protoconch 1 is not ornamented. Demarcation between protoconch and teleoconch is opisthocline. The sutures of teleoconch are not incised. The peristome is not preserved.

Remarks. — The specimens from Łuków differ slightly from type material of Gründel (2001) in smaller size of the protoconch, bulbous axial ribs of teleoconch and a lack of suture incision. All these characters can be regarded as intraspecific variability. See also remarks for *T. verrucosa* and *T. jakubowskii*.

Teutonica jakubowskii sp. n.
(Fig. 48)

Holotype: MZ VIII Mg 4225/1, Fig. 48.
Type horizon: *Quenstedtoceras lamberti* Zone, Late Callovian (Mid Jurassic).
Type locality: Łuków (block in glacial drift), Podlasie, Poland.
Derivation of the name: In honour of Gwidon Jakubowski, the collector of the type specimen.

Material. — One shell from the type locality.

Measurements. — Protoconch 1 consisting of one whorl is 0.11 mm in diameter. The whole protoconch of four whorls is 0.60 mm high and 0.52 mm in diameter. A shell with eight whorls is 2.19 mm high and 0.80 mm in diameter.

Occurrences. — Type locality only.

Diagnosis. — Protoconch ornamented with adapical spiral row of tubercules and axial, very weakly prosocline (almost orthocline) riblets, extending from upper periphery to abapical suture. Distance between row of tubercules and axial riblets of protoconch short. Teleoconch starting with strong opisthocline axial ribs and pustules arranged into spiral threads. On the later teleoconch whorls, axial ribs vanishing and pustules becoming randomly distributed.

Description. — The protoconch is not ornamented. Demarcation between protoconch 1 and 2 is poorly visible. The terminal part of the outer lip of the protoconch is fractured. Suture of teleoconch is not incised. The peristome is not preserved.

Remarks. — The protoconch of the species under consideration is similar to *T. calloviana* but the teleoconch differs significantly in the continuous reduction of the axial ribs and the arrangment of the pustules.

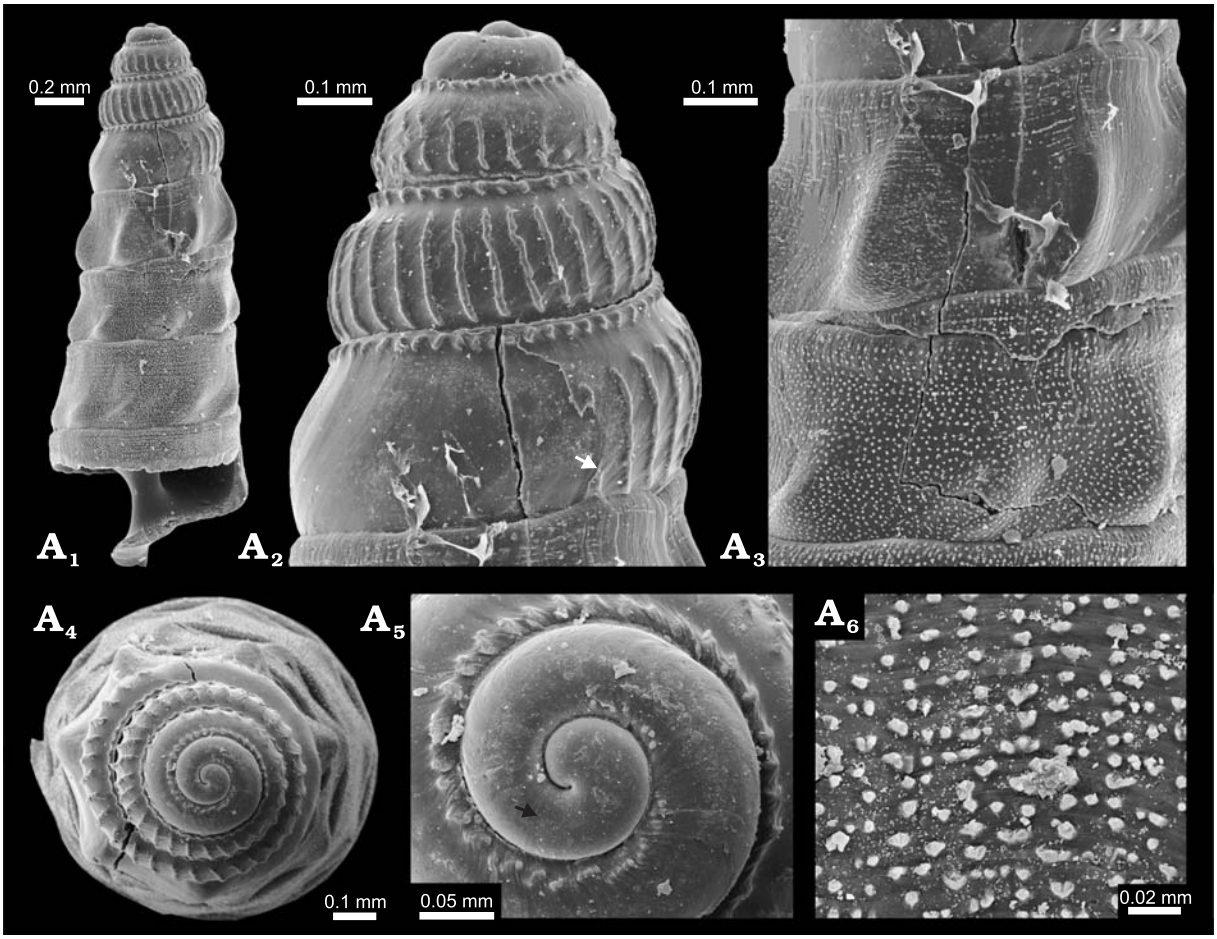


Fig. 48. The polygyrynid *Teutonica jakubowskii* sp. n. from Łuków (block in glacial drift), Podlasie, Poland, Late Callovian (Mid Jurassic). **A**. MZ VIII Mg 4225/1; A_1 lateral view, A_2 protoconch in lateral view, A_3 early teleoconch whorls, A_4 apical view, A_5 close-up of protoconch 1, A_6 details of teleoconch ornamentation. Black arrow indicates demarcation between protoconch 1and protoconch 2; white arrow indicates demarcation between protoconch and teleoconch.

Superfamily **Zygopleuroidea** Wenz, 1938
Family **Zygopleuridae** Wenz, 1938
Genus *Azyga* Nützel, 1998

Type species: *Azyga dolomitensis* Nützel, 1998; original designation. Late Carnian (Late Triassic), Campo, Dolomites, Italy.

Diagnosis. — Species of Zygopleuridae with smooth teleoconch and protoconch ornamented with a row of subsutural nodes (after Nützel 1998).

Discussion. — The only difference from *Zygopleura* Koken, 1892 is an absence of the ornamentation on the teleoconch whorls, a character that is rather tenuous as a diagnostic. It could appear independently, among different branches of zygopleurids, and thus the genus *Azyga* is potentially polyphyletic.

Range. — Carnian (Late Triassic; Nützel 1998) to Bathonian (Mid Jurassic; herein).

Azyga faustiankensis sp. n.
(Fig. 49)

Holotype: ZPAL Ga.9/62, Fig. 49.

Type horizon: *Procerites progracilis* Zone, Mid Bathonian (Mid Jurassic).

Type locality: Faustianka, Częstochowa region, Poland.

Derivation of name: After type locality.

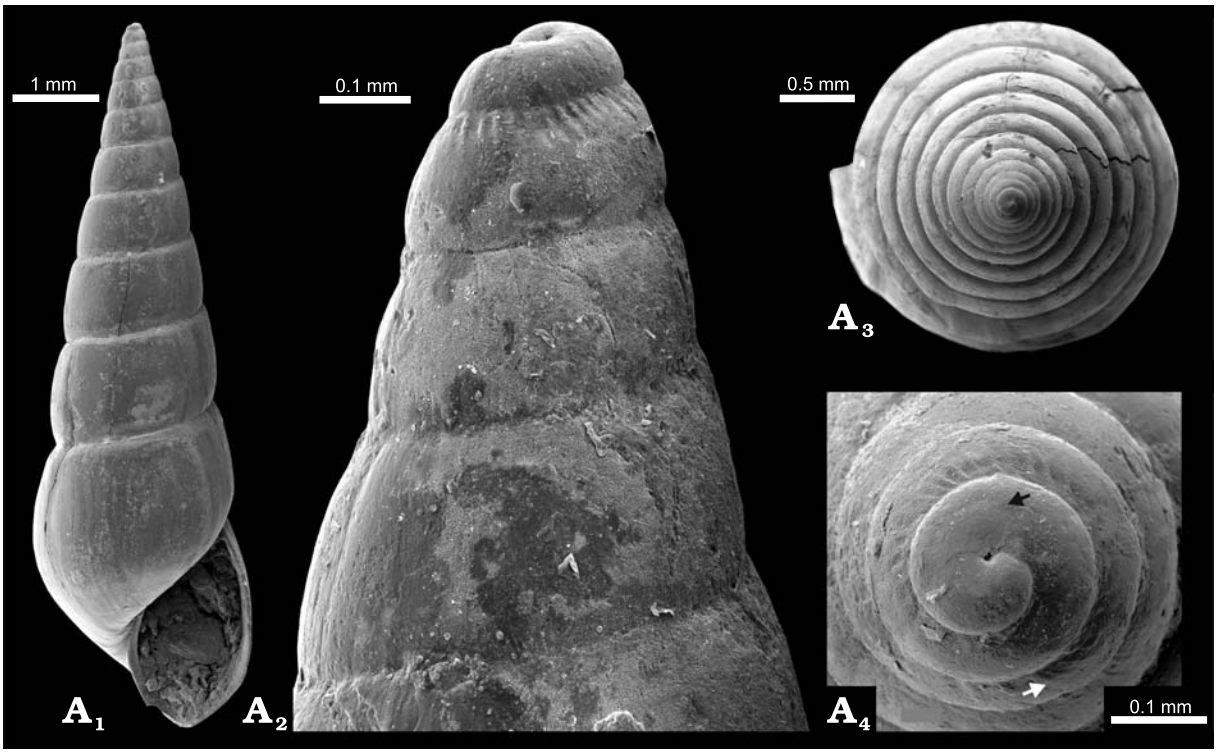


Fig. 49. The zygopleurid *Azyga faustiankensis* sp. n. **A**. ZPAL Ga.9/62 from Faustianka, Częstochowa region, Poland, Mid Bathonian (Mid Jurassic); A_1 lateral view, A_2 close-up of the apex, A_3 apical view, A_4 close-up of protoconch 1. Black arrow indicates demarcation between protoconch 1and protoconch 2; white arrow indicates demarcation between protoconch and teleoconch.

Material. — Two shells from the type locality.

Measurements. — Protoconch 1 consisting of one whorl is 0.17 mm in diameter. The protoconch of 2.5 whorls is 0.35 mm high and 0.30 mm in diameter. The shell of 11.5 whorls is 8.45 mm high and 2.30 mm in diameter.

Occurrences. — Type locality only.

Diagnosis. — Protoconch ornamented by adapical, subsutural row of weak fold-like nodes. Teleoconch smooth with many whorls (up to nine) that increase gradually.

Description. — Protoconch 1 is not ornamented. The demarcation between protoconch 1 and 2 is poorly visible. The demarcation between protoconch and teleoconch is poorly visible, opisthocyrtic. The suture of the teleoconch is weakly incised. The peristome is oval and complete.

Remarks. — This species differs from the other species of *Azyga* in having fewer whorls of the protoconch, a weakly incised suture, and regularly increasing whorls.

Azyga sp.
(Fig. 50)

Material. — One shell (ZPAL Ga.9/193) from Kawodrza-Kawodrzanka, Mid Bathonian (Mid Jurassic).

Measurements. — Protoconch 1 consisting of one whorl is 0.14 mm in diameter. The shell with 5.5 whorls is 1.16 mm high and 0.77 mm in diameter.

Description. — Protoconch 1 is smooth. Protoconch 2 is ornamented with an adapical, subsutural row of fold-like threads. The demarcation from teleoconch is not visible in the examined specimen. The teleoconch is smooth apart from an adapical subsutural spiral groove.

Remarks. — The shell described here is similar to *Azyga dolomitensis* but because of fragmentary preservation I leave it unnamed.

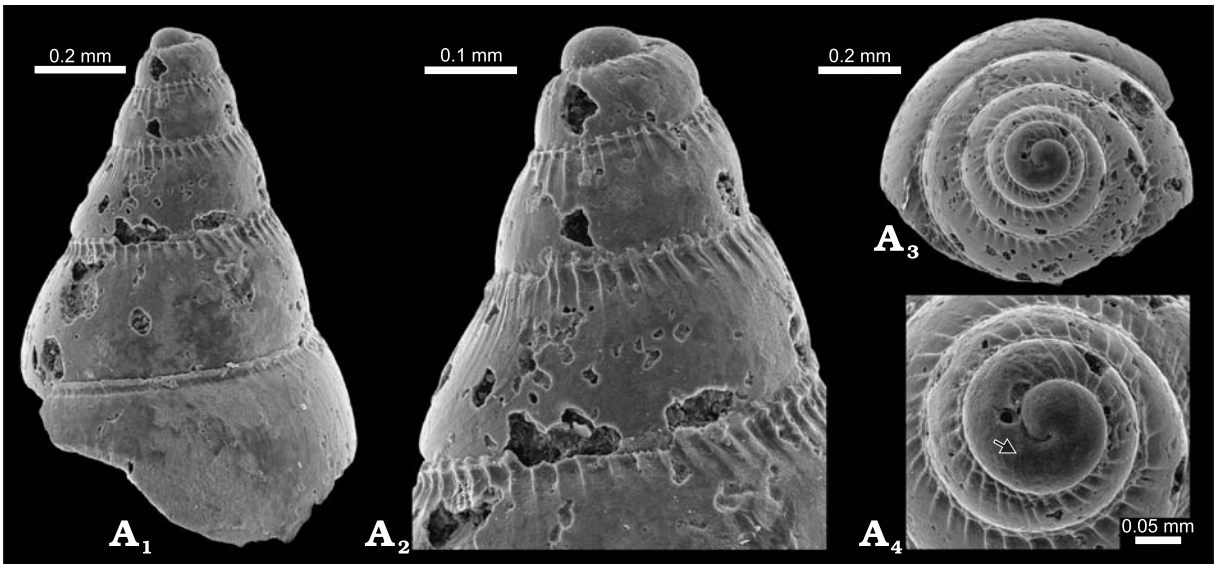


Fig. 50. The zygopleurid *Azyga* sp. **A**. ZPAL Ga.9/193 from Kawodrza-Kawodrzanka, Częstochowa region, Poland, Mid Bathonian (Mid Jurassic); A_1 lateral view, A_2 close-up of the apex, A_3 apical view, A_4 close-up of the protoconch in apical view.

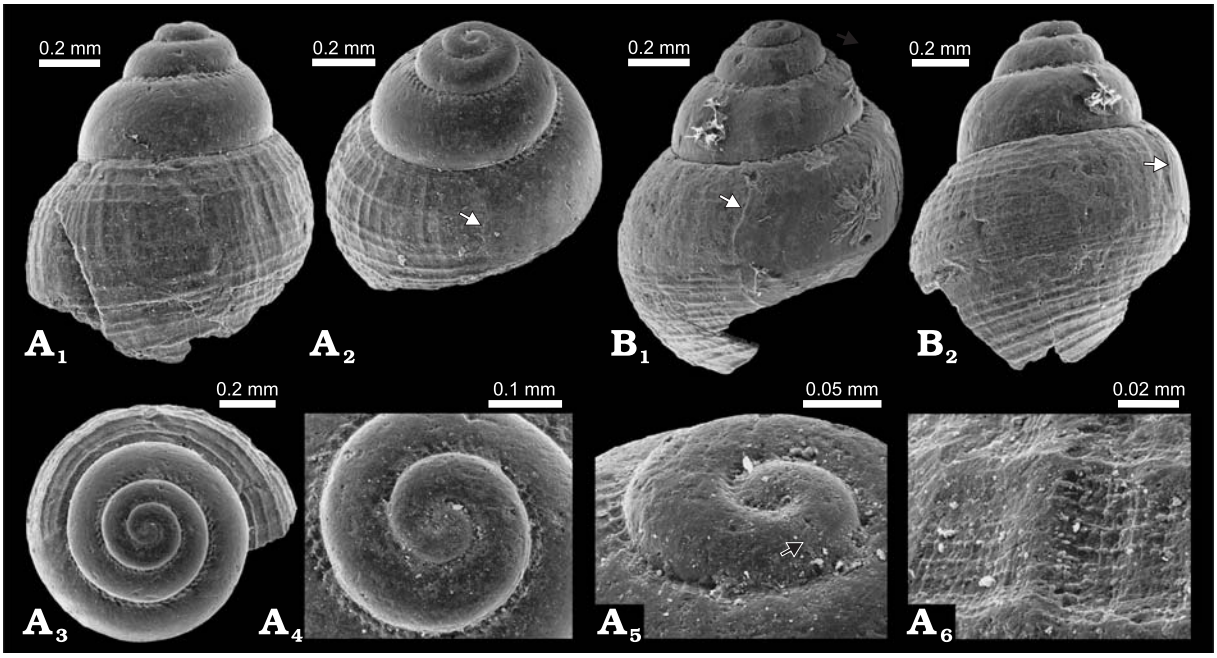


Fig. 51. The pommerozygiid *Costazygia* sp. from Wąwał, southern Mazowsze, Poland, Late Valanginian (Early Cretaceous). **A**. ZPAL Ga.9/195 from sample G3; A_1, A_2 lateral views A_3 apical view, A_4, A_5 close-up of the protoconch 1, A_6 details of the teleoconch ornamentation. **B**. ZPAL Ga.9/196 from sample H3; B_1, B_2 lateral views. Black arrow indicates demarcation between protoconch 1and protoconch 2; white arrows indicate demarcation between protoconch and teleoconch.

Family **Pommerozygiidae** Gründel, 1999

Genus *Costazygia* Gründel, 1999

Type species: *Costazygia biltzi* Gründel, 1999; original designation. Callovian (Mid Jurassic), Hohendorf, Germany.

Diagnosis. — Short and rather broad shell, with only few (6–7) whorls. Protoconch of about four whorls with rounded apex, early whorls almost planispiral. Protoconch ornamented by subsutural row of nodes. Nodes changing abapically into axial riblets. Sculpture of teleoconch consisting of numerous weak spiral

and, in some cases, axial ribs. Growth lines parasigmoidal. Aperture without callus, but abapically with short, broad channel (after Gründel 1999f).

Discussion. — The genus *Costazygia* resembles the genus *Brevizygia* Gründel, 1999. The latter differs only in having a smooth teleoconch, a character that is potentially misleading (see discussion under *Azyga*).

Range. — Bathonian (Mid Jurassic; Gründel 1999f) to Valanginian (Early Cretaceous; herein).

Costazygia sp.
(Fig. 51)

Material. — Five juvenile shells from Wąwał, southern Mazowsze, Poland, *Saynoceras verrucosum* Zone of Late Valanginian (Early Cretaceous).

Measurements. — The protoconch with 3.75 whorls is 0.80 mm high and 0.81 mm in diameter. A shell with 4.25 whorls is 1.13 mm high and 1.00 mm in diameter.

Description. — Protoconch 1 is not clearly demarcated from protoconch 2 and is smooth. The ornament of protoconch 2 consists of an adapical, subsutural row of fold-like threads. The demarcation from the teleoconch is clearly visible, sinusoidal. The teleoconch is ornamented with weak ribs, both spiral and axial . Additionaly the teleoconch is ornamented by weak spiral lirae composed of small pustules.

Remarks. — The shells under consideration differ from shells of similar *Costazygia bilzi* Gründel, 1999 in having spiral and axial ornamentation of the same dimension. Because of incomplete preservation, the shells remain unnamed.

Pommerozygiidae gen et sp. indet.
(Fig. 52)

Material. — One shell (ZPAL Ga.9/194) from the *Procerites progracilis* Zone, Mid Bathonian of Faustianka, Częstochowa region, Poland.

Measurements. — Protoconch 1 consisting of one whorl is 0.16 mm in diameter. The shell with four whorls is 1.07 mm high and 0.73 mm in diameter.

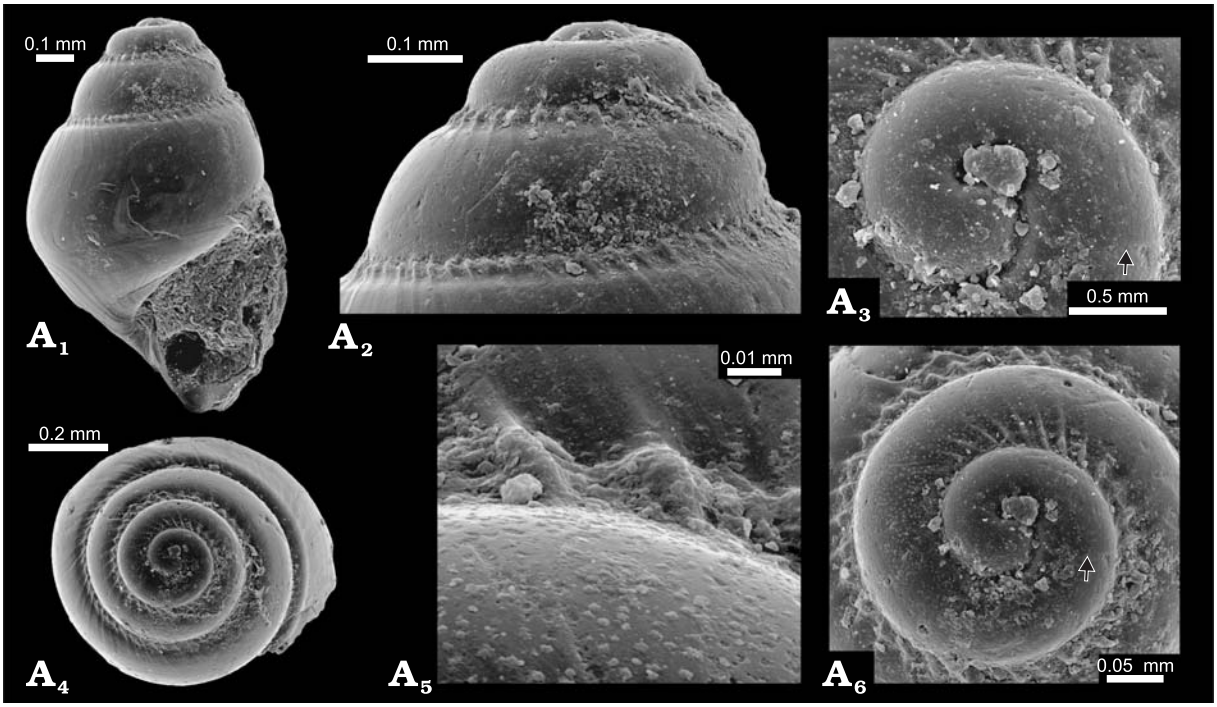


Fig. 52. Pommerozygidae gen. et sp. indet. 1. **A**. ZPAL Ga.9/194 from Faustianka, Częstochowa region, Poland, Mid Bathonian (Mid Jurassic); A_1 lateral view, A_2 close-up of the apex in lateral view, A_3 close-up of protoconch 1, A_4 apical view, A_5 detail of the early whorl ornamentation, A_6 close-up of the protoconch in apical view. Black arrows indicate demarcation between protoconch 1 and protoconch 2.

Description. — Protoconch 1 is smooth. The protoconch 2 is obtusely conical with a dome-shaped apex and ornamented with an adapical, subsutural row of fold-like threads. The first half whorl of protoconch 2 is additionally ornamented with small pustules. The growth lines of the protoconch are strongly sinusoidal. On the examined specimen, the protoconch is not clearly demarcated from the teleoconch but most probably it ends with 3.75 whorls. The preserved 0.75 of the teleoconch whorl is smooth.

Remarks. — The dome-shaped apex and the subsutural zygopleurid-like row of nodes are typical of the family Pommerozygiidae. Because of the incompletness of the teleoconch, the shell remains unnamed.

Family **Pseudozygopleuridae** Knight, 1930

Genus *Plocezyga* Knight, 1930

Type species: *Hemizyga* (*Plocezyga*) *corona* Knight, 1930; original designation. Westfalian (Upper Carboniferous), Feefee Creek, Missouri, USA.

Diagnosis. — Pseudozygopleuridae with teleoconch ornamented with strong axial ribs not reaching base and spiral lirae ornamenting both the flanks and the base of whorls (after Nützel 1998).

Discussion. — The genus *Plocezyga* and the family Pseudozygopleuridae are mainly Palaeozoic gastropods (see e.g., Nützel 1998). *Plocezyga gruendeli* sp. n. described below is the youngest member of the family Pseudozygopleuridae and the only one known from the Mesozoic.

Range. — Westfalian (Late Carboniferous; Nützel 1998) to Mid Bathonian (Mid Jurassic; herein).

Plocezyga gruendeli sp. n.

(Fig. 53)

Holotype: ZPAL Ga.9/92, Fig. 53A.

Type horizon: *Morrisiceras morrisi* Zone, Bathonian (Mid Jurassic).

Type locality: Gnaszyn, Częstochowa region, Poland.

Derivation of the name: In honour of Joachim Gründel.

Material. — Three shells from the type locality.

Measurements. — Protoconch 1 consisting of one whorl is 0.15 mm in diameter. The whole protoconch consisting of three whorls is 0.53 mm high and 0.51 mm in diameter. A shell with 6.5 whorls is 5.00 mm high and 3.65 mm in diameter.

Occurrences. — Type locality only.

Diagnosis. — Protoconch slightly set off teleoconch, ornamented by pattern of oblique, prosocline, opisthocline, spiral threads. Teleoconch ornamented with strong, prosocline axial ribs and much weaker spiral ribs.

Description. — The bulbous protoconch 1 has no visible ornamentation (not preserved?). Protoconch 2 has rounded whorls. On the adapical and abapical parts of the whorls, protoconch 2 is ornamented with opisthocline threads; slightly below on the adapical periphery, with prosocline threads; and on the median part, with spiral threads. The demarcation from the teleoconch is clearly visible and sinusoidal. The teleoconch is ornamented with 13–14 strong, prosocline axial ribs that disappear on the base, and with much weaker spiral ribs that cross without breaking the axial ribs, and also cover the basal part of the whorl. The peristome is not completely preserved, widely oval.

Remarks. — The species under consideration is similar to *Plocezyga turbinata* Hoare *et* Sturgeon, 1980 but it differs in having more inflated whorls of the teleoconch and a partially reticulate pattern of the protoconch. The latter is similar to the protoconch ornament of *Hemizyga decussata* Yoo, 1988 but the *Hemizyga* teleoconch is ornamented exclusively by weak axial ribs (see Yoo 1988: figs 88–91).

Superfamily **Stromboidea** Rafinesque, 1815

Family **Aporrhaidae** Gray, 1850

Remarks. — The extant species of the family Aporrhaidae are known to be highly variable in mature size and morphology resulting in an extraordinary splitting of the specific names (for an extreme Recent case, see Settepassi 1971). Therefore, many of the species established for Jurassic and Cretaceous genera by the earlier authors (d'Orbigny 1850a, b; Piette 1891; Hudleston 1888, 1889; Morris and Lycett 1850; and Quenstedt

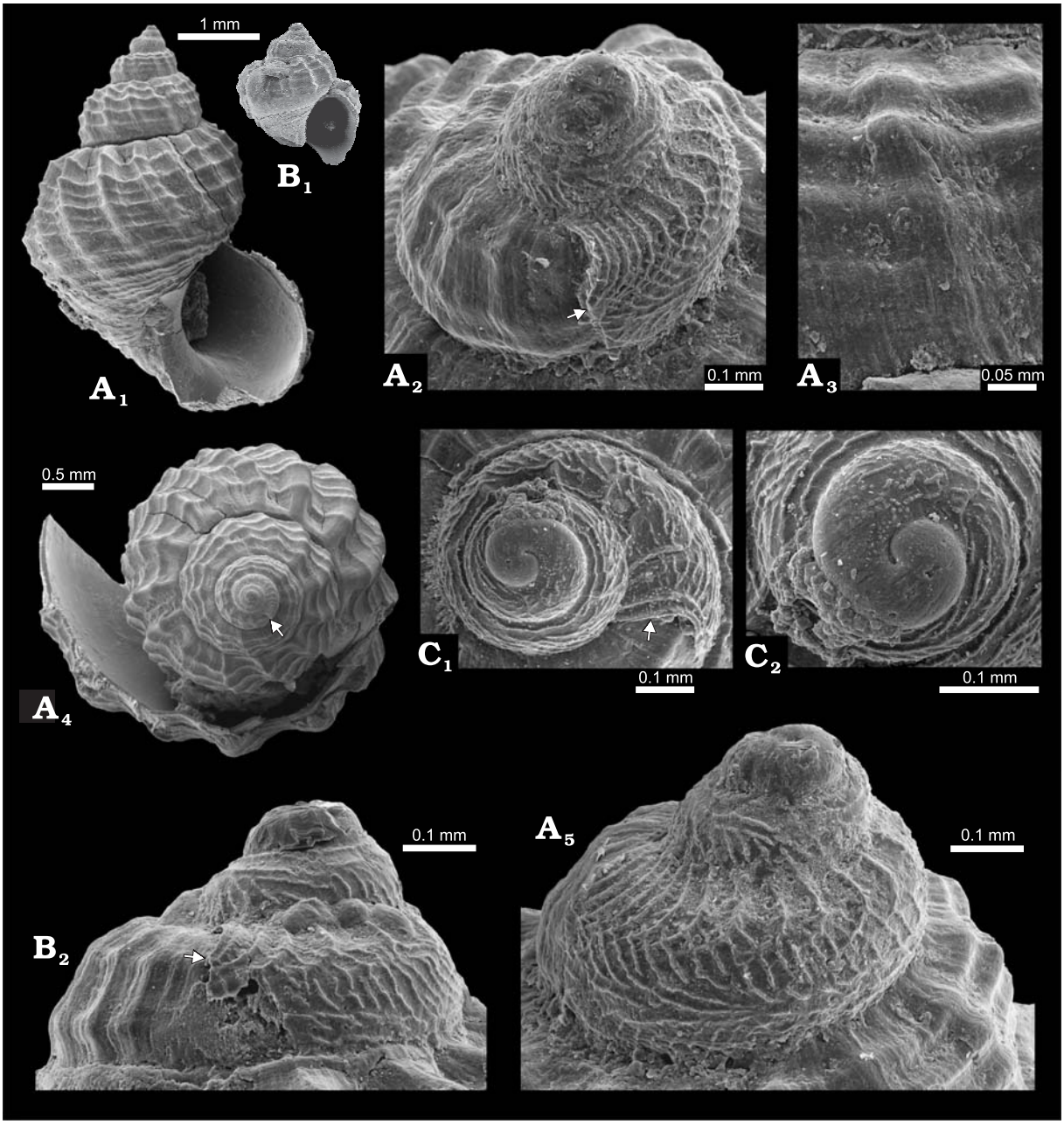


Fig. 53. The pseudozygopleurid *Plocezyga gruendeli* sp. n. from Gnaszyn (Bathonian, Mid Jurassic). **A**. ZPAL Ga.9/92 (holotype); A_1 lateral view, A_2, A_5 protoconch in lateral view, A_3 details of teleoconch ornamentation, A_4 apical view. **B**. ZPAL Ga.9/93; B_1 lateral view, B_2 protoconch in lateral view. **C**. ZPAL Ga.9/212; C_1 protoconch in apical view, C_2 close-up of protoconch 1. White arrows indicate demarcation between protoconch and teleoconch.

1858) are most probably morphotypes of only a few species belonging to a particular genus. To establish a more reliable taxonomy of Mesozoic aporrhaids a revision of the type materials is needed.

Genus *Dicroloma* Gabb, 1868

(*Alaria* Morris *et* Lycett, 1850 non Schranck, 1788; *Pterophorus* Piette, 1891 non Geoffroy, 1764)

Type species: *Pterocera lorieri* d'Orbigny, 1850; subsequent designation most probably by Cossmann 1904: 85. Bajocian, Mid Jurassic, Guéret, Sarthe, France.

Emended diagnosis. — Shell moderately large to medium sized. Whorls initially rounded, smooth, then angulated and, finally keeled. Teleoconch ornamented with spiral lirae. Body whorl ornamented with two

keels. Anterior canal long, extended into spin-like process, straight or curved anteriorly. Posterior canal absent. Outer lip somewhat extended with two long, slender, digitate spin-like processes of which the lower somewhat broader and longer (after Gabb 1868; and Wenz 1940).

Discussion. — This genus was diagnosed by Gabb (1868) for apporhaids with two spin-like processes of the outer lip. The two species I examined below additionaly have the same type of protoconch and juvenile teleoconch (see below).

Range. — Bajocian (Mid Jurassic) to Portlandian (Late Jurassic; Cossmann 1904).

Dicroloma cochleata (Quenstedt, 1858)
(Fig. 54)

1858. *Rostellaria cochleata* sp. n.; Quenstedt 1858: 489, pl. 65: 27, 28.

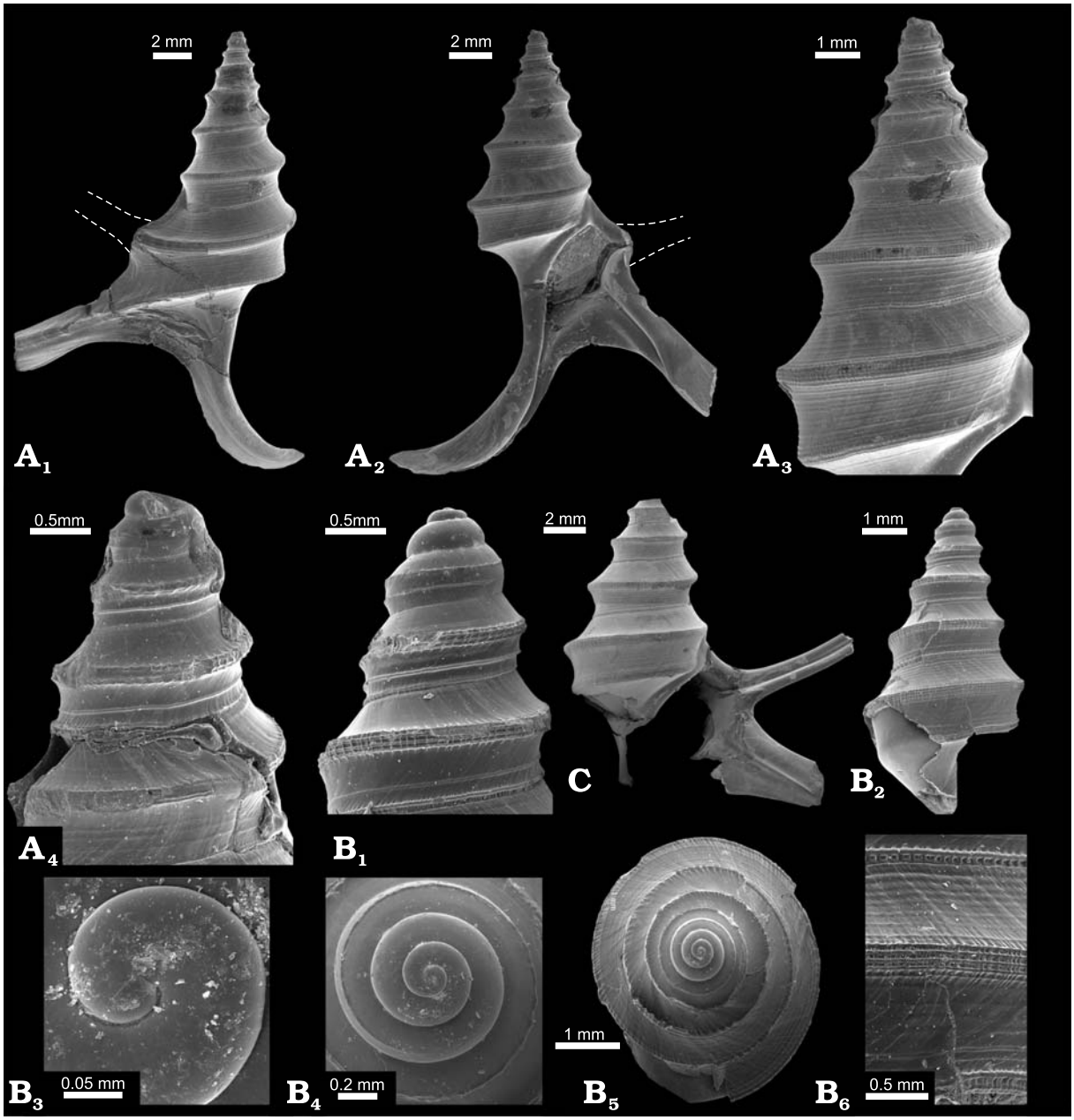


Fig. 54. The aporrhaid *Dicroloma cochleata* (Quenstedt, 1858) from Łuków (block in glacial drift), Podlasie, Poland, Late Callovian (Mid Jurassic). **A**. ZPAL Ga.9/29; A_1–A_3 lateral views, uppermost, broken spine marked by dashed line, A_4 close-up of the apex. **B**. ZPAL Ga.9/30; B_1 close-up of the apex, B_2 lateral view, B_3 close-up of protoconch 1, B_4 close-up of the apex in apical view, B_5 apical view, B_6 details of teleoconch ornamentation. **C**. ZPAL Ga.9/31; lateral view.

1883. *Alaria cochleata* (Quenstedt, 1858); Lahusen 1883: 40, pl. 3: 20–23.
1891. *Alaria cochleata* (Quenstedt, 1858); Piette 1891: 110, pl 22: 1–6.
1904. *Dicroloma cochleata* (Quenstedt, 1858); Cossmann 1904: 89, not illustrated.
1909. *Alaria cochleata* (Quenstedt, 1858); Brösamlen 1909: 304. pl. 22: 13.
1952. *Alaria cochleata* (Quenstedt, 1858); Makowski 1952: 22, pl 2: 6, 7.
1977. *Dicroloma*? aff. *cochleata* (Quenstedt, 1858); Gründel 1977: 188, pl. 2: 2, 7.
1993. *Dicroloma cochleata* (Quenstedt, 1858); Gründel 1993a: 359, pl. 1: 7, 8.
2001. *Dicroloma cochleata* (Quenstedt, 1858); Gründel 2001: 68 in part pl. 7: 6–8, 11–13 (non 9, 10 — *Dicroloma nudispira* sp. n.)

Type material: Quenstedt 1858: 489, pl. 65: 27, 28.
Type horizon: Bathonian, Mid Jurassic.
Type locality: Ehningen, Germany.

Material. — Over 100 shells from Callovian of Łuków.

Measurements. — Protoconch 1 consisting of one whorl is 0.18 mm in diameter. An adult shell consisting of eight whorls is 21.50 mm high (including a spine-like extension of the anterior channel) and 8.25 mm in diameter (without the spine-like extension of the outer lip).

Occurrences. — Late Jurassic of Europe.

Emended diagnosis. — Early teleoconch with two spiral ribs. On second whorl of teleoconch upper rib transforming into keel composed of three subordinate spiral ribs and fine axial riblets. Lower rib increasingly weaker during ontogeny. Teleoconch whorls angulated at spiral keel. Axial ornamentation consisting of strongly opisthocline growth lines at early whorls and weak spiral striae later in ontogeny. Body whorl demarcated from the base by second spiral keel. Two keels extended into spine-like processes of outer lip at the adult shell peristome. Anterior canal extended into spine-like process, curved anteriorly.

Description. — Protoconch 1 is not ornamented. The obtusely conical protoconch 2 begins with 2.5 smooth whorls. Demarcation from the teleoconch is not well developed.

Remarks. — There is some confusion with regard to this species. The type material of Quenstedt (1858) was found in Bathonian rocks. Later several authors reported the species to be from the Callovian and/or Oxfordian. These specimens have to be compared to type material to establish if they actually represent *D. cochleata*. It may turn out that the older *D. nudispira* is in fact *D. cochleata* and thus closer to Quenstedt's type material and that the Callovian–Oxfordian shells represent another species.

Many species names are available for closely similar shells (e.g., Piette 1891) and I have a feeling, without having examined the types, that many will turn out to be synonyms. The Callovian specimens of juvenile *Dicroloma* illustrated by Gründel (2001) have protoconch and juvenile whorl ornamentation identical to that of *D. cochleata*, whereas the Bathonian specimens he illustrated, when compared to *D. cochleata* (pl. 7: 9, 10 therein), probably represent *D. nudispira* described below.

Dicroloma nudispira sp. n.
(Fig. 55)

2001. *Dicroloma cochleata* (Quenstedt, 1858); Gründel 2001 in part: pl. 7: 9, 10, non 6–8, 11–13 — *Dicroloma cochleata* (Quenstedt, 1858).

Holotype: ZPAL Ga.9/41, Fig. 55B.
Type horizon: *Procerites progracilis* Zone, Mid Bathonian (Mid Jurassic).
Type locality: Faustianka, Częstochowa region, Poland.
Derivation of the name: After the absence of the spiral ornamentation on the teleoconch whorls.

Material. — Over 50 shells from Faustianka, Częstochowa region, Poland.

Measurements. — Protoconch 1 (holotype) consisting of one whorl is 0.19 mm. The protoconch (ZPAL Ga.9/40) with 2.5 of the whorl is 0.77 mm in diameter and 0.72 mm high. The largest shell studied consists of 7.5 whorls and is 3.78 mm in diameter and 6.00 mm high.

Occurrences. — The Częstochowa region and West Pomerania, both Poland.

Diagnosis. — Obtuse conical protoconch consisting of 2.5 smooth whorls. Teleoconch beginning with two blunt spiral keels and opisthocline axial ribs restricted to area somewhat above and beneath upper keel. On second whorl of teleoconch, upper keel composed of four subordinate spiral ribs, axial ribs restricted to surface of keel only. Lower keel much weaker, ornamented with weak axial ribs. During ontogeny, lower keel and axial ribs get weaker, and finally disappear. Surface of later whorls smooth.

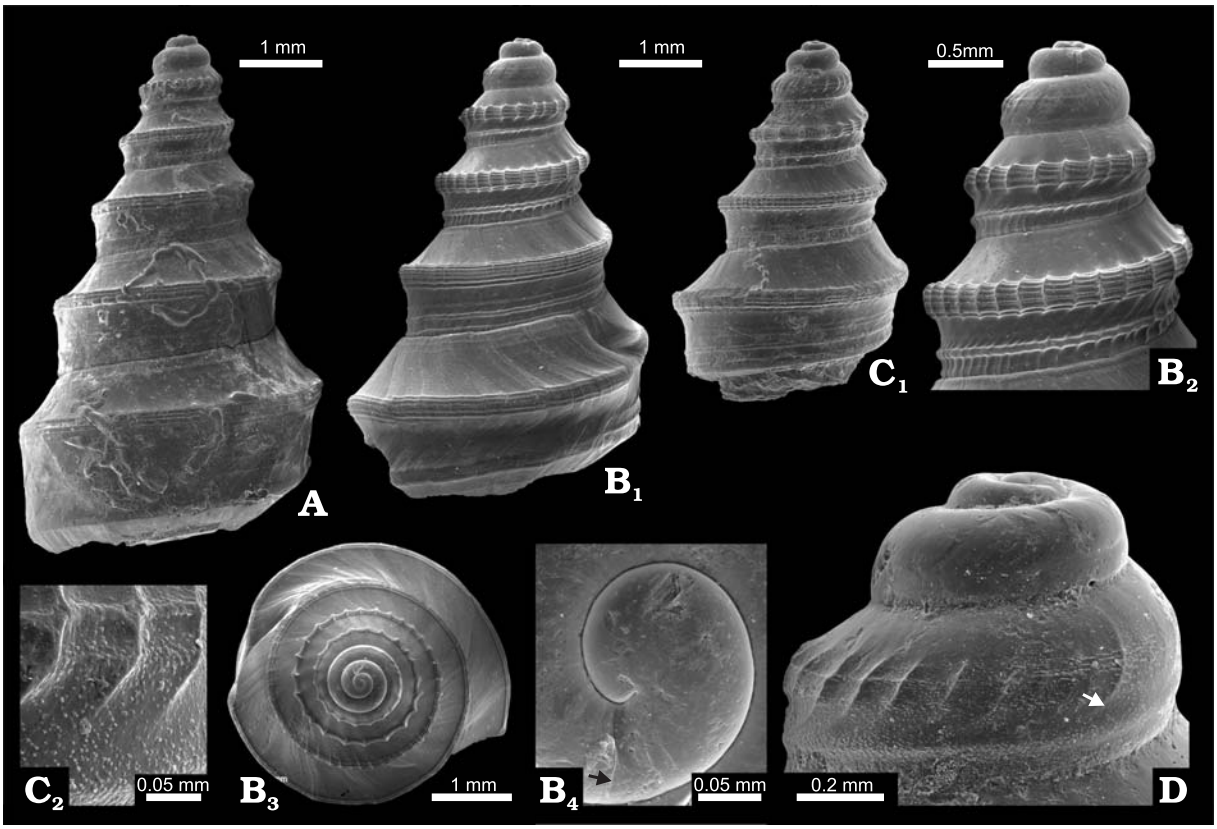


Fig. 55. The aporrhaid *Dicroloma nudispira* sp. n. from Faustianka, Częstochowa region, Poland, Mid Bathonian (Mid Jurassic). **A**. ZPAL Ga.9/39; lateral view. **B**. ZPAL Ga.9/41 (holotype); B_1 lateral view, B_2 close-up of the apex in lateral view, B_3 apical view, B_4 close-up of protoconch 1. **C**. Ga.9/38; C_1 lateral view, C_2 details of protoconch 2 ornamentation. **D**. ZPAL Ga.9/40; protoconch in lateral view. Black arrow indicates demarcation between protoconch 1 and protoconch 2; white arrow indicates demarcation between protoconch and teleoconch.

Description. — Protoconch 1 is not ornamented. The transition from the protoconch to the teleoconch has an intermediate zone that is ornamented with opisthocyrt growth lines and small pustules. The adult shell peristome is not known.

Remarks. — The species is similar to *D. cochleata* but it differs from it in having stronger axial ribs on the first two whorls of the teleoconch while the later whorls are smooth.

Genus *Pietteia* Cossmann, 1904
(*Bicorempterus* Gründel, 2001)

Type species: *Rostellaria hamus* Eudes-Deslongchamps, 1842: 173; original designation. Bajocian (Mid Jurassic), Bayeux, France.

Emended diagnosis. — Shell moderately large to medium sized. First whorl smooth, subsequently angulated, with fine spiral lirae and axial ribs. Final turn ornamented with only spiral lirae and strong keel. Base ornamented with another, weaker spiral keel. Peristome with narrow straight or weakly curved spine-like process of anterior channel. Outer lip with one, straight or weakly back-bent extension of keel, hook-like curved at the end. Inner lip thin, narrow (after Wenz 1940).

Discussion. — This genus was recognized by Cossmann (1904) for apporhaids with one spine-like process from the outer lip. Another shared character is the reticulate ornament on the first teleoconch whorl. Recently, Gründel (2001) intoduced the genus *Bicorempterus* for *Pietteia*-like gastropods without axial ribs on the late whorls of the protoconch. The reduction of the axial ornamention during ontogeny appears to be a weak argument for establishing a new genus. Therefore, the genus *Bicorempterus* Gründel, 2001 is regarded here as a synonyme of *Pietteia* Cossmann, 1904.

Range. — Late Jurassic of Europe (Cossmann 1904).

Pietteia subbicarinata (Münster, 1844)
(Fig. 56)

1844. *Rostellaria bicarinata* sp. n.; Münster 1844: 16, pl. 170: 1.
1891. *Alaria subbicarinata* (Münster, 1843); Piette 1891: 146, pl. 38: 1–6.
1904. *Dicroloma subbicarinata* (d'Orbigny, 1850); Cossmann 1904: 89, not illustrated.
1952. *Alaria subbicarinata* (Münster, 1843); Makowski 1952: 23, pl. 2: 9.

Type material: Münster 1844: 16, pl. 170: 1.
Type horizon: Late Jurassic.
Type locality. Pappenheim, Germany.

Material. — Over 20 shells from Callovian of Łuków.

Measurements. — Protoconch 1 consisting of one whorl is 0.13 mm in diameter. Protoconch 2 of 3.75 whorls is 1.04 mm high and 1.17 mm in diameter. The subadult shell of ten whorls is 14.0 mm high (excluding a spine-like extension of the anterior channel) and 9.0 mm in diameter.

Occurrences. — Late Jurassic of Europe.

Emended diagnosis. — Demarcation from teleoconch not clearly visible, opisthocyrtic with intermediate zone. Teleoconch beginning with medial row of tubercles that later transformed into keel-like rib. Whorls

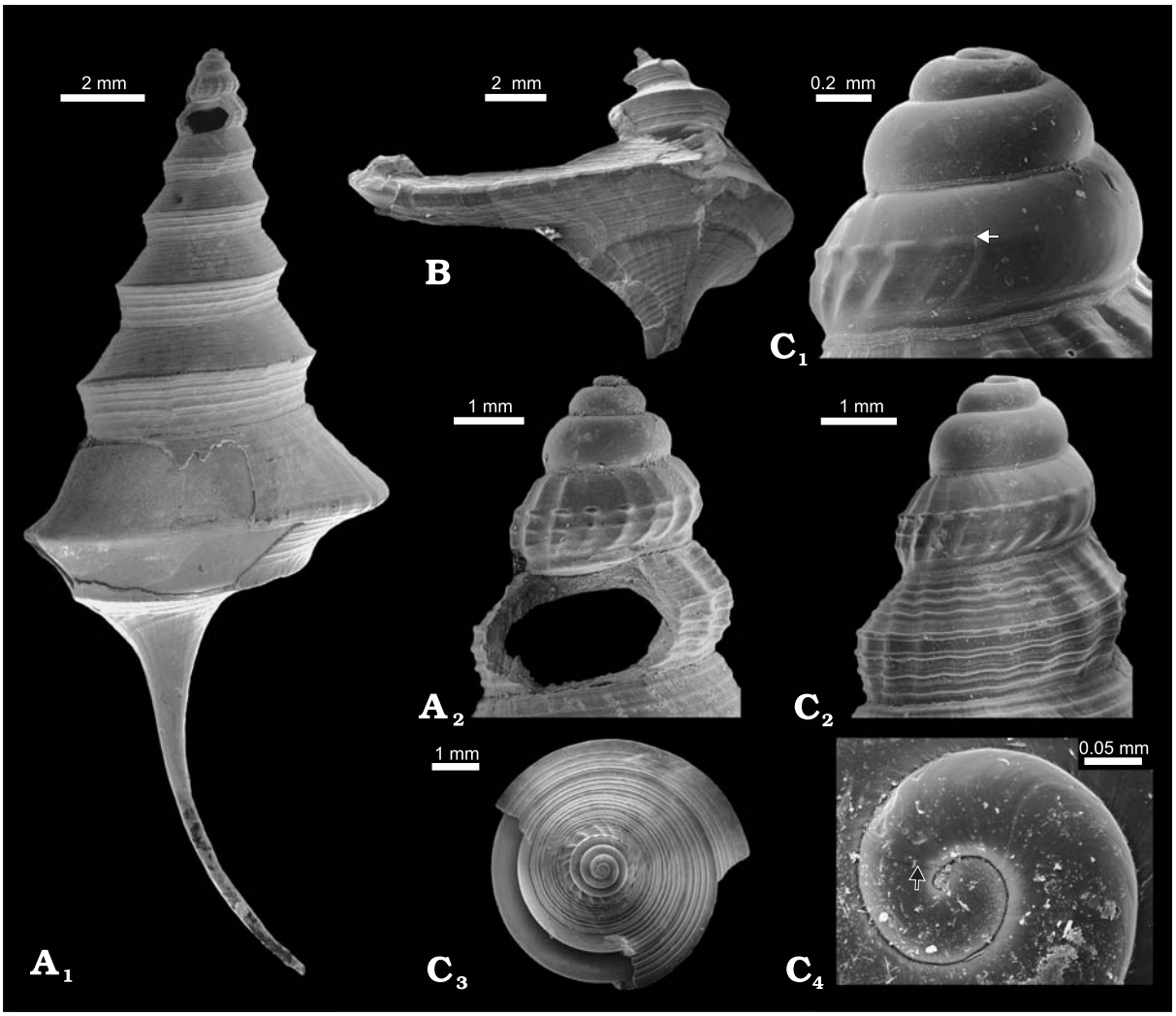


Fig. 56. The aporrhaid *Pietteia subbicarinata* (Münster, 1853) from Łuków (block in glacial drift), Podlasie, Poland, Late Callovian (Mid Jurassic). **A**. ZPAL Ga.9/33; A_1 lateral view, A_2 close-up of the apex in lateral view. **B**. ZPAL Ga.9/35; lateral view. **C**. ZPAL Ga.9/36; C_1 close-up of the protoconch in lateral view, C_2 close-up of the apex in lateral view, C_3 apical view, C_4 close-up of protoconch 1. Black arrow indicates demarcation between protoconch 1 and protoconch 2; white arrow indicates demarcation between protoconch and teleoconch.

angulated with keel-like rib. First whorl of teleoconch also ornamented with axial ribs and weak spiral ribs below medial rib. On second whorl of teleoconch, spiral ribs also appearing above medial rib. Axial ribs absent on later whorls. Base demarcated by second spiral keel. Anterior canal with long spine-like extension that strongly bent posteriorly.

Description. — Protoconch 1 is ornamented with a granular pattern. The protoconch is obtusely conical with smooth whorls. The terminal aperture is not present in the studied specimens.

Remarks. — *Pietteia subbicarinata* and *Pietteia pellati* are two very similar species and they differ mainly with regard to shell size and ornamentation of the first teleoconch whorl.

Pietteia pellati (Piette, 1867)
(Fig. 57)

1867. *Alaria pellati* sp. n.; Piette 1867: 144, pl. 37: 6–8.
1904. *Dicroloma pellati* (Piette, 1867); Cossmann 1904: 89.
1952. *Alaria pellati* Piette, 1867; Makowski 1952: 23.

Type material: Piette 1867: 144, pl. 37: 6–8.
Type horizon: Oxfordian, Upper Jurassic.
Type locality: Unspecified locality in France.

Material. — Over 20 shells from Callovian of Łuków.

Measurements. — The subadult shell of twelve whorls is 23.3 mm high (excluding the spine-like extension of the anterior channel) and 13.7 mm in diameter.

Occurrences. — Middle to Upper Jurassic of Europe.

Emended diagnosis. — First teleoconch whorl ornamented with axial and spiral ribs. Whorl angulated medially. Spiral ribs present both above and below angulation. Axial ribs absent later in ontogeny. Base demarcated by second spiral keel.

Description. — The protoconch is obtuse conical with smooth whorls. The demarcation from the teleoconch is not clearly visible. The terminal aperture is not present in the studied specimens.

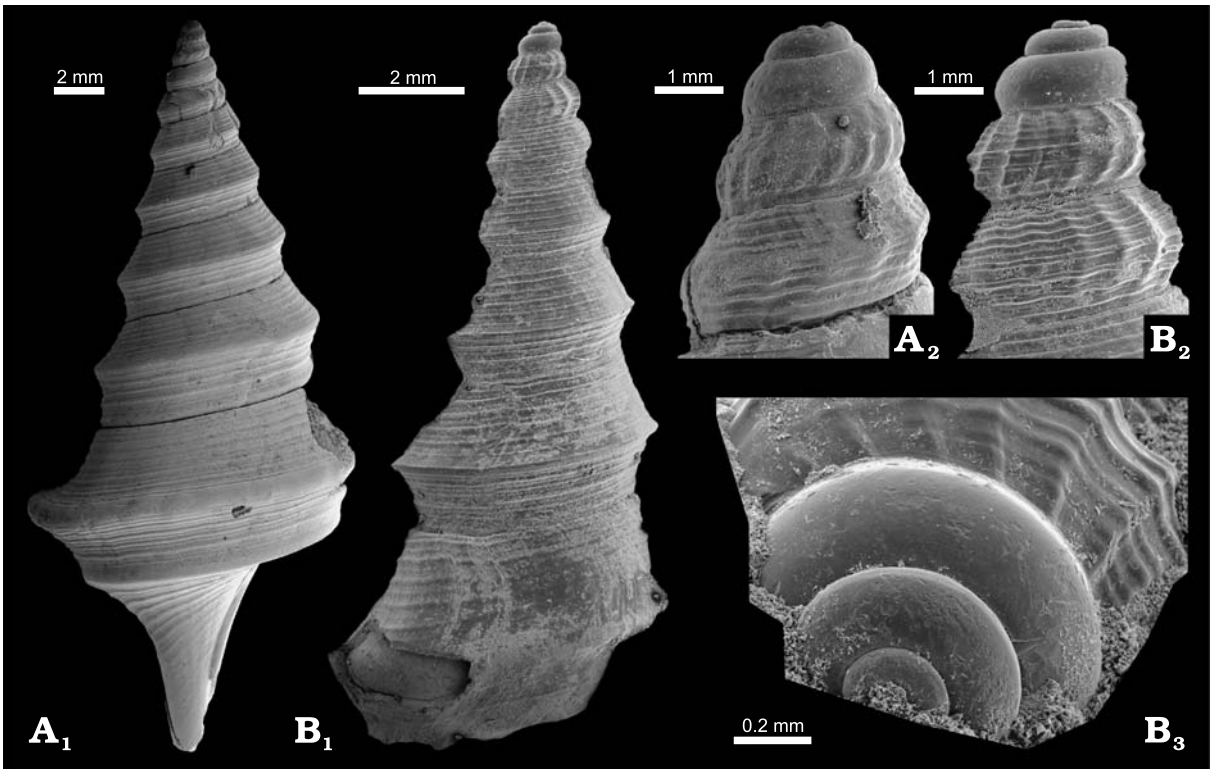


Fig. 57. The aporrhaid *Pietteia pellati* (Piette, 1891) from Łuków (block in glacial drift), Podlasie, Poland, Late Callovian (Mid Jurassic). **A**. ZPAL Ga.9/32; A_1 lateral view, A_2 close-up of the apex in lateral view. **B**. ZPAL Ga.9/34; B_1 lateral view, B_2 close-up of the apex in lateral view, B_3 close-up of the apex in apical view.

Remarks. — See under *P. subbicarinata*.

Genus *Quadrinervus* Cossmann, 1904

Type species: *Pterocera ornata* Buvignier, 1852; original designation. Sequanian (Late Jurassic), Manjouy, Meuse, France.

Emended diagnosis. — Shell moderately large to small, spindle-like. Whorls rounded initially, later angulated and ornamented with spiral lirae. Body whorl with three keels, two upper whorls more or less nodose. Lower keel broadly setting, almost straight. At end of body whorl anterior canal extending into spine-like process. Outer lip with four pointed, finger-like processes. Lateral processes being extensions of keels, uppermost one being extension of spiral rib that was covered by next whorl, bent parallel to spire, and often protruded backward (after Wenz 1940).

Discussion. — This genus was recognized by Cossmann (1904) for the Mid Jurassic to Early Cretaceous aporrhaids with four processes of the outer lip and a web-like structure in-between. In most cases the spire is partially covered by a callus of the lip.

Range. — Bajocian (Mid Jurassic) to Early Cretaceous (Cossmann 1904).

Quadrinervus elegans (Piette, 1867)
(Fig. 58)

1867. *Rostellaria? elegans* sp. n.; Piette 1867: pl. 32: 1–3.
1876. *Chenopus elegans* (Piette, 1867); Piette 1891: 277.
1904. *Quadrinervus elegans* (Piette, 1867); Cossmann 1904: 63.

Type material: Piette 1867: pl. 32: 1–3.
Type horizon: Oxfordian, Upper Jurassic.
Type locality: Unspecified locality in France.

Material. — One shell (ZPAL Ga.9/37) from Valanginian of Wąwał.

Measurements. — The shell consisting of about six whorls is 11.0 mm high (excluding the spine-like extension protruding backwards the spire) and 7.4 mm in diameter.

Occurrences. — Oxfordian (Upper Jurassic; Piette 1891) to Valanginian (Early Cretaceous; herein); Europe.

Emended diagnosis. — Teleoconch whorls ornamented with axial and spiral lirae. Two first whorls rounded, subsequent ones angulated medially. Spire partially covered by callus of outer lip process protruding backwards. Process prodruding backwards beyond protoconch.

Description. — The protoconch is obtusely conical with smooth whorls. Its transition into the teleoconch was not found in the examined specimen. The terminal aperture is not preserved.

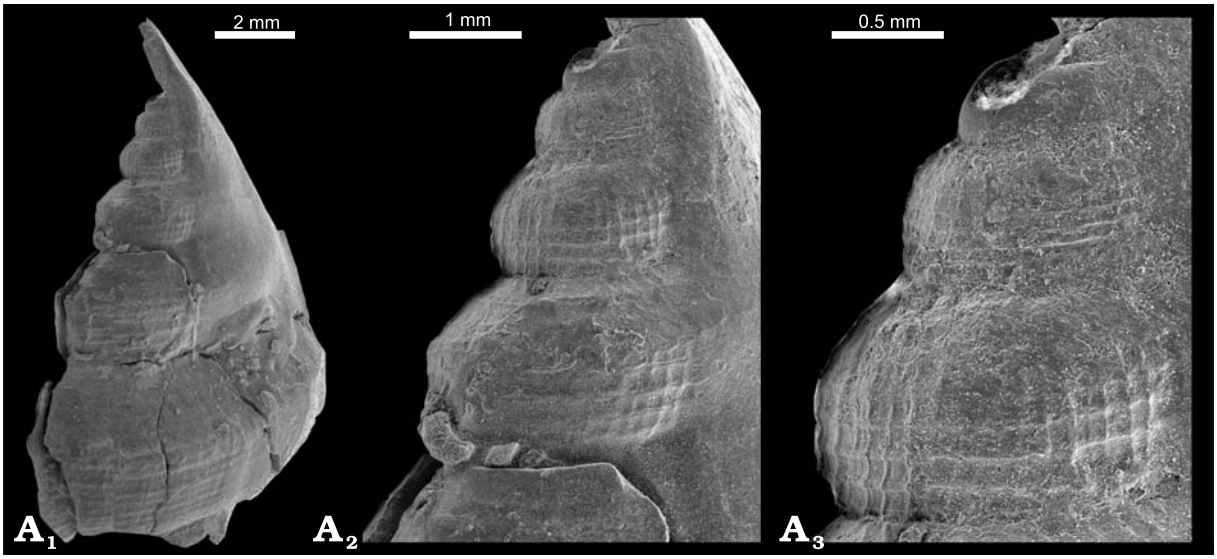


Fig. 58. The aporrhaid *Quadrinervus elegans* (Piette, 1867) from Wąwał, southern Mazowsze, Poland, Valanginan (Early Cretaceous). **A**. ZPAL Ga.9/37; A_1–A_3 lateral views.

Remarks. — The Valanginian shell closely resembles *Chenopus elegans* (see synonymy) described by Piette (1891). Although the terminal outer lip is not preserved in the shells reported by Piette (1891) and in the shell described herein, I follow Cossmann's (1904) judgement and include the species in the genus *Quadrinervus*.

Genus *Spinigera* d'Orbigny, 1850

Type species: *Ranella longispina* Eudes-Deslongchamps, 1842; monotypy. Bajocian, Mid Jurassic, Bayeux, Calvados, France.

Emended diagnosis. — Medium-sized shell, rather slim. Whorls curved, usually angulated, with spiral lirae and varices symetrically situated on both sides. Every varix is armored with straight, long, and perpendicularly oriented prickle. Base of body whorl somewhat concave. Peristome small, with very long, straight rostrum, with gutter closed by rolled up edge. Outer lip not widened, armored with long, narrow, perpendicular prickle, which extending inside gutter reaching up to end. Columella straight, smooth. Inner lip not clearly delimited (after Wenz 1938).

Discussion. — This quite distinctive genus, with laterally situated long prickles, has never been revised after Brösamlen's (1909: pl. 22: 27 and 28a) study. The early whorls of the shell of *Spinigera* were illustrated by Brösamlen (1909) with both specimens of the *Spinigera semicarinata* (Münster, 1844) differing significantly from each other. The shell in fig. 28a resembles the shells described herein, whereas the shell in fig. 27 differs in having strong axial ribs on the first whorl of the teleoconch and lacking a medial row of nodes.

Range. — Toarcian–Oxfordian (Early to Late Jurassic; Wenz 1940).

Spinigera sp.
(Fig. 59)

Material. — One shell (MZ VIII Mg 4221/1) from Blanowice and one shell (ZPAL Ga.9/183) from Faustianka, both Bathonian (Mid Jurassic).

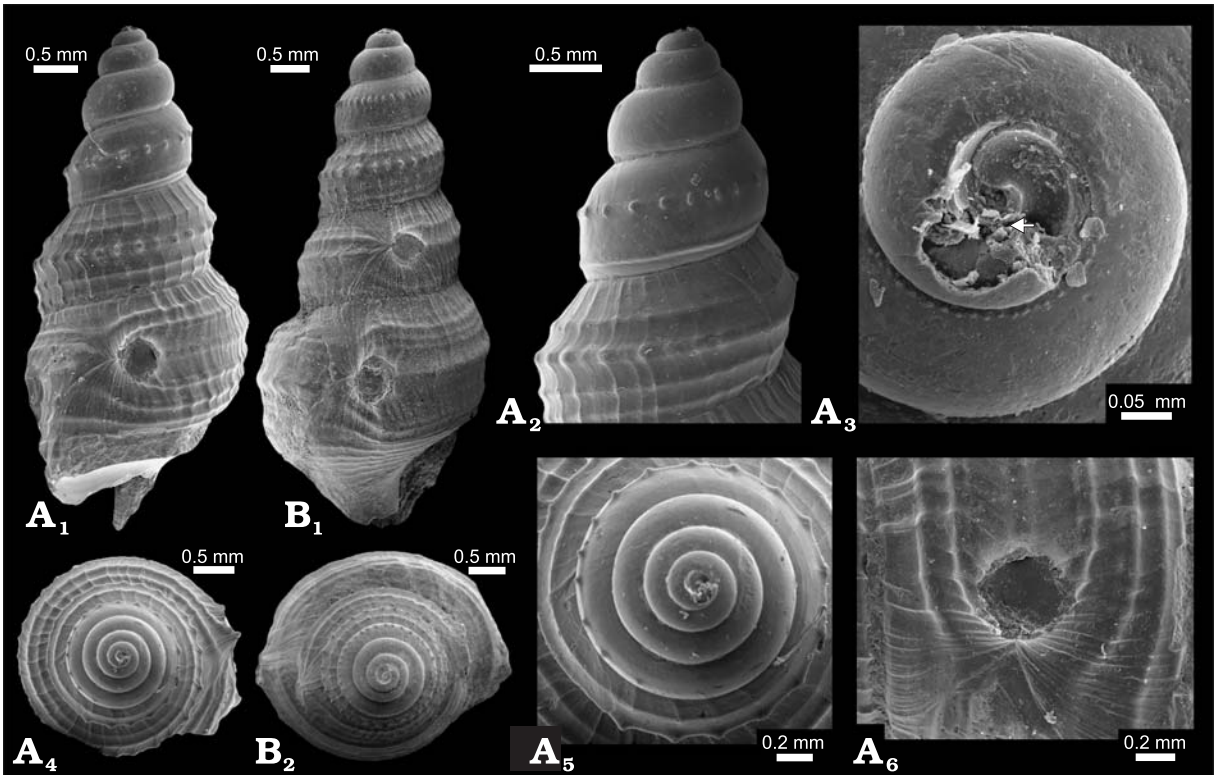


Fig. 59. The Mid Jurassic aporrhaid *Spinigera* sp. from Częstochowa region, Poland. **A**. ZPAL Ga.9/133 from Faustianka, Mid Bathonian; A_1 lateral view, A_2 protoconch in lateral view, A_3 early whorls of protoconch with typically broken off protoconch 1, A_4 apical view, A_5 protoconch in apical view, A_6 scar after broken prickle. **B**. MZ VIII Mg 4221/1 from Blanowice Bathonian; B_1 lateral view, B_2 apical view.

Measurements. — The shell of 7.5 whorls (MZ VIII Mg 4221/1) is 6.64 mm high and 3.27 mm in diameter.

Description. — The protoconch is conical with dome-shaped apex. Protoconch 1 is not preserved. Protoconch 2 has an ornamented row of small pustules close to the adapical suture. The demarcation from teleoconch is not visible. In the medial part of the fourth whorl of the shell, a row of nodes appears. One half whorl later, weak axial ribs appear. The ribs are get stronger on the next whorl. On the fifth whorl two spiral ribs appear. Starting from the sixth whorl, scars of prickles are present on the opposite sides of the shell. The aperture is not preserved on the examined shells.

Remarks. — These juvenile shells may represent *Spinigera longispina* (Eudes-Deslongchamps, 1842) or *Spinigera semicarinata* (Münster, 1844). It is also possible that these are synonyms.

Aporrhaidae gen. et sp. indet
(Fig. 60)

Material. — 55 shells from Wąwał, Valanginian (Early Cretaceous).

Measurements. — The protoconch consisting of 4.5 whorls is 1.91 mm high and 1.62 mm in diameter. A shell with 1.25 teleoconch whorls is 4.78 mm high and 2.36 mm in diameter.

Description. — Protoconch 1 is not clearly demarcated from protoconch 2. The whole protoconch is obtusely conical with dome-shaped apex, and it is smooth. The demarcation from the teleoconch is not clearly visible and there appears to be an intermediate zone. The ornament of the teleoconch starts with strong, opisthocline axial ribs (21 per whorl) and weak axial ribs (7–9 per whorl). The base is demarcated by an angulation and it is ornamented by weak spiral ribs.

Remarks. — The size of the protoconch and the ornament of the early teleoconch whorls consisting of strong axial ribs, and weak spiral ribs are similar to that of Late Cretaceous Aporrhaidae such as *Anchura* and *Drepanocheilus* (see e.g., Dockery 1993 and Fig. 140G herein).

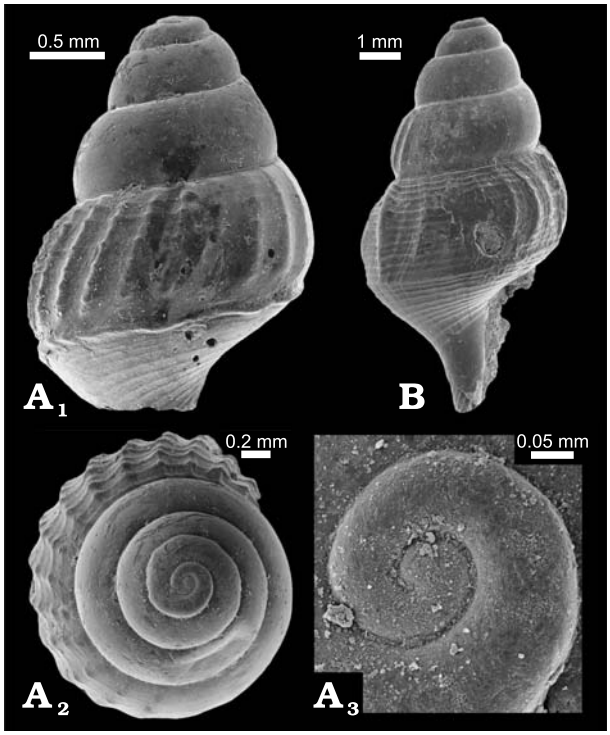


Fig. 60. Aporrhaidae gen. et sp. indet. from Wąwał, southern Mazowsze, Poland, Valanginan (Early Cretaceous). **A**. ZPAL Ga.9/185; A_1 lateral view, A_2 apical view, A_3 early whorls of protoconch. **B**. ZPAL Ga.9/184 from Wąwał (Valanginian, Early Cretaceous); lateral view.

Superfamily **Rissooidea** Gray, 1847
Family **Rissoidae** Gray, 1847

Remarks. — The Jurassic and Early Cretaceous rissoids differ from the Recent ones in more flattened initial whorls. Basing their classification mainly on this feature, Gründel and Kowalke (2002) introduced a new family, Palaeorissoinidae of Mesozoic rissoids. In my material characteristic features of at least four Recent rissoid subfamilies are recognizable. *Pusillina* sp. has a shell shape and pattern of ornamentation similar to some Recent species of the subfamily Rissoinae [e.g., *Pusillina benzi* Aradas *et* Maggiore, 1843 or *Rissoa parva* (Da Costa, 1778)]. The ornamentation of the teleoconch of *Zebina dziki* sp. n. is similar to that found among some Recent species of *Zebina* (e.g., *Zebina villenai* Rolán *et* Luque, 2000) and *Schwartziella* (e.g., *Schwartziella paradoxa* Rolán *et* Luque, 2000) of the subfamily Rissoininae. The shells of *Bralitzia* and *Buvignieria* do not exceed the variability represented among the Recent species of *Rissoina* (compare Ponder 1985). The pattern of the ornamention of protoconch 2 of *Buvignieria piserai* sp. n., *Buvignieria bandeli* sp. n., and *Buvignieria schroderi* sp. n. closely resembles the protoconch pattern that may be observed among Recent Alvaniinae Nordsieck, 1972 [e.g., *Alvania testae* (Aradas *et* Maggiore, 1844) figured by Bouchet and

Warén (1993), fig. 1387]. Some of the Carribean alvanids [e.g., *A. auberiana* (d'Orbigny, 1842)] resemble the *Buvignieria* shells in shape. All these observations lead to the conclusion that the family Palaeorissoinidae Gründel *et* Kowalke, 2002 represents a stem group for the Recent rissoinids. Therefore, I prefer to classify them under the family Rissoidae Gray, 1847 without subfamily level subdivision.

Genus *Bralitzia* Gründel, 1998
(*Palaeorissoina* Gründel, 1999; *Palaeoceratia* Gründel, 1999)

Type species: *Bralitzia foersteri* Gründel, 1998; original designation. Callovian (Mid Jurassic), erratic boulder from Neppermin, Usedom Island, Germany.

Emended diagnosis. — Protoconch cylindrical with dome-like apex. First whorl almost planispiral with no ornamentation. Teleoconch like that of *Rissoina* but without shell angulation (modified after Gründel 1999e).

Discussion. — The genus *Bralitzia* has been introduced by Gründel (1998a) for *Bralitzia foersteri* Gründel (1998a). Later Gründel (1999e) diagnosed two other rissoid genera (*Palaeorissoina* and *Palaeoceratia*), very similar to each other and are treated as synonyms here. The fossil shells of *Bralitzia* are very similar to the shells of Recent *Rissoina* illustrated by Ponder (1985). The main difference is in the flat top of *Bralitzia*'s protoconch. Moreover *Bralitzia* is very similar to *Buvignieria* (see below). The angulation of the teleoconch whorls in the latter is in fact the only difference between these two genera.

Range. — Toarcian (Early Jurassic; Gründel 1999e) to Valanginian (Early Cretaceous; Gründel 1999e and herein).

Bralitzia acuminata (Gründel, 1999)
(Fig. 61)

1990. *Rissoina acuta* (Sowerby, 1818); Gründel 1990b: 1145, pl. 2: 8 [non Sowerby 1818: 230, pl. 609: 2 — *Bralitzia acuta* (Sowerby, 1818)].

1999. *Palaeorissoina acuminata* sp. n.; Gründel 1999e: 97, pl. 4: 12–16.

Holotype: Gründel 1999e: 97, pl. 4: 12–14.

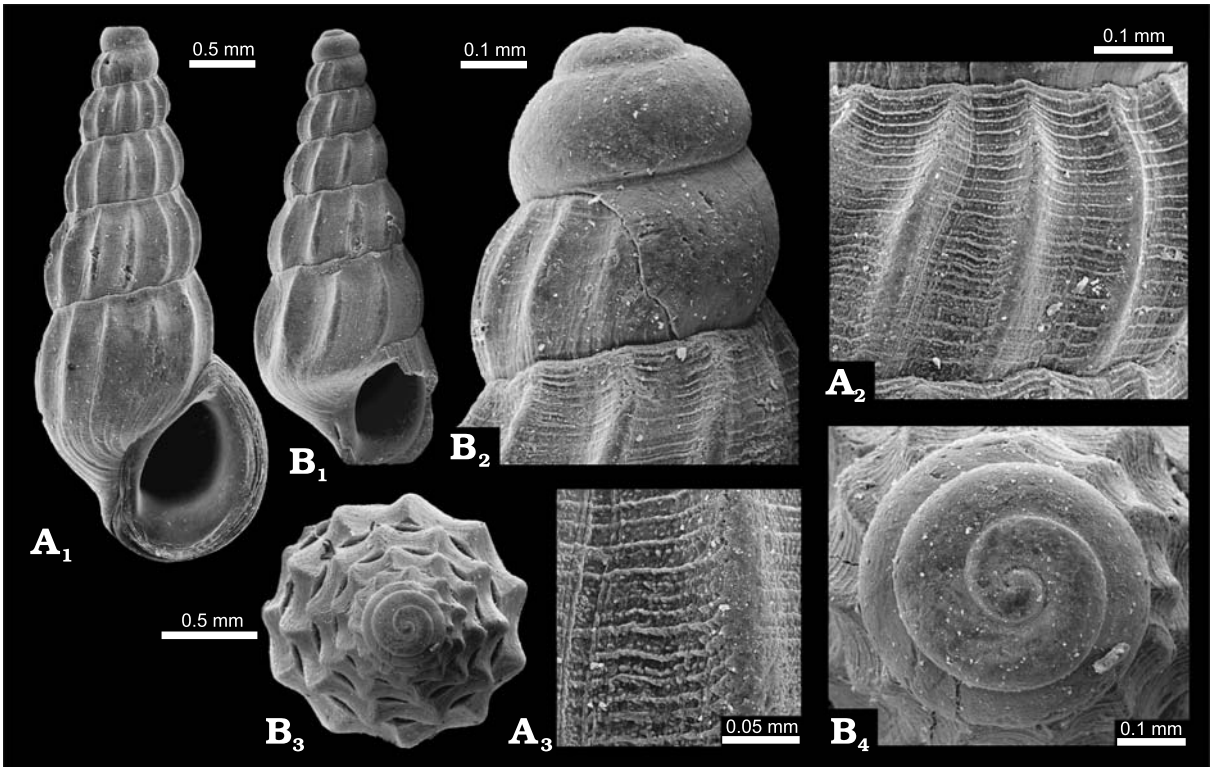


Fig. 61. The rissoid *Bralitzia acuminata* (Gründel, 1999) from Łuków (block in glacial drift), Podlasie, Poland, Callovian (Mid Jurassic). **A**. MZ VIII Mg 4237/ ; A_1 lateral views, A_2, A_3 details of teleoconch ornamentation. **B**. MZ VIII Mg 4237/2; B_1 lateral view, B_2 protoconch in lateral view, B_3 apical view, B_4 protoconch in apical view.

Type horizon: Callovian (Mid Jurassic).

Type locality: Bauer-Wehrland, Germany.

Material. — Two shells from Callovian of Łuków (block in glacial drift).

Measurements. — The adult shell MZ VIII Mg 4237/1 with five whorls of teleoconch is 4.19 mm high and 1.81 mm in diameter. The protoconch of the shell MZ VIII Mg 4237/2 with three whorls is 0.49 mm high and 0.44 mm in diameter.

Occurrences. — Callovian (Mid Jurassic) of Germany and Poland.

Emended diagnosis. — Protoconch 2 cylindrical with dome-shaped apex, smooth. Shell slender with apical part pointed. Teleoconch ornamented with strong opisthocline axial ribs and densely packed spiral lirae.

Description. — Protoconch 1 not well preserved on the accessible specimens. Demarcation between protoconch and teleoconch clearly visible, without intermediate ornamentation. The adult shell peristome has a thickened inner and outer lip.

Remarks. — The specimens figured by Gründel (1990b, 1999e) are not ornamented by spiral lirae. They are probably not preserved as was noticed by Gründel (1999e). This species may represent an intermediate species between *Bralitzia obliquata* (Sowerby, 1829) and *Bralitzia faustiankensis* sp. n. The differences are expressed in the shape of the shell (the former species is broader than *B. acuminata*, the latter is more slender) and in the strength and number of axial ribs (*B. obliquata* has stronger ribs than *B. acuminata* and *B. faustiankensis* has weaker and more axial ribs than *B. acuminata*).

Bralitzia faustiankensis sp. n.
(Fig. 62)

Holotype: ZPAL Ga.9/17, Fig. 62A.

Type horizon: *Procerites progracilis* Zone, Mid Bathonian (Mid Jurassic).

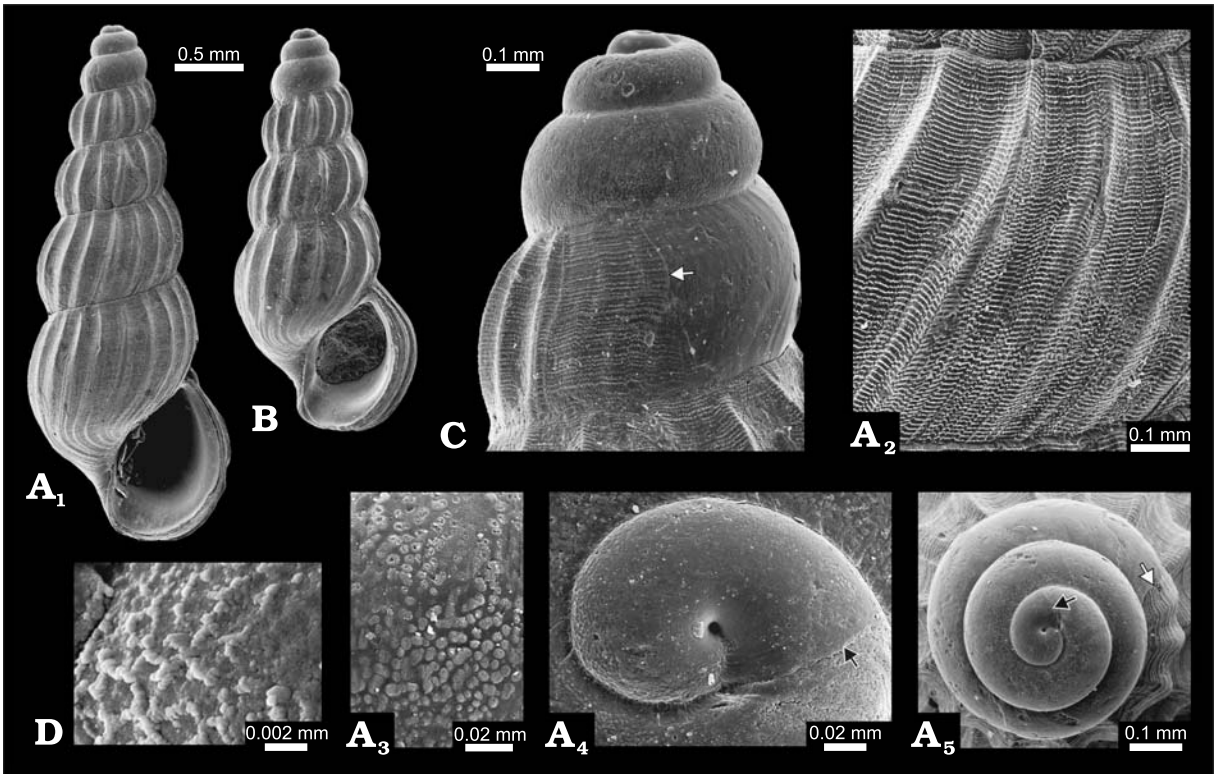


Fig. 62. The rissoinid *Bralitzia faustiankensis* sp. n. from Częstochowa region, Poland, Bathonian (Mid Jurassic). **A**. ZPAL Ga.9/17 (holotype) from Faustianka; A_1 lateral view, A_2 details of teleoconch ornamentation, A_3 details of protoconch 2 ornamentation, A_4 close-up of protoconch 1, A_5 protoconch in apical view. **B**. ZPAL Ga.9/19 from Faustianka; lateral view. **C**. ZPAL Ga.9/18 from Faustianka; protoconch in lateral view. **D**. ZPAL Ga.9/20 from Kłobuck borehole; details of protoconch 1 ornamentation. Black arrows indicate demarcation between protoconch 1 and protoconch 2; white arrows indicate demarcation between protoconch and teleoconch.

Type locality: Faustianka, Częstochowa region, Poland.
Derivation of the name. After type locality.

Material. — Over 100 shells from different localities in Poland.

Measurements. — Protoconch 1 of the holotype consisting of one whorl is 0.15 mm wide. Whole protoconch has 3–3.5 whorls and measures 0.48–0.63 mm in diameter and 0.59–0.70 mm in height. The holotype consisting of eight whorls is 1.56 mm in diameter and 3.90 mm height.

Occurrences. — Bathonian of Poland. Localities: Faustianka, Ogrodzieniec, and Kłobuck borehole.

Diagnosis. — Protoconch cylindrical with dome-shaped apex sculptured with small pustules at abapical parts of whorls. Shell very slender with up to six whorls. Teleoconch ornamented with opisthocline axial ribs (usually 2–3 more per whorl than in *B. acuminata*) and densely spaced spiral lirae.

Description. — Protoconch 1 is ornamented with remnants of a granular pattern. The demarcation between protoconch and teleoconch is clearly visible. Outer lip of the protoconch is usually fractured. The lirae of teleoconch are composed of small pustules. The peristome is tear-drop shaped and is terminally thickened.

Remarks. — The species resembles *B. acuminata* but differs in having a more slender shell shape and more numerous and weaker axial ribs.

Bralitzia wonwalensis (Gründel, 1999)
(Fig. 63)

1993. aporrhaid species; Bandel 1993a: 28, pl. 11: 2.
1995. APOR-3; Schröder 1995: 33, pl. 5: 18–21, pl. 14: 17.
1999. *Palaeorissoina wonwalensis* sp. n.; Gründel 1999e: 100, not illustrated.
2001. *Palaeorissoina wonwalensis* Gründel, 1999; Kaim 2001: tab. 2, fig. 5.

Holotype: Schröder 1995: pl. 5: 18.
Type horizon: Valanginian (Early Cretaceous).
Type locality: Wąwał, southern Mazowsze, Poland.

Material. — Over 1000 shells from the type locality.

Measurements. — Protoconch 1 of the shell ZPAL Ga.9/16 has one whorl and is 0.13 mm in diameter. The protoconch, consisting of three whorls is 0.61 mm high and 0.49 mm in diameter. The shell ZPAL Ga.9/16 with four whorls of the teleoconch is 3.15 mm high and 1.50 mm in diameter.

Occurrences. — The type locality only.

Diagnosis. — Last whorl of protoconch with some parasigmoidal axial ribs. Teleoconch whorls convex, sutures distinct. Axial ribs thick, rounded on top. Spiral striae rather strong, 15–20 from suture to suture (after Gründel 1999e).

Description. — The shell is slender. Protoconch 1 is ornamented with a dense granular pattern. Protoconch 2 is smooth, cylindrical, with a dome-shaped apex. The first whorl is almost planispiral. The demarcation between the protoconch and the teleoconch with a wide (0.25 of the whorl) zone of intermediate ornamentation composed of spiral and sigmoidally opisthocline axial lirae. The adult shell peristome is not known.

Remarks. — Some of the characters of the shell, like flat-topped protoconch or fuzzy demarcation between the protoconch and the teleoconch are often found among aporrhaids (compare e.g., Bouchet and Warén 1993: 707 and Fig. 140 herein). This led Bandel (1993a) and Schröder (1995) to the conclusion that this species might belong to the Aporrhaidae. However, this similarity seems to be only superficial. The shape of adult shell peristome is decisive in this case. In spite of the extensive search and more that 1000 shells that have been collected, the adult shell peristome is still unknown for this species. In 1999e Gründel found the same aporrhaid-like characters in *Bralitzia compacta* (Gründel, 1999) which has an adult shell peristome typical of rissoinids. Here I followed Gründel's (1999e) interpretation in classifying *B. wonwalensis* as a rissoinid.

Bralitzia obtusa (Lycett, 1850)
(Fig. 64)

1850. *Rissoina obtusa* sp. n.; Lycett 1850: 419, not illustrated.
1853. *Rissoina obtusa* sp. n.; Lycett 1853: 80, not illustrated.
1892. *Rissoina obtusa* Lycett, 1850; Hudleston 1892: 273, pl. 21: 10.

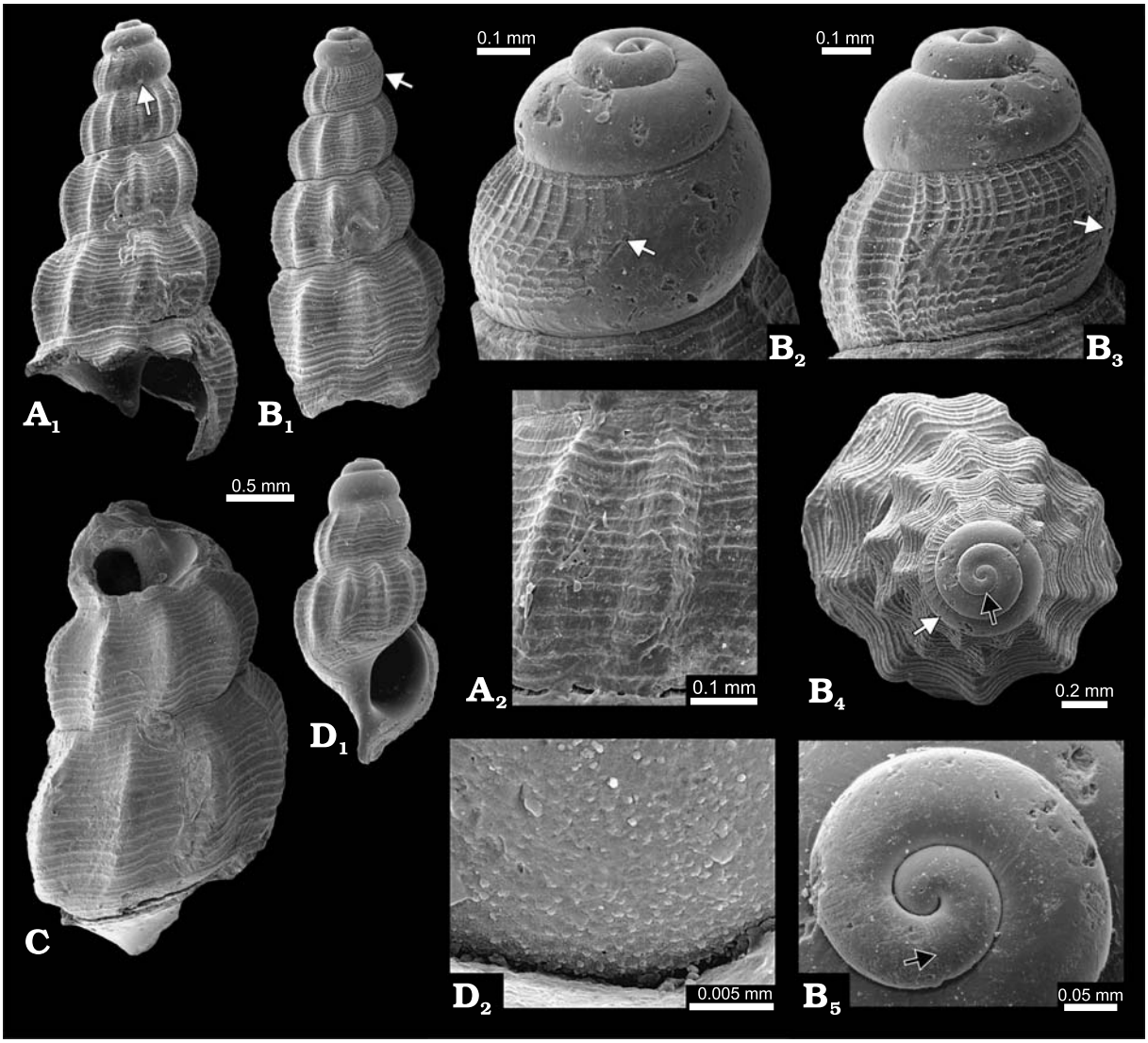


Fig. 63. The rissoid *Bralitzia wonwalensis* (Gründel, 1999) from Wąwał, southern Mazowsze, Poland, Valanginian (Early Cretaceous). **A**. ZPAL Ga.9/16 from sample F3; A_1 lateral view, A_2 details of teleoconch ornamentation. **B**. ZPAL Ga.9/8 from sample G3; B_1 lateral view, B_2, B_3 protoconch in lateral view, B_4 apical view, B_5 close-up of protoconch 1. **C**. ZPAL Ga.9/9 from sample G3; largest fragment of teleoconch found. **D**. ZPAL Ga.9/10; D_1 lateral view, D_2 details of protoconch 1 ornamentation. Black arrows indicate demarcation between protoconch 1and protoconch 2; white arrows indicate demarcation between protoconch and teleoconch.

1921. *Buvignieria obtusa* (Lycett, 1850); Cossmann 1921: 66, not illustrated.
1998. *Bralitzia foersteri* gen. et sp. n.; Gründel 1998a: 8, pl. 3: 5–10.
1999. *Bralitzia foersteri* Gründel, 1998; Gründel 1999e: 104, pl. 4: 1–3.

Holotype: Hudleston 1892: 273, pl. 21: 10.
Type horizon: Bajocian (Mid Jurassic).
Type locality: Pea-grit, Crickley, England.

Material. — Three juvenile shells from Callovian of Łuków (block in glacial drift).

Measurements. — The shell MZ VIII Mg 4242/1 with five whorls is 1.54 mm high and 0.79 mm in diameter. The protoconch consisting of three whorls is 0.56 mm high and 0.44 mm in diameter. Protoconch 1 consisting of one whorl is 0.13 mm in diameter.

Occurrences. — Mid Jurassic of Europe.

Emended diagnosis. — Shell slender with slightly convex whorls. Protoconch 2 cylindrical with dome-shaped apex; sculptured with short collabral threads only by the adapical suture. Demarcation between

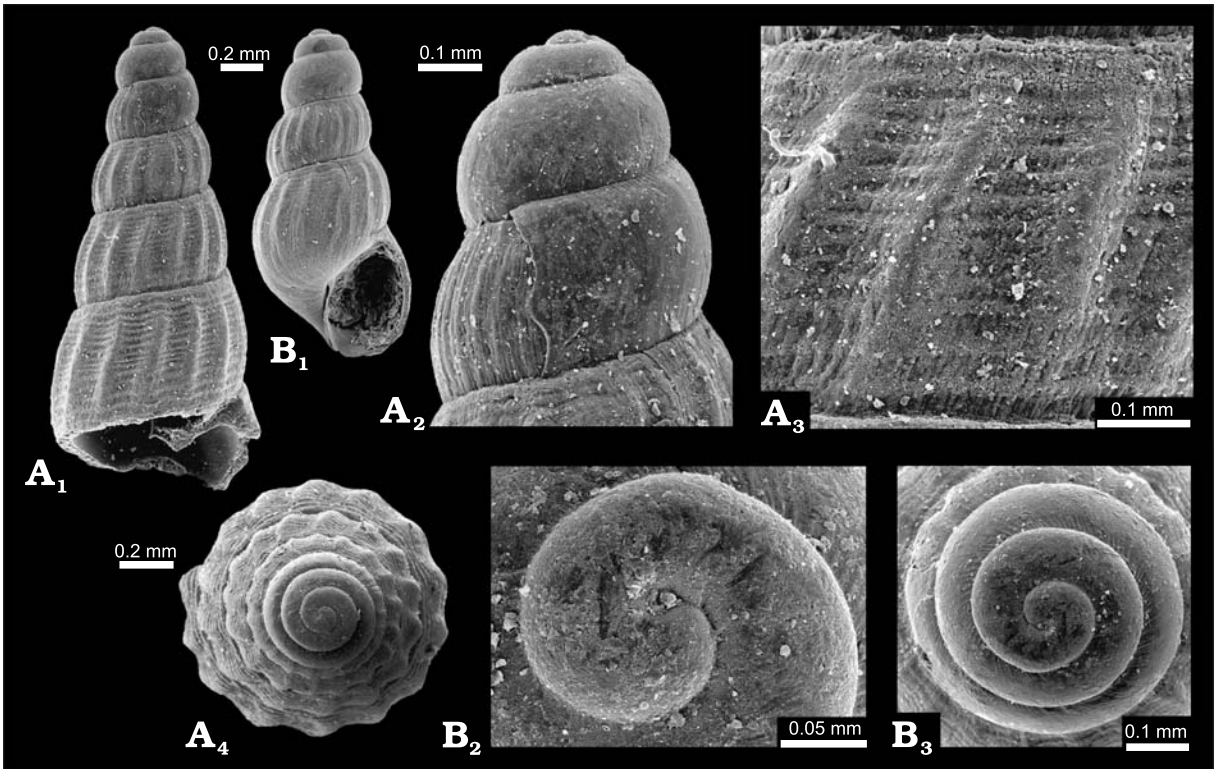


Fig. 64. The rissoid *Bralitzia obtusa* (Lycett, 1850) from Łuków (block in glacial drift), Podlasie, Poland, Callovian (Mid Jurassic). **A**. MZ VIII Mg 4242/3; A_1 lateral view, A_2 protoconch in lateral view, A_3 details of teleoconch ornamentation, A_4 apical view. **B**. MZ VIII Mg 4242/1; B_1 lateral view, B_2 close-up of protoconch 1, B_3 protoconch in apical view.

protoconch and teleoconch well-developed. Teleoconch ornamented with numerous opisthocline ribs and weak spiral lirae.

Description. — Protoconch 1 is preserved without any ornamention. The adult shell peristome is not present in the examined specimens.

Remarks. — Lycett (1850, 1853) did not illustrate the holotype and I follow Hudleston's (1892) description and illustrations. He stated that Lycett's (1850, 1853) diagnoses describe the specimens he illustrated fairly, apart from the statement that the spire is obtuse. He pointed out that this statement could refer to the obtuse apex, not to the whole spire. Gründel (1998a) described a new genus and the species *Bralitzia foersteri* Gründel, 1998 which he placed into the family Iravadiidae Thiele, 1928. According to Ponder (1984) Iravadiidae have planorbid to depressed-dome-shaped protoconchs whereas Rissoidae have dome-shaped to subconical protoconchs. The latter family seems to better fit the protoconch of the species under consideration. Moreover, the teleoconchs of the species of the Iravadiidae have a predominant spiral sculpture, not an axial one as in *B. obtusa* (see Ponder 1984). All these features suggest the inclusion of this species in the genus *Bralitzia*, along with the species of a synonymous genus, *Palaeorissoina*, although some other genera of Rissoidae also have to be considered (e.g., *Zebina* Adams *et* Adams, 1954).

Bralitzia striatissima (Gründel, 1998)
(Fig. 65)

1998. *Ceratia*? *striatissima* sp. n.; Gründel 1998a: 7, pl. 3: 1–4.
1999. *Palaeoceratia striatissima* (Gründel, 1998); Gründel 1999e: 107.

Holotype: Gründel 1998a: 7, pl. 3: 1.
Type horizon: Bathonian (Mid Jurassic).
Type locality: Ückeritz borehole 1 A/64, northern Germany.

Material. — One incomplete shell (MZ VIII Mg 4243/1) from Łuków (block in glacial drift), Podlasie, Poland, Callovian (Mid Jurassic).

Measurements. — Not measured, shell incomplete.

Occurrences. — Mid to Late Jurassic of Europe.

Diagnosis. — Smooth protoconch of about three whorls. First 1.5 whorls nearly planispiral. Teleoconch whorls with weak concavity under adapical suture, enhanced growth lines and numerous spiral lirae, present also on base. Umbilical chink present. Inner lip with concave columellar area (after Gründel 1998a).

Description. — The protoconch is not preserved. The shell is slender with weakly convex whorls. The axial ornamentation, apart from the enhanced opisthocyrt growth lines, is not present. The surface of the teleoconch is densely covered by spiral lirae. The adult shell peristome is not preserved.

Remarks. — This species is similar to *B. obtusa* (Lycett, 1850; see above). It differs only in lacking the distinct axial ribs and the continuous transition from the protoconch to the teleoconch (as observed on specimens illustrated by Gründel 1998a). These differences are not sufficient to allow designating a separate genus *Palaeoceratia* Gründel, 1999 and including it in the family Iravadiidae (see also discussion under species *B. obtusa*).

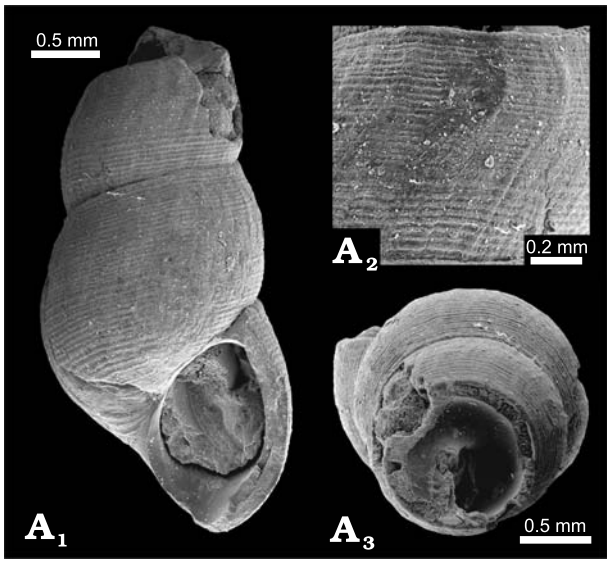


Fig. 65. The rissoid *Bralitzia striatissima* (Gründel, 1998) from Łuków (block in glacial drift), Podlasie, Poland, Callovian (Mid Jurassic). **A**. MZ VIII Mg 4243/1; A_1 lateral view, A_2 details of teleoconch ornamentation, A_3 apical view.

Genus *Buvignieria* Cossmann, 1921

Type species: *Rissoa unicarina* Buvignier, 1843; original designation. Rauracian (Oxfordian, Late Jurassic), Saint Mihiel, France.

Emended diagnosis. — Small shell with spiral and axial sculpture, and spiral cords (usually 1–2) causing angulation of whorls. Peristome more weakly channeled anteriorly than in *Rissoina.* Protoconch multispiral dome-shaped (modified after Ponder 1995).

Discussion. — Ponder (1995) argued that *Buvignieria* cointains species very close to *Rissoina*. He placed *Buvignieria* in *Rissoina* as a subgenus and restricted it exclusively to angulated forms. Moreover, *Buvignieria* is very similar to *Bralitzia*, and the only significant difference is the distinct spiral ornamention of *Buvignieria* (see discussion under genus *Bralitzia*).

Range. — Late Jurassic of Europe.

Buvignieria calloviana Gründel, 1998
(Figs 66, 67)

1998. *Buvignieria calloviana* sp. n.; Gründel 1998a: 6, pl. 2: 4, non pl. 2: 5–8 (a new species).

Holotype: Gründel 1998a: 6, pl. 2: 4.

Type horizon: Mid Callovian (Mid Jurassic).

Type locality: Ückeritz borehole 1/64, Germany.

Material. — Ten shells from Callovian of Łuków (block in glacial drift), Podlasie, Poland.

Measurements. — The protoconch consisting of 3.25 whorls is 0.54 mm in diameter and 0.58 mm high. The shell (MZ VIII Mg 4238/1) of 6.5 of the whorl is 3.37 mm high and 1.68 mm in diameter.

Occurrences. Callovian (Mid Jurassic) of Germany and Poland.

Diagnosis. — Shell relatively broad. Teleoconch ornamented with strong axial ribs (approx. 12–13 per whorl) and one medial keel. At intersections of axial ribs and keel small nodes appearing. Keel getting weaker during ontogeny, almost disappearing on the body whorl. Base well demarcated by angulation of whorl. Teleoconch surface covered by fine, densely packed lirae (after Gründel 1998a).

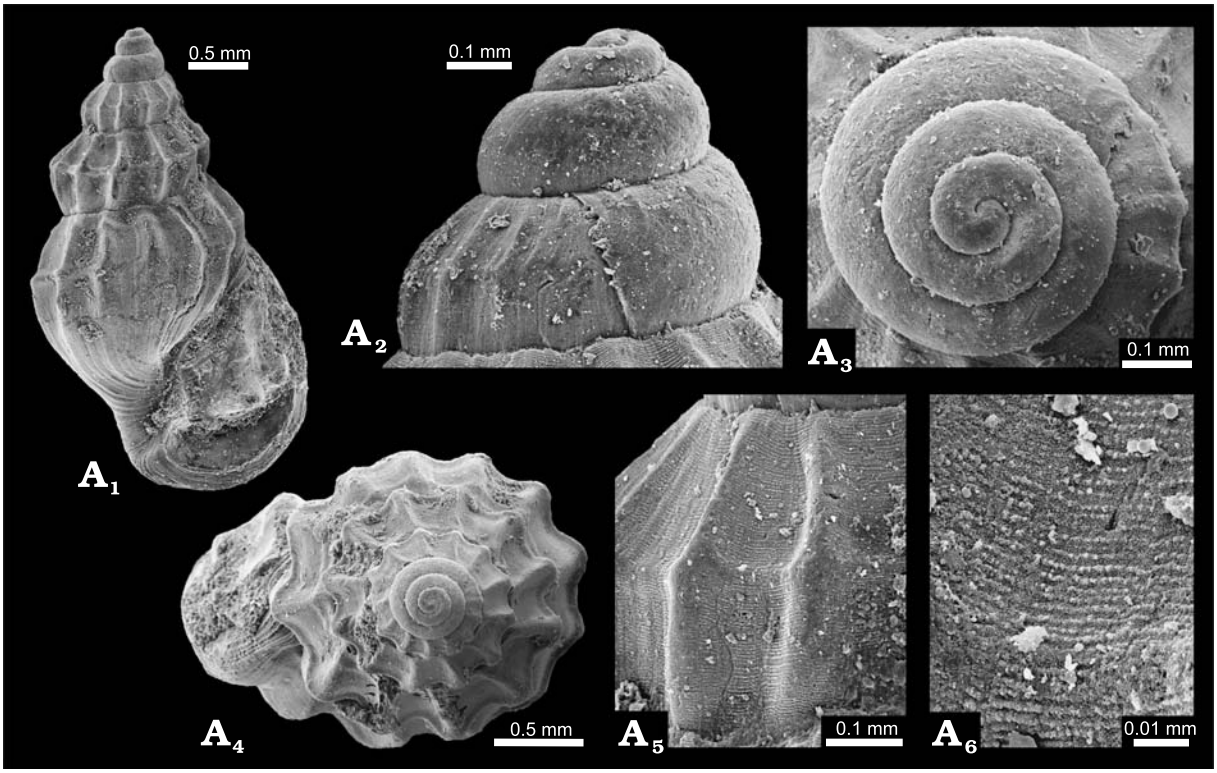


Fig. 66. The rissoid *Buvignieria calloviana* Gründel, 1998 from Łuków (block in glacial drift), Podlasie, Poland, Callovian (Mid Jurassic). **A**. MZ VIII Mg 4238/1; A_1 lateral view, A_2 protoconch in lateral view, A_3 protoconch in apical view, A_4 apical view, A_5, A_6 details of teleoconch ornamentation.

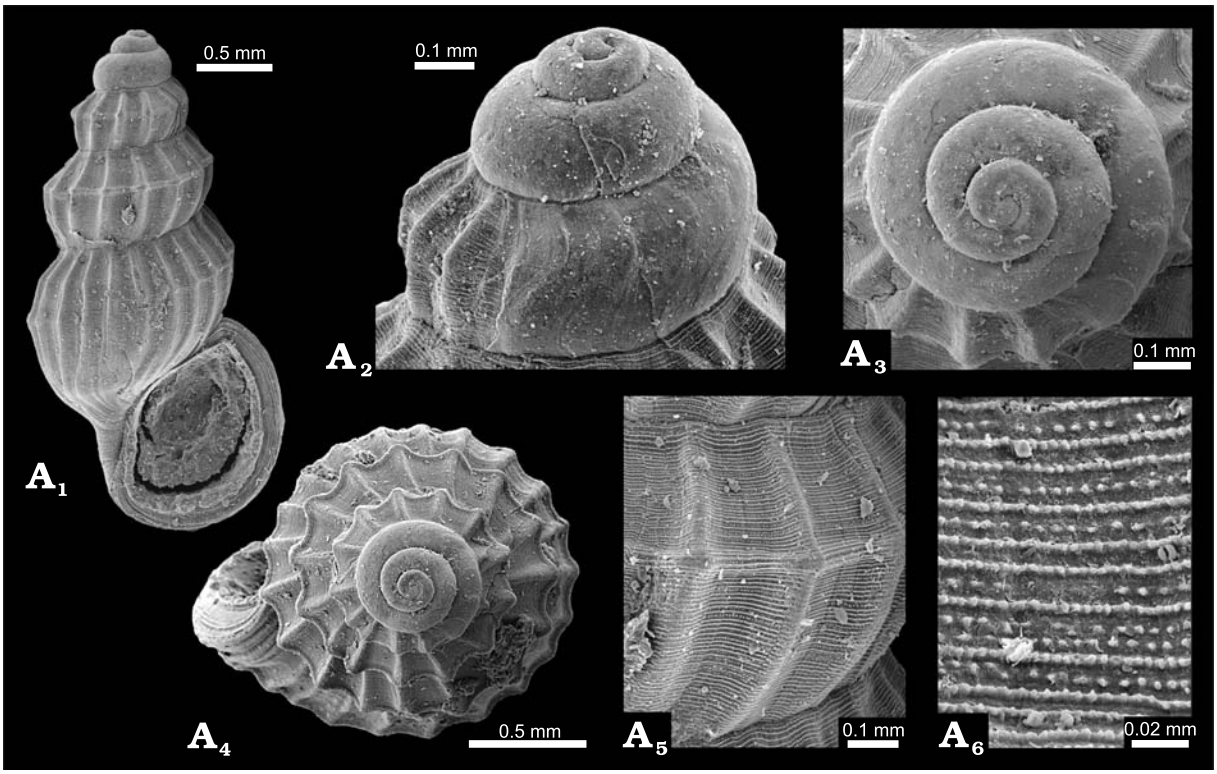


Fig. 67. Aberrant specimen of the rissoid *Buvignieria calloviana* Gründel, 1998, possibly representing a new species, from Łuków (block in glacial drift), Podlasie, Poland, Callovian (Mid Jurassic). **A**. MZ VIII Mg 4240/1; A_1 lateral view, A_2 protoconch in lateral view, A_3 protoconch in apical view, A_4 apical view, A_5, A_6 details of teleoconch ornamentation.

Description. — Protoconch 1 is ornamented with remnants of a granular pattern. Protoconch 2 is obtusely conical without ornamentation. The demarcation between the protoconch and the teleoconch is clearly visible and sigmoidal. The lirae are composed of small pustules. The drop-like peristome is terminally thickened.

Remarks. — The protoconch of Gründel's (1998a) holotype is not well preserved. He designated another juvenile shell (SMNS 63302) as the paratype. Protoconch 2 of this specimen is ornamented with prosocline spiral threads and the teleoconch is ornamented with more distantly spaced and stronger axial ribs. All specimens examined here have a smooth protoconch 2. This leads to the conclusion that specimen SMNS 63302 belongs to another, yet undescribed species.

Buvignieria studenckae sp. n.
(Fig. 68)

Holotype: MZ VIII Mg 4239/1, Fig. 68.

Type horizon: *Quenstedtoceras lamberti* Zone, Late Callovian (Mid Jurassic).

Type locality: Łuków (block in glacial drift), Podlasie, Poland.

Derivation of the name: In honour of Barbara Studencka, the curator of the Museum of the Earth PAS in Warsaw, who made the collection from Łuków accessible to me.

Material. — Three shells from Callovian of Łuków (block in glacial drift), Podlasie, Poland.

Measurements. — The protoconch with three whorls is 0.51 mm in diameter and 0.56 mm high. A shell (MZ VIII Mg 4239/1) with 6.5 whorls is 4.18 mm high and measures 2.19 mm in diameter.

Occurrences. — Type locality only.

Diagnosis. — Teleoconch ornamented with axial ribs (approx. 16–17 per whorl) and 2–3 spiral ribs. Uppermost spiral rib (situated medially) keel-like, forming angulation of whorl. At body whorl, ornamament only at adapical part of whorl. Base not demarcated by angulation of whorl, bearing two spiral ribs. Surface of teleoconch covered by densely packed fine lirae.

Description. — Protoconch 1 is smooth. Protoconch 2 is obtusely conical with no ornamentation apart from sparse, smooth, oblique or spiral threads at the adapical and abapical parts of the whorls. The demarca-

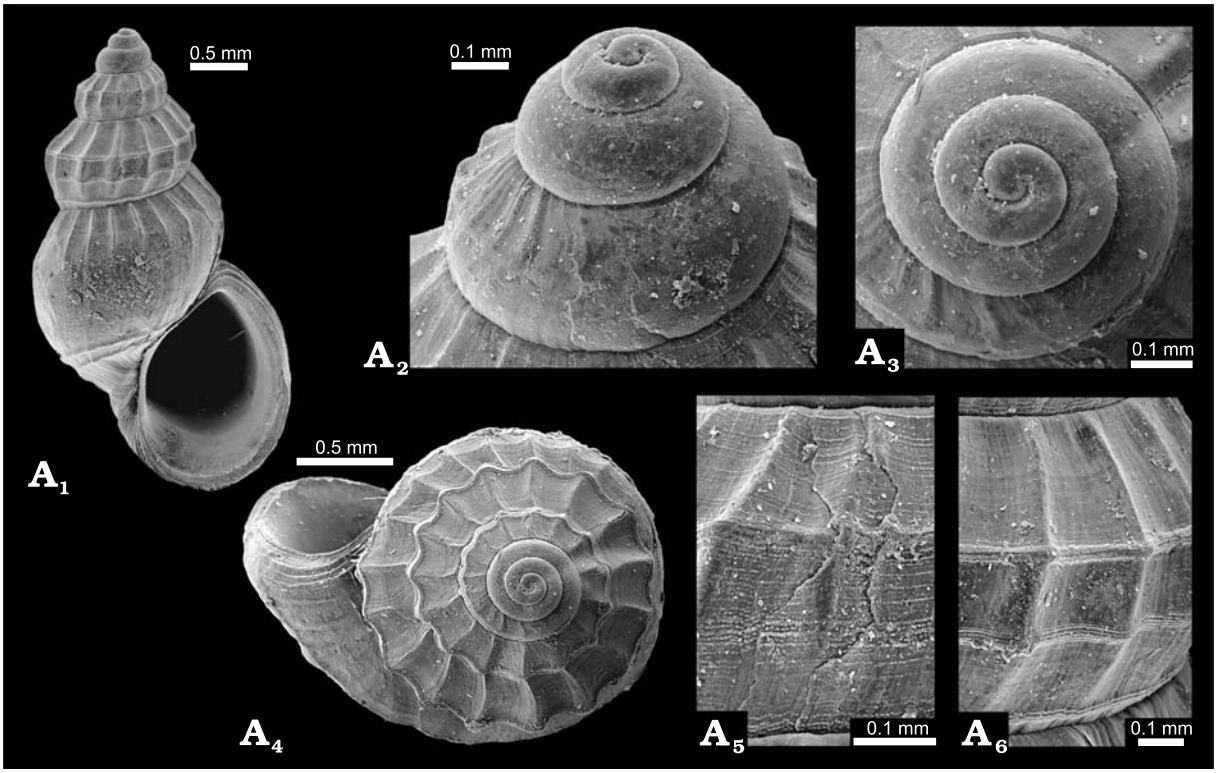


Fig. 68. The rissoid *Buvignieria studenckae* sp. n. from Łuków (block in glacial drift), Podlasie, Poland, Callovian (Mid Jurassic). **A**. MZ VIII Mg 4239/1; A_1 lateral view, A_2 protoconch in lateral view, A_3 protoconch in apical view, A_4 apical view, A_5, A_6 details of teleoconch ornamentation.

tion between the protoconch and the teleoconch is well developed, fractured. At the intersections of the axial and spiral ribs, weak nodes appear. The lirae of teleoconch are composed of small pustules. The drop-like peristome is thickened at its margin.

Remarks. — This species differs from *B. calloviana* in having less distant axial ribs, larger size, and two spiral ribs on the teleoconch.

Buvignieria piserai sp. n.
(Fig. 69)

Holotype: MZ VIII Mg 4241/1, Fig. 69.
Type horizon: *Quenstedtoceras lamberti* Zone, Late Callovian (Mid Jurassic).
Type locality: Łuków (block in glacial drift), Podlasie, Poland.
Derivation of the name: In honour to Andrzej Pisera, who donated his collection of gastropods from Wąwał for this study.

Material. — Six shells from Callovian of Łuków (block in glacial drift), Podlasie, Poland.

Measurements. — The protoconch with 3.25 whorls is 0.58 mm in diameter and 0.49 mm high. A shell (MZ VIII Mg 4241/1) with two whorls of teleoconch is 2.02 mm high and 1.30 mm in diameter.

Occurrences. — Type locality only.

Diagnosis. — Teleoconch composed of up to two whorls, ornamented with axial ribs (approx. 22–23 per whorl) and one spiral rib. Spiral rib situated on adapical part of whorl, forming weak angulation of shell. Ornamament only at adapical part of body whorl. Base demarcated by spiral rib and ornamented by one more spiral rib below. Surface of teleoconch covered by fine, densely packed lirae. Protoconch 2 ornamented by oblique or spiral threads.

Description. — Protoconch 1 is ornamented with a granular pattern. Protoconch 2 is obtusely conical and densely ornamented with threads. At the adapical part of the whorls the threads are opisthocline, at the abapical part of the whorls, the threads are prosocline, and in the medial part they are spiral. The demarcation between protoconch and teleoconch has an intermediate, sinusoidal zone. The spiral rib is composed of 6–8 subordinary spiral lirae. At the rest of the teleoconch the lirae are weakly developed. The tear-drop shaped peristome is thickened at its margin.

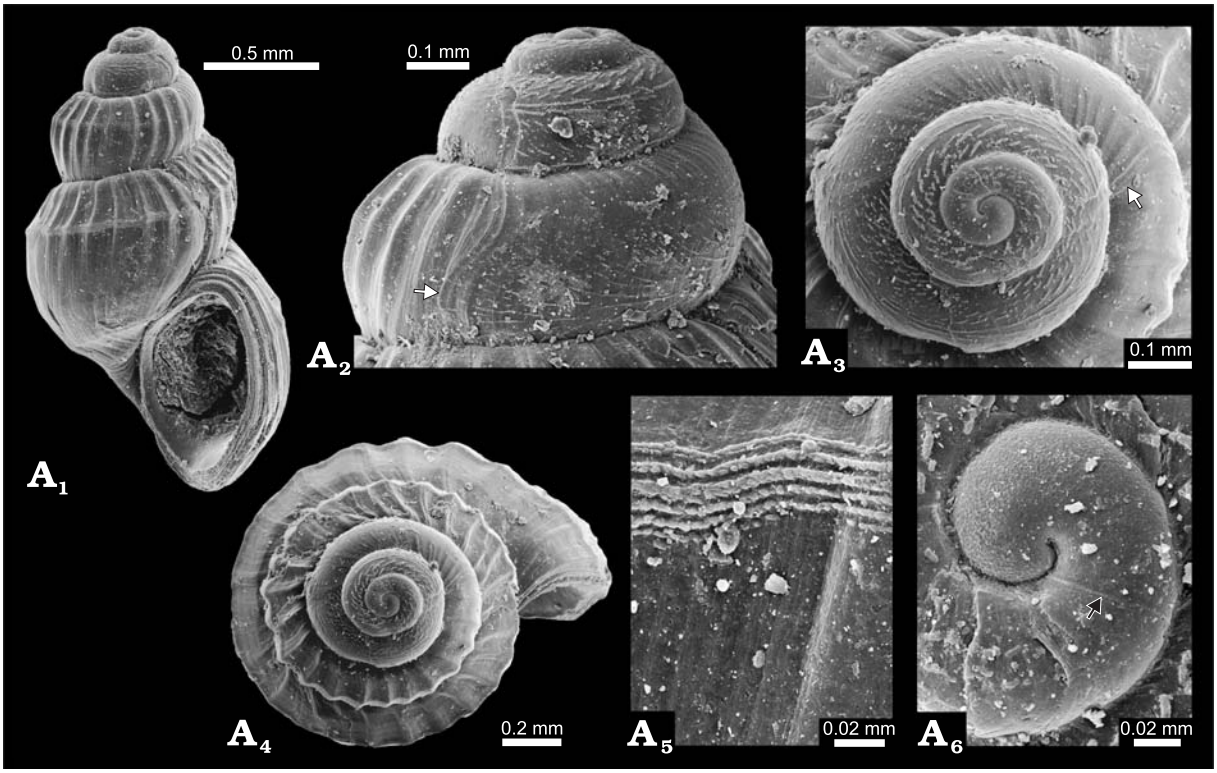


Fig. 69. The rissoid *Buvignieria piserai* sp. n. from Łuków (block in glacial drift), Podlasie, Poland, Callovian (Mid Jurassic.) **A**. MZ VIII Mg 4241/1; A_1 lateral view, A_2 protoconch in lateral view, A_3 protoconch in apical view, A_4 apical view, A_5 details of teleoconch ornamentation, A_6 close-up of the protoconch 1.

Remarks. — This species differs from the other species of *Buvignieria* in having a lower protoconch and only two whorls of the teleoconch. The pattern of ornamention of protoconch 2 is similar to that of the unnamed species illustrated by Gründel (1998a: pl. 2: 5–8); see discussion under *B. calloviana*.

Buvignieria bandeli sp. n.
(Fig. 70)

1995. ?*Dicroloma* sp.; Schröder 1995: 31, pl. 5: 10–13, pl. 14: 15.
2001. *Dicroloma* sp.; Kaim 2001: fig. 7.

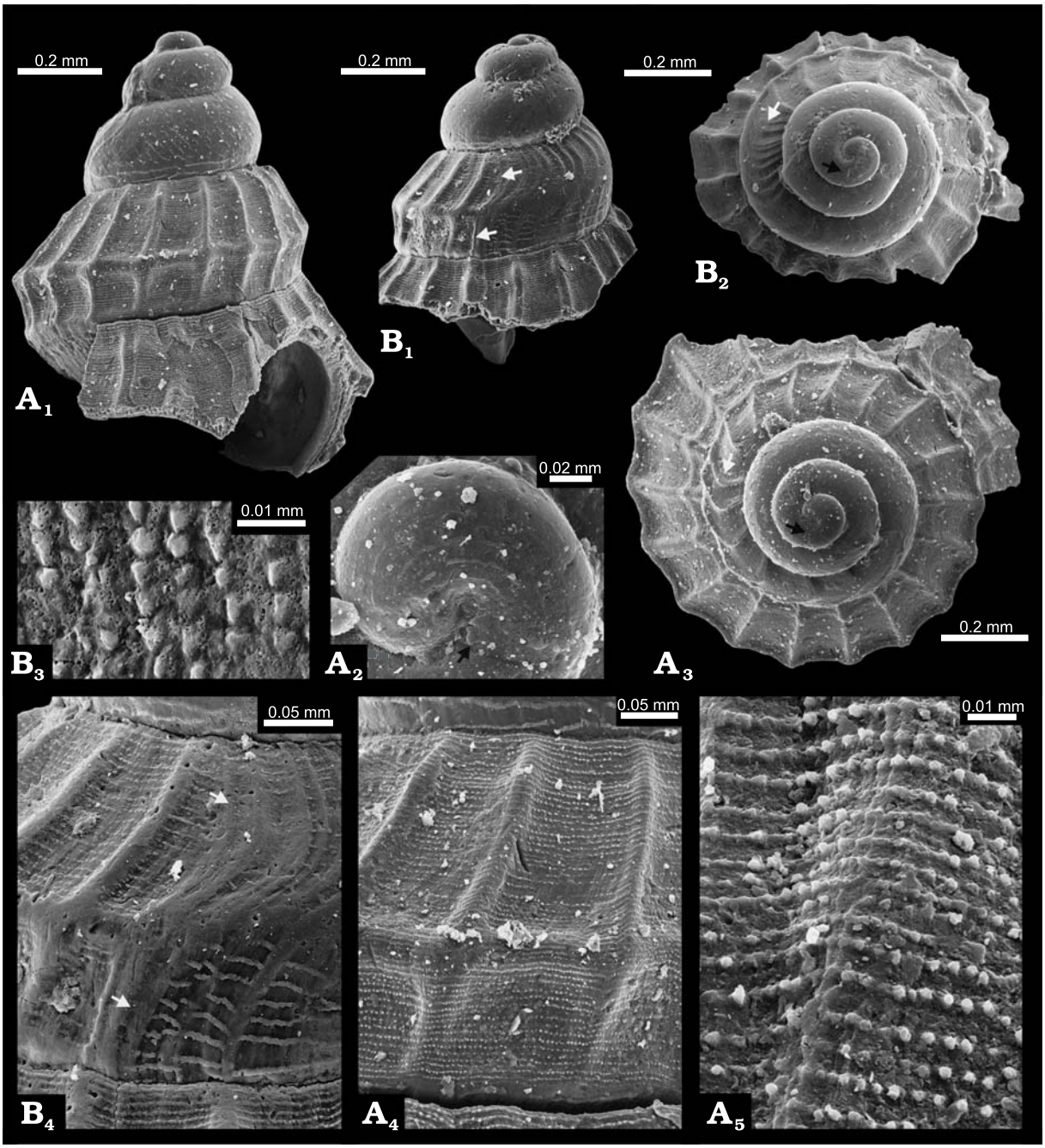


Fig. 70. The rissoid *Buvignieria bandeli* sp. n. from Wąwał, southern Mazowsze, Poland, Valanginian (Early Cretaceous). **A**. ZPAL Ga.9/59 (holotype) from sample D1; A_1 lateral view, A_2 close-up of the protoconch 1, A_3 apical view, A_4, A_5 details of teleoconch ornamentation. **B**. ZPAL Ga.9/60 from sample E1; B_1 lateral view, B_2 apical view, B_3 details of teleoconch ornamentation, B_4 transition between protoconch and teleoconch. Black arrows indicate demarcation between protoconch 1 and protoconch 2; white arrows indicate demarcation between protoconch and teleoconch.

Holotype: ZPAL Ga.9/59, Fig. 70A.

Type horizon: Sample D1, *Busnardoides campylotoxus* Zone, Early Valanginian (Early Cretaceous).

Type locality: Wąwał, southern Mazowsze, Poland.

Derivation of the name: In honour of Klaus Bandel.

Material. — Two shells from Valanginian of Wąwał.

Measurements. — The protoconch with three whorls is 0.66 mm in diameter and 0.66 mm high. Protoconch 1 is 0.13 mm in diameter. The teleoconch is incomplete and threfore could not be measured.

Occurrences. — Type locality only.

Diagnosis. — Conical teleoconch ornamented with broad axial ribs (about 17–18 per whorl) and one spiral keel situated on abapical part of whorl. Whorls strongly angulated. Base demarcated by angulation of whorl. Surface of teleoconch covered by fine, densely packed lirae. Protoconch 2 ornamented by oblique or spiral threads. Protoconch 1 ornamented by 6–7 spiral threads.

Description. — The protoconch is conical, densely ornamented with threads on the abapical part of the whorl. The demarcation between the protoconch and the teleoconch having intermediate zone, sinusoidal. On the intersections of axial ribs and the keel blunt nodes appear. The adult shell peristome is not preserved.

Remarks. — This species differs from the other species of *Buvignieria* in having the widest teleoconch and a spiral keel at the abapical portion of the whorl. The pattern of ornamention of protoconch 2 is similar to that of an unnamed species illustrated by Gründel (1998a: pl. 2: 5–8; see discussion under *B. calloviana*) and *B. piserai*. The pattern of protoconch 1 and 2 ornamentation is similar to that of many Recent and Tertiary Alvaniinae [e.g., protoconch 1 of *Alvania venus* (d'Orbigny, 1853) illustrated by Lozouet *et al*. 2001 and protoconch 2 of *Alvania testae* (Aradas *et* Maggiore, 1844) figured by Bouchet and Warén (1993)].

Buvignieria schroederi sp. n.
(Fig. 71)

1995. APOR.1; Schröder 1995: 31, pl. 5: 5–9, pl. 14: 14.

2001. APOR-1 of Schröder (1995); Kaim 2001: tab. 2, fig. 5.

2002. *Rissoina* (*Buvignieria*) sp.; Kaim 2002: fig. 3.

Holotype: ZPAL Ga.9/44, Fig. 71A.

Type horizon: Sample A5, *Saynoceras verrucosum* Zone, Late Valanginian (Early Cretaceous).

Type locality: Wąwał, southern Mazowsze, Poland.

Derivation of the name: In honour of Michael Schröder who first illustrated a shell of this species.

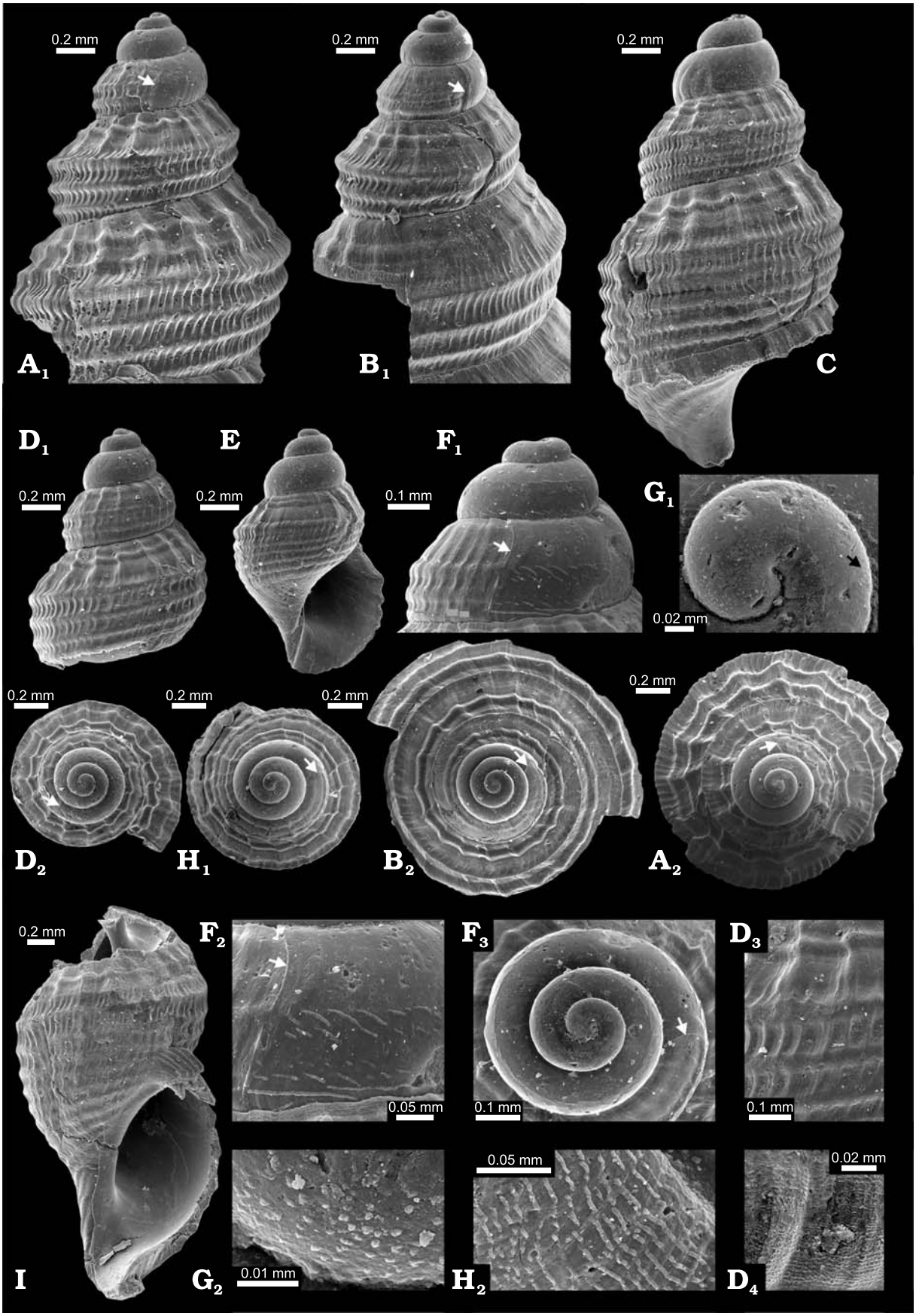
Material. — 174 shells from Valanginian of Wąwał.

Measurements. — The protoconch 1 with 0.75 whorls is 0.11 mm in diameter. The largest protoconch consists of 2.75 whorls and is 0.44 mm in diameter and 0.53 mm high. The width of the first whorl of the teleoconch varies from 0.68 to 0.97 mm.

Occurrences. — Early to Late Valanginian of Wąwał.

Diagnosis. — Protoconch 1 with tuberculate microornamentation. Abapical part of whorls of protoconch 2 ornamented with short oblique threads. Demarcation between protoconch and teleoconch well developed, opisthocyrtic. First whorl of teleoconch possessing three to four strong spiral ribs on abapical part of whorl. Later in ontogeny, number of ribs remaining constant or increasing. Most adapical rib forming angulation of whorl. Adapical part of whorl bearing one, weaker rib. Adapical part of whorl ornamented by broad, rounded

Fig. 71. The rissoid *Buvignieria schroederi* sp. n. from Wąwał, southern Mazowsze, Poland, Valanginian (Early Cretaceous). → **A**. ZPAL Ga.9/44 (holotype) from sample A5; A_1 lateral view, A_2 apical view. **B**. ZPAL Ga.9/46 from sample C2; B_1 lateral view, B_2 apical view. **C**. ZPAL Ga.9/52 from sample C1; lateral view. **D**. ZPAL Ga.9/48 from I1; D_1 lateral view, D_2 apical view, D_3, D_4 details of teleoconch ornamentation; **E**. ZPAL Ga.9/49 from sample M1; lateral view. **F**. ZPAL Ga.9/54 from sample F2; F_1 protoconch in lateral view, F_2 ornamentation of protoconch 2 at demarcation from the teleoconch, F_3 protoconch in apical view. **G**. ZPAL Ga.9/43 from sample L1; G_1 close-up of protoconch 1, G_2 details of protoconch 1 ornamentation. **H**. ZPAL Ga.9/53 from sample C1; H_1 apical view, H_2 details of teleoconch ornamentation at the abapical part of the whorl. **I**. ZPAL Ga.9/57 from sample H1; the largest shell known. Black arrow indicates demarcation between protoconch 1 and protoconch 2; white arrows indicate demarcation between protoconch and teleoconch.


0.2 mm
A1
0.2 mm
B1
0.2 mm
C
D1
0.2 mm
E
0.2 mm
F1
0.1 mm
G1
0.02 mm
0.2 mm
D2
0.2 mm
H1
0.2 mm
B2
0.2 mm
A2
0.2 mm
I
F2
0.05 mm
F3
0.1 mm
D3
0.1 mm
G2
0.01 mm
0.05 mm
H2
0.02 mm
D4

axial ribs. At junction between spiral and axial ribs blunt nodes appearing. Abapical part of whorl ornamented by narrow axial ribs.

Description. — The protoconch is of obtusely conical shape. The surface of the depressions between the axial and spiral ribs of the teleoconch is ornamented with delicate spiral striae. The adult shell peristome is not known. The peristome of the largest specimen (ZPAL Ga.9/57) seems to extend anteriorly into a weak anterior canal. The callus of the inner lip partially covers the columellar area. The size and ornamentation are highly variable and changed in time (Kaim 2002).

Remarks. — The first description of the shells belonging to this species come from Schröder (1995), who left the taxon in open nomenclature calling it APOR.1 (meaning Aporrhaidae). The survey of Jurassic and Early Cretaceous rissoids and aporrhaids (see discussion under Aporrhaidae) leads to the conclusion that this taxon may be best included in the Rissoidae. Moreover, the protoconch (conical shape, oblique threads, opisthocytic demarcation with teleoconch) and teleoconch characters (angulation at the spiral cord) allow the inclusion of the species in the genus *Buvignieria*. The gradual evolution of this species in the Wąwał section was described by Kaim (2002).

Genus *Zebina* Adams *et* Adams, 1854

Type species: *Rissoina semiglabrata* Adams, 1854; subsequent designation by Rehder 1980: 27. Recent, Indo-Pacific.

Diagnosis. — Shell small to large in size, non-umbilicate, ovate-conic to elongate-conic, smooth, often shiny, often with axial ribbing on upper teleoconch whorls, sometimes with spiral sculpture and, in one species, with thin axial lamellae over whole surface. Peristome pyriform, channeled posteriorly, rounded or weakly channeled anteriorly, peristome simple; outer lip usually with heavy varix, sometimes dentate within, opisthocline. Protoconch 2 smooth, sometimes decollate, multispiral to paucispiral (after Ponder 1985).

Discussion. — The species of rissoids with a *Rissoina*-like protoconch and a smooth shell surface are included in this genus. According to Ponder (1985) the main differences between *Zebina* and *Rissoina* are in the stomach morphology, the lack of an opercular peg and the form of the anterior apertural channel in *Zebina*. Only the last character can be observed on the fossil shell. A rounded or weakly anteriorly channeled peristome is also common among the species of the fossil genus *Bralitzia* (see above).

Range. — Jurassic (Ponder 1985 and herein) to Recent (e.g., Ponder 1985).

Zebina dziki sp. n.
(Fig. 72)

2001. APOR-5; Kaim 2001: tab. 2, fig. 5.

Holotype: ZPAL Ga.9/3, Fig. 72A.

Type horizon: Sample C1, *Busnardoides campylotoxus* Zone, Early Valanginian (Early Cretaceous).

Type locality: Wąwał, southern Mazowsze, Poland.

Derivation of the name: In honour of Jerzy Dzik.

Material. — 424 shells from Valanginian of Wąwał.

Measurements. — Protoconch 1 with 0.75 whorls is 0.14 mm in diameter. The protoconch consisting of 3.75 whorls is 0.67 mm in diameter and 0.69 mm high. The teleoconch consisting of 6.5 whorls is 2.79 mm high and 1.30 in diameter.

Occurrences. — Type locality only.

Diagnosis. — Protoconch obtusely conical. Demarcation between protoconch and teleoconch is well developed, opisthocyrtic. Teleoconch with weakly convex whorls ornamented by striae composed of small pits. Drop-like peristome with weak posterior canal terminally thickened.

Description. — Protoconch 1 bears tuberculate microornamentation. Protoconch 2 is not ornamented apart from growth lines. The body whorl has a weak angulation in the adapical part of the whorl.

Remarks. — The obtusely conical protoconch and terminally thickened peristome testifies that this species belongs to Rissoidae. The weak microornamentation of the teleoconch is similar to that observed among Recent species of *Zebina* (e.g., *Zebina villenai* Rolán *et* Luque, 2000, figs 133–136 therein) and *Schwartziella* (e.g., *Schwartziella paradoxa* Rolán *et* Luque, 2000, figs 130–132 therein).

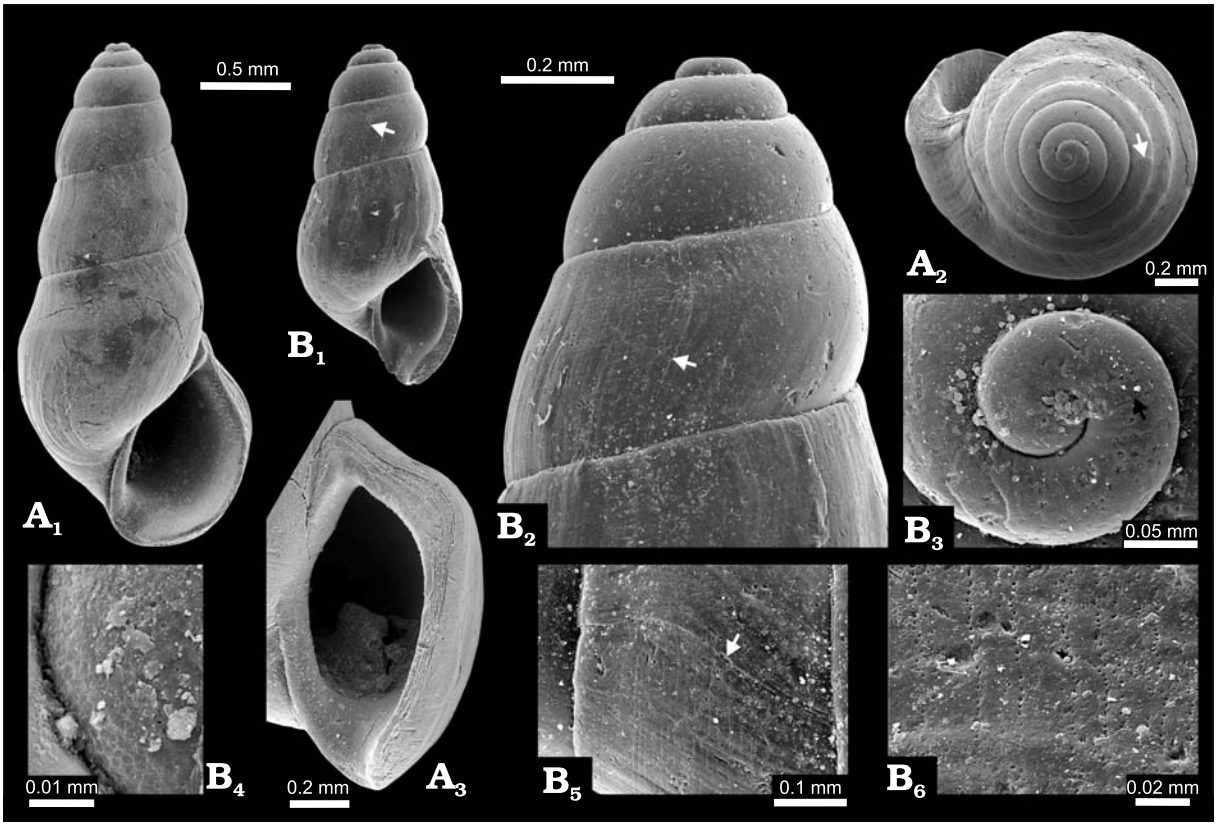


Fig. 72. The rissoid *Zebina dziki* sp. n. from Wąwał, southern Mazowsze, Poland, Valanginian (Early Cretaceous). **A**. ZPAL Ga.9/3 (holotype) from sample C1; A_1 lateral view, A_2 apical view, A_3 close-up of the peristome. **B**. ZPAL Ga.9/4 from sample C1; B_1 lateral view, B_2 protoconch in lateral view, B_3 close-up of the protoconch 1, B_4 details of the teleoconch ornamentation, B_5 demarcation between protoconch and teleoconch, B_6 details of teleoconch ornamentation. Black arrow indicates demarcation between protoconch 1 and protoconch 2; white arrows indicate demarcation between protoconch and teleoconch.

Zebina sp.
(Fig. 73)

Material. — One shell (ZPAL Ga.9/177) from the Kłęby outcrop, Oxfordian (Late Jurassic).

Measurements. — The shell with seven whorls is 3.67 mm high and 1.81 mm in diameter.

Description. — The shell is narrowly conical with very weakly convex whorls. The protoconch with a dome-shaped apex is not visibly differenciated from the teleoconch. The sufaces of the protoconch and teleoconch have no visible ornament, which has probably eroded. The peristome is only partially preserved.

Remarks. — The shell described here is very similar to Jurassic *Zebina laevis* (Sowerby, 1829) illustrated by Ponder (1985) and *Zebina gymnoides* (Hudleston, 1892) illustrated by Hudleston (1892). The first differs from the shell under consideration in having a more ovate shell shape and the latter has more slender shell.

Genus *Pusillina* Monterosato, 1884

Type species: *Rissoa pusilla* Philippi, 1836; original designation. Recent, Mediterranean Sea.

Diagnosis. — Shell minute to small, ovate to conic, with or without umbilicus, smooth or, typically, with axial ribs stronger than spiral sculpture; axial ribs usually obsolete on base. Aperture with simple peristome, inner lip narrow, attached to parietal wall, anterior end rounded, simple. Outer lip opisthocline to prosocline, with or without external varix. Protoconch 2 of 1.5 to 2.25 whorls, smooth or with spiral threads or spiral rows of minute, closely spaced pustules (after Ponder 1985).

Discussion. — As pointed out by Ponder (1985) the species of *Pusillina* are similar in many characters of the shell, the radula, and soft body to species of *Rissoa*. The most important difference is the lack of a pallial prostate gland and acquisition of penial prostatic tissue in *Rissoa* (Ponder 1985), the modifications from a

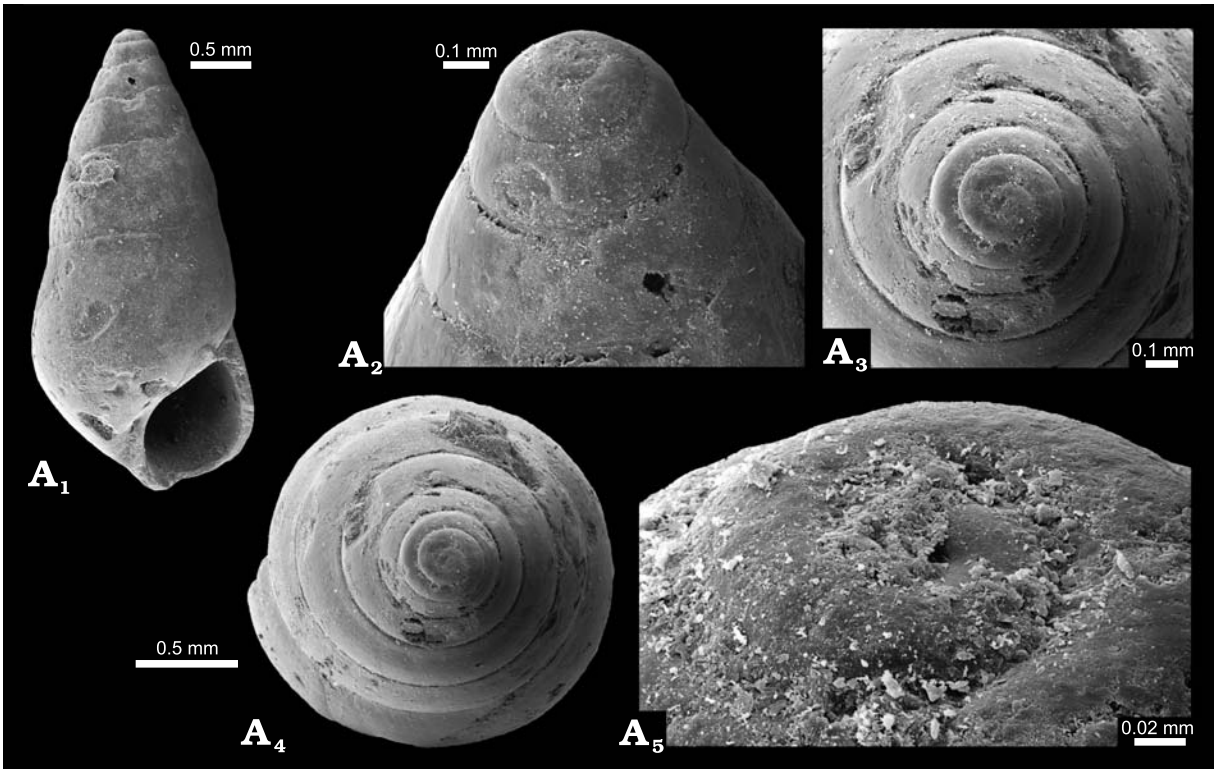


Fig. 73. The rissoid *Zebina* sp. from Kłęby outcrop, western Pomerania, Oxfordian (Late Jurassic). **A**. ZPAL Ga.9/177; A_1 lateral view, A_2 apex in lateral view, A_3 apex in apical view, A_4 apical view, A_5 close-up of the initial whorls.

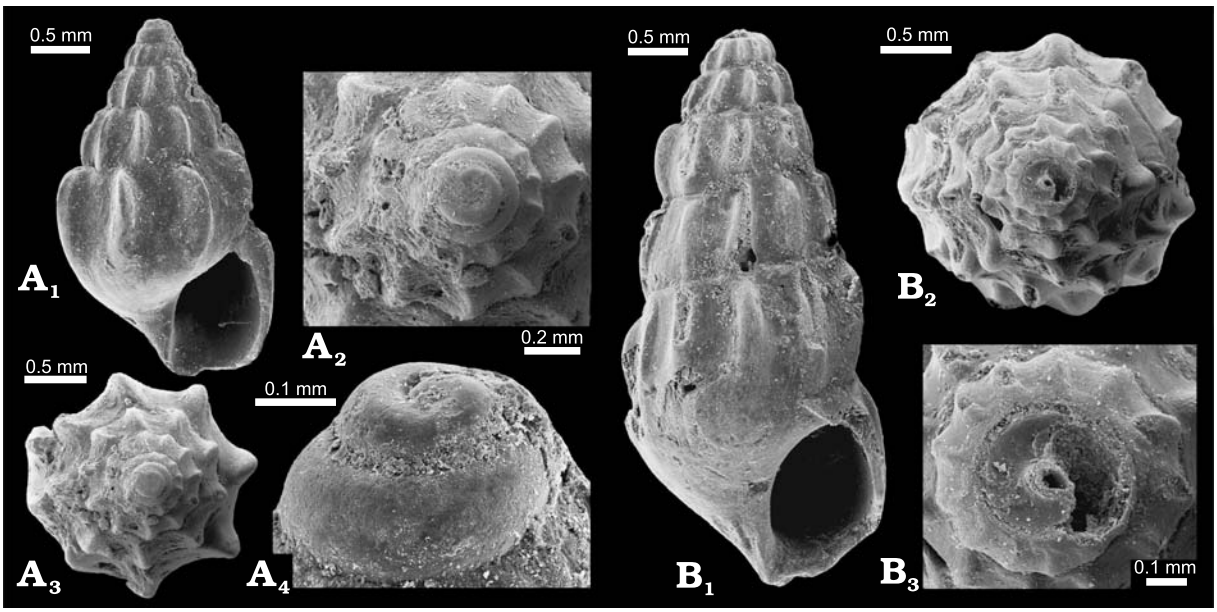


Fig. 74. The rissoids *Pusillina* sp. and unidentified rissoid from the Kłęby outcrop, Oxfordian (Late Jurassic). **A**. *Pusillina* sp., ZPAL Ga.9/174; A_1 lateral views, A_2 close-up of the early whorls in an apical view, A_3 apical view, A_4 close-up of the protoconch. **B**. Unidentified rissoid, ZPAL Ga.9/175; B_1 lateral view, B_2 apical view, B_3 apical view of the apex.

more primitive state seen in *Pusillina* (a pallial prostate gland and a simple penis). Regrettably, these features are not preserved in the fossil record.

Range. — Oxfordian (Late Jurassic; herein) to Recent (e.g., Ponder 1985).

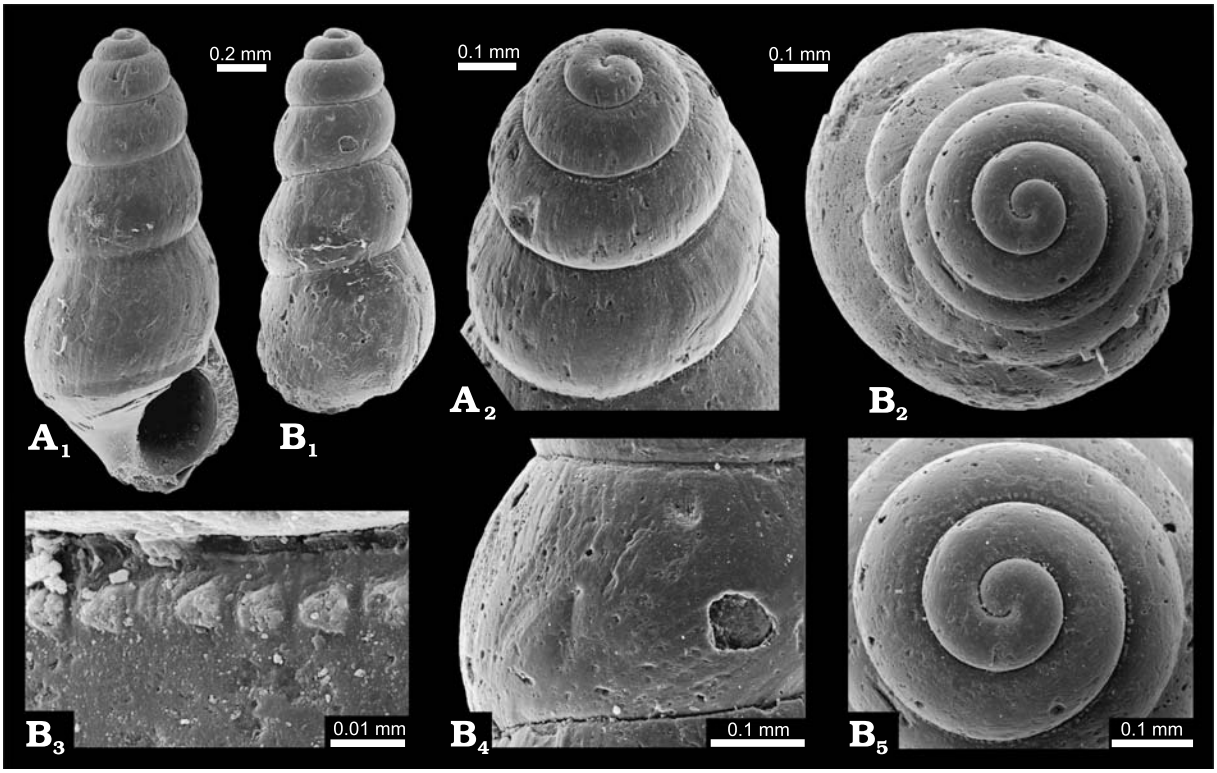


Fig. 75. Possible rissooid *Knightella baluki* sp. n. from Wąwał, southern Mazowsze, Poland, Valanginian (Early Cretaceous). **A**. ZPAL Ga.9/5 (holotype) from sample H3; A_1 lateral view, A_2 protoconch in lateral view. **B**. ZPAL Ga.9/6 from sample H3; B_1 lateral view, B_2 apical view, B_3 subsutural row of microtubercles on the protoconch, B_4 demarcation between protoconch and teleoconch, B_5 apex in apical view.

Pusillina sp.
(Fig. 74, 75)

1971. *Rissoina obliquata* (Sowerby, 1829); Dmoch 1971, partim: pl. 1: 8, non pl. 1: 7 — unidentified rissoid [non *Rissoa obliquata* Sowerby 1829: 230 — *Bralitzia obliquata* (Sowerby, 1829)].

Material. — One shell (ZPAL Ga.9/174) from Kłęby outcrop, Oxfordian (Late Jurassic).

Measurements. — The protoconch consisting of about 2–2.5 whorls is 0.38 mm in diameter. The shell with six whorls is 3.14 mm high and 1.94 mm in diameter.

Description. — The protoconch is conical with a dome-shaped apex. The suface of protoconch 2 is eroded so that the ornament is not preserved. The teleoconch is of a wide-conical shape and ornamented by broad axial ribs. There is no spiral ornament and the shell surface is smooth.

Remarks. — This species resembles some Recent species [e.g., *Pusillina benzi* Aradas *et* Maggiore, 1843 or *Rissoa parva* (Da Costa, 1778)]. The species under consideration is the earliest known *Rissoa*-like gastropod. There is also some resemblance to the shells of the members of the family Barleeidae (see e.g., Ponder 1983). The strata where the shell was found are interpreted to have been deposited in a shallow water environment (Cedro 1999). The underestimation of *Rissoa*-like gastropod species in the Mesozoic is probably caused by the scarcity of small, well-preserved shells derived from the shallow water environment (compare also Ponder 1985). Together with the single specimen identified with confidence as *Pusillina* two other rissoid shells have been found. They differ in having more slender shells and more weakly incised sutures.

Family **uncertain**

Genus *Knightella* Longstaff, 1933
(*Knightia* Longstaff, 1933 non Jordan, 1907)

Type species: *Knightia irregularis* Longstaff, 1933; original designation by Longstaff 1933: 118. Carboniferous, Dykes, Scotland.

Diagnosis. — Small, slender, high-spired with numerous whorls. Teleoconch smooth or ornamented with spiral threads. Protoconch smooth or with subordinate spiral ornament (after Nützel 1998).

Discussion. — Longstaff (1933) and Wenz (1938) included the genus *Knightella* in the Loxonematidae Koken, 1889 whereas Knight *et al.* (1960) included this genus in the Pseudozygopleuridae Knight, 1930. Most recently Nützel (1998) regarded *Knightella* as a member of the Acanthonematidae Wenz, 1938, a family of Cerithimorpha on the basis of protoconch similarity. Unfortunately the specimens illustrated by Longstaff (1933), Knight (1941), Knight *et al.* (1960), and Nützel (1998) have poorly preserved protoconchs. If the species described below belong to the genus *Knightella*, then it should rather be included in the Rissoidea, as they show similarities to the Mesozoic species of *Bralitzia* and *Zebina* (see above) in having a cylindrical protoconch with a dome-shaped apex.

Range. — Carboniferous (Longstaff 1933; Nützel 1998) to Early Cretaceous (herein).

Knightella baluki sp. n.
(Fig. 75)

Holotype: ZPAL Ga.9/5, Fig. 75A.
Type horizon: Sample H3, *Saynoceras verrucosum* Zone, Late Valanginian (Early Cretaceous).
Type locality: Wąwał, southern Mazowsze, Poland.
Derivation of the name: In honour of Wacław Bałuk.

Material. — 158 shells from Valanginian of Wąwał.

Measurements. — The protoconch consisting of 3.25 whorls is 0.46 mm in diameter and 0.61 mm high. A shell consisting of five whorls is 1.58 mm high and 0.76 in diameter.

Occurrences. — Type locality only.

Diagnosis. — Shell slender, high-spired. Protoconch cylindrical with dome-shaped apex, not ornamented apart from row of small pustules at adapical suture. Demarcation between protoconch and teleoconch poorly visible and sinusoidal. Teleoconch with weakly convex whorls not ornamented.

Description. — Protoconch 1 is smooth. The demarcation between protoconch 1 and 2 is not visible. On the surface of the teleoconch, only growth lines are visible. The peristome is not preserved.

Remarks. — This species is similar in shell shape to *Knightella irregularis* Longstaff, 1933, the type species of *Knightella*, illustrated by Knight (1941) but the adapical row of pustules on the protoconch is not reported in this species.

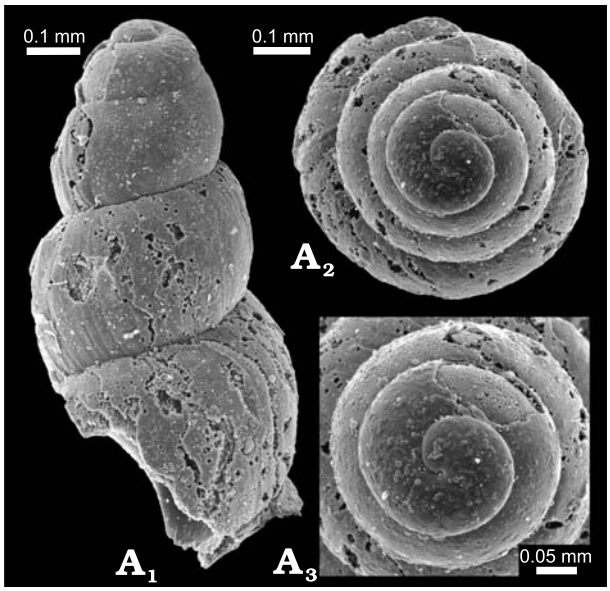


Fig. 76. Rossible rissooid *Knightella* sp. from Łuków (block in glacial drift), Podlasie, Poland (Callovian, Mid Jurassic). **A**. ZPAL Ga.9/178; A_1 lateral view, A_2 apical view, A_3 apical view of the apex.

Knightella sp.
(Fig. 76)

Material. — One shell (ZPAL Ga.9/178) from Łuków (block in glacial drift), Podlasie, Poland, Callovian (Mid Jurassic).

Measurements. — The shell consisting of four whorls is 1.00 mm high and 0.52 mm in diameter.

Description. — The shell is slender, high-spired. The demarcations between protoconch 1 and 2, and between the protoconch and the teleoconch are not visible. Both the protoconch and the teleoconch are without ornamention but the surface is partially eroded. Suture incised deeper than in *Knightella baluki*.

Remarks. — The shell illustrated here is similar to the Carboniferous *K. irregularis* and Cretaceous *K. baluki*. Because of poor preservation, I leave it unnamed.

Superfamily **Pseudomelanoidea** Hoernes, 1884
Family **Pseudomelaniidae** Hoernes, 1884

Remarks. — This mainly Mesozoic family was suggested by Ponder (1985) to be the possible stem group of the Rissoidea. This assumption has to be better constituted as in the Jurassic, Rissoidea already appear in a shell shape very close to the Recent Rissoidea, without intermediate forms of Pseudomelaniidae. It is most probable that the Pseudomelaniidae is a group related to the Zygopleuridae, especially to the *Azyga*-group (see p. 66).

Genus *Pseudomelania* Pictet *et* Campiche, 1862

Type species: *Pseudomelania gresslyi* Pictet *et* Campiche, 1862; original designation. Neocomian (Early Cretaceous), Sainte-Croix, Switzerland. The holotype is an indeterminable inner mould (Joachim Gründel, personal communication 2003), and therefore the status of the genus and higher rank taxa based on it, is uncertain.

Diagnosis. — Shell high-spired, elongated (spire pointed), not umbilicated, thick; ornaments usually confined to lines of growth; aperture oval, entire, regularly rounded in front, and terminating posteriorly at angle; columella thick, and sharing in the general curvature of mouth, always without folds (after Hudleston 1892a).

Discussion. — This genus groups fossil shells of similar, simple morphology. At the moment, it is impossible to say whether they represent many different species or a few species with large variability in shell shape. Most of the known species included in this genus have an unknown protoconch shape and it is potentially possible that they belong to the eulimids, the zygopleurids or other groups.

Range. — Triassic to Cretaceous (Cossmann 1909).

Pseudomelania trochiformis (Piette, 1857)
(Fig. 77)

1857. *Turritella trochiformis* sp. n.; Piette 1857: 559, pl. 8: 5.
1885. *Pseudomelania laubei* sp. n.; Cossmann 1885: 176, pl. 1: 32, 33, pl. 15: 47.
1975. *Pseudomelania laubei* Cossmann, 1885; Gründel 1975b: 778, pl. 1: 1, 2.
1993. *Pseudomelania laubei* Cossmann, 1885; Gründel 1993b: 373, pl. 2: 7–9.
2001. *Pseudomelania trochiformis* (Piette, 1857); Gründel 2001: 49, pl. 1: 15–17, pl. 2: 1–5.

Type material: Piette 1857: 559, pl. 8: 5.
Type horizon: Bathonian (Mid Jurassic).
Type locality: Rumigny, France.

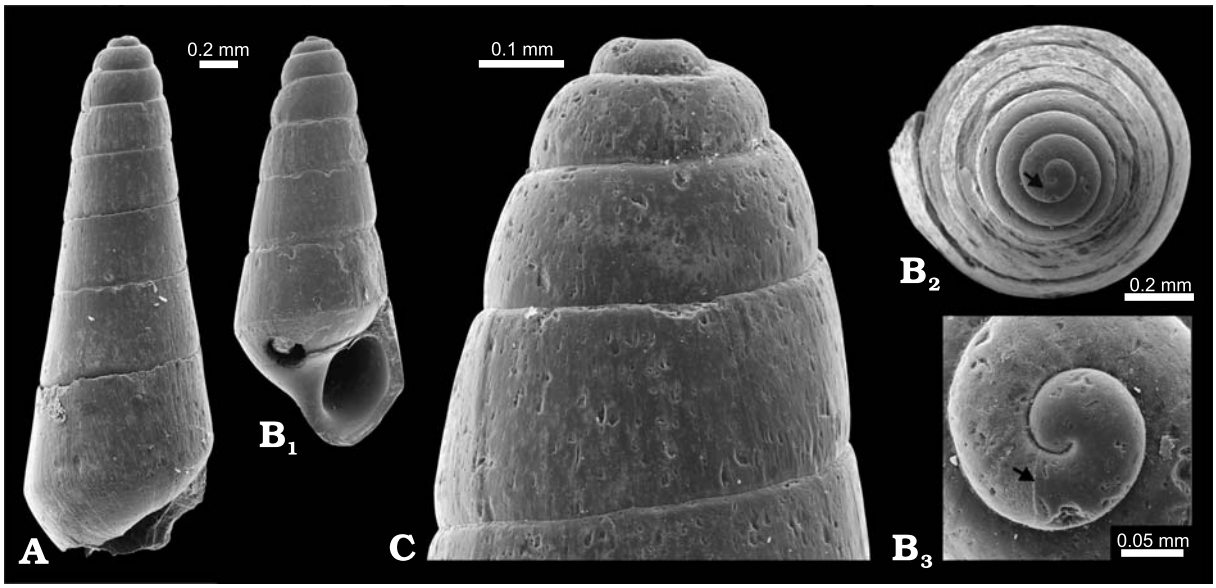


Fig. 77. *Pseudomelania trochiformis* (Piette, 1857) from Wąwał, southern Mazowsze, Poland, Valanginian (Early Cretaceous). **A**. ZPAL Ga.9/26; lateral view. **B**. ZPAL Ga.9/24; B_1 lateral view, B_2 apical view, B_3 close-up of protoconch 1. **C**. ZPAL Ga.9/28; close-up of the apex in lateral view. Black arrows indicate demarcation between protoconch 1and protoconch 2.

Material. — 110 shells from Valanginian of Wąwał.

Measurements. — Protoconch 1 consisting of one whorl is 0.14 mm in diameter. A shell with seven whorls is 2.16 mm high and 0.87 mm in diameter.

Occurrences. — Bathonian (Mid Jurassic) to Valanginian (Early Cretaceous) of Europe.

Emended diagnosis. — Protoconch with dome-shaped apex. Both protoconch and teleoconch not ornamented. Demarcation between protoconch and teleoconch not visible. Shell glossy, slender, tower-like with not incised suture and with flat whorls.

Description. — The demarcation between protoconch 1 and 2 is clearly visible. The peristome is not well preserved.

Remarks. — The shells from Wąwał are very similar to the juvenile shell of *P. laubei* illustrated by Gründel (1975b). The species differs from *P. paucispira* (see below) in having a more shallow suture and multispiral protoconch.

Pseudomelania paucispira sp. n.
(Fig. 78)

Holotype: ZPAL Ga.9/21, Fig. 79B.

Type horizon: Sample L1, *Tirnovella pertransiens* Zone, Early Valanginian (Early Cretaceous).

Type locality: Wąwał, southern Mazowsze, Poland.

Derivation of the name: After paucispiral protoconch.

Material. — 182 shells from Valanginian of Wąwał.

Measurements. — The protoconch consisting of 1.25 whorls is 0.22 mm in diameter and 0.22 mm high. The shell with 6.5 whorls is 1.97 mm high and 0.80 in diameter.

Occurrences. — Type locality only.

Diagnosis. — Protoconch paucispiral. Demarcation of teleoconch clearly visible, prosocline. Shell glossy, tower-like, not ornamented apart from growth lines. Suture very weakly incised, whorls almost flat. Inner lip straight, with umbilical chink.

Description. — The demarcation between protoconch and teleoconch is emphasized by a difference in colour. The aperture is not well preserved, rather narrow, and anteriorly channeled.

Remarks. — The species is similar to *Pseudomelania laevigata* (Morris *et* Lycett, 1850) but differs from it by having an umbilical chink. The protoconch of the latter species is unknown and comparison with that of *P. paucispira* is therefore impossible.

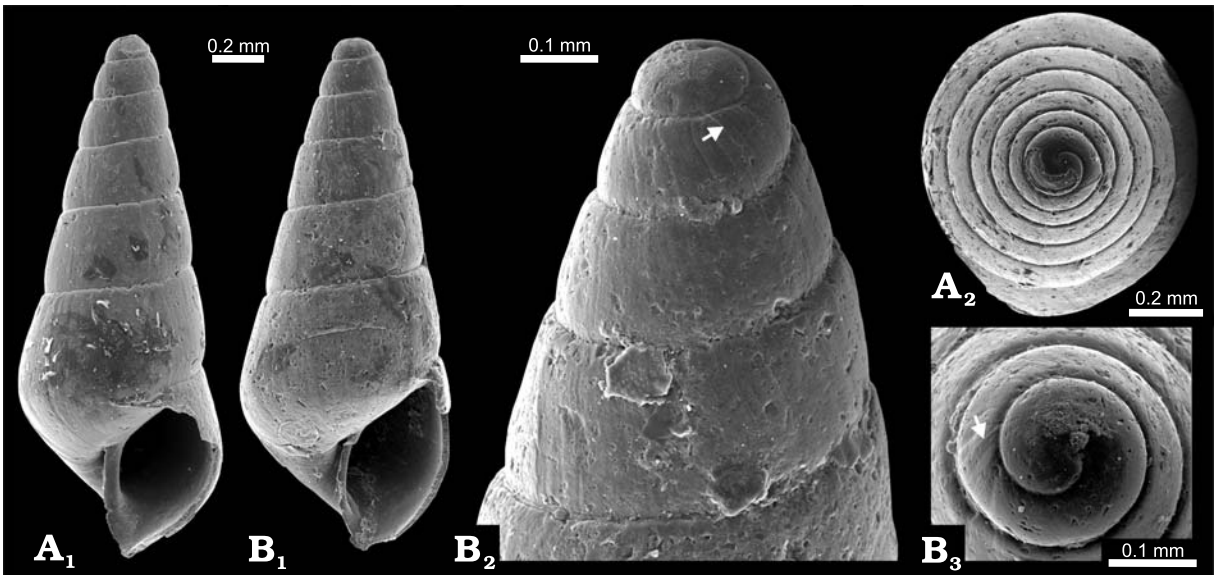


Fig. 78. *Pseudomelania paucispira* sp. n. from Wąwał, southern Mazowsze, Poland, Valanginian (Early Cretaceous). **A**. ZPAL Ga.9/22 from sample F1; A_1 lateral view, A_2 apical view. **B**. ZPAL Ga.9/21 (holotype) from sample L1; B_1 lateral view, B_2 close-up of the apex in lateral view, B_3 close-up of the protoconch. White arrows indicate demarcation between protoconch and teleoconch.

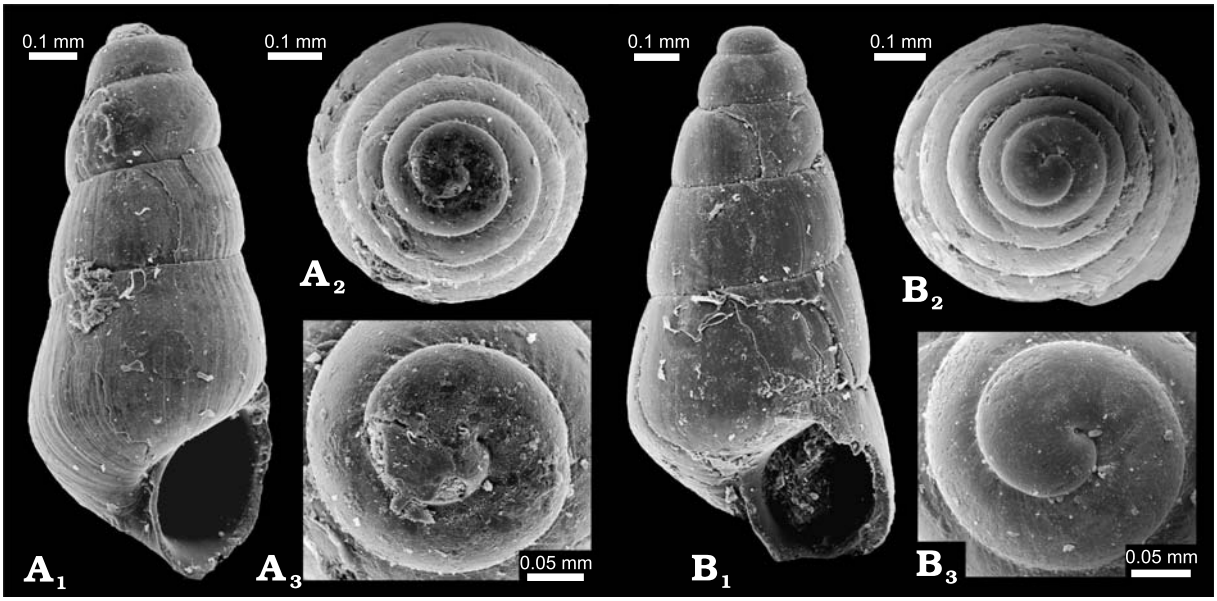


Fig. 79. Caenogastropod gen. indet. spp. from Łuków (block in glacial drift), Podlasie, Poland, Callovian (Mid Jurassic). **A**. ZPAL Ga.9/179; A_1 lateral view, A_2 apical view, A_3 apical view of the apex. **B**. ZPAL Ga.9/180; B_1 lateral view, B_2 apical view, B_3 close-up of protoconch 1.

Superfamily **uncertain**

Gen. indet. spp.

(Fig. 79A)

Material. — Two shells from Łuków (block in glacial drift), Podlasie, Poland, Callovian (Mid Jurassic).

Measurements. — The shell (ZPAL Ga.9/179) consisting of five whorls is 1.19 mm high and 0.54 mm in diameter. The shell (ZPAL Ga.9/180) consisting of 5.25 whorls is 1.19 mm high and 0.60 mm in diameter. The protoconch with 2.5 whorls is 0.35 mm high and 0.31 mm in diameter. Protoconch 1 with 0.75 whorls is 0.17 mm in diameter.The shell (ZPAL Ga.9/180) consisting of 5.25 whorls is 1.19 mm high and 0.60 mm in diameter. The protoconch with 2.5 whorls is 0.35 mm high and 0.31 mm in diameter. Protoconch 1 with 0.75 whorls is 0.17 mm in diameter.

Description. — The shell is slender and high-spired. The demarcation between protoconch 1 and 2 is not visible. The demarcation between the protoconch and the teleoconch is hardly visible, expressed only by a change from sinusoidal growth lines on the protoconch into opisthocyrtic growth lines on the teleoconch. Both the protoconch and the teleoconch are not ornamented, apart from short collabral threads close to the adapical suture. The suture is weakly incised and the whorls are weakly convex. The peristome has an umbilical chink.

Remarks. — The shape of this shell resembles that of *Knightella* but it differs from it in having collabral threads close to the adapical suture. This character is observed among the zygopleurids (see below), some rissoinids (e.g., *B. obtusa*, see above), and gen. indet. sp. 2 (see below). The shell shape of the last species is similar (a weakly incised suture and nearly flat whorls) to those known among the pseudomelanids (see above). The gen. indet. sp. 1 also resembles a species of *Cima* (see e.g., Warén 1993). Due to the absence of taxonomically important characters, I leave the shells as "species uncertain".

Gen. indet. sp. 2

(Fig. 80)

Material. — One shell (ZPAL Ga.9/181) from Łuków (block in glacial drift), Podlasie, Poland, Callovian (Mid Jurassic).

Measurements. — The shell consisting of six whorls is 3.03 mm high and 1.34 mm in diameter. Protoconch 1 with 0.75 whorls is 0.12 mm in diameter.

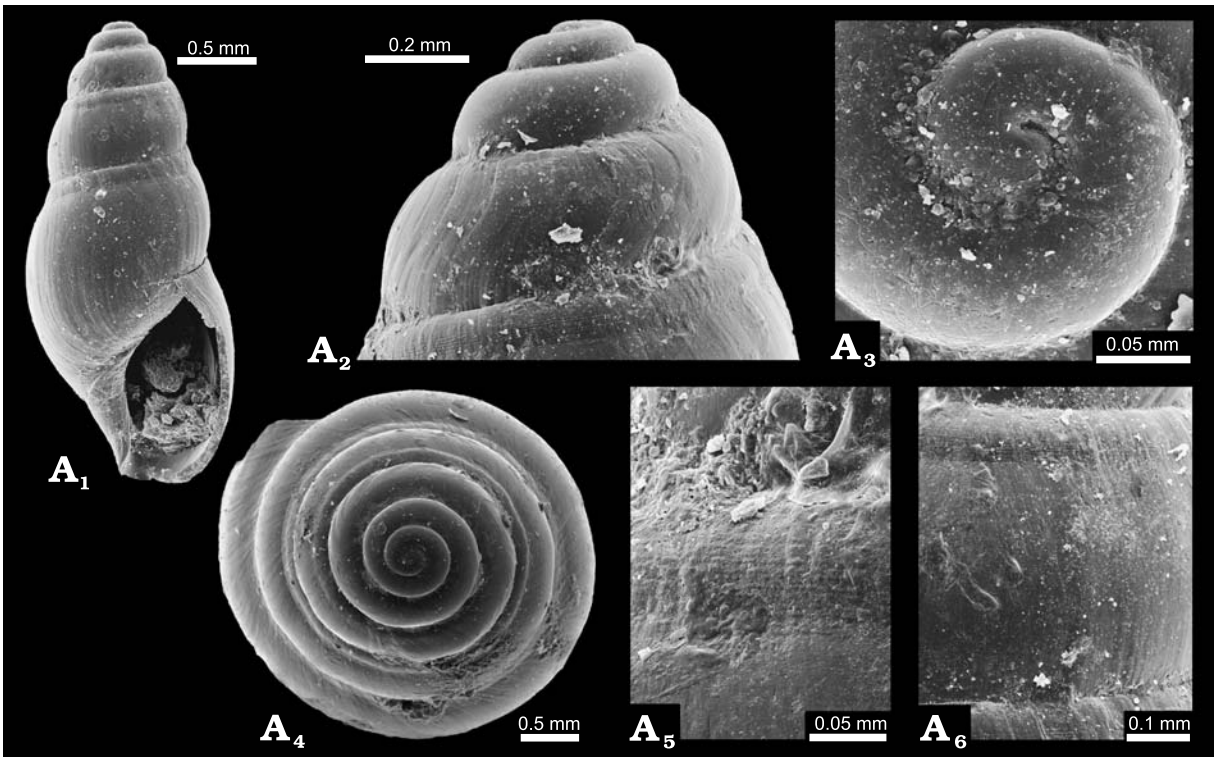


Fig. 80. Caenogastropod gen. indet. sp. 2 from Łuków (block in glacial drift), Podlasie, Poland, Callovian (Mid Jurassic). **A**. ZPAL Ga.9/181; A_1 lateral view, A_2 protoconch in lateral view, A_3 apex in apical view, A_4 apical view, A_5, A_6 details of teleoconch ornamentation.

Description. — The shell is slender and high-spired. The demarcation between protoconch 1 and 2 fairly visible. The demarcation between the protoconch and the teleoconch is poorly visible, expressed by a change from sinusoidal growth lines on the protoconch into opisthocyrtic lines on the teleoconch. The protoconch is not ornamented. The teleoconch has an adapical, subsutural spiral groove. The part of the whorl above the groove is ornamented with very weak spiral threads. The peristome is not completely preserved with callus of the inner lip covering the columellar area.

Remarks. — This shell is similar to *Brevizygia spiralosulcata* Bandel, Gründel, *et* Maxwell, 2000 in having a subsutural spiral groove. It differs in lacking the subsutural row of nodes typical of Zygopleuroidea (see above) that is present in *Brevizygia* shells. Moreover, the shell under consideration has callus of the inner lip covering the columellar areas while the species of *Brevizygia* have the inner lip separated from the columella by an umbilical chink (Gründel 1999d).

Superfamily **Calyptraeoidea** Lamarck, 1809
Family **Hipponicidae** Troschel, 1861
Genus *Gnaszynium* gen. n.

Type species: *Gnaszynium baumilleri* sp. n.; monotypy. Bathonian (Mid Jurassic), Gnaszyn, Częstochowa region, Poland.

Derivation of the name: After type locality.

Diagnosis. — Protoconch with three whorls and stable rate of expansion, ornamented adapically with low, axial ribs. Protoconch peristome with sinusigera notch. Teleoconch cap-like, ornamented with collabral, densely spaced, low ribs.

Discussion. — A similar protoconch was described by Bandel (1992) as that of *Palaeonarica concentrica* (Münster, 1841) from the Late Triassic of the Alps. It has a similar protoconch shape, terminated with a sinusigera notch, although the details are not very visible. The ornamentation of the early teleoconch is composed of collabral ribs and small granules and also strongly resembles that of *Gnaszynium*. However, the adult shell, illustrated by Münster (1841), is spirally coiled, whereas in *Gnaszynium* it is limpet-like. Another similar

form is *Thylacus cretaceus* Conrad, 1860, the type species of *Thylacus* Conrad, 1860, from the Late Cretaceous of the United States (see e.g., Dockery 1993). It has a similar protoconch with delicate axial ribs situated adapically and a stable rate of whorl expansion. The peristome of the protoconch has a weakly developed sinusigera sinus. The limpet-like teleoconch of *T. cretaceus* is not ornamented apart from growth lines. The similar Tertiary species, *Thylacus squamaeformis* (Lamarck, 1802), has no signs of sinusigera. *Palaeonarica* is interpreted to be a member of the Nerithimorpha by Bandel (1992), whereas *Thylacus* and the synonymous *Leptonotis* Conrad, 1866 are interpreted to be Hipponicidae (Bouchet and Warén 1993; Bandel and Riedel 1994). The protoconch of neritid gastropods has a typically increasing rate of whorl expansion, whereas the protoconch of *Gnaszynium* has a stable rate of whorl expansion that is more typical of Hipponicidae.

Range. — Mid Bathonian (Mid Jurassic).

Gnaszynium baumilleri sp. n.
(Fig. 81)

Holotype: ZPAL Ga.9/219, Fig. 81.

Type horizon: *Morrisiceras morrisi* Zone, Mid Bathonian (Mid Jurassic).

Type locality: Gnaszyn, Częstochowa region, Poland.

Derivation of the name: In honour of Tomasz K. Baumiller.

Material. — Holotype only.

Measurements. — Protoconch 1 consisting of one whorl is 0.17 mm wide. Protoconch with three whorls is 0.68 mm in diameter and 0.69 mm high.

Occurrence. — Bathonian of Gnaszyn, Poland.

Diagnosis. — Protoconch 1 partially covered by succesive whorls. Sinusigera notch in medial part of shell. Teleoconch ornamented with spiral ribs and fine granules arranged in delicate, spiral rows.

Description. — Protoconch 1 smooth, apically flattened. Early whorls of protoconch with flat suture, later weakly incised.

Remarks. — The species under consideration resembles the Late Cretaceous *Thylacus cretaceus* Conrad, 1860 and the Late Triassic *Palaeonarica concentrica* (Münster, 1841).

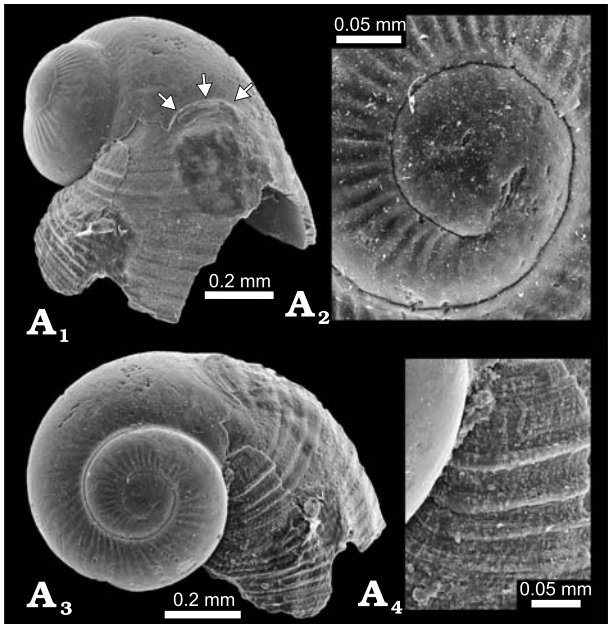


Fig. 81. The possible hipponicid *Gnaszynium baumilleri* gen. et sp. n. from Gnaszyn, Częstochowa region, Poland, Mid Bathonian (Mid Jurassic). **A**. ZPAL Ga.9/219 (holotype); A_1 lateral view, A_2 close-up of protoconch 1, A_3 apical view, A_4 details of the teleoconch ornamentation. The arrows show the sinusigera notch.

Suborder **Neogastropoda** Thiele, 1929
Superfamily **Muricoidea** Rafinesque, 1815
Family **uncertain**

Muricoidea gen. et sp. indet.
(Fig. 82A)

Material. — One juvenile shell (ZPAL Ga.9/182) from sample E1 of Wąwał, southern Mazowsze, Poland, Early Valanginian (Early Cretaceous).

Measurements. — Protoconch 1, consisting of one whorl, is 0.16 mm in diameter. The protoconch with 3.75 whorls is 1.14 mm high and 0.94 mm in diameter. The complete shell is 1.91 mm high and 1.42 mm in diameter.

Description. — Protoconch 1 is flat is not visibly ornamentated. The protoconch is cylindrical with a dome-shaped apex and a weakly incised suture. Protoconch 2 is ornamented with a spiral ribbon at the abapical suture. The demarcation from the teleoconch is not clearly visible, opisthocyrtic. The teleoconch starts with axial ribs and after 0.25 whorls, two spiral ribs appear with distinct tubercules at the intersections.

Remarks. — The size, shape and ornament of the protoconch show a great similarity to Recent members of Muricoidea e.g., *Latirus rugosissimus* (Locard, 1897) and *Fusinus bocagei* (Fischer, 1882), both of the

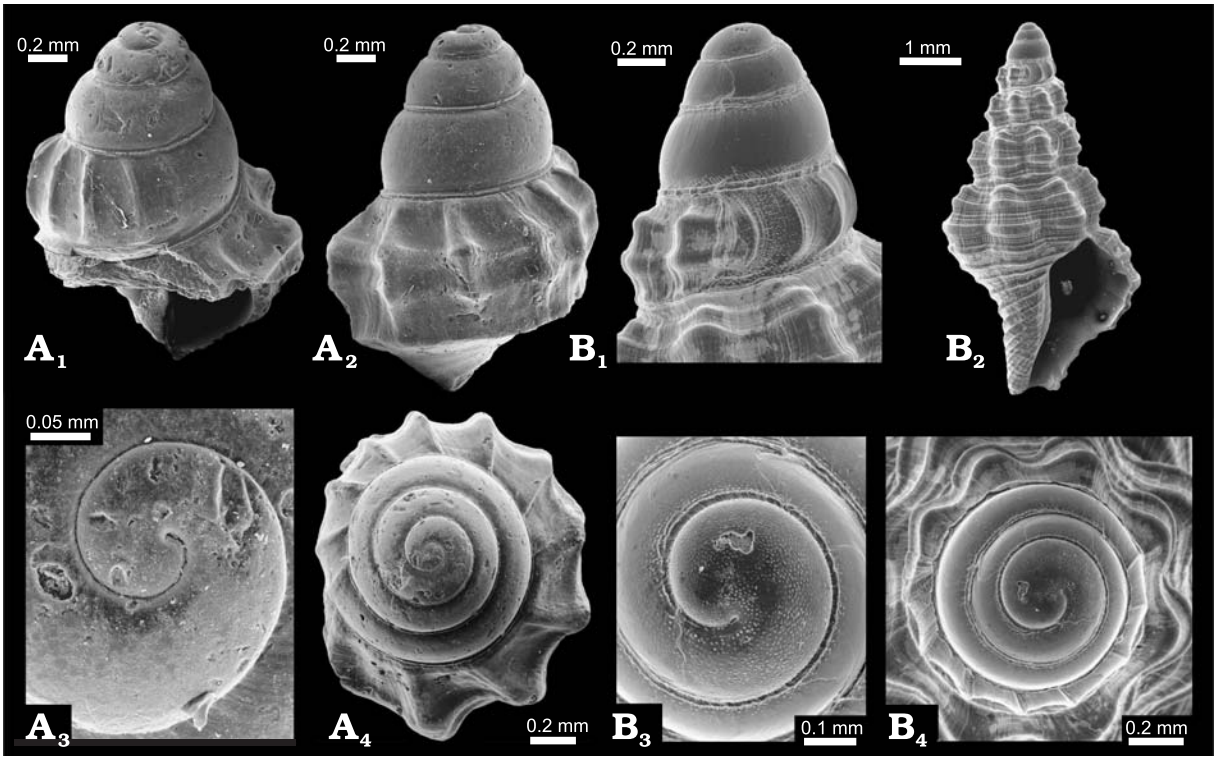


Fig. 82. The possible relationship between fossil and Recent Muricoidea. Note the close resemblance of the protoconch and early teleoconch whorls. **A**. Muricoidea gen. et sp. indet., ZPAL Ga.9/182 from Wąwał, southern Mazowsze, Poland, Valanginian (Early Cretaceous); A_1, A_2 lateral views, A_3 close-up of early protoconch whorls, A_4 apical view. **B**. *Latirus rugosissimus* (Locard, 1897), MNHN MEB 3611 from Hyères bank (depth 310 m), North Atlantic, Recent (courtesy of S. Gofas and Muséum National d'Histoire Naturelle in Paris); B_1 protoconch in lateral view, B_2 lateral view, B_3 close-up of protoconch 1, B_4 protoconch in apical view.

family Fasciolariidae Gray, 1853, illustrated by Gofas (2000). There is also some resemblance to the planktotrophic protoconchs of *Murex* (compare Ponder and Vokes 1988). It seems likely that this apex represents a very early member or predecessor of the Muricoidea.

Superfamily **uncertain**
Family **Maturifusidae,** Gründel, 2001

Remarks. — The family Maturifusidae was established by Gründel (2001) for the species of the genus *Maturifusus* Szabó, 1983. Apparently, this genus is the younger synonym of *Astandes* Wade, 1917 (see below). The members of the family have a typically large, highly conical protoconch with numerous whorls, ornamented with two strong spiral ribs. The convex teleoconch whorls are ornamented with strong axial and spiral ribs. The peristome is channeled both anteriorly and posteriorly. The protoconch of *Astandes* to some degree resembles the protoconchs of some Buccinidae (e.g., Bandel *et al.* 1997: fig. 18A–G) and it seems highly probable that this group of gastropods may be the ancestral group for Tertiary and Recent neogastropods, as already suggested by Riedel (2000). Still, the systematic position of the group remains unclear (see also discussion under *Astandes*).

Genus *Astandes* Wade, 1917
(*Maturifusus* Szabó, 1983)

Type species: *Astandes densatus* Wade, 1917; monotypy. Late Cretaceous, Coon Creek, Tennessee, USA.

Emended diagnosis. — Medium-sized anomphalous trochoid shell with round-sided whorls marked by numerous strong spiral lirae and thick collabral axial ribs. Aperture D-shaped with short anterior canal (after Wade 1917; and Sohl 1960, 1967).

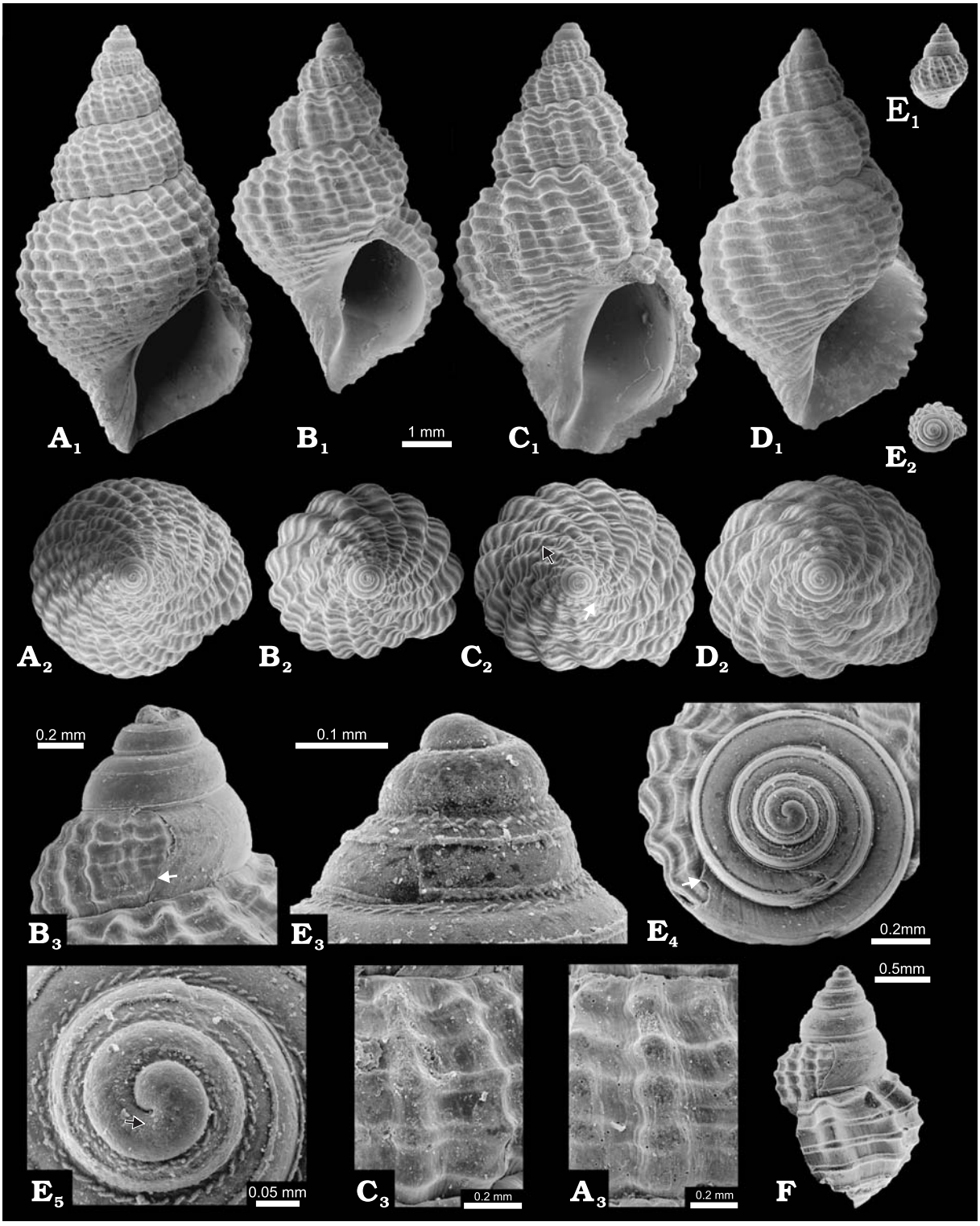


Fig. 83. The maturifusid *Astandes conspicuus* (Eichwald, 1868) from Łuków (block in glacial drift), Podlasie, Poland, Callovian (Mid Jurassic). **A**. MZ VIII Mg 4227/4; A_1 lateral view, A_2 apical view, A_3 details of teleoconch ornamentation. **B**. MZ VIII Mg 4227/1; B_1 lateral view, B_2 apical view, B_3 protoconch in lateral view. **C**. MZ VIII Mg 4227/7; C_1 lateral view, C_2 apical view, C_3 details of teleoconch ornamentation. **D**. MZ VIII Mg 4227/10; D_1 lateral view, D_2 apical view. **E**. MZ VIII Mg 4227/3; E_1 lateral view, E_2 apical view, E_3 close-up of the early protoconch whorls, E_4 protoconch in apical view, E_5 close-up of protoconch 1. **F**. MZ VIII Mg 4227/1; lateral view. Black arrow indicates demarcation between protoconch 1 and protoconch 2; white arrows indicate demarcation between protoconch and teleoconch.

Discussion. — The type species of *Astandes* is described and known exclusively from the Late Cretaceous of the United States (Wade 1917, 1926; Sohl 1960, 1967). Russian authors (Beisel 1983, Gerasimov 1992) included some Late Jurassic and Early Cretaceous species in the genus *Astandes*, whereas Szabó (1983), Schröder (1995) and Gründel (1998a, 2001) described new Jurassic species under the generic name *Maturifusus*, introduced by Szabó (1983). Sohl (1960, 1967), Beisel (1983), and Gerasimov (1992) regarded *Astandes* as a genus of Trichotropidae Gray, 1850 (a younger synonym of Capulidae Fleming, 1822). This relationship seems to be improbable, as the protoconchs of *Astandes* and trichotropids differ significantly. Szabó (1983) and Schröder (1995) suggested that *Maturifusus* (*Astandes* herein) may belong to Buccinidae Rafinesque, 1815. Riedel (2000) stated that *Maturifusus* most probably represents the early stage of neogastropod evolution and can be regarded as the common, main line of Laubierinioidea, Cassoidea, Ficoidea and Neogastropoda. As *Maturifusus* is still well demarcated from the later evolutionary forms, Gründel (2001) established the new family Maturifusinidae for it.

Range. — Bathonian (Mid Jurassic) to Late Cretaceous.

Astandes conspicuus (Eichwald, 1868)
(Fig. 83)

1868. *Murex conspicuus* sp. n.; Eichwald 1868: 956, pl. 31: 10.
1992. *Astandes conspicuus* (Eichwald, 1868); Gerasimov 1992: 97, pl. 5: 5, pl. 13: 1, 6, pl. 27: 3, 7.
1998. *Maturifusus montagi* sp. n.; Gründel, 1998a: 17, pls 5–8.

Type material: Eichwald, 1868: 956, pl. 31: 10.
Type horizon: Oxfordian, Jurassic.
Type locality: Goliowo near Moscow, Russia.

Material. — Over 100 shells from Callovian of Łuków (block in glacial drift), Podlasie, Poland.

Measurements. — The shell MZ VIII Mg 4227/4, with more weakly expressed axial ribs of four teleoconch whorls, is 8.76 mm high and 4.48 mm in diameter. Another shell MZ VIII Mg 4227/7, with ribs better expressed and four whorls of the teleoconch, is 8.37 mm high and 4.62 mm in diameter. The protoconch MZ VIII Mg 4227/1 with 5.25 whorls is 1.21 mm high and 0.88 mm in diameter.

Occurrences. — Callovian–Oxfordian (Mid to Late Jurassic) of Russia and Poland.

Emended diagnosis. — Protoconch 2 conical, ornamented with two ribbon-like spiral keels. Shell conical with incised suture. Teleoconch ornamented with strong prosocline axial ribs (12–15 on the first whorl of teleoconch) and weaker spiral ribs (about six on the second whorl of teleoconch). Peristome with short anterior and weak posterior channels. Inner lip with or without a narrow callus.

Description. — Protoconch 1 has no visible ornament. The first whorl of protoconch 2 is ornamented with small pustules at its adapical part. On the later whorls, the pustules change into a row of short dash-like threads and finally disappear on the last whorl. Demarcation between the protoconch and the teleoconch is opisthocyrtic and clearly visible, fractured. Sometimes, an umbilical chink is developed.

Remarks. — The rich material from Łuków shows that this species is higly variable, both in number of axial ribs, and in their strength (compare Fig. 83A–F). The shell named *Maturifusus montagi* by Gründel (1998a) does not exceed the variability among the *Astandes conspicuus* from Łuków. *Astandes ticurelatus* (Gründel, 2001) is also very similar in shell morphology. It differs only in the presence of rich pustulose ornamentation on the early part of the protoconch (see Gründel 2001 and below). I am not confident that this character is of specific importance, but here I leave the species apart until richer and better preserved material for *A. ticurelatus* will be found. *Astandes kostromensis* (Gerasimov, 1955) differs significantly from both *A. conspicuus* and *A. ticurelatus* in having more numerous and weaker spiral ribs. The species *Astandes densatus* Wade, 1917, *Astandes densicostatus* (Szabó, 1983), *Astandes piccuus* Beisel, 1983, and *Astandes szaboi* (Schröder, 1995) appear to be very similar to each other in having weaker axial ribs than *A. conspicuus*, *A. ticurelatus*, and *A. kostromensis*. Still, the relationship between them is not certain as the available material for these species is not preserved well enough. The Oxfordian to Kimmeridgian (Late Jurassic) *Astandes keyserlingianus* (Rouillier, 1846) from Central Russia differs from the species under consideration in having both spiral and axial ribs of the same dimension. It is however possible that this species represents an extremal morph of the *A. conspicuus* (compare with Fig. 83A$_1$) population. If so, then the shells of *A. conspicuus* have to be classified under *A. keyserlingianus* as an older synonym.

Astandes kostromensis (Gerasimov, 1955)
(Fig. 84)

1955. *Brachytrema kostromense* sp. n.; Gerasimov 1955: 196, pl. 39: 17.
1983. *Astandes kostromensis* (Gerasimov, 1955); Beisel 1983: 76, pl. 4: 2.
1992. *Astandes kostromensis* (Gerasimov, 1955); Gerasimov 1992: 97, pl. 27: 9, 10, 12.

Holotype: Gerasimov 1955: 196, pl. 39: 17.
Type horizon: Mid Callovian (Mid Jurassic).
Type locality: Polovchinovo, Kostromskaja oblast', Russia.

Material. — 20 shells from Callovian of Łuków (block in glacial drift), Podlasie, Poland.

Measurements. — The shell MZ VIII Mg 4228/2 consisting of four whorls of the teleoconch is 10.12 mm high and 6.26 mm in diameter. The protoconch of the shell MZ VIII Mg 4228/4 is 0.95 mm in diameter.

Occurrences. — Callovian (Mid Jurassic) of Russia, Siberia, and Poland.

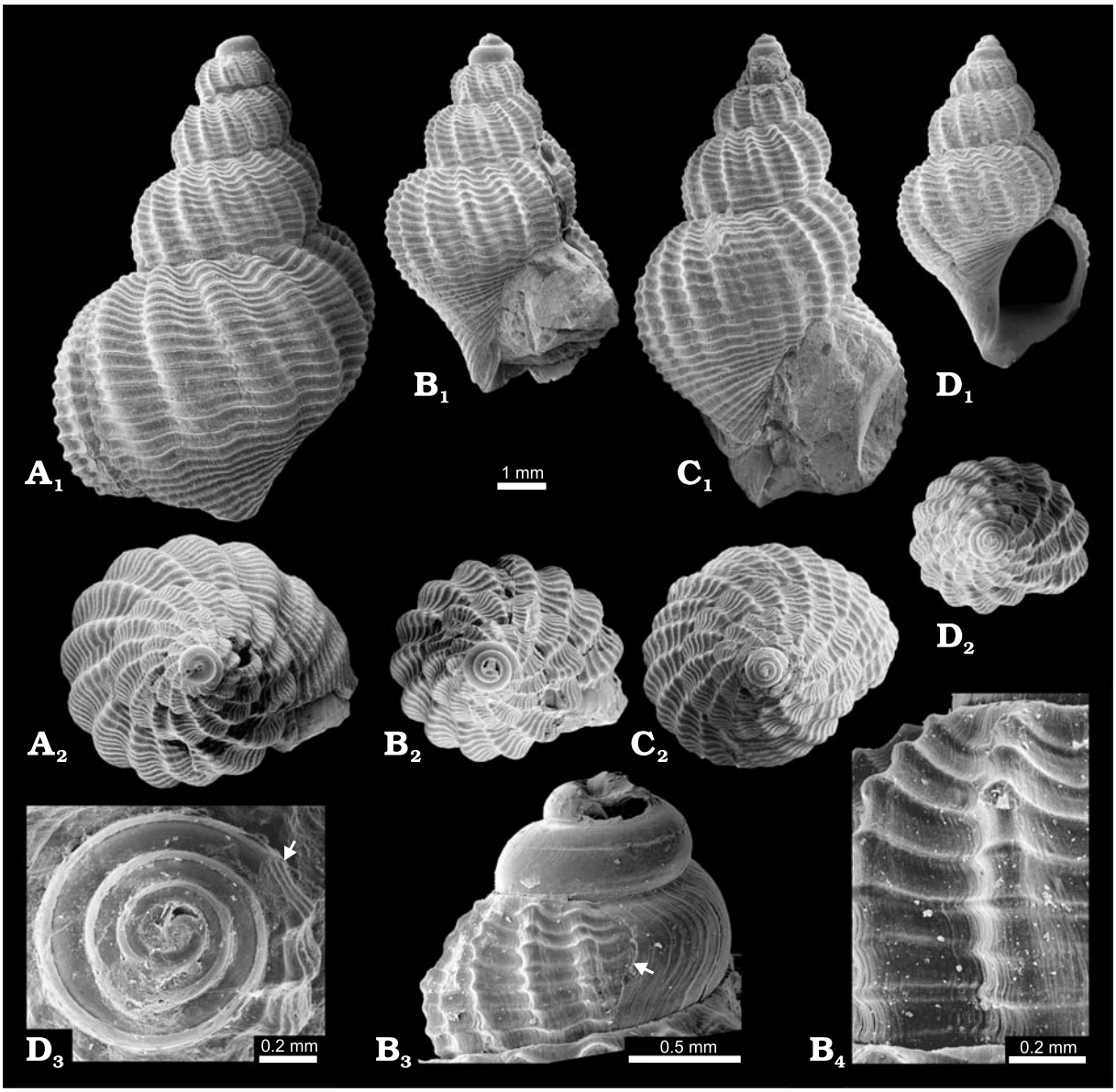


Fig. 84. The maturifusid *Astandes kostromensis* (Gerasimov, 1955) from Łuków (block in glacial drift), Podlasie, Poland, Callovian (Mid Jurassic). **A**. MZ VIII Mg 4228/2; A_1 lateral view, A_2 apical view. **B**. MZ VIII Mg 4228/1; B_1 lateral view, B_2 apical view, B_3 protoconch in lateral view, B_4 details of teleoconch ornamentation. **C**. MZ VIII Mg 4228/3; C_1 lateral view, C_2 apical view. **D**. MZ VIII Mg 4228/4; D_1 lateral view, D_2 apical view, D_3 protoconch in apical view. White arrows indicate demarcation between protoconch and teleoconch.

Emended diagnosis. — Protoconch 2 conical with two ribbon-like spiral keels. Shell conical with incised sutures. Teleoconch ornamented with strong, wide prosocline axial ribs (14–15 on first whorl of teleoconch) and much weaker spiral ribs (about eleven on second whorl of teleoconch). Peristome with short anterior and weak posterior channels.

Description. — Protoconch 1 is not known. The demarcation between the protoconch and the teleoconch is opisthocyrtic and well developed; fractured. The inner lip either has or does not have a narrow callus.

Remarks. — See remarks under *A. conspicuus*.

Astandes ticurelatus (Gründel, 2001)
(Fig. 85)

1997. sp. 1; Gründel 1977: 190, pl. 1: 6–8.
2001. *Maturifusus ticurelatus* sp. n.; Gründel 2001: 75, pl. 9: 6–14.

Holotype: Gründel 2001: 75, pl. 9: 9–11.
Type horizon: Late Bathonian (Mid Jurassic).
Type locality: Kłęby borehole 1/37, West Pomerania, Poland.

Material. — 20 shells from Bathonian of Faustianka, Częstochowa region, Poland and about 20 shells from Bathonian of Gnaszyn, Częstochowa region, Poland.

Measurements. — The shell ZPAL Ga.9/78 from Gnaszyn has three whorls of the teleoconch and is 6.43 mm high and 3.26 mm in diameter. Its protoconch is 0.86 in diameter. The shell ZPAL Ga.9/83 from Faustianka has 2.5 whorls of the teleoconch and is 5.56 mm high and 2.80 mm in diameter. Its protoconch is 0.93 in diameter.

Occurrences. — Bathonian (Mid Jurassic) of Poland and Germany.

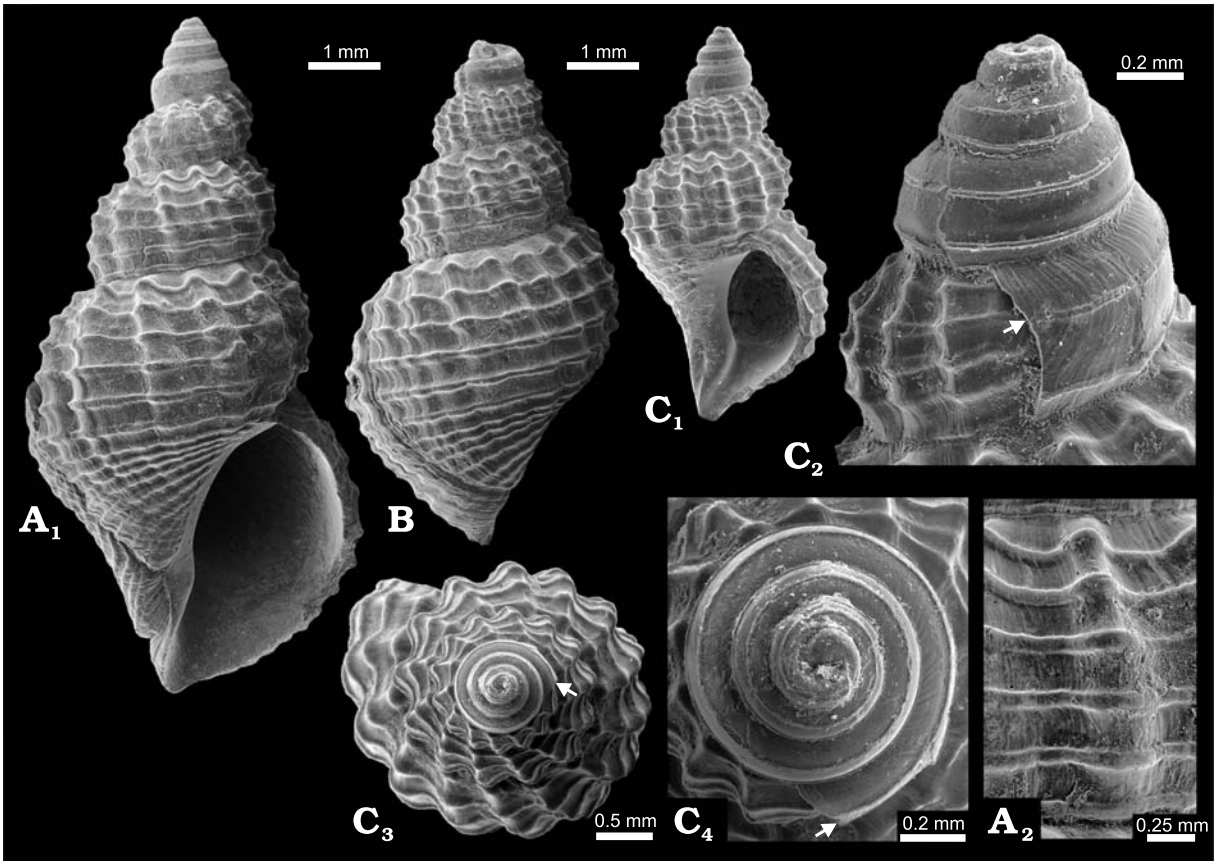


Fig. 85. The maturifusid *Astandes ticurelatus* (Gründel, 2002) from Faustianka, the Częstochowa region, Poland, Bathonian (Mid Jurassic). **A**. ZPAL Ga.9/84; A_1 lateral view, A_2 details of teleoconch ornamentation. **B**. ZPAL Ga.9/85; lateral view. **C**. ZPAL Ga.9/83; C_1 lateral view, C_2 protoconch in lateral view, C_3 apical view, C_4 protoconch in apical view. White arrows indicate demarcation between protoconch and teleoconch.

Emended diagnosis. — Protoconch 2 conical with two ribbon-like spiral keels. Shell conical with incised sutures. Teleoconch ornamented with strong prosocline axial ribs (14 on first whorl of teleoconch) and weaker spiral ribs (about six on second whorl of teleoconch). Later in ontogeny, axial ribs getting weaker. Peristome with short anterior and weak posterior channels.

Description. — Protoconch 1 is not preserved. The first two whorls of protoconch 2 are ornamented with small pustules. On later whorls, the pustules change into a row of short dash-like threads and finally disappear on the last whorl. The demarcation between the protoconch and the teleoconch is opisthocyrtic and clearly visible; fractured. The teleoconch is ornamented with strong prosocline axial ribs (14 on the first whorl of the teleoconch. On the the specimens from Faustianka the number of ribs remains the same during ontogeny, whereas in the specimens from Gnaszyn their number is reduced to 10 per whorl) and weaker spiral ribs (about six on the second whorl of the teleoconch). The inner lip has a narrow callus.

Remarks. — See remarks under *A. conspicuus*.

Family **Purpurinidae** Zittel, 1895

Genus *Purpurina* d'Orbigny, 1850

Type species: *Purpurina bellona* d'Orbigny, 1850a: pl. 331: 1–3; subsequent designation by Piette 1860: 587, and Eudes-Deslongchamps 1860: 135. Bajocian (Mid Jurassic), Bayeux, Calvados, France.

Diagnosis. — Shell moderately large to medium sized. Spire short. Whorls more or less broad, angulated with adapical ramp. Below angulation, whorl weakly convex and ornamented with numerous axial and spiral ribs. Body whorl very large, base rounded with predominant spiral sculpture. Aperture large, ovate. Outer lip almost even up to angulation. Thin inner lip covers umbilical chink (after Wenz 1939).

Discussion. — There are many species of the genus *Purpurina* described in the 1800s and early 1900s (see e.g., Hudleston 1888; Brösamlen 1909). The genus has never been revised and its species compared. There is high probability that many species of very similar morphology are in fact conspecific. The broad shells with an adapically subsutural ramp are very distinctive among the Jurassic genera. In 1895 Zittel established the new family Purpurinidae to incorporate *Purpurina*-like gastropods. The subgenus *Eucycloidea* Hudleston, 1888 was shown by Gründel (1997c) to be a vetigastropod, thus excluded from the Purpurinidae. The family Purpurinidae was placed into Cerithiacea by Cossmann (1906), and into Littorinacea by Wenz (1938) and Gerasimov (1992). Taylor *et al.* (1980) regarded the family as a potential sister group to the Neogastropoda. The obtusely conical shape and large size of the protoconchs of the species described below suggest a relationship with the family Maturifusidae, which is regarded here as a stem group of the Neogastropoda.

Range. — Carnian (Late Triassic) to Oxfordian (Late Jurassic).

Purpurina coronata Hébert *et* Eudes-Deslongchamps, 1860

(Fig. 86)

1860. *Purpurina coronata* sp. n.; Hébert and Eudes-Deslongchamps 1860: 177, pl. 1: 7.
1909. *Purpurina coronata* Hébert *et* Eudes-Deslongchamps, 1860; Makowski 1952: 23, pl. 2: 10.

Type material: Hébert *et* Eudes-Deslongchamps, 1860: 177, pl. 1: 7.
Type horizon: Callovian (Mid Jurassic).
Type locality: Montreuil-Bellay, France.

Material. — Four shells from Callovian of Łuków (block in glacial drift), Podlasie, Poland.

Measurements. — The shell MZ VIII Mg 4229/1 with 4.5 whorls of the teleoconch is 10.75 mm high and measures 7.87 mm in diameter. The protoconch of the shell MZ VIII Mg 4229/2 is 0.82 mm high and 0.96 mm wide.

Occurrences. — Callovian (Mid Jurassic) of Europe.

Emended diagnosis. — Obtusely conical protoconch. Shell with wide whorls and possessing adapical ramp perpendicular to shell axis. Below angulation, teleoconch ornamented with strong, wide axial ribs (17–18 per whorl) and spiral ribs (4–5 per whorl). Peristome ellipsoidal with rounded anterior channel. columellar lip with narrow callus.

Description. — Protoconch 1 is not known. Protoconch 2 is obtusely conical with no visible ornament. The demarcation between the protoconch and the teleoconch is not clearly visible due to imperfect preserva-

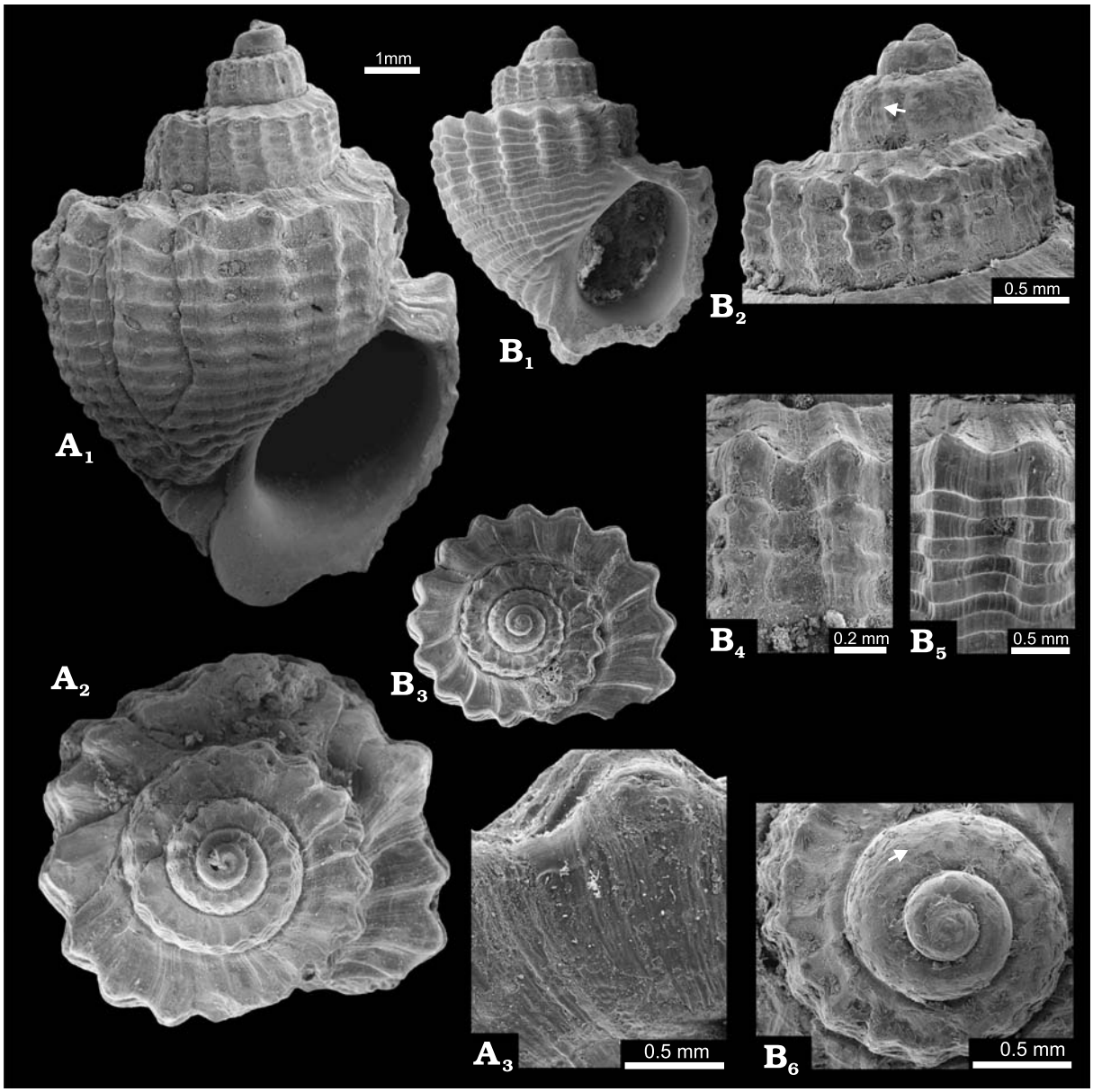


Fig. 86. *Purpurina coronata* Hébert *et* Eudes-Deslongchamps, 1860 from Łuków (block in glacial drift), Podlasie, Poland, Callovian (Mid Jurassic). **A**. MZ VIII Mg 4229/1; A_1 lateral view, A_2 apical view, A_3 details of the sutural ramp ornamentation. **B**. MZ VIII Mg 4229/2; B_1 lateral view, B_2 close-up of the apex, B_3 apical view, B_4 details of early teleoconch ornamentation, B_5 details of late teleoconch ornamentation, B_6 apex in apical view. White arrows indicate demarcation between protoconch and teleoconch.

tion. The peristome is not well preserved in the accessible specimens, but appears to be ellipsoidal, with a rounded anterior channel.

Remarks. — The species under consideration differs from *P. formosa* (see below) in having wider whorls, a perpendicular adapical ramp and a more weakly expressed anterior channel. Some similar forms were ilustrated by Hudleston (1988) and Brösamlen (1909) and it is not certain whether they are conspecific or not (see discussion under genus *Purpurina*).

Purpurina formosa (Eichwald, 1868)
(Fig. 87)

1849. *Fusus minutus* Rouillier in Rouillier *et* Fahrenkohl, 1849: 377, pl. 50: 94 (non *Fusus minutus* Roemer 1836: 140).
1868. *Fusus formosus* sp. n.; Eichwald 1868: 946, pl. 31: 7.

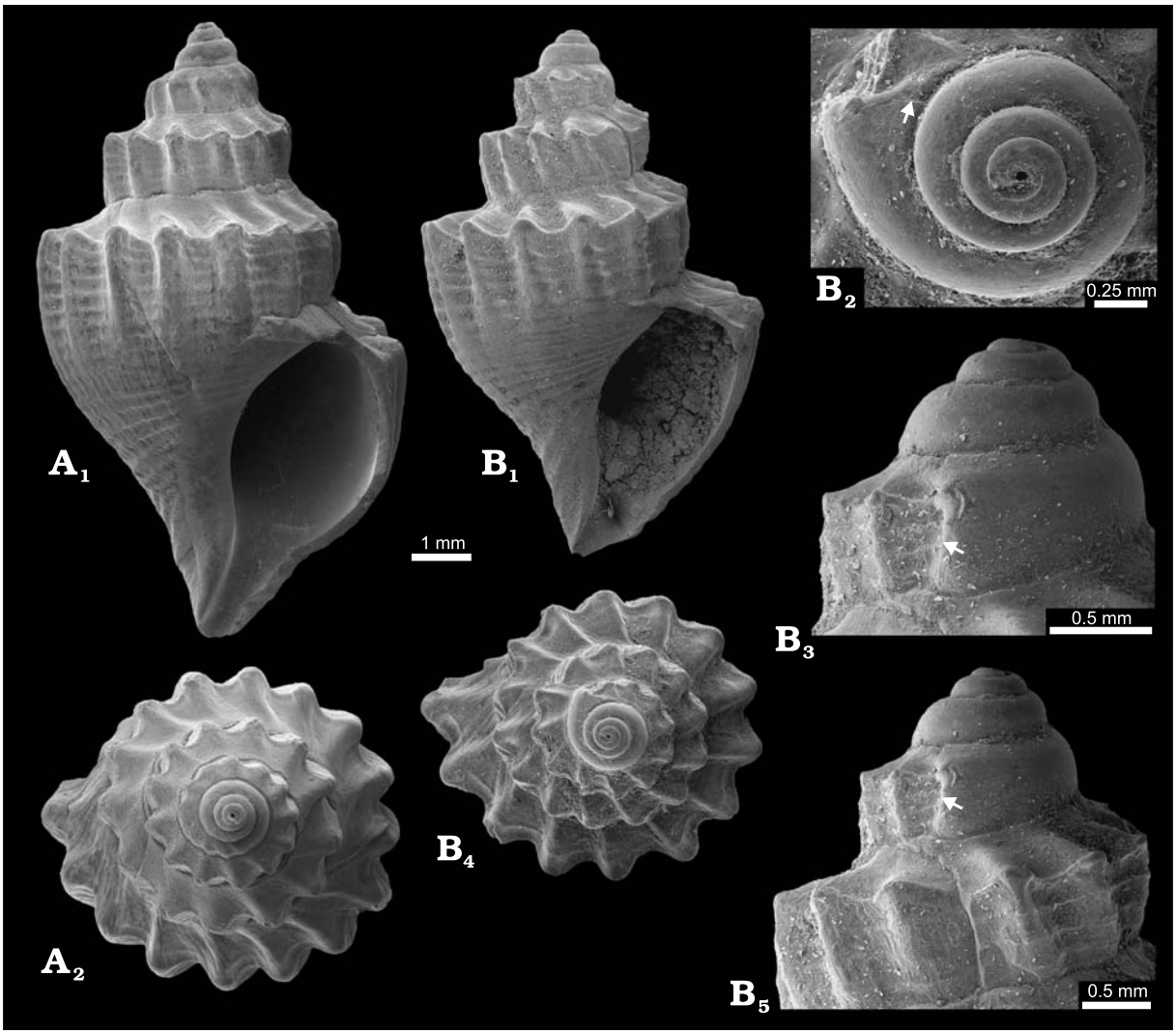


Fig. 87. *Purpurina formosa* (Eichwald, 1868) from Łuków (block in glacial drift), Podlasie, Poland, Callovian (Mid Jurassic). **A**. MZ VIII Mg 4230/3; A_1 lateral view, A_2 apical view. **B**. MZ VIII Mg 4230/1; B_1 lateral view, B_2 protoconch in apical view, B_3 protoconch in lateral view, B_4 apical view, B_5 apex in lateral view. White arrows indicate demarcation between protoconch and teleoconch.

1955. *Purpurina formosa* (Eichwald, 1868); Gerasimov 1955: 179, pl. 39: 12.
1992. *Paracerithium* (*Fossacerithium*) *formosum* (Eichwald, 1868); Gerasimov 1992: 87, pl. 24: 1–5, 10.

Type material: Eichwald 1868: 946, pl. 31: 7.
Type horizon: Oxfordian (Late Jurassic).
Type locality: Suburbs of Moscow, Russia.

Material. — Four shells from Callovian of Łuków (block in glacial drift), Podlasie, Poland.

Measurements. — The shell MZ VIII Mg 4230/3 consisting of 3.5 whorls of the teleoconch is 10.50 mm high and measures 6.12 mm in diameter. The protoconch of the shell MZ VIII Mg 4230/1 is 1.25 mm high and 1.52 mm wide.

Occurrences. — Mid to Late Jurassic of Russia and Poland.

Emended diagnosis. — Protoconch 2 obtuse conical. Shell with wide whorls possessing adapical ramp slightly oblique to shell axis. Under teleoconch, angulation ornamented with strong, wide axial ribs (15–16 per whorl) and much weaker spiral ribs (five per whorl). Peristome ellipsoidal with well pronounced anterior channel. Columellar lip with callus covering umbilical area.

Description. — Protoconch 1 is not preserved. Protoconch 2 is obtusely conical and appears to be smooth. The demarcation between the protoconch and the teleoconch is clearly visible, with a thickened apertural margin.

Remarks. — Gerasimov (1992) included the species in the genus *Paracerithium* Cossmann, 1902. Nevertheless, *Paracerithium acanthocolpum* Cossmann, 1902, the type species of *Paraceritium*, differs significantly from *P. formosa* in having a much more slender shell; angulation of the whorl instead of a subsutural ramp; and a D-shaped peristome (compare Cossmann 1906, Gründel 1997c). For the differences with *P. coronata*, see the remarks for the latter.

Subclass **HETEROBRANCHIA** Gray, 1840
Order **Heterostropha** Fischer, 1885
Superfamily **Pyramidelloidea** Gray, 1840
Family **Pyramidellidae** Gray, 1840
Genus *Chrysallida* Carpenter, 1856
(*Urlocella* Gründel, 1998)

Type species: *Chemnitzia communis* Adams, 1852; original designation. Recent, coast of Panama.

Emended diagnosis (shell). — Protoconch hyperstrophic, coaxial. Teleoconch slender, ornamented with broad axial ribs. Axial ribs may or may not appear in depression between spiral ribs. Aperture ovate, umbilicus small, narrow. columellar fold absent. Base usually smooth apart from growth lines.

Discussion. — No detailed treatment of the genus exists (compare to Warén 1991) and thus a short and provisional diagnosis is presented above. The Jurassic *Urlocella* established by Gründel (1998b) is very similar to the Recent and Tertiary species of *Chrysallida*, especially *C. sarsi* Nordsieck, 1972 (compare fig. 30A, C in Warén 1991 and Fig. 88 herein) and so it most probably congeneric.

Range. — Bathonian (herein) to Recent (e.g., Warén 1991).

Chrysallida minuera (Gründel, 1998)
(Fig. 88)

1998. *Urlocella minuera* sp. n.; Gründel 1998b: 5, pl. 1: 11–13, pl. 2: 14–16.

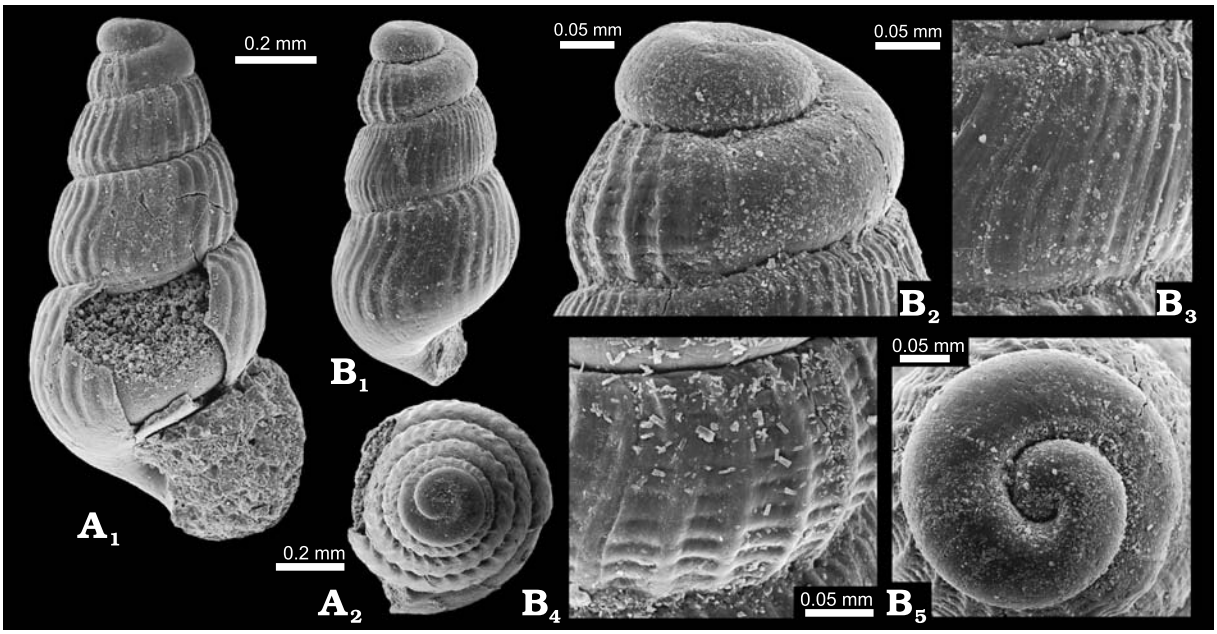


Fig. 88. The pyramidellid *Chrysallida minuera* (Gründel, 1998) from Faustianka, Częstochowa region, Poland, Bathonian (Mid Jurassic). **A**. ZPAL Ga.9/221; A_1 lateral view, A_2 apical view. **B**. ZPAL Ga.9/220; B_1 lateral view, B_2 protoconch in lateral view, B_3, B_4 details of teleoconch ornamentation, B_5 protoconch in apical view.

Holotype: Gründel 1998b: 5, pl. 1: 11–12.

Type horizon: Late Bathonian (Mid Jurassic).

Type locality: Kłęby borehole 1/37, West Pomerania, Poland.

Material. — Two shells from Bathonian (Mid Jurassic) of Faustianka, Częstochowa region, Poland.

Measurements. — Protoconch 1 of about 0.75 whorls is 0.09 mm in diameter. The whole protoconch is 0.26 mm in diameter. A shell (ZPAL Ga.9/221) with 1.5 teleoconch whorls is 0.34 mm high and 1.04 mm in diameter.

Occurrences. — Type locality only.

Emended diagnosis. — Protoconch hyperstrophic, coaxial. Demarcation from teleoconch clearly visible, orthocline. Teleoconch slender, ornamented with sigmoidal, axial ribs (usually 28–30 ribs per whorl) and, on early whorls, blunt spiral ribs.

Remarks. — The Jurassic *C. minuera* is very similar to Recent *C. sarsi* Nordsieck, 1972 (compare to e.g., Warén 1991). The latter differs by broader axial ribs and the presence of weak spiral ribs on all whorls of the teleoconch.

Family **Amathinidae** Ponder, 1987

Genus *Leucotina* Adams, 1860

Type species: *Acteon dianae* Adams, 1855 (*Leucotina niphonensis* Adams, 1860); original designation. Recent, Japan.

Diagnosis (shell). — Shell thick, ovate to oblong ovate. Strong spiral keels with longitudinal striae in interspaces on whole surface of shell (from Hori and Tsuchida 1995).

Discussion. — The Recent *Leucotina* is a group of small gastropods living on the sandy bottom of the Pacific Ocean (Hori and Tsuchida 1995). The genus was established by Adams (1860) as part of the family Acteonidae, based on shell characters. After examining the soft parts, Ponder (1987) supposed that *Leucotina* can be classified as an amathinid. Hori and Tsuchida (1995) examined the species of this genus in more detail and confirmed their own assessment that the species belong to the family Amathinidae. The Callovian (Mid Jurassic) genus *Heteronerita* Gründel, 1998 is very similar to Recent *Leucotina* and most probably the former genus belongs to family Amathinidae or even is congeneric with *Leucotina*.

Range. — Early Cretaceous (herein) to Recent.

Leucotina stolarskii sp. n.

(Fig. 89)

1995. ?*Olygoptycha* sp.; Schröder 1995: 70, pl. 13: 5–8, 16.

Holotype: ZPAL Ga.9/281, Fig. 89A.

Type horizon: Sample L1, *Tirnoviella pertransiens* Zone, Early Valanginian (Early Cretaceous).

Type locality: Wąwał, southern Mazowsze, Poland.

Derivation of the name: In honour of Jarosław Stolarski.

Material. — 23 shells from the type locality.

Measurements. — The protoconch measures 0.30 mm in diameter. The shell of the holotype consisting of three teleoconch whorls is 3.36 mm high and 2.16 mm in diameter.

Occurrences. — Type locality, *Tirnoviella pertransiens* Zone to *Saynoceras verrucosum* Zone.

Diagnosis. — Protoconch clearly demarcated from teleoconch, medioaxial, smooth, sunken deeply into first teleoconch whorl. Shell broadly spindle-like, 1.55 times as high as broad. Teleoconch starting with growth lines only, after half whorl 7–8 spiral, pitted, evenly spaced striae appearing. Shape of pits rhoboidal to rectangular. Base ornamented with striae as found on later part of whorls. Teleoconch whorls rounded with narrow, well pronounced adapical ramp. Peristome elongated. Columella thick, without folds. Columellar area with weakly developed, narrow umbilical chink.

Remarks. — *L. stolarskii* differs from the Recent species of *Leucotina* in having a thick inner lip and a very weakly developed umbilical chink.

Genus *Cyclothyca* Stearns, 1890

Type species: *Cyclothyca corrugata* Stearns, 1890; monotypy. Recent, west coast of Nicaragua.

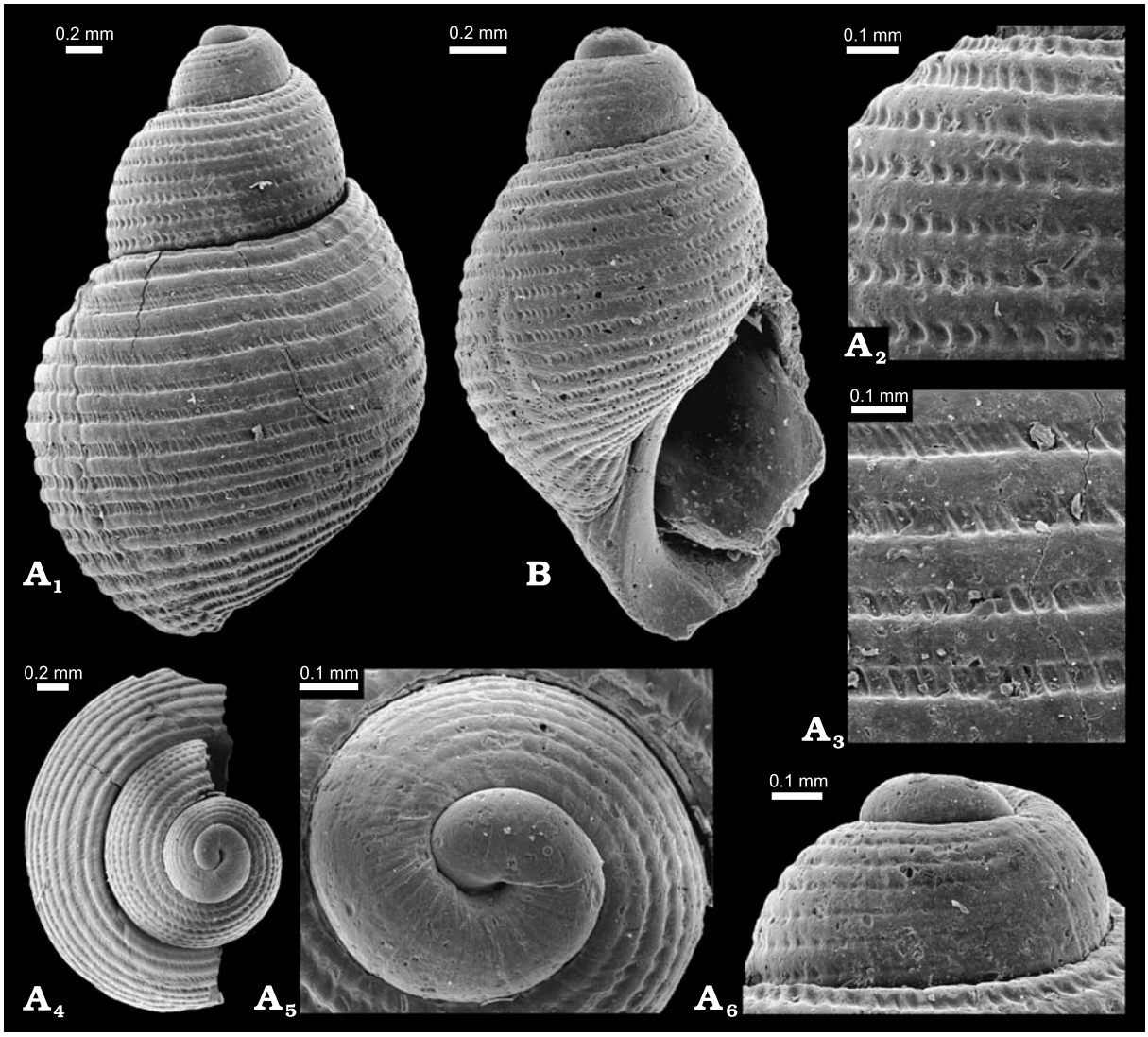


Fig. 89. The amathinid *Leucotina stolarskii* sp. n. from Wąwał, southern Mazowsze, Valanginian (Early Cretaceous). **A**. ZPAL Ga.9/281 (holotype) from sample L1; A_1 lateral view, A_{2-3} details of the teleoconch ornamentation at the second and third whorls respectively, A_4 apical view A_5 close-up of the apex in apical view, A_6 close-up of the apex in lateral view. **B**. ZPAL Ga.9/294 from sample H1; lateral view.

Diagnosis. — Small shell, spiral, few whorls. Spire short, and body whorl large and transversely elongated or produced. Aperture oblong, ovate, more or less oblique, very large, continuous and effuse. Surface spirally ribbed and marked with longitudinal growth lines (after Stearns 1890).

Discussion. — Stearns (1890) originally included the genus in the family Capulidae Fleming, 1822. Ponder (1987) mentioned the genus as the probable member of the family Amathinidae. *Cyclothyca corrugata* Stearns, 1890, the type species of *Cyclothyca* has a heterostrophic protoconch (unpublished materials of Anders Warén) and actually represents the "pyramidellid limpet" of the family Amathinidae.

Range. — Early Cretaceous (herein) to Recent (Stearns 1890).

Cyclothyca valanginiana sp. n.
(Fig. 90)

Holotype: ZPAL Ga.9/209, Fig. 90.

Type horizon: Sample B3, *Saynoceras verrucosum* Zone, Late Valanginian (Early Cretaceous).

Type locality: Wąwał, southern Mazowsze, Poland.

Derivation of the name: After Valanginian (Early Cretaceous).

Material. — One shell from the type locality.

Measurements. — The shell (holotype) with one teleoconch whorl is 0.60 mm high and mesures 0.76 mm in diameter.

Occurrences. — Type locality only.

Diagnosis. — Shell low-spired with nerly flat upper surface and slightly convex lateral surface. Protoconch heterostrophic. Teleoconch with six strong spiral keels on lateral part of whorl and blunt spiral grooves on upper part of whorl. Axial sculpture consisting of thickened growth lines only.

Description. — The protoconch is smooth at the visible part. A shallow groove is the demarcation between the protoconch and the teleoconch. The peristome is large and badly preserved.

Remarks. — This species is most similar to the Recent *C. corrugata* and that is why I decided to include it in the genus *Cyclothyca*. There is also some resemblance to the genus *Phasianema* Wood, 1842, also belonging to the family Amathinidae (Ponder 1987).

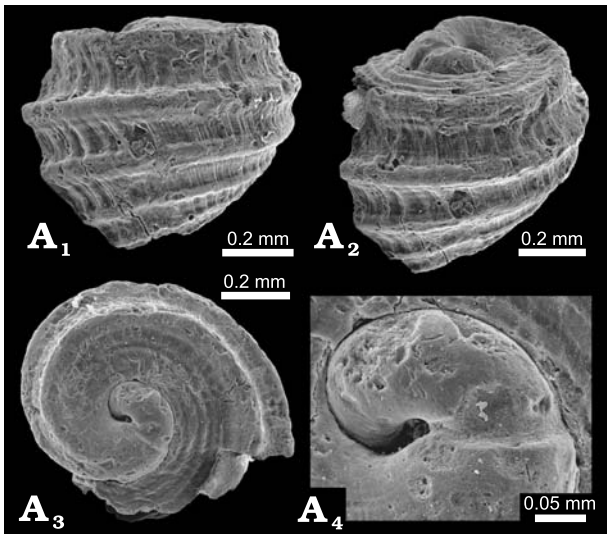


Fig. 90. The amathinid *Cyclothyca valanginiana* n.sp. from Wąwał, southern Mazowsze, Poland, Valanginian (Early Cretaceous). **A**. ZPAL Ga.9/209 (holotype) from sample B3; A_1, A_2 lateral views, A_3 apical view, A_4 close-up of the protoconch.

Amathinidae gen. et sp. indet.
(Fig. 91)

Material. — One incomplete adult shell and one juvenile shell from *Saynoceras verrucosum* Zone of Late Valanginian, Wąwał, southern Mazowsze, Poland.

Measurements. — The shell (ZPAL Ga.9/319) of about three teleoconch whorls is 1.1 mm high and 1.78 mm in diameter.

Description. — The shell is low spired and 0.62 times as high as broad. The protoconch is heterostrophic. The demarcation from the teleoconch is not visible on the accessible specimens. Teleoconch ornamented with evenly spaced, pitted spiral striae. The peristome remains unknown.

Remarks. — The low spired, rapidly expanded shells described above are similar to some genera of the family Amathinidae e.g., *Iselica* Dall, 1918 and *Phasianema* Wood, 1842 (see e.g., Ponder 1987). The pat-

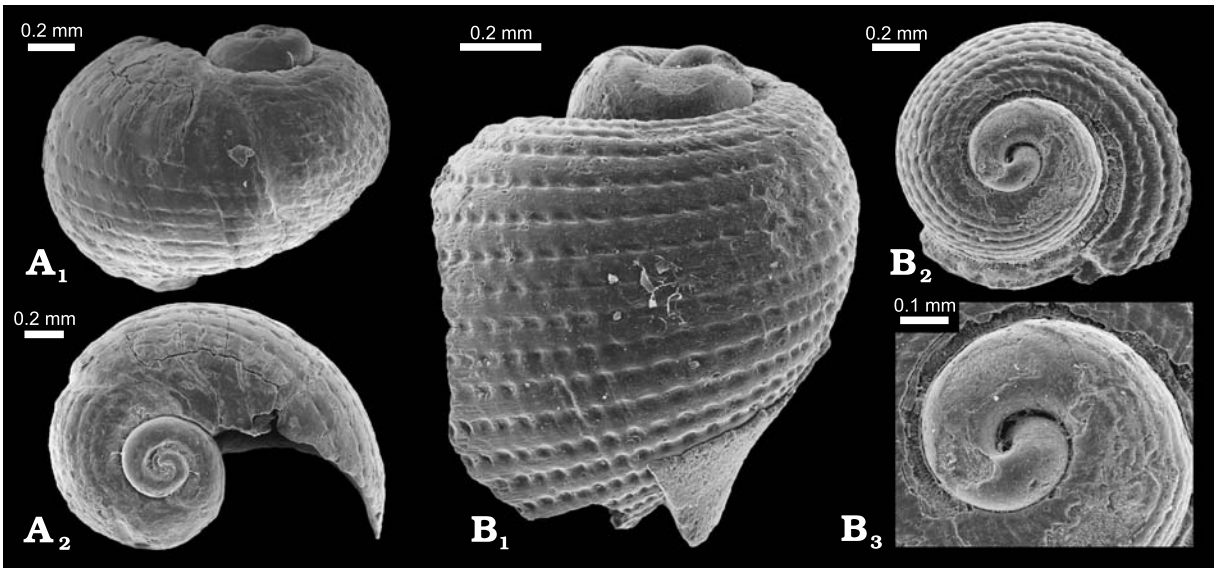


Fig. 91. Amathinidae gen et sp. indet. from Wąwał, southern Mazowsze, Poland, Valanginian (Early Cretaceous). **A**. ZPAL Ga.9/319; A_1 lateral view, A_2 apical view. **B**. ZPAL Ga.9/318; B_1 lateral view, B_2 apical view, B_3 apex in apical view.

tern of ornamentation resembles that of *Leucotina* (see above) but also some cephalaspid opisthobranchs (see below e.g., *Acteon*, *Tornatellaea*, *Ringicula*). The incomplete preservation does not allow a no more detailed determination of this species.

Family **Ebalidae** Warén, 1995
Genus *Ebala* Leach in Gray, 1847
(*Falsoebala* Gründel, 1998)

Type species: *Turbo nitidissima* Montagu, 1803; monotypy. Recent.

Emended diagnosis (shell). — Protoconch hyperstrophic, medioaxial. Teleoconch cylindrical, smooth or with faint spiral lines and fine straight or flexuous axial lines, often with notch at suture (based on family diagnosis by Warén 1994).

Discussion. — The genus is not easy to recognize conchologically (Warén 1994). The species of *Ebala* can only be safely recognized when the jaw apparatus is analysed (Warén 1994) and thus only a short diagnosis for the shell is presented above. The Jurassic *Falsoebala* established by Gründel (1998b) is very similar to the Recent species of *Ebala*, especially *Ebala striatula* (Jeffreys 1856). The diagnostic character as presented by Gründel (1998b) which is the sinuous growth line pattern, is also present among Recent species of *Ebala*.

Range. — Pliensbachian (Schröder 1995) to Recent (e.g., Warén 1994).

Ebala varsoviensis sp. n.
(Fig. 92)

Holotype: ZPAL Ga.9/222, Fig. 92.

Type horizon: *Quenstedtoceras lamberti* Zone, Late Callovian (Mid Jurassic).

Type locality: Łuków (block in glacial drift), Podlasie, Poland.

Derivation of the name: After the latinization of Warszawa, the capital of Poland.

Material. — One complete shell from the type locality.

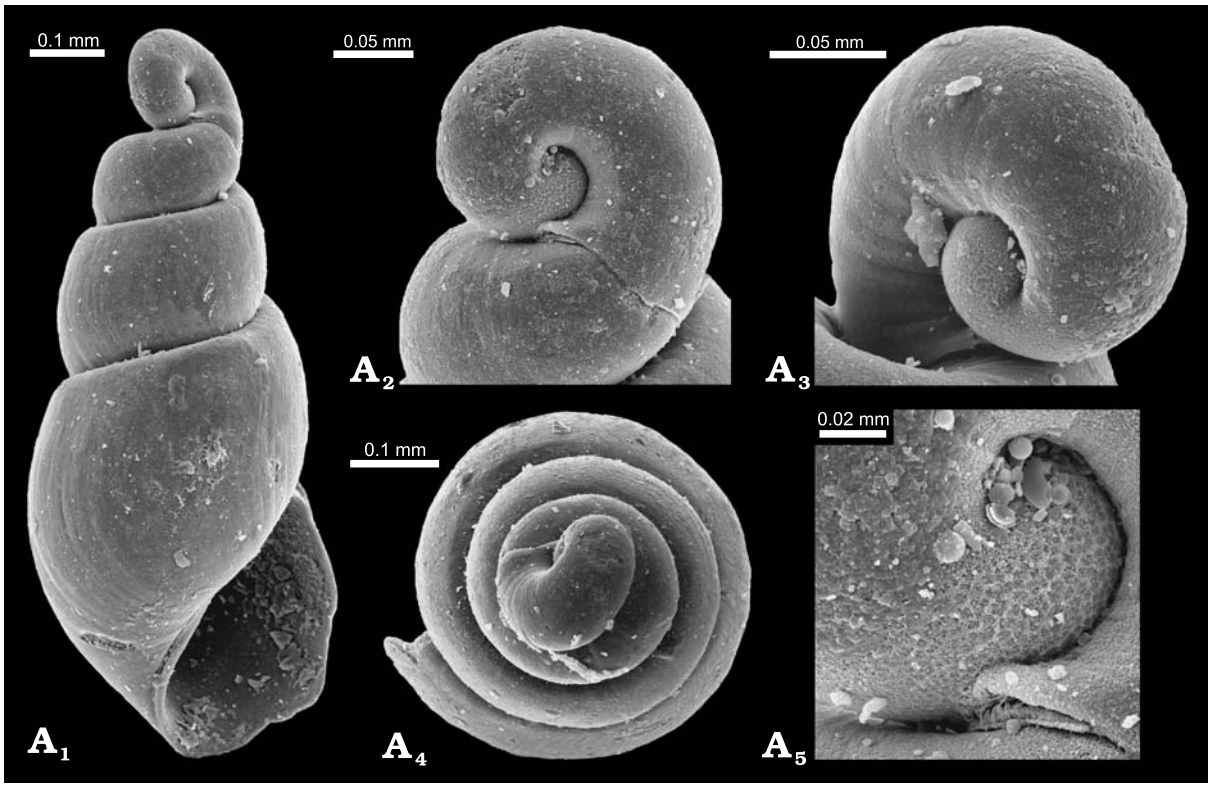


Fig. 92. *Ebala varsoviensis* sp. n. from Łuków (Callovian, Mid Jurassic). **A**. ZPAL Ga.9/222; A_1 lateral view, A_2 protoconch in umbilical view, A_3 protoconch in apical view, A_4 apical view, A_5 details of protoconch 1 ornamentation.

Measurements. — Protoconch with about 1.25 whorls is 0.21 mm in diameter. The holotype consisting of three teleoconch whorls is 0.98 mm high and 0.43 mm in diameter.

Occurrences. — Type locality only.

Diagnosis. — Teleoconch long, multispiral, 2.27 times as high as broad. Whorls rounded. Protoconch 1 ornamented with granulate pattern. Protoconch 2 hyperstrophic, medioaxial, smooth apart from growth lines. Teleoconch smooth apart from prosocyrt growth lines. Aperture with very narrow inner lip and very narrow umbilical furrow.

Description. — As in diagnosis.

Remarks. — The shell of *E. varsoviensis* is broader than the shells of similar *Ebala compacta* (Gründel, 1998) from Mid Callovian (Mid Jurassic) of northwest Poland, and has no axial lirae on the protoconch.

Ebala spp.
(Fig. 93)

Material. — 23 shells, all of which have a broken protoconch, from Wąwał, Southern Mazowsze, Poland, *Tirnoviella pertransiens* and *Busnardoides campylotoxus* Zones of the Early Valanginian (Early Cretaceous).

Measurements. — Protoconch not known. Teleoconch ZPAL Ga.9/225 consisting of five whorls is 1.38 mm high and 0.43 mm in diameter. Teleoconch (ZPAL Ga.9/224) consisting of four whorls is 1.06 mm high and 0.41 mm in diameter. Teleoconch ZPAL Ga.9/223 consisting of four whorls is 1.69 mm high and 0.38 mm in diameter.

Description. — The shell is elongated, 2.59 to 4.45 times as high as broad. The protoconch is not known. The teleoconch has very weak stripes and sigmoidal growth lines. The suture is weakly incised. The columellar area covered by narrow inner lip.

Remarks. — The shells described above are similar to *Ebala procera* (Gründel, 1998) but it differs in lacking the axial ribs. The shell ZPAL Ga.9/224 is similar to *Ebala compacta* (Gründel, 1998) but differs from it by a much weaker incised suture.

Superfamily **Architectonicoidea** Gray, 1850

Family **Mathildidae** Dall, 1865

Genus *Mathilda* Semper, 1865
(*Tricarilda* Gründel, 1973)

Type species: *Turbo quadricarinatus* Brocchi, 1814; subsequent designation by De Boury 1883: 112. Pliocene, Italy.

Diagnosis. — Protoconch hyperstrophic, diverging about 100–145° from teleoconch axis, smooth or, in some Mesozoic species, with adapical and abapical, axial folds. Teleoconch slender to broadly cone-shaped. Upper side with round to quadrangular, apertural lip, often slightly channeled at columella and under major spiral ribs of body whorl. First teleoconch whorl already with at least a subset of adult axial and spiral sculpture. Exposed primary sculpture on upper side consisting of 3 or more spiral ribs, 1 or 2 of main spiral ribs markedly more prominent than others. Number of spiral ribs increasing during ontogeny. At rib intersections, spiral ribs crossed by weaker axial ribs, threads or enhanced growth lines, usually with sculpture of rounded, more-or-less coarse, nodes. Base concave or slightly inflated, with several spiral threads or ribs, surrounding solid columella, or narrow umbilical chink, or funnel-shaped umbilicus (after Bieler 1995).

Discussion. — The review by Bieler (1995) of the mathildids from a single geographical region, has shown that a wide range of morphological diversity exists among the Recent species of *Mathilda*. The most stable character uniting the species of *Mathilda* is the number of spiral ribs on the early teleoconch, which is three-to-four among the Recent species of *Mathilda*. A similar pattern of ornamention is found in the fossil genus *Tricarilda* of Gründel (1973) which is regarded here as congeneric with *Mathilda*. The oldest known species, which can be identified as *Mathilda*, is Aalenian-to-Valanginian *M. schmidti* and it probably represents an early offshoot of the lineage of the more weakly ornamented *Promathildia* (see Fig. 138).

Range. — Mid Jurassic (e.g., Gründel 1997a and herein) to Recent (e.g., Bieler 1995).

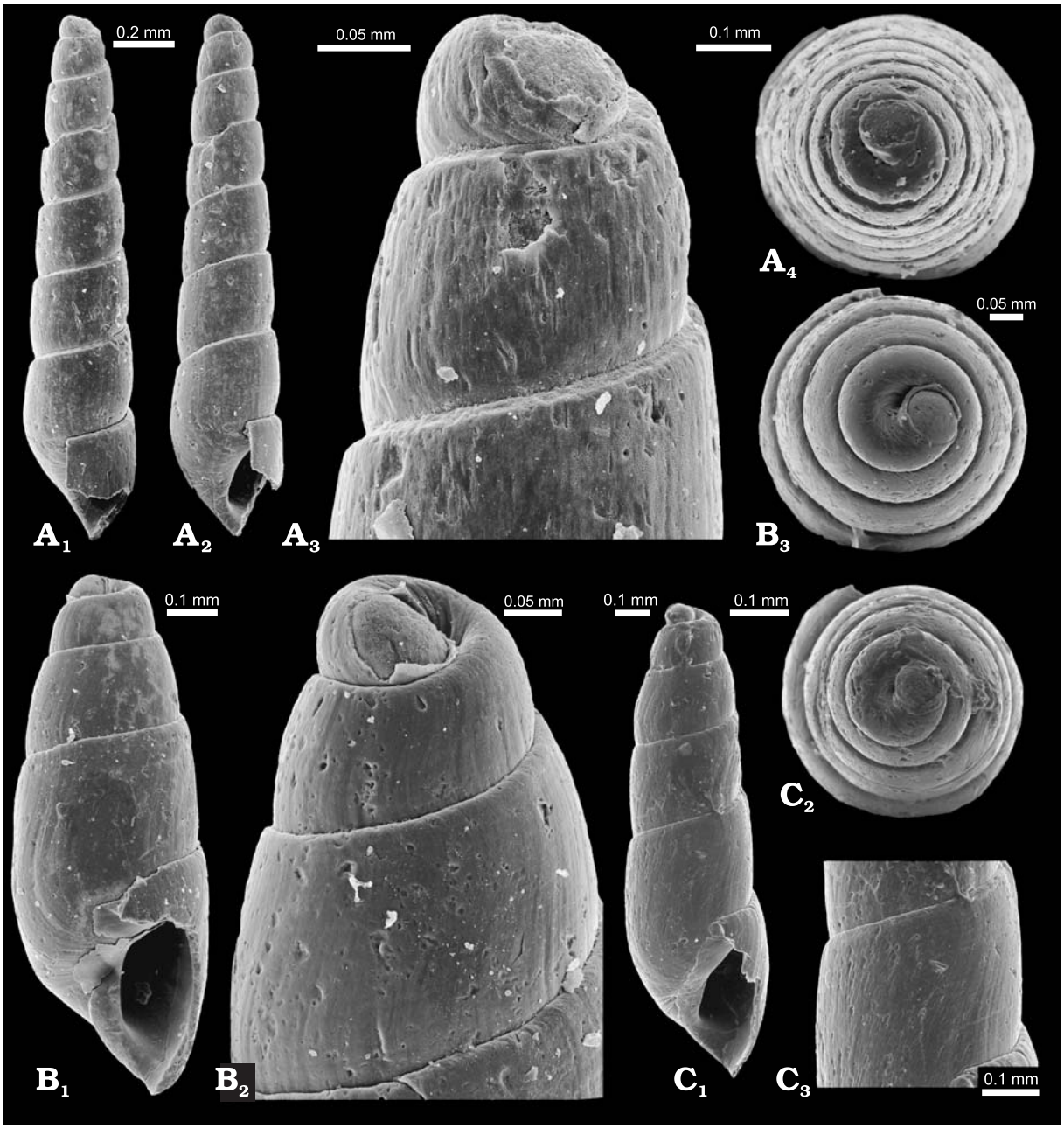


Fig. 93. *Ebala* spp. from Wąwał, southern Mazowsze, Poland, Valanginian (Early Cretaceous). **A**. ZPAL Ga.9/223 from sample D1; A_1, A_2 lateral views, A_3 apex in lateral view, note the broken off protoconch, A_4 apical view. **B**. ZPAL Ga.9/224 from sample D1; B_1 lateral view, B_2 apex in lateral view, note broken off protoconch, B_3 apical view. **C**. ZPAL Ga.9/225 from sample D1; C_1 lateral view, C_2 apical view, C_3 close-up of the teleoconch surface.

Mathilda schmidti (Walther, 1951)
(Fig. 94)

1951. *Promathildia schmidti* sp. n.; Walther 1951: 67, pl. 2A: 10, pl. 3: 9, pl. 5: 10.2.

1995. *Mathilda schmidti* (Walther, 1951); Schröder 1995 partim: 44, pl. 7: 18–21, pl. 15: 8, non pl. 7: 16, 17 — *M. plana* Gründel, 1973.

1997. *Tricarilda schmidti* (Walther, 1951); Gründel 1997a: 139, not illustrated.

Holotype: Walther 1951: 67, pl. 3: 9A.

Type horizon: Dogger δ_1, Late Bajocian (Mid Jurassic).

Type locality: Fuhrberg borehole 18, Germany.

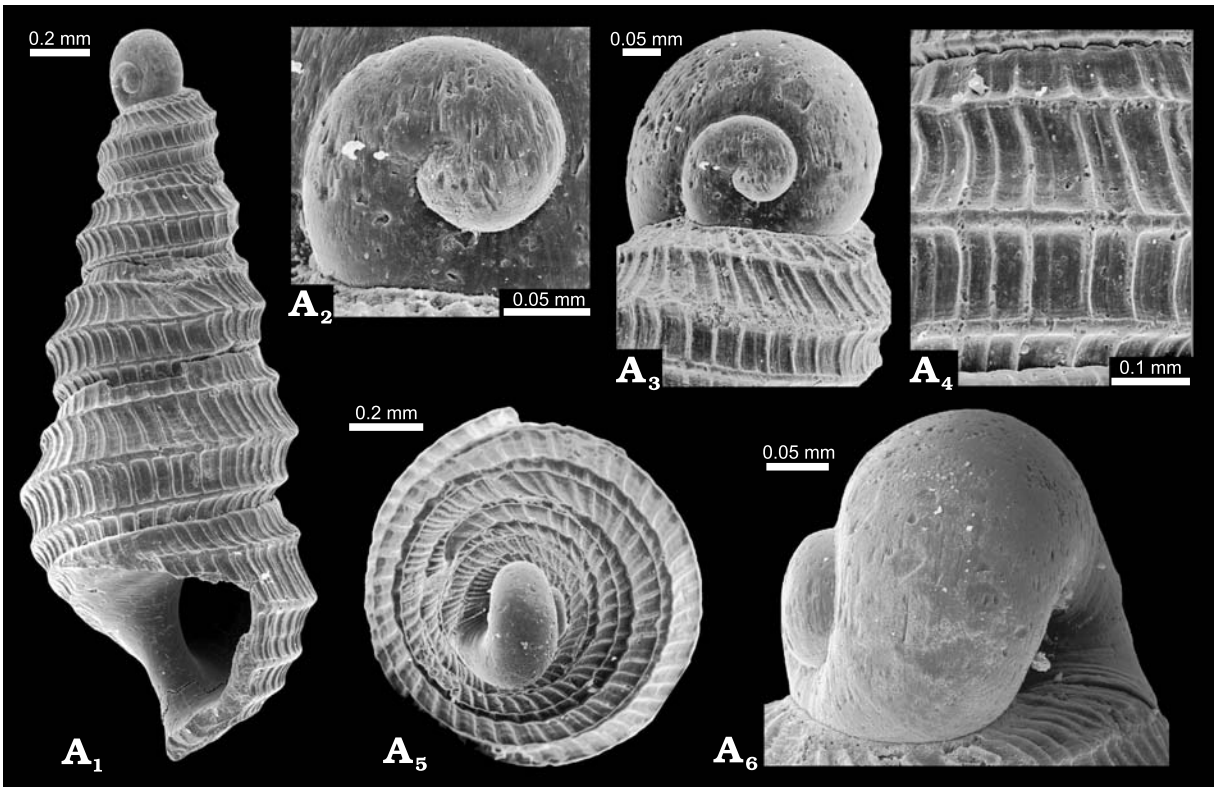


Fig. 94. *Mathilda schmidti* (Walther, 1951) from Wąwał, southern Mazowsze, Poland, Valanginian (Early Cretaceous). **A**. ZPAL Ga.9/226; A_1 lateral view, A_2 close-up of the protoconch 1, A_3 protoconch in apical view, A_4 details of teleoconch ornamentation, A_5 apical view, A_6 protoconch in lateral view.

Material. — 27 shells from Valanginian (Early Cretaceous) of Wąwał, southern Mazowsze, Poland and 14 shells from Callovian (Mid Jurassic) of Łuków (block in glacial drift), Podlasie, Poland.

Measurements. — The protoconch consisting of about two whorls is 0.32 mm high and 0.36 mm in diameter. A shell (ZPAL Ga.9.226) with 4.25 teleoconch whorls is 2.42 mm high and 0.94 mm in diameter.

Occurrences. — Bajocian, Mid Jurassic (Walther, 1951) to Valanginian, Early Cretaceous (herein).

Emended diagnosis. — Shell elongate, 2.3 times as high as broad. Protoconch hyperstrophic, diverging about 106° from teleoconch axis, smooth. Teleoconch starting with three prominent and one subsutural spiral rib. The latter is later submerged under following whorl (Fig. 139). Whorls slightly angulated at spiral ribs. Spiral ribs crossed by weaker, prosocline axial ribs (about 41–42 per whorl).

Description. — The suture is incised. The peristome is elongated posteriorly into a wide, shallow channel. The thin inner lip covers the columellar area.

Remarks. — The *M. schmidti* is most similar to *M. makowskii* but the latter has four spiral ribs and more rounded whorls. Also similar, *M. striatissima* has distintly angulated whorls and the number of its spiral ribs increases during ontogeny.

Mathilda makowskii sp. n.
(Fig. 95)

1952. *Turritella krantzi* Rouillier, 1849; Makowski 1952, partim: fig. 4, non pl. 5: 8 — *Gordenella krantzi* (Rouillier, 1949).

Holotype: ZPAL Ga.9/273, Fig. 95A.

Type horizon: *Quenstedtoceras lamberti* Zone, Late Callovian (Mid Jurassic).

Type locality: Łuków (block in glacial drift), Podlasie, Poland.

Derivation of the name: In honour of the late Prof. Henryk Makowski.

Material. — Three shells from Łuków (block in glacial drift), Podlasie, Poland and one shell from Faustianka, Częstochowa region, Poland.

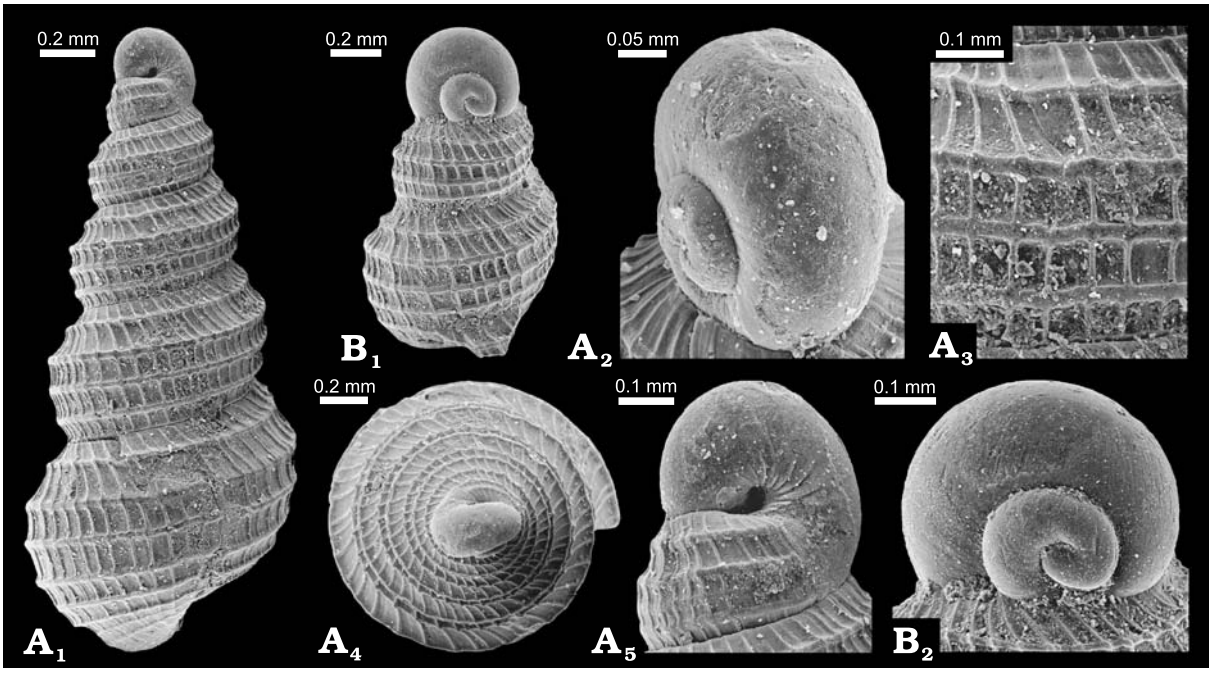


Fig. 95. Mid Jurassic *Mathilda makowskii* sp. n. from Poland. **A**. ZPAL Ga.9/273 (holotype) from Łuków (block in glacial drift), Podlasie, Callovian; A_1 lateral view, A_2 protoconch in latero-apical view, A_3 details of teleoconch ornamentation, A_4 apical view, A_5 protoconch in umbilical view. **B**. ZPAL Ga.9/274 from Faustianka, the Częstochowa region, Bathonian; B_1 lateral view, B_2 protoconch in apical view.

Measurements. — The protoconch is 0.29 mm high and 0.42 mm in diameter. The holotype consisting of 5.5 teleoconch whorls is 2.21 mm high and 1.26 mm in diameter.

Occurrences. — Callovian (Mid Jurassic) of Łuków and Bathonian (Mid Jurassic) of Faustianka.

Diagnosis. — Shell elongate, 1.76 times as high as broad. Protoconch hyperstrophic, diverging about 112° from teleoconch axis, ornamented by abapical folds and remnants of adapical folds. Teleoconch starting with four prominent spiral ribs whose number stable during ontogeny. Distances between spiral ribs equal. Whorls rounded. Spiral ribs crossed by weaker, prosocline axial ribs (about 37–38 per whorl).

Remarks. — *M. makowskii* differs from the similar *M. angulata* in having equal distances between the spiral ribs and a more slender shell shape. For differences with *M. schmidti*, see at the latter.

Mathilda angulata (Gründel, 1997)
(Fig. 96)

1990. *Mathilda* (*Turritelloidea*) sp.; Gründel 1990b: 1139, pl. 2: 10, 11.
1997. *Turrithilda angulata* (Gründel, 1997); Gründel 1997a: 146, pl. 5: 73–77.

Holotype: Gründel 1997a: 146, pl. 5: 77.
Type horizon: Late Callovian (Mid Jurassic).
Type locality: Hohendorf (erratic boulder), Mecklenburg-Vorpommern, Germany.

Material. — Three shells from Łuków (block in glacial drift), Podlasie, Poland.

Measurements. — The protoconch consisting of about two whorls is 0.40 mm in diameter. A shell (ZPAL Ga.9/251) consisting of 3.5 teleoconch whorls is 1.51 mm high and 0.75 mm in diameter.

Occurrences. — Callovian (Mid Jurassic) of Germany and Poland.

Emended diagnosis. — Shell elongate, 2.0 times as high as broad. Protoconch hyperstrophic, ornamented by adapical and abapical axial folds. Teleoconch starting with four prominent spiral ribs (Fig. 139); their number increasing during ontogeny (to six on the third whorl). The most adapical spiral rib and the following rib more widely spaced than the others. Whorls weakly angulated at most adapical spiral rib. Otherwise whorls rounded. Spiral ribs crossed by weaker, prosocline or weakly sigmoidal axial ribs (about 44–45 per whorl).

Remarks. — *M. angulata* differs from *M. podlasiensis* by having fewer spiral ribs and stronger and less numerous axial ribs. For differences with *M. makowskii* see at the latter.

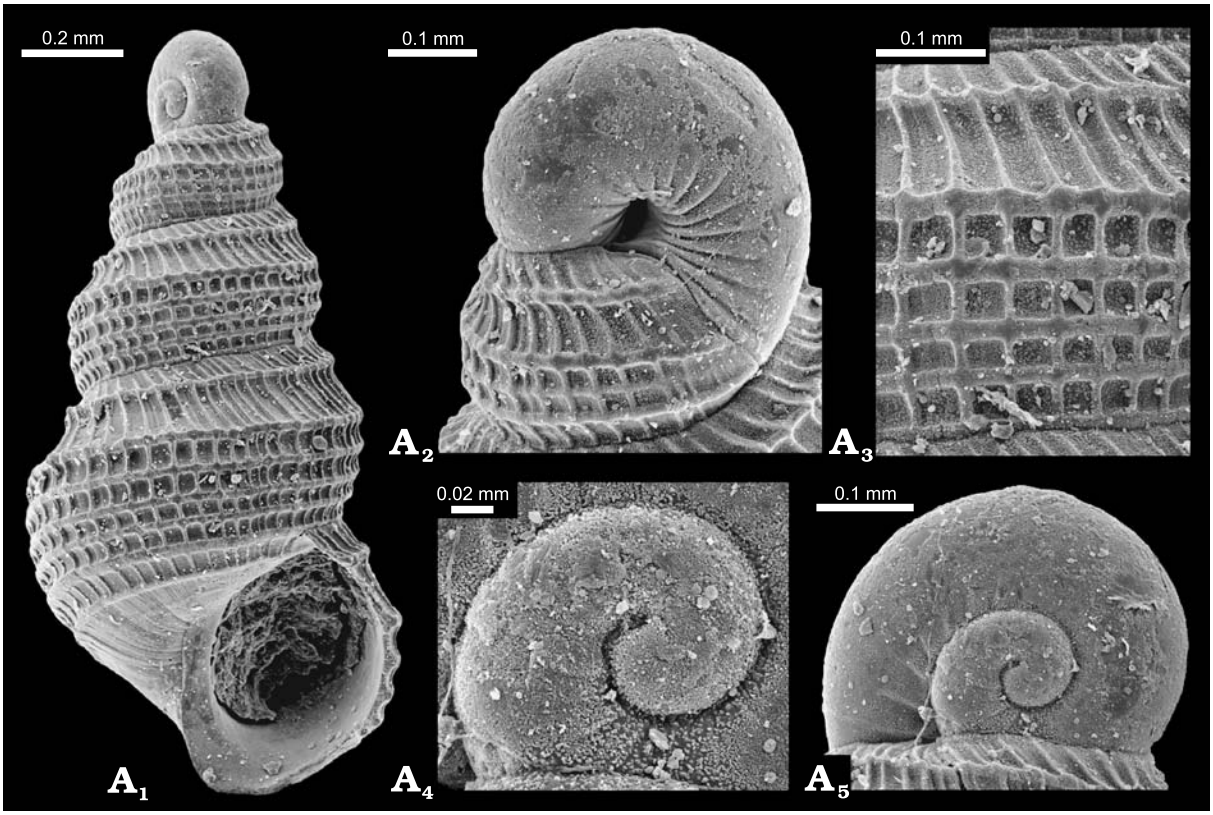


Fig. 96. *Mathilda angulata* (Gründel, 1997) from Łuków (block in glacial drift), Podlasie, Poland, Callovian (Mid Jurassic). **A**. ZPAL Ga.9/238; A_1 lateral view, A_2 protoconch in umbilical view, A_3 details of teleoconch ornamentation, A_4 close-up of protoconch 1, A_5 protoconch in apical view.

Mathilda podlasiensis sp. n.
(Fig. 97)

Holotype: ZPAL Ga.9/267, Fig. 97.
Type horizon: *Quenstedtoceras lamberti* Zone, Late Callovian (Mid Jurassic).
Type locality: Łuków (block in glacial drift), Podlasie, Poland.
Derivation of the name: After Podlasie, type region of the species.

Material. — One shell from Łuków (block in glacial drift), Podlasie, Poland.

Measurements. — The protoconch is 0.36 mm high and 0.36 mm in diameter. The shell of holotype consisting of 3.75 teleoconch whorls is 2.68 mm high and 1.11 mm in diameter.

Occurrences. — Type locality only.

Diagnosis. — Elongate shell, 2.41 times as high as broad. Protoconch hyperstrophic, ornamented by abapical folds and remnants of adapical folds. Teleoconch starting with three prominent and one subsutural spiral ribs (Fig. 139). Medial ribs broader than adapical and subsutural ribs. The number of spiral ribs incresing during ontogeny (twelve ribs on third teleoconch whorl). Whorls rounded, delicately angulated at primary adapical spiral rib. Spiral ribs crossed by weaker, prosocline axial ribs (about 74–75 per whorl).

Remarks. — *M. podlasiensis* is most similar to *M. angulata*. For differences, see the latter.

Mathilda valanginiana sp. n.
(Fig. 98)

Holotype: ZPAL Ga.9/233, Fig. 98.
Type horizon: Sample L1, *Tirnoviella pertransiens* Zone, Early Valanginian (Early Cretaceous).
Type locality: Wąwał, southern Mazowsze, Poland.
Derivation of the name: After Valanginian (Early Cretaceous).

Material. — One shell from the type locality.

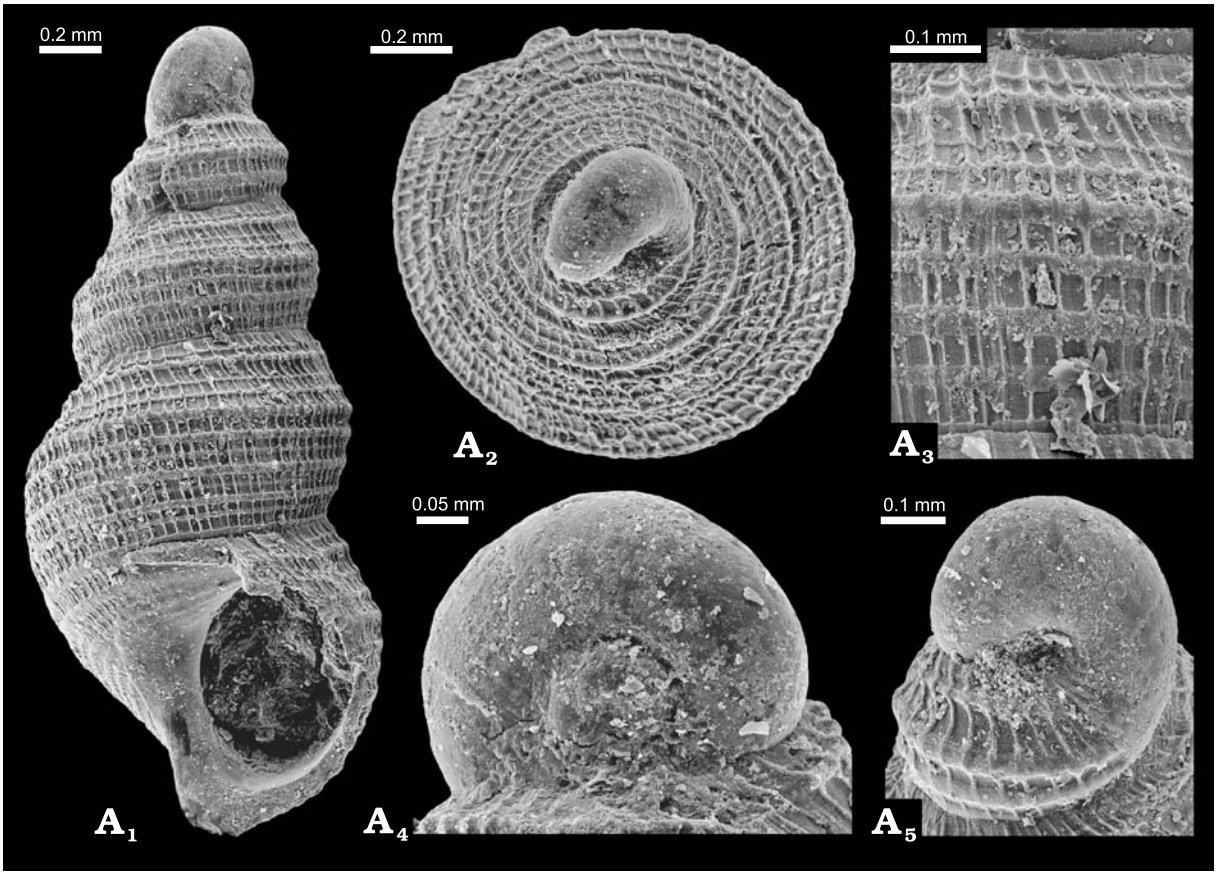


Fig. 97. *Mathilda podlasiensis* sp. n. from Łuków (block in glacial drift), Podlasie, Poland, Callovian (Mid Jurassic). **A**. ZPAL Ga.9/267 (holotype); A_1 lateral view, A_2 apical view, A_3 details of teleoconch ornamentation, A_4 protoconch in apical view, A_5 protoconch in umbilical view.

Measurements. — The protoconch is 0.35 mm in diameter. The holotype consisting of six teleoconch whorls is 3.54 mm high and 1.61 mm in diameter.

Occurrences. — Type locality only.

Diagnosis. — Shell elongate, 2.2 as high as broad. Protoconch hyperstrophic, smooth. Protoconch deeply immersed in teleoconch making protoconch 1 invisible. Teleoconch starting with two prominent and one subsutural spiral rib (Fig. 139). Later, secondary spiral ribs appearing (eight on fifth whorl). Delicate spiral lirae present between spiral ribs. Whorls angulated at the lower spiral rib. Spiral ribs crossed by weaker, slightly opisthocyrt axial ribs (about 45–47 per whorl). At intersections, blunt nodes appearing.

Remarks. — The most similar species, *M. striatissima*, differs in having unimmersed protoconch and by lacking the nodes at the intersections between the axial and the spiral ornamentation. Moreover, the latter is also ornamented by a higher number of spiral ribs.

Mathilda striatissima (Gründel, 1999)
(Fig. 99)

1997. *Tricarilda clathrata* (Terquem *et* Joudry, 1871); Gründel 1997a: 142, pl. 4: 52, 55–58, 60.
1999. *Tricarilda striatissima* sp. n.; Gründel 1999c: 292, pl. 1: 1–3.

Holotype: Gründel 1999c: 292, pl. 1: 1–3.
Type horizon: Late Bathonian (Mid Jurassic).
Type locality: Usedom borehole 3/63, Vorpommern, Germany.

Material. — One shell from Łuków (block in glacial drift), Podlasie, Poland.

Measurements. — The protoconch consisting of about two whorls is 0.34 mm high and 0.43 mm in diameter. The shell (MZ VIII Mg 4248/1) consisting of five teleoconch whorls is 3.89 mm high and 1.71 mm in diameter.

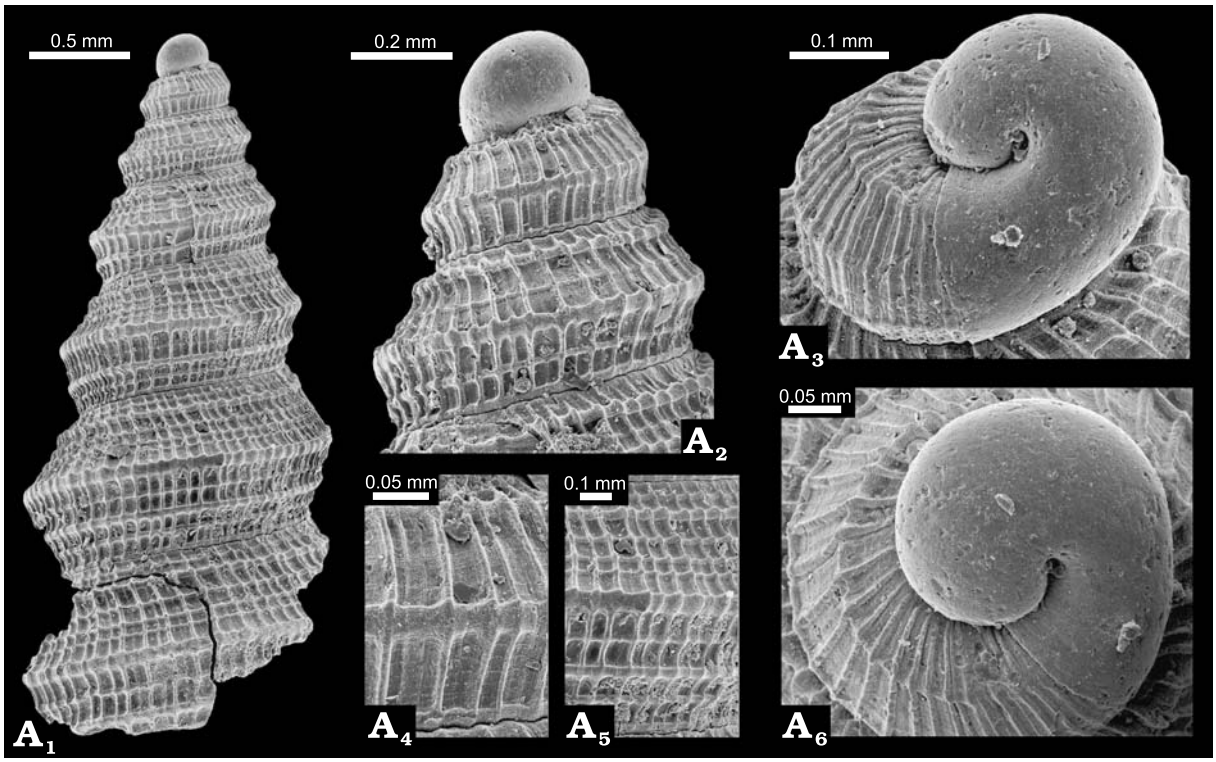


Fig. 98. *Mathilda valanginiana* sp. n. from Wąwał, southern Mazowsze, Poland, Valanginian (Early Cretaceous). **A**. ZPAL Ga.9/233 (holotype) from sample L1; A_1 lateral view, A_2 close-up of the apex, A_3, A_6 protoconch in umbilical views, A_4 details of teleoconch ornamentation at the first whorl of teleoconch, A_5 details of teleoconch ornamentation at the fifth whorl of teleoconch.

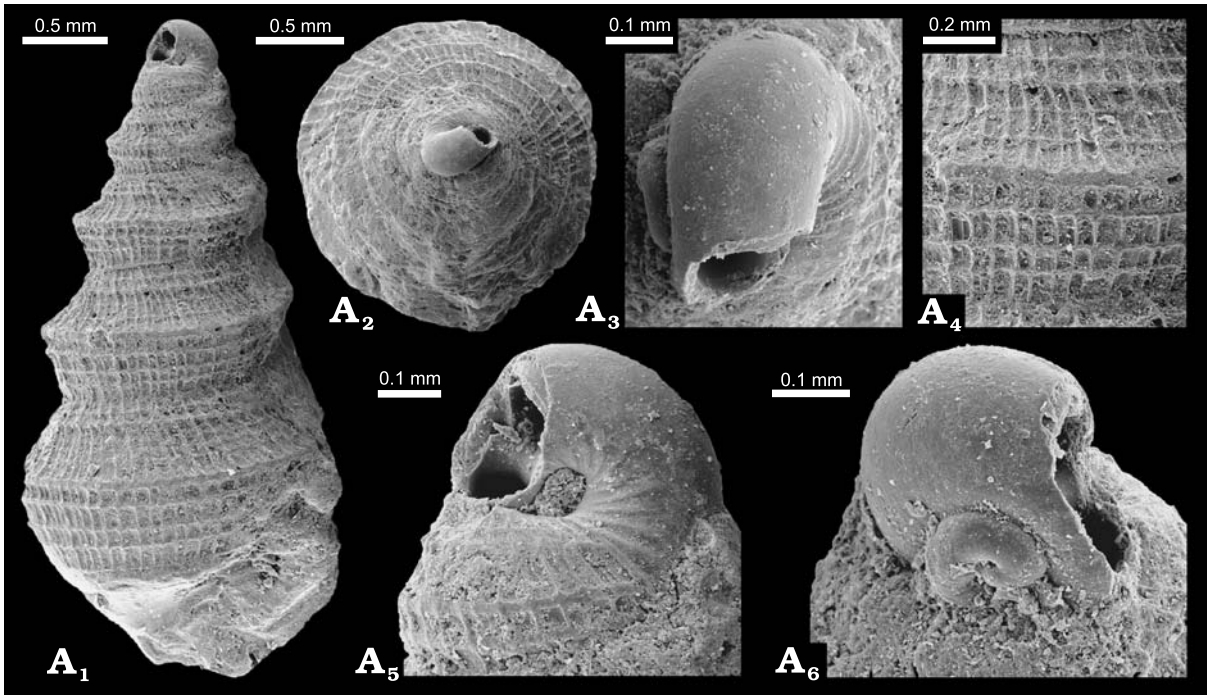


Fig. 99. *Mathilda striatissima* (Gründel, 1999) from Łuków (block in glacial drift), Podlasie, Poland, Callovian (Mid Jurassic). **A**. MZ VIII Mg 4248/1; A_1 lateral view, A_2 apical view, A_3 protoconch in lateral view, A_4 details of teleoconch ornamentation, A_5 protoconch in umbilical view, A_6 protoconch in apical view.

Occurrences. — Bathonian to Callovian (Mid Jurassic) of Germany and Poland.

Emended diagnosis. — Shell elongate, 2.3 times as high as broad. Protoconch hyperstrophic, ornamented by abapical axial folds. Teleoconch starting with three prominent and one subsutural spiral rib. Number of ribs increasing during ontogeny (twelve on third whorl). Whorls angulated at medial spiral rib. Spiral ribs crossed by weaker, weakly prosocline axial ribs (about 70–74 per whorl).

Remarks. — *M. striatissima* differs from *M. schmidti* in angulated whorls and an increasing number of spiral ribs during ontogeny. For differences with *M. valanginiana*, see the latter.

Mathilda mazoviensis sp. n.
(Fig. 100)

Holotype: ZPAL Ga.9/257, Fig. 100.

Type horizon: Sample D1, *Busnardoides campylotoxus* Zone, Early Valanginian (Early Cretaceous).

Type locality: Wąwał, southern Mazowsze, Poland.

Derivation of the name: After the latinization of Mazowsze, the central region of Poland.

Material. — One shell from the type locality.

Measurements. — The protoconch is 0.39 mm in diameter. The shell of the holotype consisting of 1.75 teleoconch whorls is 0.83 mm high and 0.60 mm in diameter.

Occurrences. — Type locality only.

Diagnosis. — Shell elongate, 1.39 as high as broad. Protoconch almost transaxial, ornamented with adapical and abapical axial folds. Protoconch half-immersed in teleoconch. Teleoconch starting with two prominent spiral ribs and about twelve spiral lirae. Later in ontogeny, number of lirae and their strength increasing. Whorls angulated with two keel-like spiral ribs crossed by opisthocline axial ribs (about 68–69 per whorl).

Description. — The keel and the second primary rib are covered by delicate spiral lirae. The peristome is unknown.

Remarks. — This carinate mathildid can be classified as *Carinathilda*, especially from the lineage which leads to the genus *Gymnothilda* (compare Fig. 138) as it has a medial keel, a transaxial protoconch, and spiral lirae resembling the spiral microornamentation of the carinathildids. Here it is classified under *Mathilda* as

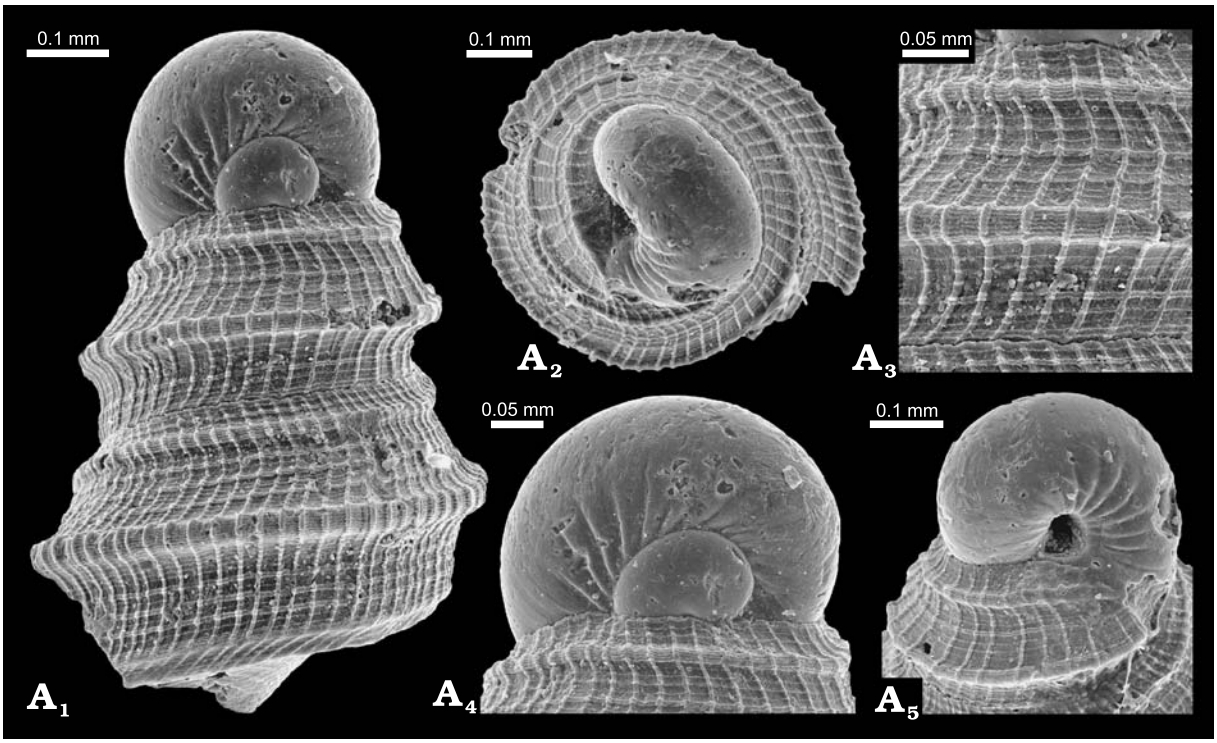


Fig. 100. *Mathilda mazoviensis* sp. n. from Wąwał, southern Mazowsze, Poland, Valanginian (Early Cretaceous). **A**. ZPAL Ga.9/255 (holotype) from sample D1; A_1 lateral view, A_2 apical view, A_3 details of teleoconch ornamentation, A_4 protoconch in apical view, A_5 protoconch in umbilical view.

its teleoconch begins with spiral ornamentation composed of numerous elements and it has a keel-like medial rib, similar to that of some Late Cretaceous, e.g., *M. pentalira* Dockery, 1993, and Recent mathildids, e.g., *M. sansibarica* Thiele, 1925.

Genus *Promathildia* Andreae, 1887

Type species: *Cerithium bisertum* Koken, 1889 [non *Cerithium bisertum* Münster, 1841 — *P. subnodosa* (Münster, 1841)]; subsequent designation by Koken 1889; see also Bandel 1995: 7. Carnian, Triassic, Italy.

Emended diagnosis. — Protoconch hyperstrophic, diverging more than 100° from teleoconch axis, smooth or, in some species with adapical and abapical, axial folds. Teleoconch slender to broadly cone-shaped. First teleoconch whorl with two spiral ribs of which abapical one usually distinctly angulating whorls. Number of spiral ribs stable during ontogeny or increasing to three. Spiral ribs crossed by weaker axial ribs, threads or enhanced growth lines, at rib intersections usually without nodes.

Discussion. — Despite of numerous reviews (Gründel 1976a, 1997a; Bandel 1995), the systematic position of the genus *Promathildia* still seems to be unclear. Herein, I propose using this generic name for most of the Triassic ancestors of Mathildidae and the lineage comprising *P. subnodosa*, *P. concava*, *P. conoidea*, *P. wonwalensis*, *P. orthocosta*, *P. naricata*, and *P. gruendeli*. In this sense, the genus *Promathildia* comprises species ancestral to *Mathilda*, *Carinathilda*, *Gymnothilda*, *Erratothilda*, and *Tuba* (compare Fig. 138, p. 164). The important feature uniting the *Promathildia* species is the simple ornamentation of the early teleoconch, composed of two spiral ribs and weak axials.

Range. — Late Triassic (e.g., Bandel 1995) to Early Cretaceous (Schröder 1995 and herein).

Promathildia conoidea Gründel, 1997
(Fig. 101)

1997. *Promathildia conoidea* sp. n.; Gründel 1997a: 134, pl. 1: 5–8.

Holotype: Gründel, 1997a: 134, pl. 1: 7, 9.
Type horizon: Bathonian (Mid Jurassic).
Type locality: Kłęby, West Pomerania, Poland.

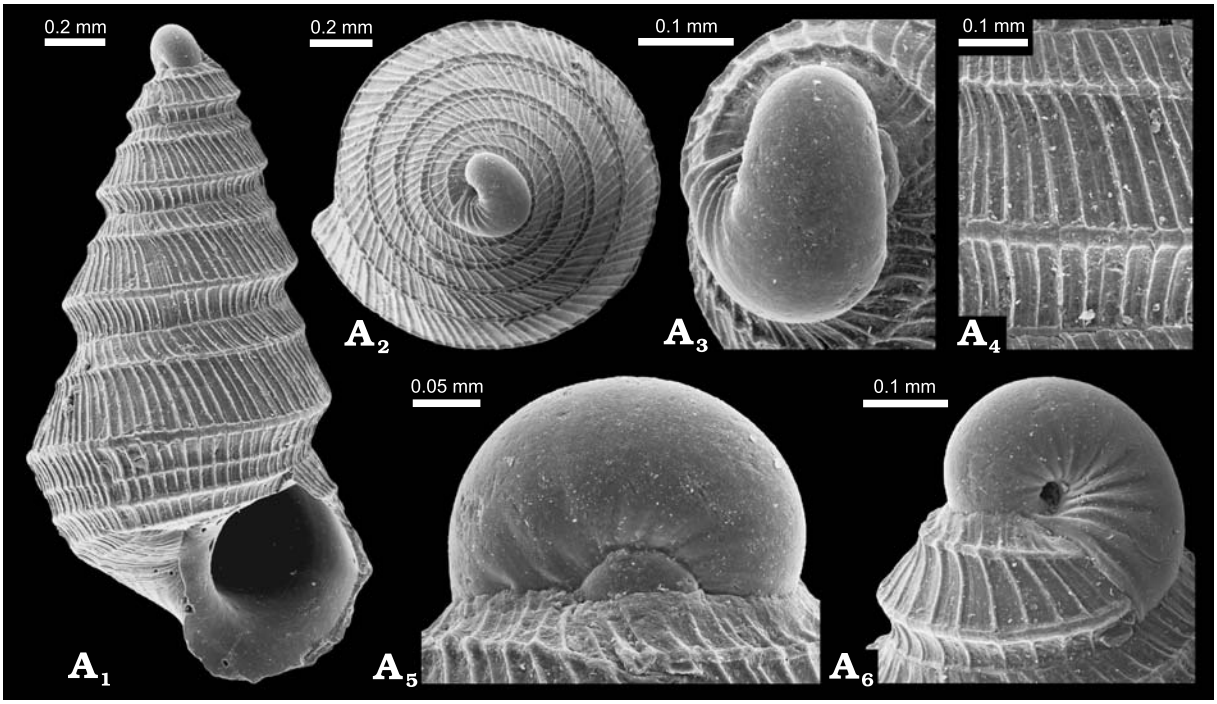


Fig. 101. The mathildid *Promathildia conoidea* (Gründel, 1997) from Gnaszyn, Częstochowa region, Poland, Mid Bathonian (Mid Jurassic). **A**. ZPAL Ga.9/260; A_1 lateral view, A_2 apical view, A_3 protoconch in lateral view, A_4 details of teleoconch ornamentation, A_5 protoconch in apical view, A_6 protoconch in umbilical view.

Material. — Ten shells from Bathonian of Gnaszyn, Częstochowa region, Poland.

Measurements. — The protoconch with about two whorls is 0.23 mm high and 0.27 mm in diameter. A shell (ZPAL Ga.9/260) consisting of four teleoconch whorls is 2.175 mm high and 1.15 mm in diameter.

Occurrences. — Type locality only.

Emended diagnosis. — Shell elongate, 1.9 times as high as broad. Protoconch hyperstrophic, diverging about 130° from teleoconch axis, ornamented by adapical an abapical axial folds. Teleoconch starting with two prominent and one subsutural spiral rib. Later in ontogeny, additional spiral ribs appearing. Whorls angulated at lower spiral rib. Spiral ribs crossed by weaker, prosocline axial ribs (about 61–62 per whorl) and axial lirae.

Description. — The protoconch is immersed in the teleoconch to about half of its diameter. The suture is incised. The peristome is rounded. Thin inner lip covers columellar area.

Remarks. — *P. conoidea* has a much broader shell than *P. concava*. The most important difference from *P. naricata* is the stable number of spiral ribs and the stronger lower spiral rib.

Promathildia concava Walther, 1951
(Fig. 102)

1951. *Promathildia* (*Teretrina*) *concava* sp. n.; Walther 1951: 69, pl. 2A: 11, pl. 3: 12.
1973. *Mathilda* (*Jurilda*) *crasova* sp. n.; Gründel 1973: 953, pl. 1: 1–3.
1997. *Promathildia concava* Walther, 1951; Gründel 1997a: 134, pl. 1: 1–4.

Holotype: Gründel, 1973: 953, pl. 1: 7, 9.
Type horizon: Bathonian (Mid Jurassic).
Type locality: Wenzen (Blatt Dassel), Germany.

Material. — One shell from Bajocian/Bathonian of Kłobuck borehole, Częstochowa region, Poland.

Measurements. — The protoconch with about two whorls is 0.23 mm high and 0.35 mm in diameter. The shell (ZPAL Ga.9/251) consisting of five teleoconch whorls is 2.20 mm high and 0.85 mm in diameter.

Occurrences. — Type locality only.

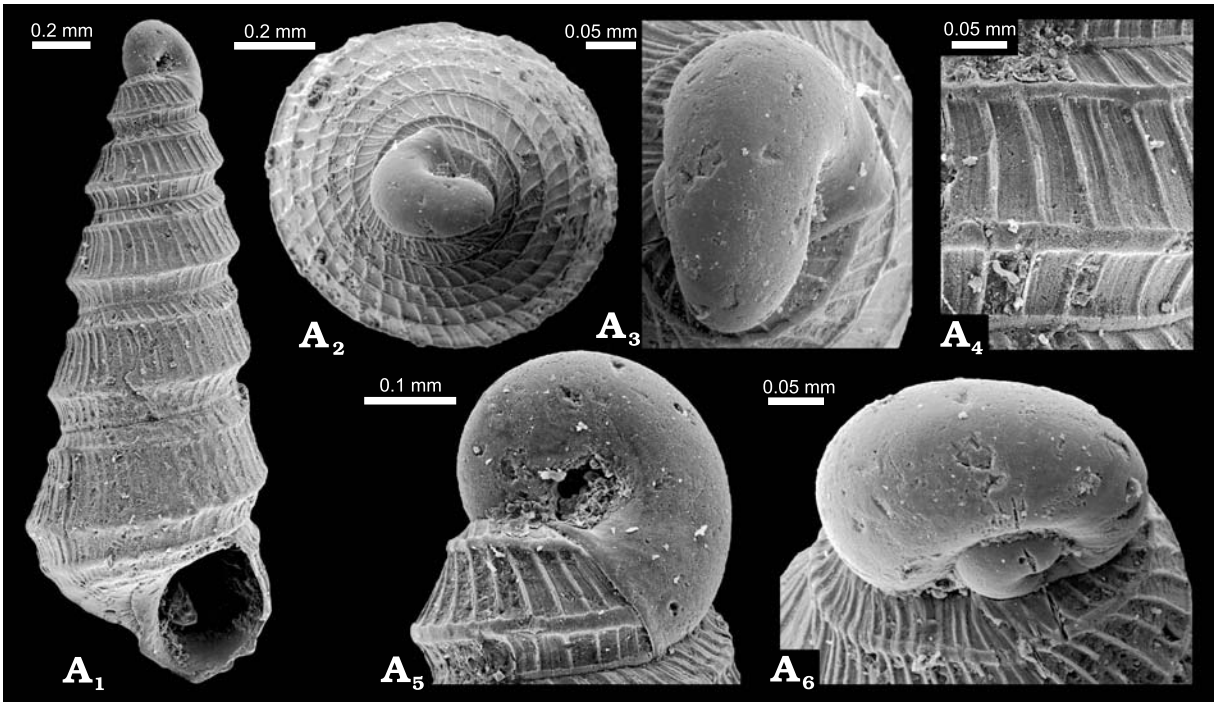


Fig. 102. The mathildid *Promathildia concava* Walther, 1951 from Kłobuck borehole 22, Częstochowa region, Poland, Bathonian (Mid Jurassic). **A**. ZPAL Ga.9/25; A_1 lateral view, A_2 apical view, A_3 protoconch in lateral view, A_4 details of teleoconch ornamentation, A_5 protoconch in umbilical view, A_6 protoconch in apical view.

Emended diagnosis. — Shell elongate, 2.6 as high as broad. Protoconch hyperstrophic, smooth. Teleoconch starting with two prominent and one subsutural spiral ribs. Whorls angulated at lower spiral rib. Spiral ribs crossed by weaker, prosocline axial ribs (about 37–38 per whorl).

Description. — The suture is incised. The peristome is tear-drop shaped. Thin inner lip covers the columellar area.

Remarks. — *P. concava* differs from other promathildiids by its very slender shell shape.

Promathildia orthocosta (Schröder, 1995)
(Fig. 103)

1995. *Mathilda orthocosta* sp. n.; Schröder 1995: 45, pl. 8: 1–5.

Holotype: Schröder 1995: pl. 8: 1.
Type horizon: Valanginian (Early Cretaceous).
Type locality: Wąwał, southern Mazowsze, Poland.

Material. — 333 shells from the type locality.

Measurements. — The protoconch with about two whorls is 0.21 mm high and 0.29 mm in diameter. A shell (ZPAL Ga.9/243) consisting of three teleoconch whorls is 1.60 mm high and 1.03 mm in diameter.

Occurrences. — Type locality only.

Emended diagnosis. — Shell elongate, 1.6 times as high as broad. Protoconch hyperstrophic, diverging about 120° from teleoconch axis, ornamented by adapical and abapical axial folds. Teleoconch starting with two prominent and one subsutural spiral rib (Fig. 139). Whorls angulated at medial spiral rib. Spiral ribs crossed by weaker, orthocline axial ribs (about 25–26 per whorl).

Description. — The protoconch is immersed in the teleoconch to more than half of its diameter. In the grooves between axial folds of protoconch 2, weak spiral lirae are visible. The suture is incised. The peristome is rounded. Thin inner lip covers columellar area.

Remarks. — *P. orthocosta* differs from the other promathildids by its orthocline, more distantly spaced axial ribs.

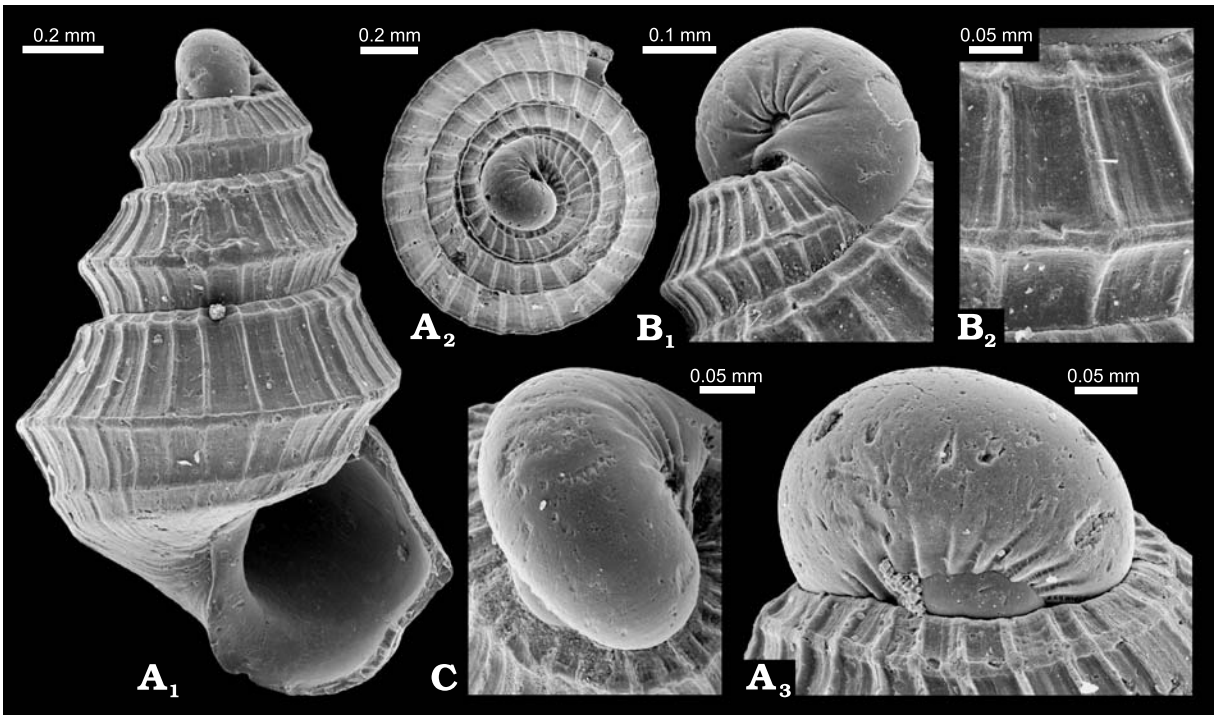


Fig. 103. The mathildid *Promathildia orthocosta* (Schröder, 1995) from Wąwał, southern Mazowsze, Poland, Valanginian (Early Cretaceous). **A**. ZPAL Ga.9/243 from sample M1; A_1 lateral view, A_2 apical view, A_3 protoconch in apical view. **B**. ZPAL Ga.9/240 from sample N1; B_1 protoconch in umbilical view, B_2 details of teleoconch ornamentation. **C**. ZPAL Ga.9/241 from sample D2; protoconch in lateral view.

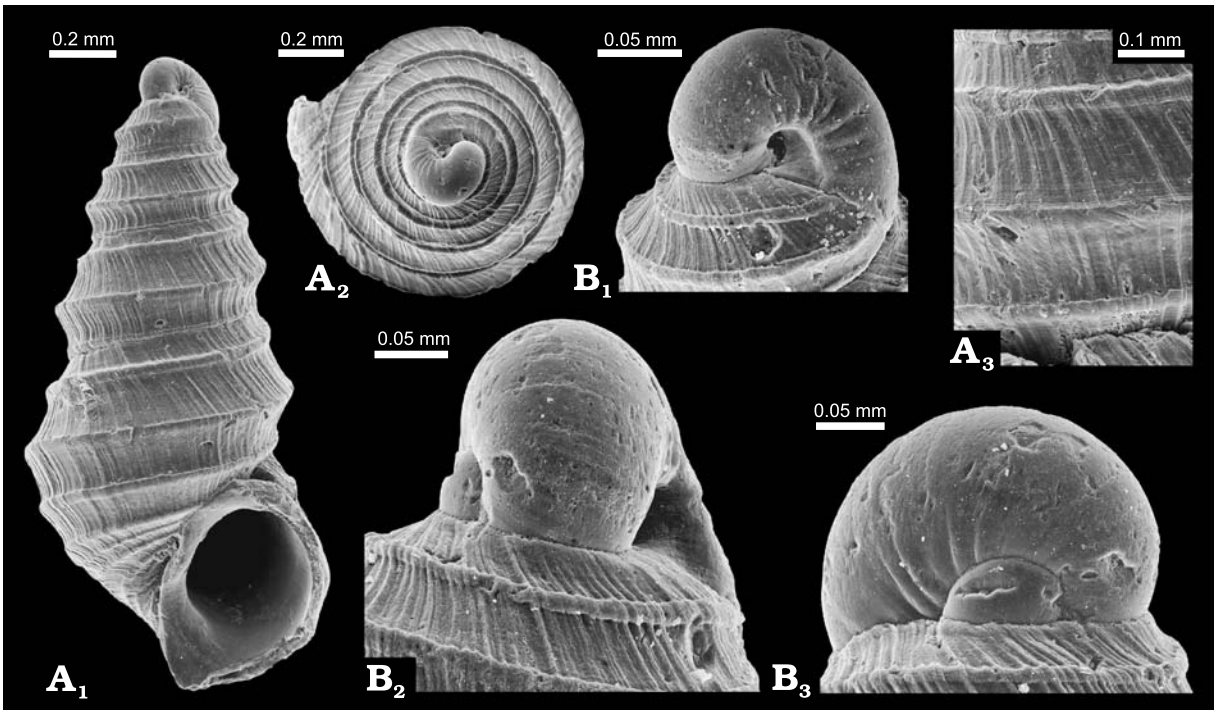


Fig. 104. The mathildid *Promathildia wonwalensis* (Schröder, 1995) from Wąwał, southern Mazowsze, Poland, Valanginian (Early Cretaceous). **A**. ZPAL Ga.9/231; A_1 lateral view, A_2 apical view, A_3 details of teleoconch ornamentation. **B**. ZPAL Ga.9/232 from sample C5; B_1 protoconch in umbilical view, B_2 protoconch in lateral view, B_3 protoconch in apical view.

Promathildia wonwalensis (Schröder, 1995)
(Fig. 104)

1995. *Mathilda wonwalensis* sp. n.; Schröder 1995: 46, pl. 8: 6–9.

Holotype: Schröder 1995: pl. 8: 6.
Type horizon: Valanginian (Early Cretaceous).
Type locality: Wąwał, southern Mazowsze, Poland.

Material. — 68 shells from the type locality.

Measurements. — The protoconch with about two whorls is 0.21 mm high and 0.26 mm in diameter. A shell (ZPAL Ga.9/231) consisting of four teleoconch whorls is 1.87 mm high and 1.08 mm in diameter.

Occurrences. — Type locality only.

Emended diagnosis. — Shell elongate, 1.7 times as high as broad. Protoconch hyperstrophic, diverging about 104° from teleoconch axis, ornamented by adapical an abapical axial folds. Teleoconch starting with three prominent and one subsutural spiral rib (Fig. 139). Whorls weakly angulated at spiral ribs. Spiral ribs intersected by prosocline axial lirae.

Description. — The protoconch is half-immersed in the teleoconch. The suture is incised. The peristome is rounded. the umbilical area has a narrow chink.

Remarks. — *P. wonwalensis* differs from the most similar *P. conoidea* by much weaker axial ornamentation composed of fine lirae.

Promathildia gruendeli sp. n.
(Fig. 105)

Holotype: MZ VIII Mg 4251/1, Fig. 105.
Type horizon: *Quenstedtoceras lamberti* Zone, Late Callovian (Mid Jurassic).
Type locality: Łuków (block in glacial drift), Podlasie, Poland.
Derivation of the name: In honour of Joachim Gründel.

Material. — Two shells from the type locality.

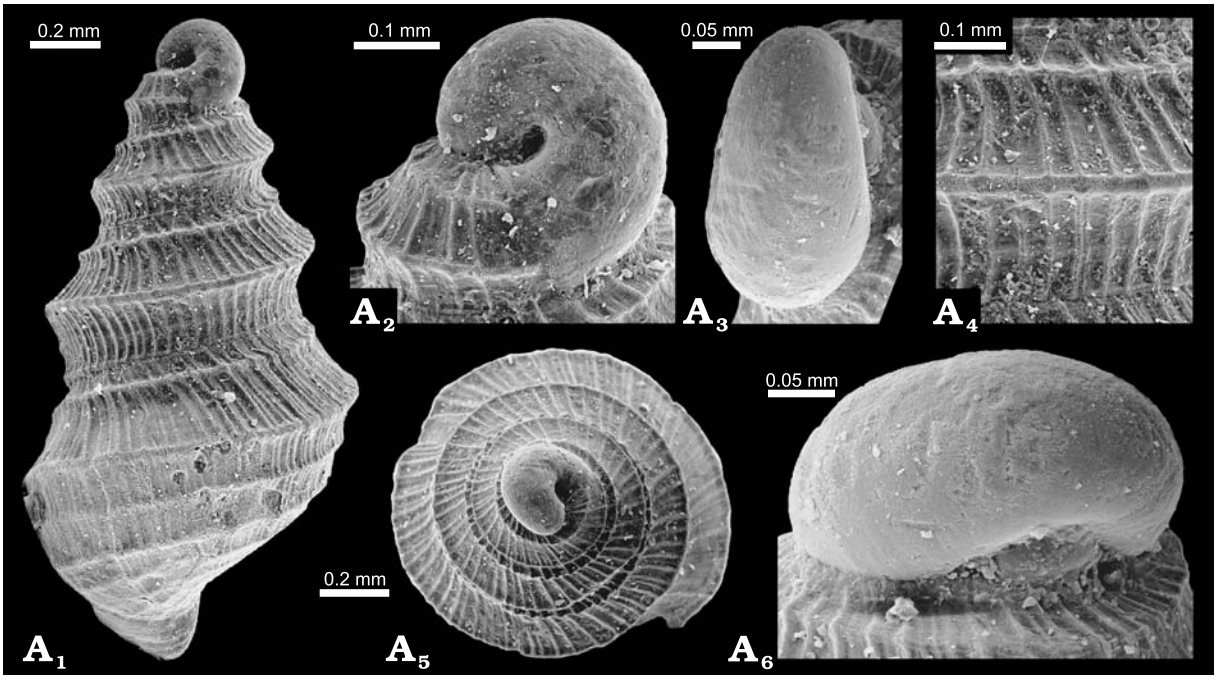


Fig. 105. The mathildid *Promathildia gruendeli* sp. n. from Łuków (block in glacial drift), Podlasie, Poland, Callovian (Mid Jurassic). **A**. MZ VIII Mg 4251/1 (holotype); A_1 lateral view, A_2 protoconch in umbilical view, A_3 protoconch in lateral view, A_4 details of teleoconch ornamentation, A_5 apical view, A_6 protoconch in latero-apical view.

Measurements. — The protoconch with about two whorls is 0.18 mm high and 0.33 mm in diameter. A shell (MZ VIII Mg 4251/1) consisting of four teleoconch whorls is 1.85 mm high and 1.00 mm in diameter.

Occurrences. — Type locality only.

Diagnosis. — Shell elongate, 1.85 times as high as broad. Protoconch medioaxial, smooth. Teleoconch starting with one prominent and one subsutural spiral rib. Whorls angulated at medial spiral ribs, which are almost keel-like. Spiral ribs crossed by prosocline axial ribs.

Description. — The protoconch is immersed in the teleoconch to more than half of its diameter. The suture is incised. The peristome is rounded and not well-preserved in the available specimens. A thin inner lip covers the columellar area.

Remarks. — *P. gruendeli* is similar to *P. naricata* but it differs by the smooth protoconch, stable number of spiral ribs, and the abapical spiral rib forming the incipient keel.

Promathildia sp.
(Fig. 106)

Material. — One shell from Gnaszyn, Częstochowa region, Poland, Mid Bathonian (Mid Jurassic).

Measurements. — The protoconch with about two whorls is 0.34 mm high and 0.44 mm in diameter. A shell (ZPAL Ga.9/261) consisting of four teleoconch whorls is 1.58 mm high and 0.80 mm in diameter.

Description. — The shell is cone-shaped, 1.98 times as high as broad. The protoconch is transaxial and ornamented by adapical and abapical axial folds. The teleoconch starts with two prominent and and one subsutural spiral ribs. The whorls are angulated at the medial rib, which is almost keel-like. The spiral ribs are crossed by opisthocytic axial ribs (68–69 ribs per whorl). The number of spiral ribs is stable on the known teleoconch whorls. The peristome is unknown.

Remarks. — The shell described above probably represents a new species. The large protoconch emerges over the teleoconch more than half its surface what is unique among the known promathildiids. The lack of further whorls on the examined specimen prevents me from establishing a new species.

Genus *Carinathilda* Gründel, 1997

Type species: *Carinathilda carinata* Gründel, 1997; original designation. Bathonian, Mid Jurassic, Kłęby borehole, Poland.

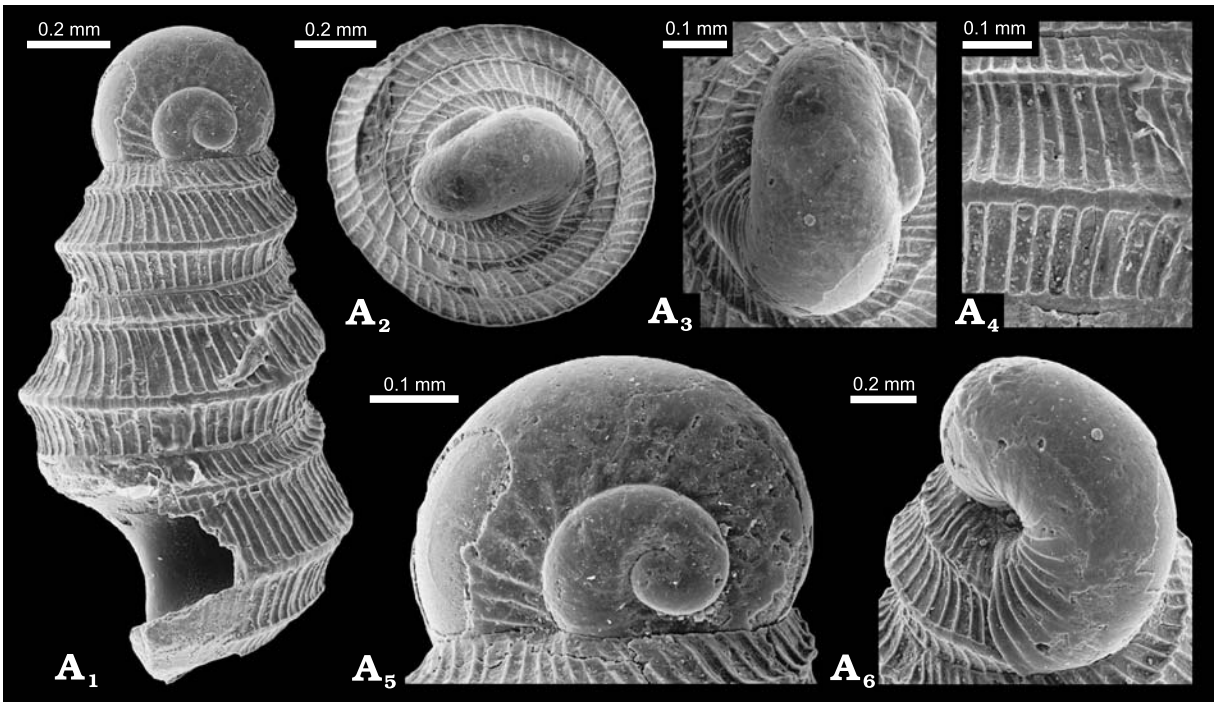


Fig. 106. The mathildid *Promathildia* sp. from Gnaszyn, Częstochowa region, Poland, Mid Bathonian (Mid Jurassic). **A**. ZPAL Ga.9/261; A_1 lateral view, A_2 apical view, A_3 protoconch in lateral view, A_4 details of teleoconch ornamentation, A_5 protoconch in apical view, A_6 protoconch in umbilical view.

Emended diagnosis. — Protoconch hyperstrophic, highly medioaxial to almost coaxial, smooth or, in some species, with adapical and abapical, axial folds. Teleoconch broadly cone-shaped. First teleoconch whorl with two spiral ribs of which abapical one makes distinct angulation of whorls and changing into keel. Number of spiral ribs may increase during ontogeny. Spiral ribs crossed by weaker axial ribs or threads, at rib intersections, with or without weak nodes. Teleoconch surface covered with spiral microornamentation.

Discussion. — *Carinathilda* probably derived from the angulated Triassic or Early Jurassic promathildids (see Fig. 138). A similar genus, *Erratothilda*, has a coaxial or nearly coaxial protoconch and numerous primary spiral ribs.

Range. — Late Triassic (e.g., Bandel 1995) to Late Cretaceous (Kiel *et al.* 2002).

Carinathilda tectispira (Schröder, 1995)
(Fig. 107)

1995. *Teretrina tectispira* sp. n.; Schröder 1995: 52, pl. 9: 1–4.
1997. *Carinathilda tectispira* (Schröder, 1995); Gründel 1997a: 149, not illustrated.

Holotype: Schröder 1995: pl. 9: 1–4.
Type horizon: Valanginian (Early Cretaceous).
Type locality: Wąwał, southern Mazowsze, Poland.

Material. — 15 shells from the type locality.

Measurements. — The protoconch with about two whorls is 0.33 mm in diameter. A shell (ZPAL Ga.9/252) consisting of 4.5 teleoconch whorls is 3.75 mm high and 1.95 mm in diameter.

Occurrences. — Type locality only.

Emended diagnosis. — Shell broadly cone-shaped, 1.92 times as high as broad. Protoconch highly medioaxial, ornamented by weak abapical axial folds. Teleoconch starting with growth lines only. After 0.25 of the whorl two spiral ribs appearing. Lower rib becoming keel-like on second teleoconch whorl. Spiral ribs crossed by delicate, weakly opisthocyrtic to weakly prosocline axial ribs (167–168 ribs per whorl). Spiral microornamentation usually visible only at intersections with axial ribs.

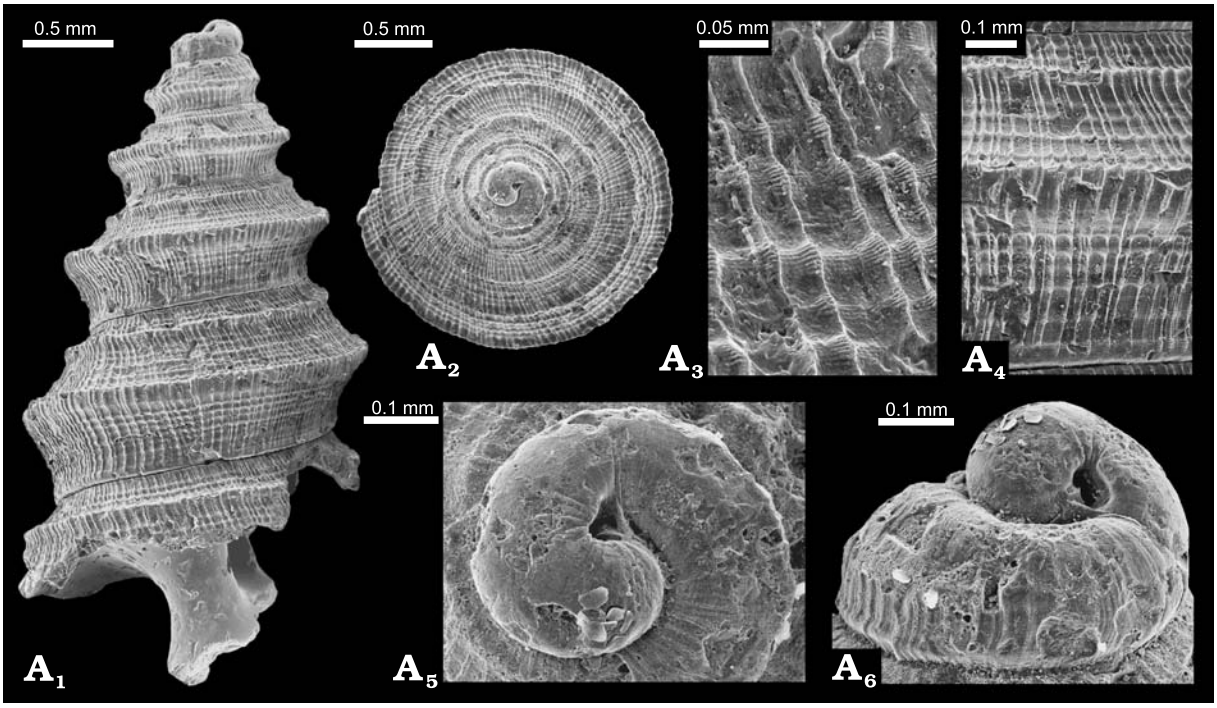


Fig. 107. The mathildid *Carinathilda tectispira* (Schröder, 1995) from Wąwał, southern Mazowsze, Poland, Valanginian (Early Cretaceous). **A**. ZPAL Ga.9/252; A_1 lateral view, A_2 apical view, A_3 details of teleoconch ornamentation with microornamentation visible, A_4 details of teleoconch ornamentation the fourth teleoconch whorl, A_5 protoconch in umbilical view, A_6 apex in lateral view.

Description. — The adapical portion of the protoconch is completely immersed in the teleoconch. The suture is incised. The peristome is unknown.

Remarks. — *C. tectispira* differs from the most similar *C. kieli* in the more densely distributed axial ribs and the presence of microornamentation on the intersections of the spiral and the axial ribs only.

Carinathilda kieli sp. n.
(Fig. 108A)

Holotype: ZPAL Ga.9/277, Fig. 108A.

Type horizon: Sample A3, *Saynoceras verrucosum* Zone, Late Valanginian (Early Cretaceous).

Type locality: Wąwał, southern Mazowsze, Poland.

Derivation of the name: In honour of Steffen Kiel.

Material. — Three shells from the type locality.

Measurements. — The protoconch is 0.30 mm in diameter. The shell of the holotype consisting of three teleoconch whorls is 1.53 mm high and 1.16 mm in diameter.

Occurrences. — Type locality only.

Diagnosis. — Shell broadly cone-shaped, 1.32 times as high as broad. Protoconch highly medioaxial, ornamented by abapical axial folds. Teleoconch starting with two spiral ribs. Lower rib becoming keel-like on second teleoconch whorl. Spiral ribs crossed by nearly orthocline axial ribs (80–81 ribs per whorl). On intersections, distinct nodes appearing. Surface of teleoconch covered by spiral microornamentation.

Description. — The adapical portion of the protoconch is completely immersed in the teleoconch. The suture is incised. The peristome is unknown.

Remarks. — *C. kieli* differs from *C. saulae* by the distinct nodes on the intersections of the axial and spiral ribs and the more sparcely distributed axial ribs. For differences with *C. tectispira*, see the latter.

Carinathilda saulae sp. n.
(Fig. 108B)

Holotype: ZPAL Ga.9/278, Fig. 108B.

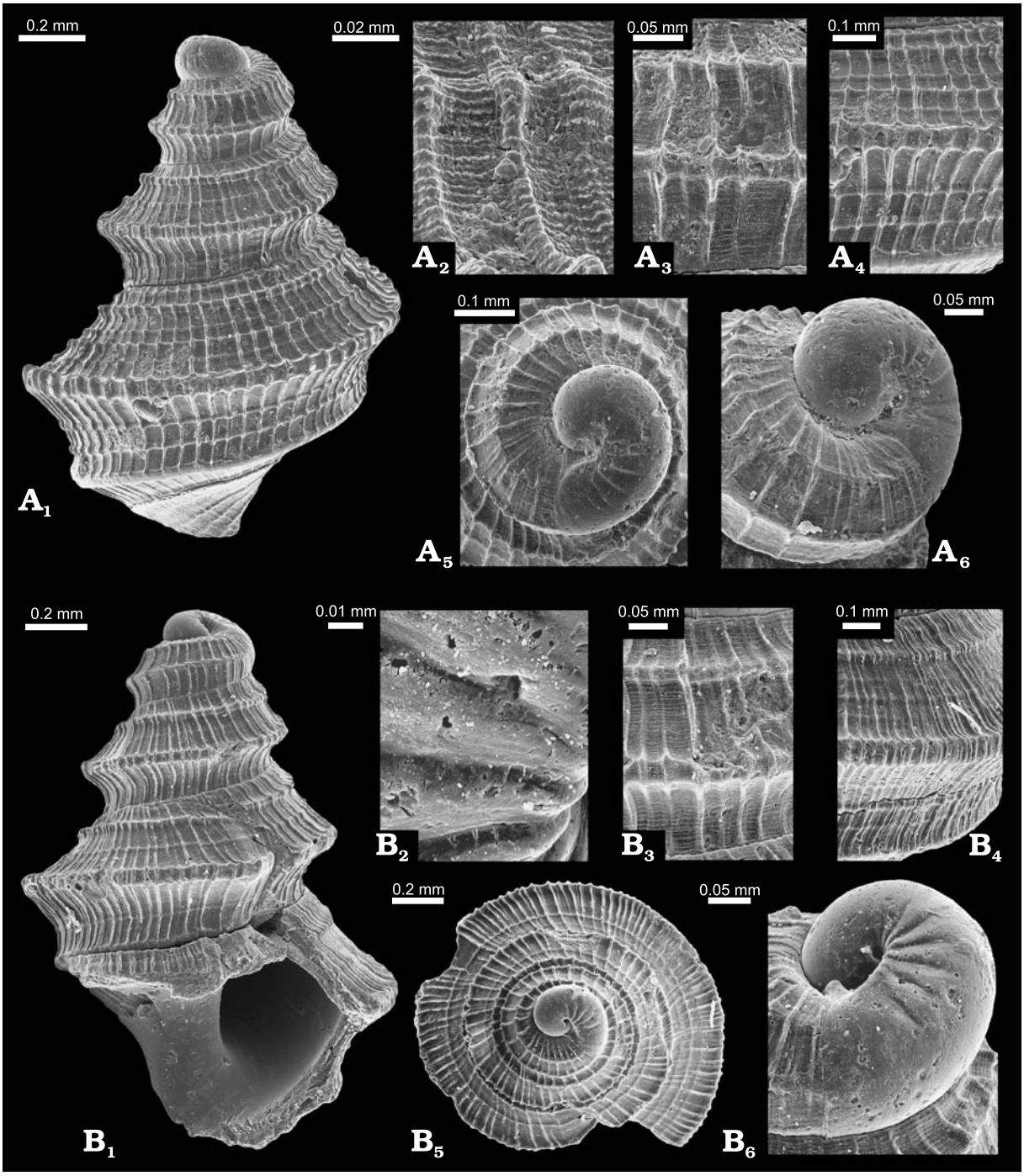


Fig. 108. The carinate mathildids from Wąwał, southern Mazowsze, Poland, Valanginian (Early Cretaceous). **A**. *Carinathilda kieli* sp. n. ZPAL Ga.9/277 (holotype) from sample A3; A_1 lateral view, A_2 details of the microornamentation on the third teleoconch whorl, A_3, A_4 Details of the teleoconch ornamentation on the first and third teleoconch whorls respectively, A_5 protoconch in umbilical view, A_6 protoconch in latero-umbilical view. **B**. *Carinathilda saulae* sp. n. ZPAL Ga.9/278 (holotype); B_1 lateral view, B_2 details of umbilical protoconch ornamentation, B_3, B_4 details of teleoconch ornamentation on the first and fourth whorl respectively, B_5 apical view, B_6 protoconch in latero-umbilical view.

Type horizon: *Saynoceras verrucosum* Zone, Late Valanginian (Early Cretaceous).

Type locality: Wąwał, southern Mazowsze, Poland.

Derivation of the name: In honour of LouElla Saul.

Material. — One shell from the type locality.

Measurements. — The protoconch is 0.33 mm in diameter. The shell of the holotype consisting of three teleoconch whorls is 1.84 mm high and 1.25 mm in diameter.

Occurrences. — Type locality only.

Diagnosis. — Shell broadly cone-shaped, 1.47 times as high as broad. Protoconch highly medioaxial, ornamented by abapical axial folds. Teleoconch starting with two spiral ribs. Lower rib becoming keel on second teleoconch whorl. On second and third teleoconch whorls, two secondary spiral ribs appearing. Spiral ribs crossed by weakly opisthocytic axial ribs (95–100 ribs per whorl). At intersections, blunt nodes appearing. Surface of teleoconch covered by spiral microornamentation.

Description. — The adapical portion of the protoconch is completely immersed in the teleoconch. The suture is incised. The peristome is unknown.

Remarks. — The most similar *C. calloviensis* Gründel, 1997 differs in the stable number of spiral ribs during ontogeny. *C. saulae* differs from *C. microstriata* and *C. squiresi* in a much stronger spiral keel. For differences with *C. kieli*, see the latter.

Carinathilda microstriata (Schröder, 1995)
(Fig. 109)

1995. *Teretrina microstriata* sp. n.; Schröder 1995: 51, pl. 8: 15–19, pl. 15: 9.
1997. *Carinathilda microstriata* (Schröder, 1995); Gründel 1997a: 149, not illustrated.

Holotype: Schröder 1995: pl. 8: 15, 17.
Type horizon: Valanginian (Early Cretaceous).
Type locality: Wąwał, southern Mazowsze, Poland.

Material. — 2324 shells from the type locality.

Measurements. — The protoconch with about two whorls is 0.32 mm in diameter. A shell (ZPAL Ga.9/253) consisting of 3.25 teleoconch whorls is 1.96 mm high and 1.23 mm in diameter.

Occurrences. — Type locality only.

Emended diagnosis. — Shell broadly cone-shaped, 1.59 times as high as broad. Protoconch highly medioaxial, ornamented by weak, abapical axial folds. Spiral lirae present between folds. Teleoconch starting with two prominent and one subsutural spiral rib. Medial rib becoming keel on first teleoconch whorl.

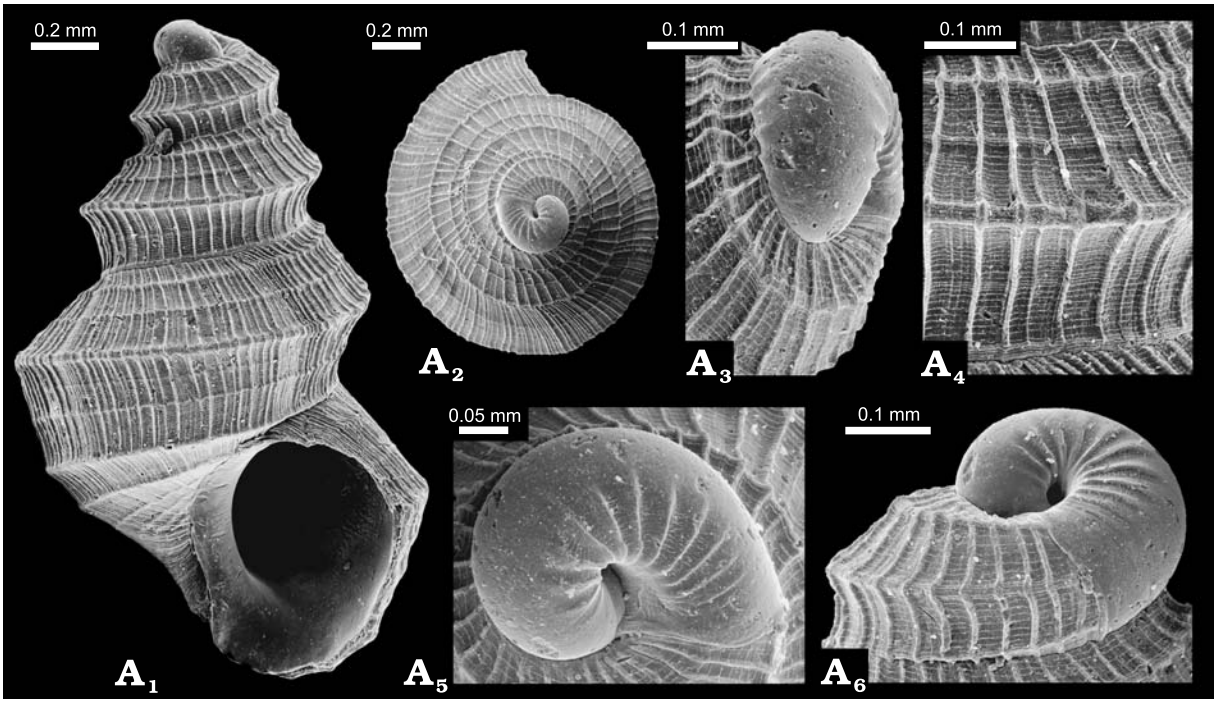


Fig. 109. The mathildid *Carinathilda microstriata* (Schröder, 1995) from Wąwał, southern Mazowsze, Poland, Valanginian (Early Cretaceous). **A**. ZPAL Ga.9/253 from sample C1; A_1 lateral view, A_2 apical view, A_3 protoconch in lateral view, A_4 details of teleoconch ornamentation, A_5 protoconch in umbilical view, A_6 apex in lateral view.

Spiral ribs crossed by weakly prosocline axial ribs (53–54 ribs per whorl). Surface of teleoconch covered by spiral microornamentation.

Description. — The adapical portion of protoconch is completely immersed in the teleoconch. The suture is incised. Additional spiral ribs appearing during ontogeny. The peristome is rounded. A thin inner lip covers the columellar area.

Remarks. — *C. microstriata* is similar to *C. bathoniensis* Gründel, 1999 which differs in less hyperstrophic protoconch and stronger keel.

Carinathilda squiresi sp. n.
(Fig. 110)

Holotype: ZPAL Ga.9/270, Fig. 110A.

Type horizon: Sample N1, *Busnardoides campylotoxus* Zone, Early Valanginian (Early Cretaceous).

Type locality: Wąwał, southern Mazowsze, Poland.

Derivation of the name: In honour of Richard L. Squires.

Material. — 30 shells from Wąwał, southern Mazowsze, Poland.

Measurements. — The protoconch with about two whorls is 0.42 mm in diameter. A shell (ZPAL Ga.9/270) consisting of about three teleoconch whorls is 1.56 mm high and 1.06 mm in diameter.

Occurrences. — Type locality only.

Diagnosis. — Shell broadly cone-shaped, 1.47 times as high as broad. Protoconch almost coaxial, smooth. Teleoconch starting with two prominent and one subsutural spiral rib. Abapical rib becomin keel on first teleoconch whorl. Spiral ribs crossed by weakly prosocline axial ribs (53–54 ribs per whorl). Surface of teleoconch covered by spiral microornamentation.

Description. — The adapical portion of the protoconch is completely immersed in the teleoconch. The suture is incised. Additional spiral ribs appear during ontogeny. The peristome is unknown.

Remarks. — *C. squiresi* differs from the most similar *C. microstriata* by its larger and non-ornamented protoconch and abapically situated keel. The latter is situated medially at *C. microstriata*.

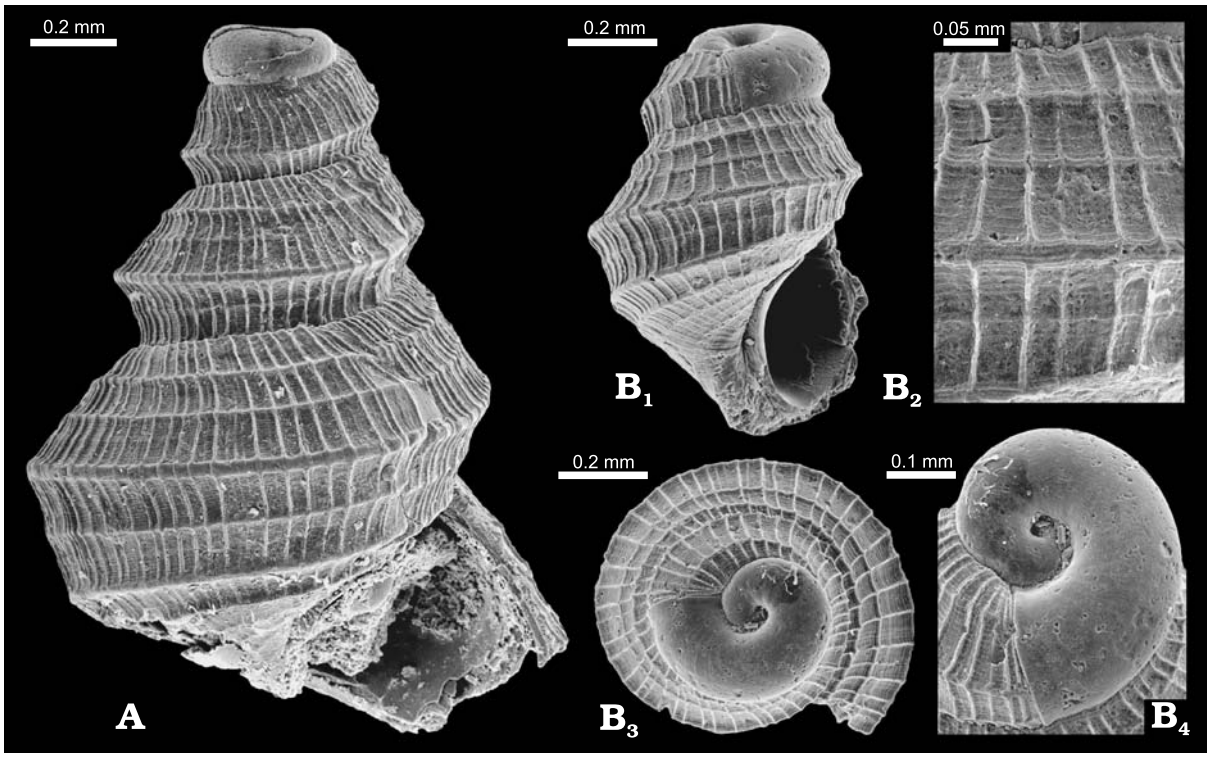


Fig. 110. The mathildid *Carinathilda squiresi* sp. n. from Wąwał, southern Mazowsze, Poland, Valanginian (Early Cretaceous). **A**. ZPAL Ga.9/270 (holotype) from sample N1; lateral view. **B**. ZPAL Ga.9/271 from sample I1; B_1 lateral view, B_2 details of teleoconch ornamentation, B_3 apical view, B_4 protoconch in umbilical view.

?*Carinathilda naricatoidea* sp. n.
(Fig. 111)

Holotype: ZPAL Ga.9/270, Fig. 111.

Type horizon: *Morrisiceras morrisi* Zone, Mid Bathonian (Mid Jurassic).

Type locality: Gnaszyn, Częstochowa region, Poland.

Derivation of the name: After some resemblance to specimen illustrated by Gründel (1997a, pl. 2: 23, 25) as *Promathildia naricata naricata* (Gründel, 1973)

Material. — One shell from the type locality.

Measurements. — The protoconch with about two whorls is 0.35 mm in diameter. A shell (ZPAL Ga.9/262) consisting of three teleoconch whorls is 1.60 mm high and 1.00 mm in diameter.

Occurrences. — Type locality only.

Diagnosis. — Shell broadly cone-shaped, 1.6 times as high as broad. Protoconch almost medioaxial, with adapical and abapical axial folds. Teleoconch starting with two prominent and one subsutural spiral rib. Medial rib becoming keel on first teleoconch whorl. Number of spiral ribs stable on known whorls of teleoconch. Spiral ribs crossed by weakly prosocline axial ribs (62–63 ribs per whorl). Surface of teleoconch covered by spiral microornamentation.

Description. — The protoconch is completely immersed in the teleoconch for its half width. The suture is incised.

Remarks. — This species has characters typical of *Carinathilda* (e.g., presence of the keel and spiral microornamentation) but simultaneously also has a medioaxial protoconch. This feature is more typical for *Promathildia* and *Mathilda*. This species probaly represents an intermediate form between *Promathildia* and *Carinathilda*. It is also probable that *C. naricatoidea* is ancestral to the keeled species of *Gymnothilda* with medioaxial to transaxial protoconchs. A similar shell was illustrated by Gründel (1997a, pl. 2: 23, 25) as *Promathildia naricata naricata* (Gründel, 1973). The mentioned specimen differs from the holotype of *P. naricata* in the keeled medial rib and the presence of spiral microornamentation. The specimen figured by Gründel (1997a) differs from ?*C. naricatoidea* in the smooth protoconch and the appearance of secondary spiral ribs during ontogeny.

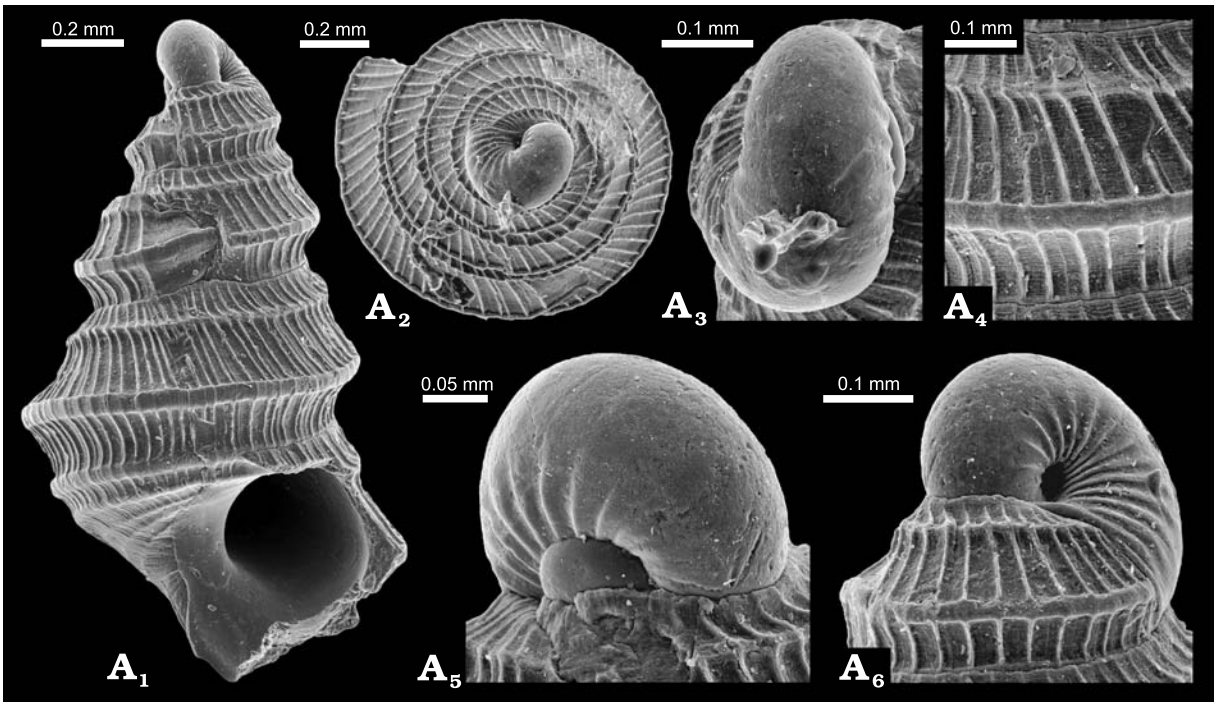


Fig. 111. The mathildid ?*Carinathilda naricatoidea* sp. n. from Gnaszyn, Częstochowa region, Poland, Mid Bathonian (Mid Jurassic). **A**. ZPAL Ga.9/262 (holotype); A_1 lateral view, A_2 apical view, A_3 protoconch in lateral view, A_4 details of teleoconch ornamentation, A_5 protoconch in apical view, A_6 protoconch in umbilical view.

?*Carinathilda* sp.
(Fig. 112)

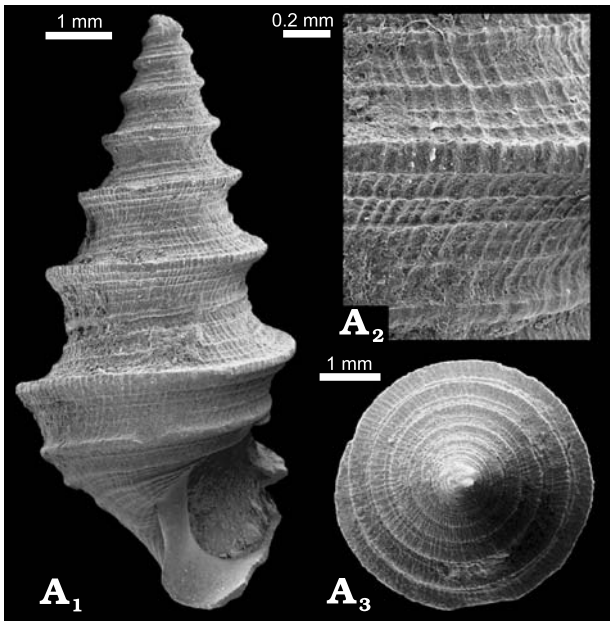


Fig. 112. The mathildid ?*Carinathilda* sp. from Kawodrza-Sowa, Częstochowa region, Poland, Late Bajocian (Mid Jurassic) **A**. ZPAL Ga.9/250; A_1 lateral view, A_2 details of teleoconch ornamentation, A_3 apical view.

Material. — Three shells from Kawodrza Sowa, Częstochowa region, Poland, Late Bajocian (Mid Jurassic).

Measurements. — A shell (ZPAL Ga.9/250) consisting of about seven teleoconch whorls is 1.56 mm high and 1.06 mm in diameter.

Description. — The shell is cone-shaped, 2.06 times as high as broad. The protoconch is not known. The teleoconch starts with two prominent and spiral ribs. The medially situated rib becomes a keel on the first teleoconch whorl. Spiral ribs are crossed by opisthocytic axial ribs (104–105 ribs per whorl). Additional spiral ribs appear during ontogeny (ten ribs on the seventh whorl). The peristome is elongated posteriorly into a wide, shallow channel. A thin inner lip covers the columellar area.

Remarks. — The shells described above probably represent a new species differing by the presence of very strong keel and the lack of spiral microornamentation. The lack of a protoconch and the badly preveserved surface of the teleoconch in examined specimens, prevents me from establishing a new species. Moreover, the shells may represent both early species of *Carinathilda* or *Erratothilda*.

Genus *Gymnothilda* Schröder, 1995

Type species: *Gymnothilda levata* Schröder, 1995; monotypy. Valanginian, Early Cretaceous, Wąwał, Poland.

Emended diagnosis. — Teleoconch broadly cone-shaped. Protoconch hyperstrophic, transaxial to weakly medioaxial, smooth or, in some species with adapical and abapical axial folds. Protoconch peristome with thickened outer lip. First teleoconch whorl with one to two spiral ribs. At least one of ribs changing into keel. Axial ribs present only on early teleoconch whorls, visible only on keel, or reduced. Microornamentation present only in some species and restricted to some places (e.g., surface of keel).

Discussion. — *Gymnothilda* probably derived from the keeled carinathildids with weakly medioaxial to transaxial protoconchs (e.g., ?*Carinathilda naricatoidea* sp. n.). Bathonian *Gymnothilda dispiralis* Gründel, 1997 is probably a species of *Promathildia*, and the reduced axial ornamentation derived independently.

Range. — Valanginian (Early Cretaceous; Schröder 1995 and herein).

Gymnothilda levata Schröder, 1995
(Fig. 113A)

1995. *Gymnothilda levata* sp. n.; Schröder 1995: 48, pl. 9: 9–12.

Holotype: Schröder 1995: pl. 9: 9.
Type horizon: Valanginian (Early Cretaceous).
Type locality: Wąwał, southern Mazowsze, Poland.

Material. — 30 shells from the type locality.

Measurements. — The protoconch with about two whorls is 0.28 mm high and 0.40 mm in diameter. A shell (ZPAL Ga.9/229) consisting of 4.25 teleoconch whorls is 3.04 mm high and 1.55 mm in diameter.

Occurrences. — Type locality only.

Emended diagnosis. — Cone-shaped shell, 1.96 times as high as broad. Protoconch almost transaxial, ornamented by adapical and abapical axial folds. Teleoconch starting with one prominent spiral rib which

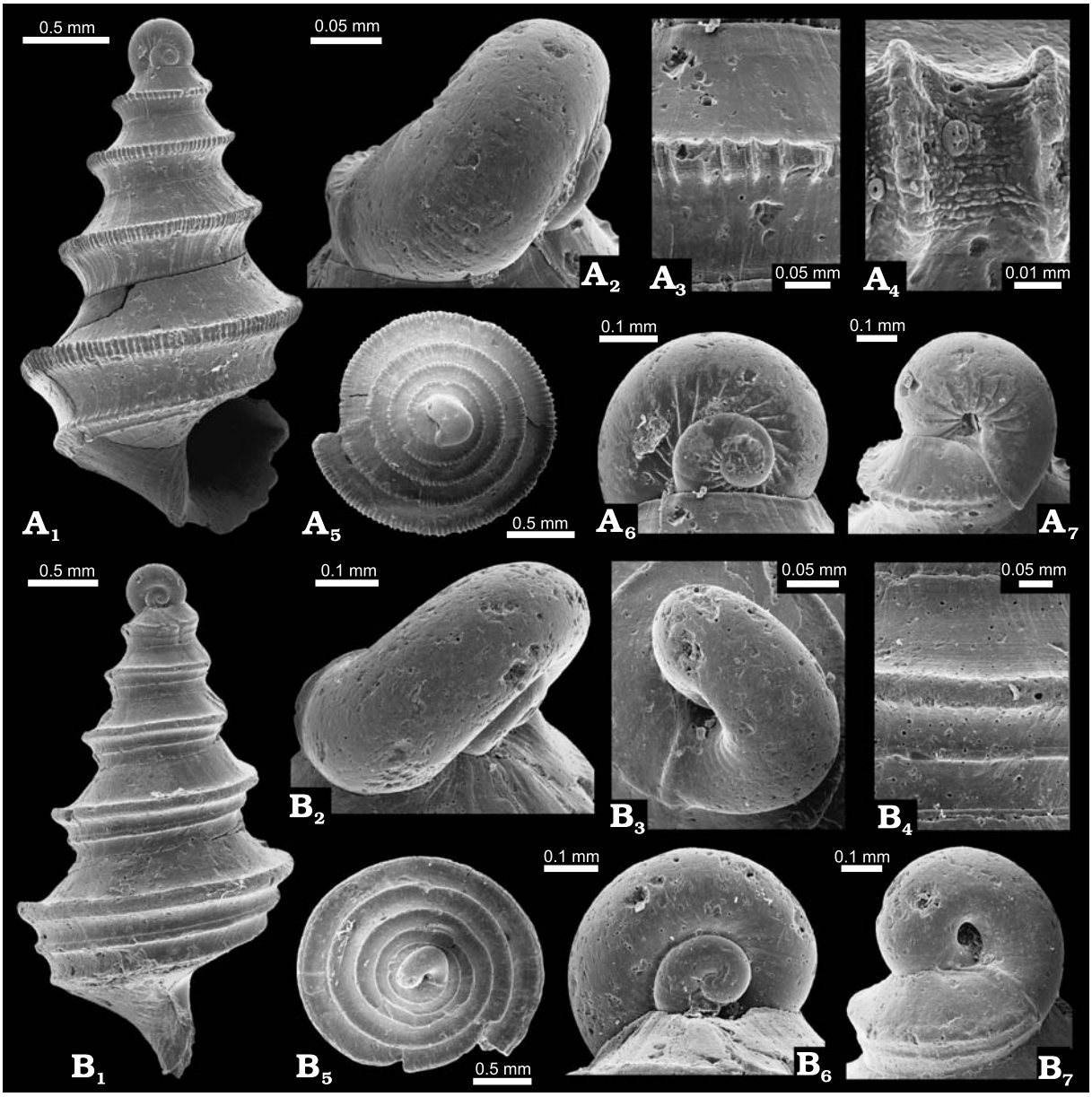


Fig. 113. The mathildid *Gymnothilda* from Wąwał, southern Mazowsze, Poland, Valanginian (Early Cretaceous). **A**. *Gymnothilda levata* Schröder, 1995 ZPAL Ga.9/229; A_1 lateral view, A_2 protoconch in lateral view, A_3, A_4 details of teleoconch ornamentation, A_5 apical view, A_6 protoconch in apical view, A_7 protoconch in umbilical view. **B**. *Gymnothilda reesi* sp. n. ZPAL Ga.9/230 (holotype); B_1 lateral view, B_2 protoconch in lateral view, B_3 protoconch in lateral view (apical view of the apex), B_4 details of teleoconch ornamentation, B_5 apical view, B_6 protoconch in apical view, B_7 protoconch in umbilical view.

quickly becoming keel. Remnants of axial ribs visible only at intersections with keel, ornamented also with spiral microornamentation. Otherwise teleoconch smooth.

Description. — Only one-third of the protoconch is immersed in the teleoconch. The base is ornamented with 5–6 weak spiral ribs. The peristome is badly preserved.

Remarks. — In some specimens (see e.g., pl. 9: 11 of Schröder 1995) a remnant of the upper spiral rib is visible at the beginning of the teleoconch. This suggests that *G. levata* had developed from two-ribbed forms.

Gymnothilda reesi sp. n.
(Fig. 113B)

Holotype: ZPAL Ga.9/270, Fig. 113B.

Type horizon: *Saynoceras verrucosum* Zone, Late Valanginian (Early Cretaceous).

Type locality: Wąwał, southern Mazowsze, Poland.

Derivation of the name: In honour of Jan Rees.

Material. — 17 shells from Wąwał, southern Mazowsze, Poland.

Measurements. — The protoconch with about two whorls is 0.30 mm high and 0.46 mm in diameter. A shell (ZPAL Ga.9/230) consisting of five teleoconch whorls is 3.75 mm high and 1.76 mm in diameter.

Occurrences. — Type locality only.

Diagnosis. — Shell cone-shaped, 1.76 times as high as broad. Protoconch weakly medioaxial, smooth. Teleoconch starting with two spiral ribs. Adapical rib becoming keel on first teleoconch whorl. Some remnants of spiral microornamentation present, otherwise teleoconch smooth.

Description. — Only one-third of the protoconch is immersed into the teleoconch. The base is ornamented with 5–6 weak spiral ribs. The peristome is badly preserved.

Remarks. — *G. reesi* has the most reduced ornamentation among the known gymnothildids. It also differs from other gymno- and carinathildids in developing the keel from the adapical spiral rib, not from the abapical one.

Gymnothilda tomaszina (Schröder, 1995)
(Fig. 114)

1995. *Mathilda tomaszina* sp. n.; Schröder 1995: 47, pl. 8: 10–14.

Holotype: Schröder 1995: pl. 8: 10.

Type horizon: Valanginian (Early Cretaceous).

Type locality: Wąwał, southern Mazowsze, Poland.

Material. — 17 shells from the type locality.

Measurements. — The protoconch with about two whorls is 0.39 mm in diameter. A shell (ZPAL Ga.9/244) consisting of 3.5 teleoconch whorls is 1.60 mm high and 0.93 mm in diameter.

Occurrences. — Type locality only.

Emended diagnosis. — Shell cone-shaped, 1.72 as high as broad. Protoconch weakly medioaxial, ornamented by adapical and abapical axial folds. Teleoconch starting with two prominent spiral ribs. Abapical rib

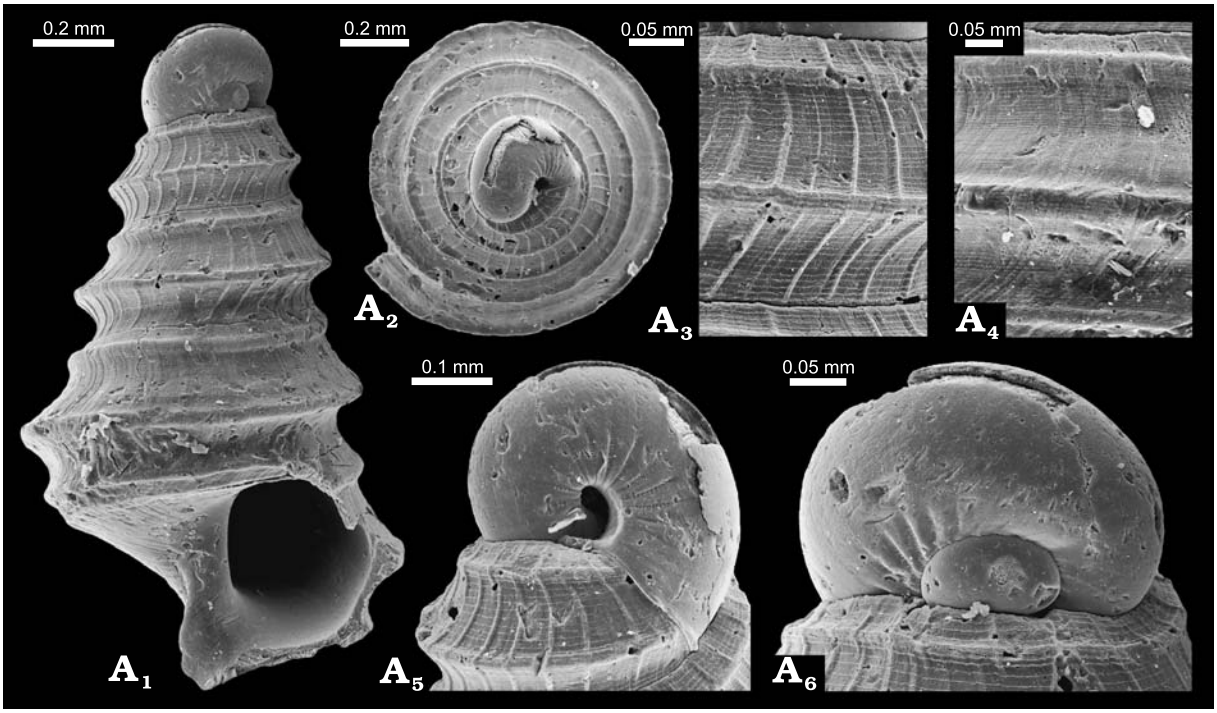


Fig. 114. The mathildid *Gymnothilda tomaszina* (Schröder, 1995) from Wąwał, southern Mazowsze, Poland, Valanginian (Early Cretaceous). **A**. ZPAL Ga.9/244 from sample E2; A_1 lateral view, A_2 apical view, A_3 details of teleoconch ornamentation at the first whorl of teleoconch, A_4 details of teleoconch ornamentation at the fourth whorl of teleoconch, A_5 protoconch in umbilical view, A_6 protoconch in apical view.

quickly becoming keel. First two whorls of teleoconch ornamented with opisthocline axial rib, later ribs disappearing. Surface of teleoconch covered by spiral microornamentation.

Description. — The protoconch is half-immersed in the teleoconch. The peristome is badly preserved.

Remarks. — *G. tomaszina* represents an intermediate form between *Carinathilda* and *Gymnothilda* (see Fig. 138). Schröder (1995) classified it under *Mathilda*, although he admitted its close relationship to *Gymnothilda*.

Genus *Erratothilda* Gründel, 1997

Type species: *Eucycloidea erratica* Gründel, 1990; monotypy. Callovian, Mid Jurassic, erratic boulder from Bauer-Wehrland, Germany.

Emended diagnosis. — Teleoconch cone-shaped. Protoconch hyperstrophic, coaxial to strongly medioaxial, smooth. First teleoconch whorl with three or more spiral ribs. At least one of ribs changing into keel. Number of spiral ribs may increase or decrease during ontogeny. Spiral ribs crossed by weaker axial ribs or threads. Teleoconch surface covered with spiral microornamentation.

Discussion. — *Erratothilda* is probably a sister genus to *Carinathilda*. It is also possible that both the genera are congeneric. The most important differences are more spiral ribs at the beginning of the teleoconch and a highly hyperstrophic protoconch.

Range. — Callovian (Mid Jurassic; Gründel 1997a) to Valanginian (Early Cretaceous; herein).

Erratothilda dziki sp. n.
(Fig. 115)

Holotype: ZPAL Ga.9/255, Fig. 115.

Type horizon: Sample C1, *Busnardoides campylotoxus* Zone, Early Valanginian (Early Cretaceous).

Type locality: Wąwał, southern Mazowsze, Poland.

Derivation of the name: In honour of Jerzy Dzik.

Material. — Holotype only.

Measurements. — The protoconch with about two whorls is 0.49 mm in diameter. The holotype consisting of 3.5 teleoconch whorls is 2.09 mm high and 1.36 mm in diameter.

Occurrences. — Type locality only.

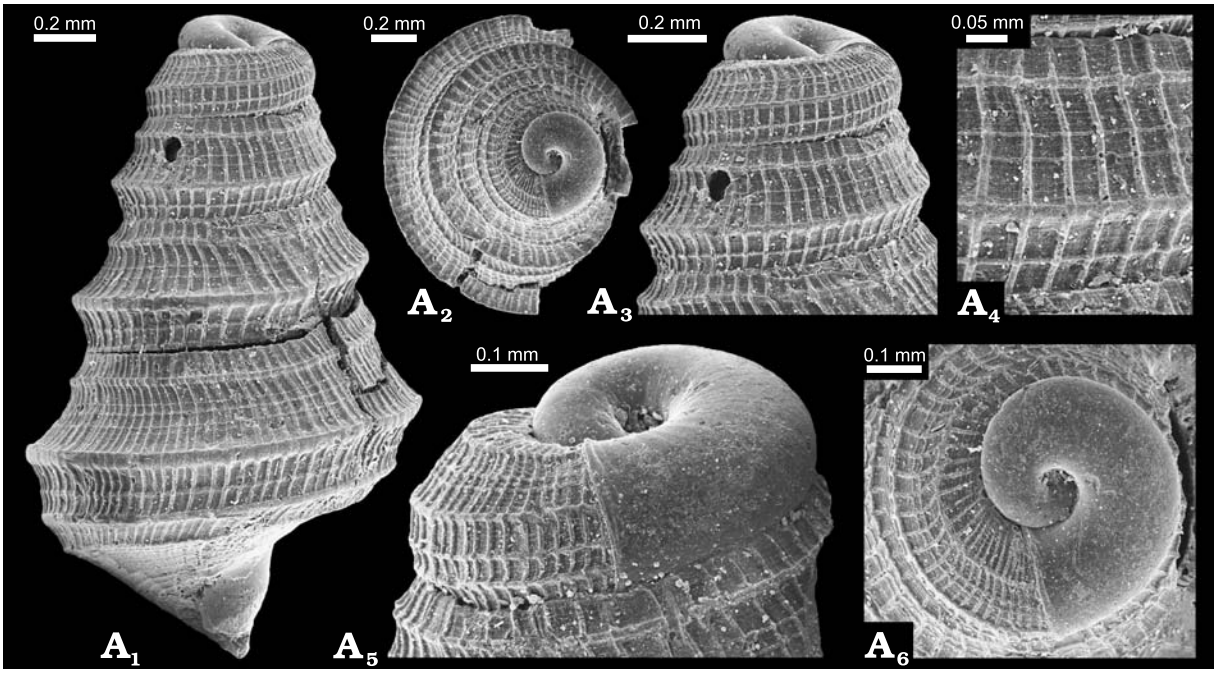


Fig. 115. The mathildid *Erratothilda dziki* sp. n. from Wąwał, southern Mazowsze, Poland, Valanginian (Early Cretaceous). **A**. ZPAL Ga.9/255 (holotype) from sample C1; A_1 lateral view, A_2 apical view, A_3 close-up of the apex, A_4 details of teleoconch ornamentation, A_5 demarcation between protoconch and teleoconch, A_6 protoconch in umbilical view.

Diagnosis. — Shell broadly cone-shaped, 1.53 times as high as broad. Protoconch almost coaxial, smooth. Teleoconch starting with six spiral ribs. Medial rib becoming keel on second teleoconch whorl. Number of ribs increasing in region above keel. Most abapical rib shifted to suture, only on first teleoconch whorl. Spiral ribs crossed by weakly opisthocyrtic axial ribs (about 60 ribs per whorl). Surface of teleoconch covered by spiral microornamentation.

Description. — The adapical portion of the protoconch is completely immersed in the teleoconch. The peristome is unknown. The columellar area is covered by the inner lip.

Remarks. — *E. dziki* differs from the other species of *Erratothilda* in the more numerous spiral ribs at the beginning of the teleoconch.

Erratothilda krawczynskii sp. n.
(Fig. 116)

Holotype: ZPAL Ga.9/259, Fig. 116.

Type horizon: Sample M1, *Tirnovella pertransiens* Zone, Early Valanginian (Early Cretaceous).

Type locality: Wąwał, southern Mazowsze, Poland.

Derivation of the name: In honour of Wojciech Krawczyński.

Material. — Holotype only.

Measurements. — The protoconch with about two whorls is 0.42 mm in diameter. The holotype of 2.5 teleoconch whorls is 1.23 mm high and 0.94 mm in diameter.

Occurrences. — Type locality only.

Diagnosis. — Broadly cone-shaped shell, 1.30 times as high as broad. Protoconch almost coaxial, smooth. Teleoconch starting with four spiral ribs. Medial rib becoming keel on first teleoconch whorl. Other ribs lost. Spiral ribs crossed by weakly opisthocyrtic axial ribs (about 60 ribs per whorl), poorly developed in latest known part of shell. Remnants of axial ribs present on keel surface. Surface of teleoconch covered by spiral microornamentation.

Description. — The adapical portion of the protoconch is completely immersed in the teleoconch. The peristome is unknown.

Remarks. — *E. krawczynskii* differs from the other species of *Erratothilda* in the reduction of the ornamentation similar to that observed among the species of *Gymnothilda*.

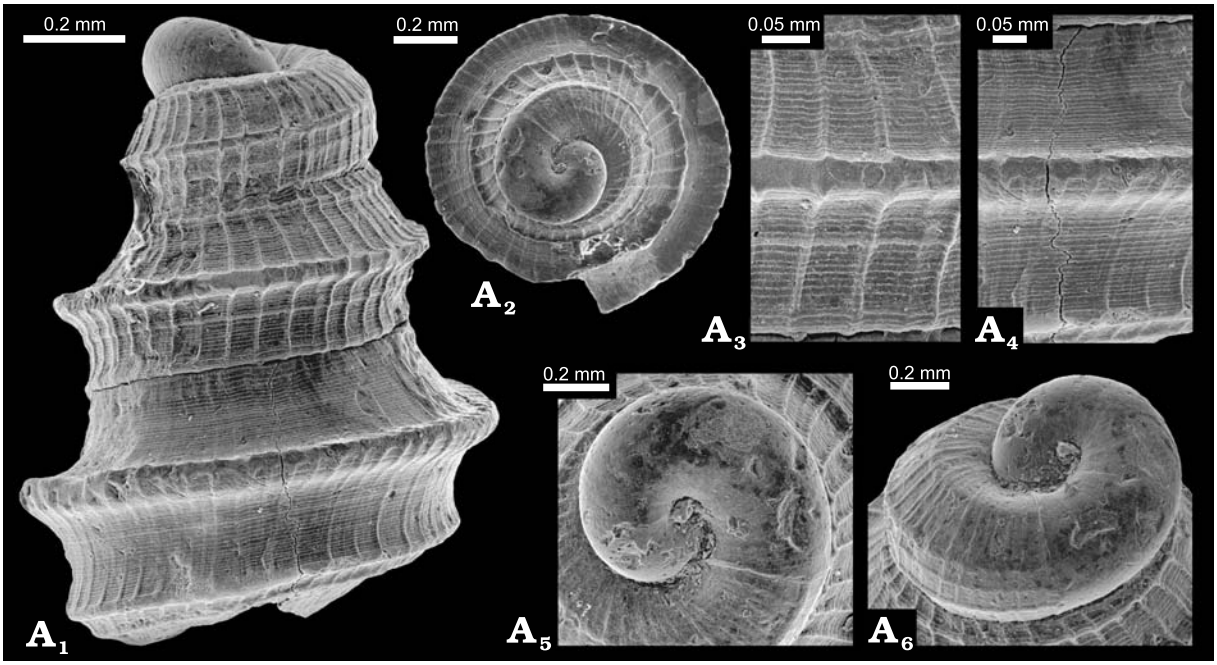


Fig. 116. The mathildid *Erratothilda krawczynskii* sp. n. from Wąwał, southern Mazowsze, Poland, Valanginian (Early Cretaceous). **A**. ZPAL Ga.9/259 (holotype) from sample M1; A_1 lateral view, A_2 apical view, A_3, A_4 details of teleoconch ornamentation at the third and the fourth whorl of the teleoconch respectively, A_5 protoconch in umbilical view, A_6 demarcation between the protoconch and teleoconch.

Genus *Tuba* Lea, 1883
(*Gegania* Jeffreys, 1884)

Type species: *Tuba alternata* Lea, 1883; subsequent designation by Cossmann (1912). Eocene, Alabama, USA.

Diagnosis. — Protoconch hyperstrophic, coaxial to strongly medioaxial, smooth. Teleoconch broadly cone-shaped with bulging whorls. Periphery and base rounded. First teleoconch whorl with 3–5 spiral ribs. Spiral ribs crossed by weaker, opisthocline to sinuous, axial ribs or threads or enhanced growth lines. At intersections ornamented with rounded, more-or-less coarse, nodules. Peristome round, apertural lip slightly channeled at columella. Umbilicus funnel shaped (after Bieler 1995).

Discussion. — For discussion of the Recent *Tuba* see Bieler (1995). The Mesozoic species of *Tuba* (see e.g., Dockery 1993; Schröder 1995; and herein) are similar to the Recent species, although they differ in some details, e.g., the absence of anal keel on the protoconch aperture. Some similar forms are also classified as Architectonicidae (*Heliacus* sensu Dockery 1993). Judging only by the shell, it is hard to determine the definite taxonomic position of those species.

Range. — Valanginian (Early Cretaceous; Schröder 1995 and herein) to Recent (e.g., Bieler 1995).

Tuba seriaformis (Schröder, 1995)
(Fig. 117)

1995. *Gegania seriaformis* sp. n.; Schröder 1995: 54, pl. 9: 13–18, pl. 15: 10.

Holotype: Schröder 1995: pl. 9: 13.

Type horizon: Valanginian (Early Cretaceous).

Type locality: Wąwał, southern Mazowsze, Poland.

Material. — 144 shells from the type locality.

Measurements. — The protoconch is 0.40 mm in diameter. A shell (ZPAL Ga.9/235) consisting of about two teleoconch whorls is 1.98 mm high and 1.38 mm in diameter.

Occurrences. — Type locality only.

Emended diagnosis. — Teleoconch broadly cone-shaped with bulging whorls, 1.43 times as high as broad. Protoconch coaxial, smooth. Teleoconch starting with 3–4 spiral ribs and densely packed orthocline axial ribs. Number of spiral ribs increasing during ontogeny. Surface of teleoconch covered by spiral microornamentation.

Description. — The adapical portion of the protoconch is completely immersed in the teleoconch. The peristome is rounded. The umbilicus is funnel-shaped and partially covered by the inner lip.

Remarks. — The similar Campanian *Tuba mississippiensis* (Dockery, 1993) differs in having a higher number of primary spiral ribs of which three become more prominent than the others, during further growth.

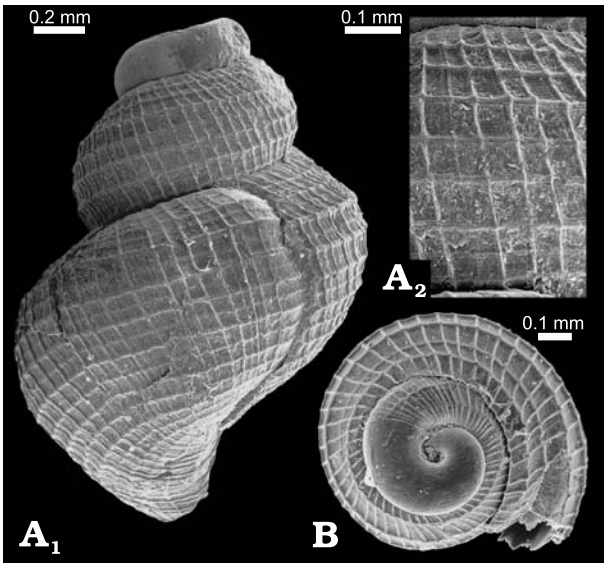


Fig. 117. The mathildid *Tuba seriaformis* (Schröder, 1995) from Wąwał, south Mazowsze, Poland, Valanginian (Early Cretaceous). **A**. ZPAL Ga.9/235 from sample N1; A_1 lateral view, A_2 detail of the teleoconch ornamentation. **B**. ZPAL Ga. 9/236 from sample N1; apical view.

Genus *Clathrobaculus* Cossmann, 1912

Type species: *Cerithium ziczac* Eudes-Deslongchamps, 1842; original designation. Pliensbachian (Early Jurassic), Fountaine-Etoupefour, France.

Emended diagnosis. — Protoconch hyperstrophic, transaxial to weakly medioaxial, smooth. Teleoconch strongly elongated. First teleoconch whorl with 3–4 spiral ribs. Spiral ribs crossed by weaker, orthocline to weakly opisthocline or weakly opisthocyrtic, axial ribs or threads. At intersections rounded nodules may appear.

Discussion. — The genus *Clathrobaculus* of Cossmann (1912) encompasses the mathildid species with strongly elongated shells. As the heterostrophic protoconch is weakly attached to the teleoconch, it usually breaks off. The material illustrated below clearly shows the heterostrophic nature of the *Clathrobaculus* protoconch. The species of *Clathrobaculus*, especially those illustrated by Eudes-Deslongchamps (1842), are poorly known and their taxonomic status is not fully recognized. Most probably, they are closely related to *Mathilda* (see also Gründel 2000b). Another genus, *Gordenella* Gründel, 1990, differs only in the simplification of the axial ornament during ontogeny. It is probable that both genera are synonyms but to confirm this, additional well-preserved material is needed. Gründel (2000b) regards *Gordenella* as a member of its own family Gordenellidae Gründel, 2000. In general, the shells of *Gordenella* do not differ very significantly from those of Mathildidae (compared to those of the mathildids illustrated by Bieler 1995) and, they are therefore not interpreted here as representive of the members of a separate family. *Clathrobaculus* and *Gordenella* are here considered as belonging to the Mathildidae until more comprehensive material from both genera is examined.

Range. — Hettangian (Early Jurassic; Cossmann 1912) to Valanginian (Early Cretaceous; herein) and possibly Eocene (Cossmann 1912).

Clathrobaculus sp. 1
(Fig. 118)

Material. — One shell from sample J1 of Wąwał, southern Mazowsze, Poland, *Tirnoviella pertransiens* Zone of Early Valanginian (Early Cretaceous).

Measurements. — The teleoconch (ZPAL Ga.9/227) consisting of about ten whorls is 3.73 mm high and 1.20 mm in diameter.

Description. — The shell is highly elongate, 3.11 times as high as broad. The hyperstrophic protoconch is broken off just before the demarcation from the teleoconch. The teleoconch begins with four spiral ribs. The two abapical ribs are much stronger than the subsutural rib. The number of ribs is stable during ontogeny. The spiral ribs are crossed by opisthocline axial ribs (33–34 ribs per whorl). The peristome is not known.

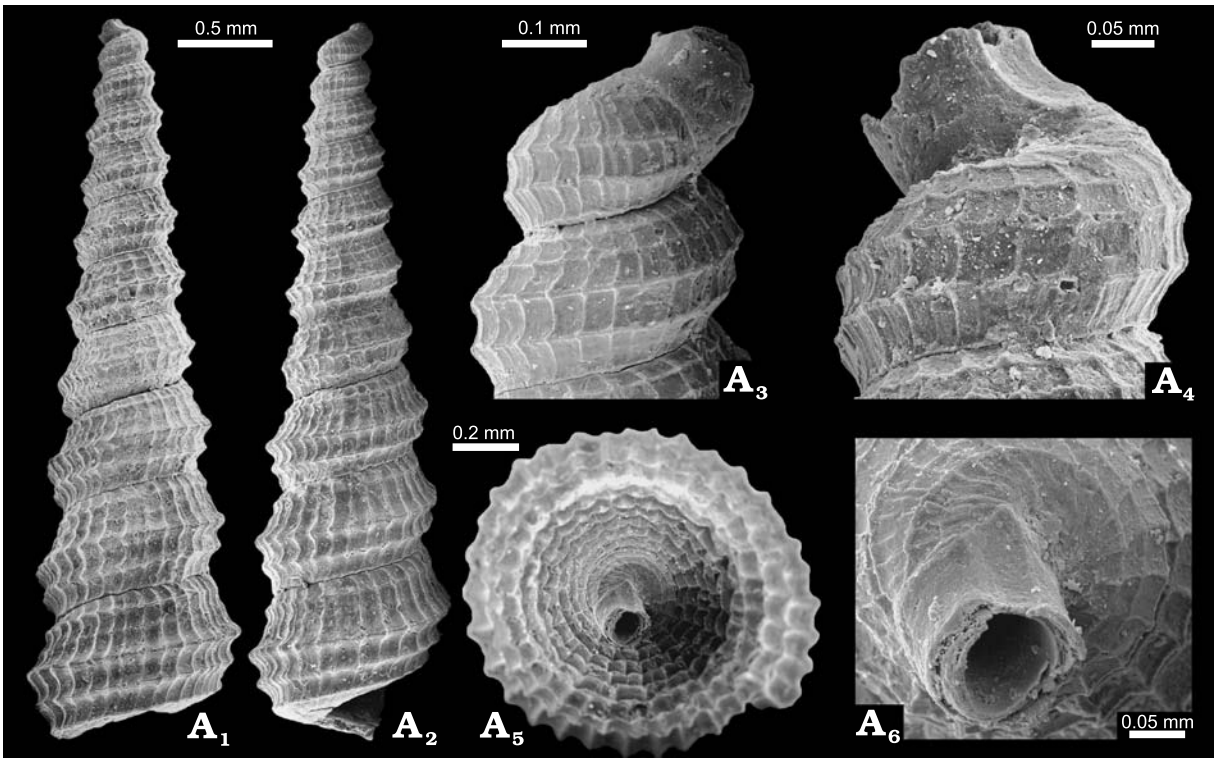


Fig. 118. The mathildid *Clathrobaculus* sp. 1 from Wąwał, southern Mazowsze, Poland, Valanginian (Early Cretaceous). **A**. ZPAL Ga.9/227 from sample J1; A_1, A_2 lateral views, A_3, A_4 close-ups of the apex in lateral view, note the broken-off heterostrophic protoconch, A_5 apical view, A_6 the apex in apical view.

Remarks. — The shell described above is very similar to the Callovian *Clathrobaculus eucyclus* (Hébert *et* Eudes-Deslongchamps, 1862) but the type material has to be reexamined to confirm this.

Clathrobaculus sp. 2
(Fig. 119)

Material. — One shell from Łuków (block in glacial drift), Podlasie, Poland, Late Callovian (Mid Jurassic).

Measurements. — The teleoconch (ZPAL Ga.9/228) consisting of about five whorls is 5.38 mm high and 2.34 mm in diameter.

Description. — The shell is elongate, 2.30 times as high as broad. The protoconch is unknown. The youngest known teleoconch whorl is ornamented with four spiral ribs, two adapical and two abapical, with an in-between unornamented area. The third rib, if counting from the apex, is the strongest. At this rib, the whorls are distinctly angulated. The number of ribs is stable during ontogeny apart from the latest known whorl at which additional weak, spiral ribs appear. The spiral ribs are crossed by opisthocyrtic axial ribs (35–36 ribs per whorl). The peristome is not known.

Remarks. — The shell described above is an intermediate form between *Clathrobaculus* and *Gordenella* Gründel, 1990 which may be considered as congeneric.

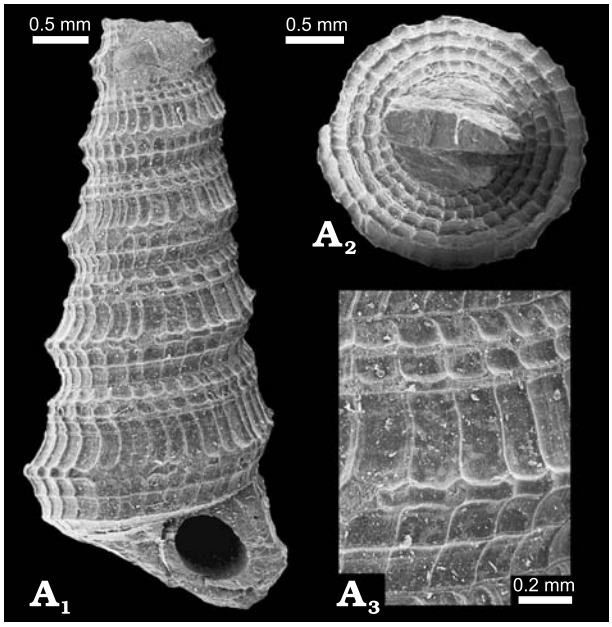


Fig. 119. The mathildid *Clathrobaculus* sp. 2. from Łuków (block in glacial drift), Podlasie, Poland, Callovian (Mid Jurassic) **A**. ZPAL Ga.9/228; A_1 lateral view, A_2 apical view, A_3 details of teleoconch ornamentation.

Clathrobaculus sp. 3
(Fig. 120)

Material. — One juvenile shell from Ogrodzieniec, Częstochowa region, Poland, Bathonian (Mid Jurassic).

Measurements. — The protoconch with about two whorls is 0.48 mm in diameter. A shell (ZPAL Ga.9/246) consisting of about two teleoconch whorls is 0.60 mm high and 0.42 mm in diameter.

Description. — The shell is elongate. The protoconch is large, almost planispiral and weakly medioaxial, with weak abapical axial rows but smooth otherwise. The protoconch ends with a narrow apertural lip. The teleoconch starts with three spiral ribs, of which the medial rib is the strongest. At this rib, the whorls are distinctly angulated. Later whorls and the peristome are not known.

Remarks. — The shell described above is the first shell of *Clathrobaculus* with the protoconch preserved that has been recorded. The large, delicate protoconch usually breaks off from the slender and delicate teleoconch. Another probable *Clathrobaculus* protoconch has been illustrated by Gründel (1997a, pl. 3: 46, 47, pl. 4: 48) as "*Tricarilda plana* Gründel, 1973 with an aberrant protoconch".

Family **Tofanellidae** Bandel, 1995

Genus *Cristalloella* Bandel, 1995 November
(*Wonwalica* Schröder, 1995 December)

Type species: *Cristalloella cassiana* Bandel, 1995; original designation. Early Carnian (Late Triassic), Alpe di Specie above Carbonin, Italian Alps.

Emended diagnosis. — Teleoconch slender, elongated. Sinistral protoconch gradually changed into dextral, smooth or with weak axial ribs, terminated with thickened peristome. First teleoconch whorl with medial keel and numerous, fine spiral ribs. Spiral ribs crossed by weaker, sometimes sinusoidal axial ribs (based on Bandel 1995; Schröder 1995; and own material).

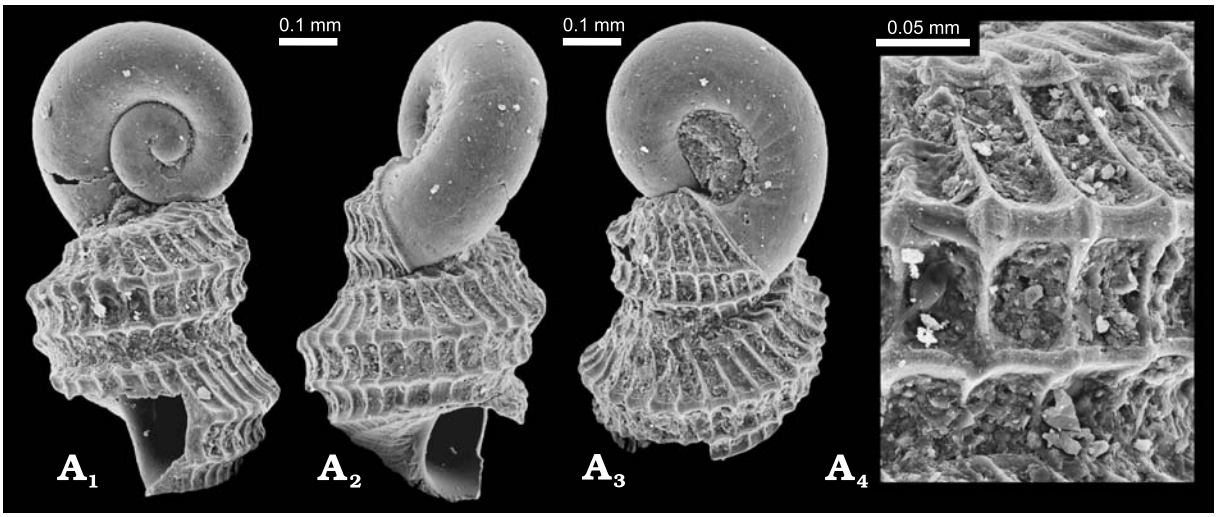


Fig. 120. The mathildid *Clathrobaculus* sp. 3. from Ogrodzieniec, Częstochowa region, Poland, Bathonian (Mid Jurassic) **A**. ZPAL Ga.9/246; A_{1-3} lateral views, A_4 details of teleoconch ornamentation.

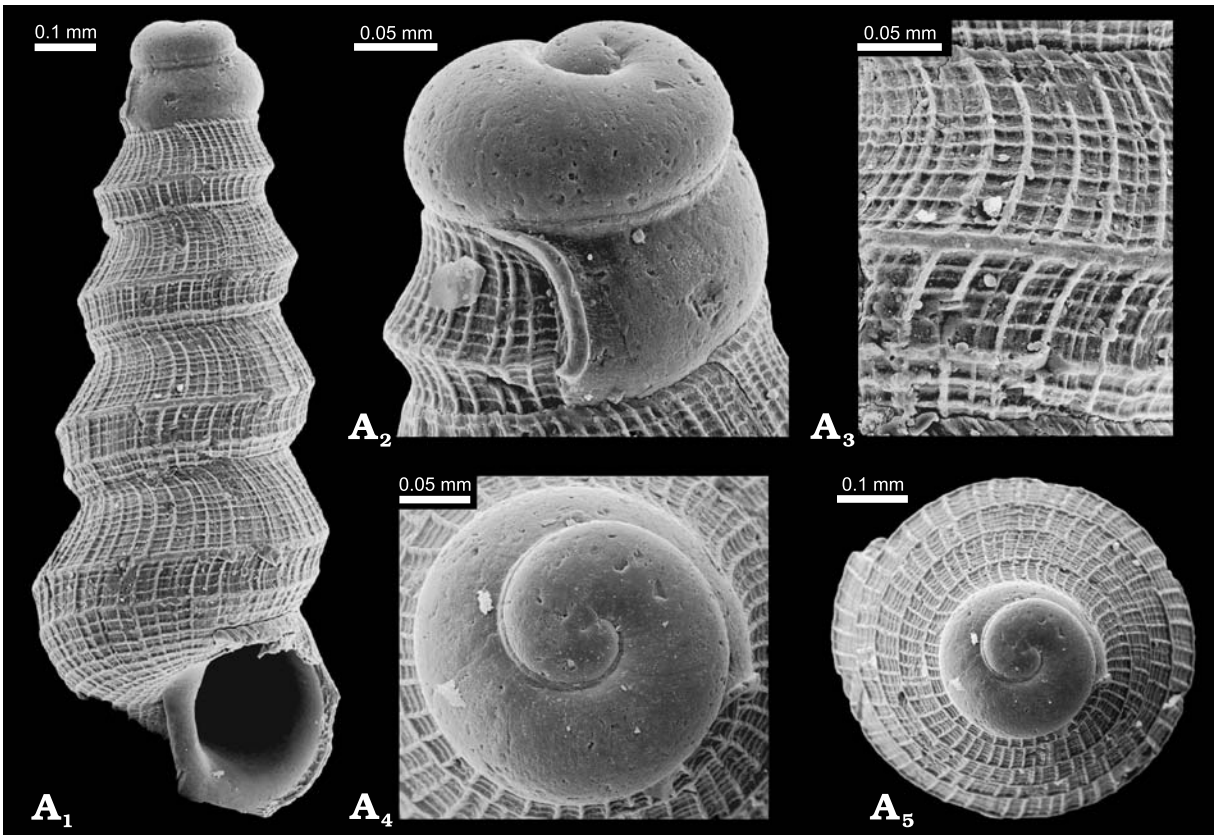


Fig. 121. The tofanellid *Cristalloella minuta* (Schröder, 1995) from Wąwał, southern Mazowsze, Poland, Valanginian (Early Cretaceous). **A**. ZPAL Ga.9/247 from sample M1; A_1 lateral view, A_2 protoconch in lateral view, A_3 details of teleoconch ornamentation at the third whorl of the teleoconch, A_4 protoconch in apical view, A_5 apical view.

Discussion. — The species of *Cristalloella* Bandel, 1995 cannot be differentiated on the generic level from the species of *Wonwalica* Schröder, 1995. The differences given by Bandel (1995: 24) appear to be only of specific importance. The Early Cretaceous *Cristalloella boczarowskii* described below also has "a sunken and sinistrally coiled first whorl that dips below the larval shell". *Cristalloella* closely resembles some species of *Graphis* Jeffreys, 1867 (see illustrations in Van Aartsen 2002), which are usually classified in the family Aclididae (Van Aartsen 2002).

Range. — Carnian (Late Triassic; Bandel 1995) to Valanginian (Early Cretaceous; Schröder 1995 and herein).

Cristalloella minuta (Schröder, 1995)
(Fig. 121)

1995. *Wonwalica minuta* sp. n.; Schröder 1995: 56, pl. 10: 1–5, pl. 15: 12.

Holotype: Schröder 1995: pl. 10: 1–3.
Type horizon: Valanginian (Early Cretaceous).
Type locality: Wąwał, southern Mazowsze, Poland.

Material. — Seven shells from the type locality.

Measurements. — The protoconch with 2.25 whorls is 0.22 mm high and 0.25 mm in diameter. A shell (ZPAL Ga.9/247) consisting of 4.5 teleoconch whorls is 1.27 mm high and 0.52 mm in diameter.

Occurrences. — Type locality only.

Emended diagnosis. — Shell elongated, 2.44 times as high as broad. Early portion of protoconch sinistral, changing into dextral during ontogeny. Hyperstrophy hardly visible. Protoconch peristome with sinusigera lip. Teleoconch ornamented with one prominent rib and about 15 weaker ribs. Whorls at prominent rib distinctly angulated. Spiral ribs crossed by sinusoidal axial ribs (60–61 ribs per whorl). Base demarcated by an additional, prominent spiral rib, otherwise ornamented like lateral flanks of whorls. Peristome rounded, columellar area with narrow inner lip.

Remarks. — *C. minuta* differs from the most similar *C. boczarowskii* in having densely spaced axial ribs and by being hardly visible hyperstrophy.

Cristalloella boczarowskii sp. n.
(Fig. 122)

Holotype: ZPAL Ga.9/248, Fig. 122.

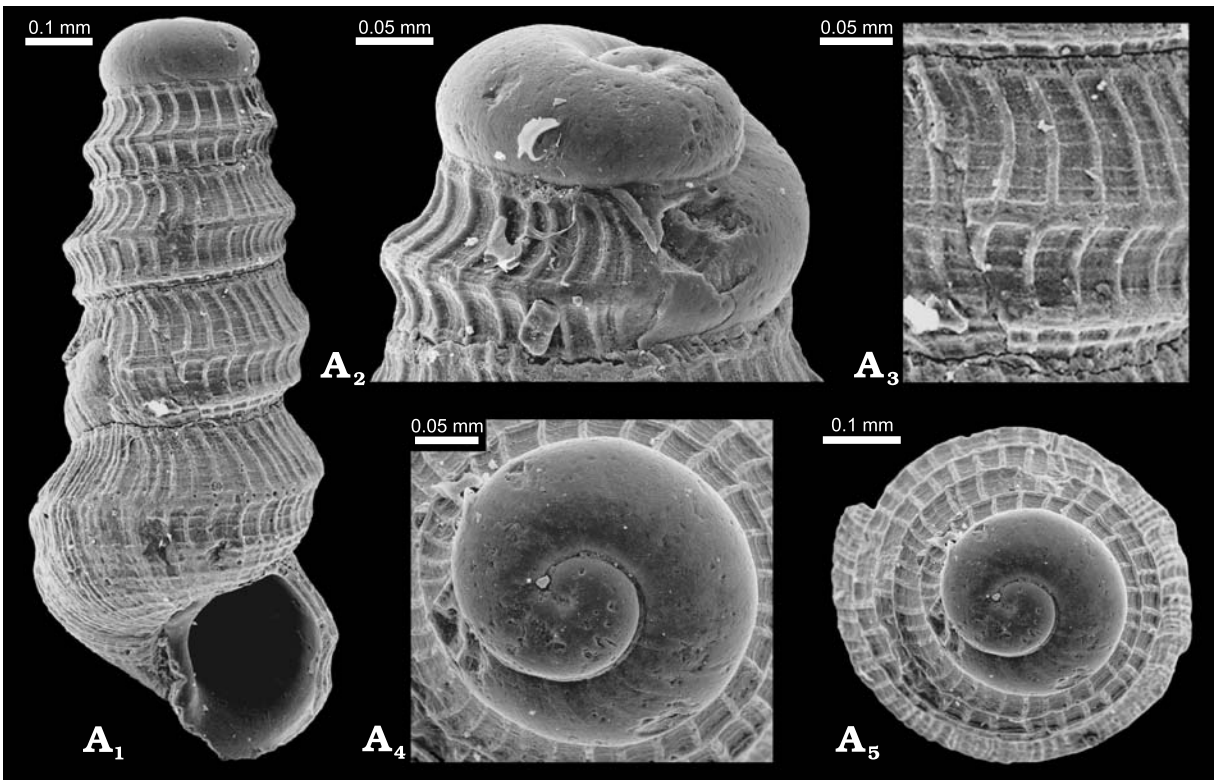


Fig. 122. The tofanellid *Cristalloella boczarowskii* sp. n. from Wąwał, southern Mazowsze, Poland, Valanginian (Early Cretaceous). **A**. ZPAL Ga.9/248 (holotype); A_1 lateral view, A_2 protoconch in lateral view, A_3 details of teleoconch ornamentation at the third whorl of the teleoconch, A_4 protoconch in apical view, A_5 apical view.

Type horizon: *Saynoceras verrucosum* Zone, Late Valanginian (Early Cretaceous).

Type locality: Wąwał, southern Mazowsze, Poland.

Derivation of the name: In honour of Andrzej Boczarowski.

Material. — Twelve shells from the type locality.

Measurements. — The protoconch with 1.75 whorls is 0.20 mm high and 0.25 mm in diameter. The shell of the holotype consisting of 4.25 teleoconch whorls is 1.13 mm high and 0.48 mm in diameter.

Occurrences. — Type locality only.

Emended diagnosis. — Elongated shell, 2.35 as high as broad. Early portion of protoconch sinistral, sunken a little below following whorl, during ontogeny changes into dextral. Protoconch peristome with sinusigera lip. Teleoconch ornamented with one prominent medial rib and about 15 weaker ribs. Two other prominent ribs visible close to suture on both whorl sides. Whorls distinctly angulated at medial rib. Spiral ribs crossed by sinusoidal axial ribs (33–34 ribs per whorl). Base ornamented like lateral flanks of whorls. Peristome rounded, columellar area with narrow inner lip.

Remarks. — For differences see *C. minuta*.

Superfamily **uncertain**
Family **uncertain**

Remarks. — The taxa described below have featureless teleoconch and a sinistral protoconch. The species of the genus *Bandellina* have shells similar to those of the members of the families Cornirostridae, Hyalogyrinidae, and Cimidae. At present, according to Bieler *et al.* (1998), classifying these featureless shells under any of these families is difficult, thus I leave them as heterobranchs without a superfamily/family assessment, until a more comprehensive data set of these gastropods is accumulated.

Genus *Bandellina* Schröder, 1995
(*Alexogyra* Bandel, 1996; *Carboninia* Bandel, 1996; Doggerostra Gründel, 1998)

Type species: *Bandellina laevissima* Schröder, 1995; monotypy. Valanginian (Early Cretaceous), Wąwał, southern Mazowsze, Poland.

Diagnosis. — Coaxial protoconch. Sinistral embryonal shell. Larval shell almost planispiral, with thickened adult shell peristome. Teleoconch is widely conical, turbiniform with bulgy-convex final turn and wide umbilicus. Whorls at the suture are not terraced. Growth lines are weakly prosocyrt, shell otherwise smooth. The base is demarcated from the umbilicus by an angulated bulge-like edge. Peristome rounded, complete with bulging inner lip. Outer lip not thickened (after Schröder 1995).

Discussion. — As already admitted by Bandel (1996) *Bandellina* resembles extant *Hyalogyra* Marshall, 1998 which lives on sunken wood (Marshall 1988) and hot vent associations (Warén and Bouchet 1993). According to Bandel (1996) *Bandellina* has a protoconch with more whorls, and the increase in shell diameter of the teleoconch is smaller than in *Hyalogyra*. The genera *Carboninia* and *Alexogyra* established by Bandel (1996) and *Doggerostra* Gründel, 1998 are here regarded as younger synonyms of *Bandellina*. *Carboninia valvatiforma* Bandel, 1996, the type species of *Carboninia*, is very similar to *Bandellina miniperforata* illustrated below (Fig. 123C). The latter species has a protoconch with a thickened adult shell peristome, the character typical of the genus *Bandellina*.

Range. — Late Triassic (Bandel 1996) to Early Cretaceous (Schröder 1995 and herein).

Bandellina laevissima Schröder, 1995
(Fig. 123A, B)

1995. *Bandellina laevissima* sp. n.; Schröder 1995: 42, pl. 7: 9–12, pl. 15: 6.

Holotype: Schröder 1995: 42, pl. 7: 9–12, pl. 15: 6.

Type horizon: Valanginian, Early Cretaceous.

Type locality: Wąwał, southern Mazowsze, Poland.

Material. — Two shells from Lower Valanginian of Wąwał, central Poland.

Measurements. — The protoconch with 1.5 whorls visible measures 0.21 mm in diameter. A shell (ZPAL Ga.9/201) consisting of 1.75 teleoconch whorls is 0.61 high and 0.83 mm in diameter.

Occurrences. — Type locality only.

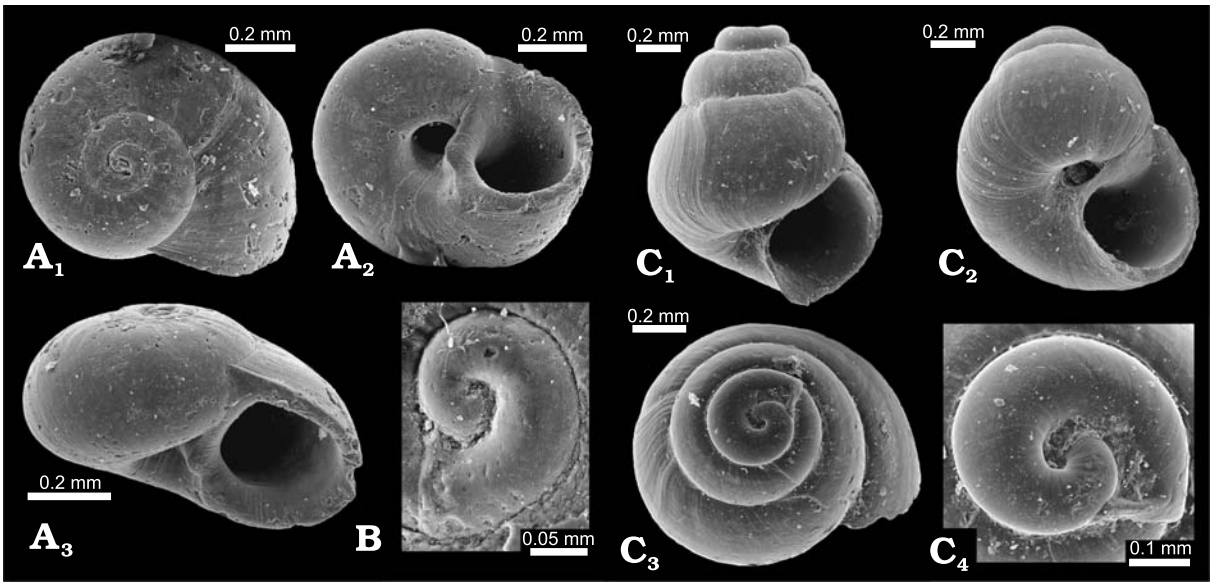


Fig. 123. The heterostroph *Bandellina*. **A**, **B**. *Bandellina laevissima* Schröder, 1995, ZPAL Ga.9/200 from sample J1(A) and 9/201from sample G1(B) of Wąwał, southern Mazowsze, Poland, Valanginian (Early Cretaceous); A_1 apical view, A_2 umbilical view, A_3 lateral view, B close-up of protoconch. **C**. *Bandellina miniperforata* (Gründel, 1998), MZ VIII Mg 4247/1 from Łuków (block in glacial drift), Podlasie, Poland, Callovian (Mid Jurassic); C_1 lateral view, C_2 umbilical view, C_3 apical view, C_4 close-up of protoconch.

Emended diagnosis. — Shell low-spired, turbinate. Protoconch sinistral, hyperstrophic with no ornamention. Terminal part of protoconch thickened. Teleoconch with thick wall, unornamented apart from prosocyrt growth lines. Suture adpressed. Peristome in one plane, inclined adapically, complete. Outer lip even, inner lip with two undulations. Umbilicus circular, wide open.

Remarks. — *B. laevissima* differs from *B. cassiana* Bandel, 1996 in having a smaller number of protoconch whorls and clearly visible undulations of the inner lip.

Bandellina miniperforata (Gründel, 1998)
(Fig. 123C)

1998. *Carboninia miniperforata* sp. n.; Gründel 1998b: 14, pl. 5: 60, 61, pl. 7: 94.

Holotype: Gründel 1998b: 14, pl. 7: 94.

Type horizon: Probably Callovian (Mid Jurassic).

Type locality: Dobromyśl borehole, West Pomerania, Poland.

Material. — Three shells from Callovian of Łuków (block in glacial drift), Podlasie, Poland.

Measurements. — The protoconch with about two whorls measures 0.41 mm in diameter. A shell (MZ VIII Mg 4247/1) consisting of two teleoconch whorls is 1.31 mm high and 1.10 mm in diameter.

Occurrences. — Northern Germany, West Pomerania (northwestern Poland), and Łuków (block in glacial drift, Podlasie, Poland).

Emended diagnosis. — Shell littoriniform with shallow incised suture. Protoconch sinistral, hyperstrophic, unornamented. Terminal part of protoconch strongly thickened. Growth lines opisthocyrt. Otherwise shell smooth. Peristome tear-drop shaped, even, complete. Umbilicus circular, medium-sized.

Remarks. — *B. miniperforata* differs from *B. laevissima* and *B. cassiana* by being much more high spired and having a larger protoconch. The overall shell shape is similar to that of *Bandellina valvatiforma* (Bandel, 1996) but it differs from the latter in having a strongly thickened adult shell peristome.

Bandellina riedeli (Gründel, 1998)
(Fig. 124A, B)

1998. *Doggerostra riedeli* sp. n.; Gründel 1998b: 14, pl. 5: 56–59.

Holotype: Gründel 1998b: 14, pl. 5: 56–58.

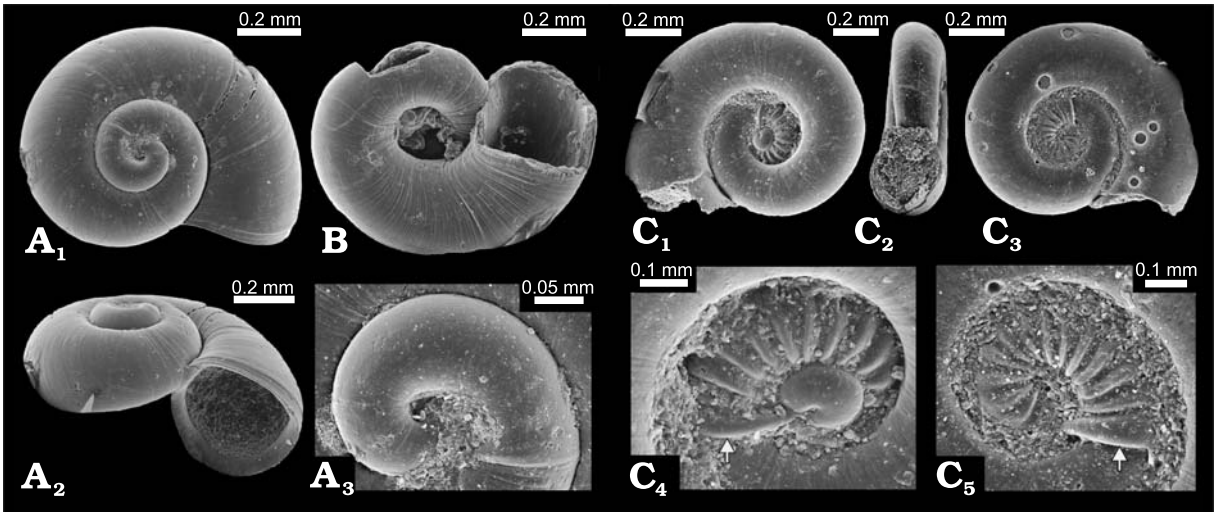


Fig. 124. Mid Jurassic heterostrophs *Bandellina* and *Stuoraxis* from Bathonian of Częstochowa region, Poland. **A**, **B**. *Bandellina riedeli* (Gründel, 1998), ZPAL Ga.9/202 from Faustianka (A) and ZPAL Ga.9/213 from Gnaszyn (B); A_1 lateral view, A_2 apical view, A_3 close-up of protoconch, B umbilical view. **C**. *Stuoraxis wareni* sp. n. ZPAL Ga.9/206 (holotype) from Faustianka; C_1 umbilical view, C_2 lateral view, C_3 apical view, C_4 protoconch in apical view, C_5 protoconch in umbilical view.

Type horizon: Late Bathonian (Mid Jurassic).

Type locality: Kłęby borehole 1/37, West Pomerania, Poland.

Material. — Three shells from the Mid Bathonian of Faustianka and one shell from the Bathonian of Gnaszyn, both Częstochowa region, Poland.

Measurements. — Number of protoconch whorls is not clearly visible. Protoconch is 0.26 mm in diameter. Shell (ZPAL Ga.9/203) of 1.5 of teleoconch whorls is 0.64 mm high and 0.86 mm in diameter.

Occurrences. — Kłęby borehole 1/37 (West Pomerania), Faustianka, and Gnaszyn (both Częstochowa region), all Poland.

Diagnosis. — Low spired shell. Sinistral protoconch, hyperstrophic, unornamented. Terminal part of protoconch weakly thickened. Growth lines prosocline, otherwise shell smooth. Peristome circular, even, complete, slightly elongated anteriorly. Umbilicus circular, wide open.

Remarks. — *B. riedeli* resembles *B. cassiana* but the former differs in having fewer whorls of the protoconch and the peristome slightly elongated anteriorly. It resembles *B. magna* (Gründel, 1998), which nevertheless differs by a more planispirally coiled teleoconch.

Superfamily **uncertain**

Family **uncertain**

Genus *Turrithilda* Schröder, 1995

Type species: *Turritella opalina* Quenstedt, 1858; monotypy. Aalenian, Mid Jurassic, Teufelsloch, Germany.

Emended diagnosis. — Long, multispiral teleoconch. Whorls rounded. Protoconch hyperstrophic, coaxial. First teleoconch whorl with four or more spiral ribs. Spiral ribs on early whorls crossed by weaker axial ribs or threads. Later axial ornamentation disappearing.

Discussion. — *Turrithilda* was established by Schröder (1995) with the type species *Turritella opalina* Quenstedt, 1858, but the species he actually illustrated and described was a species of *Mathilda* similar to *M. makowskii* (described herein). Here, the genus *Turrithilda* is based on the shell of *T. opalina* of Quenstedt 1858 (although the holotype is a badly preserved specimen; Joachim Gründel, personal communication 2003), and not on the shells illustrated by Schröder (1995). In 1995 Bandel described two species of *Turrithilda* from the Triassic of the Italian Alps which are probably the true turrithildids. *Turrithilda* resembles some Recent pyramidellids (*Chrysallida* and *Rissopsetia*) and there is also some resemblance to the mathildids. Here, *Turrithilda* retains its status as "family and superfamily uncertain".

Range. — Carnian, Late Triassic (Bandel 1995) to Valanginian, Early Cretaceous (herein).

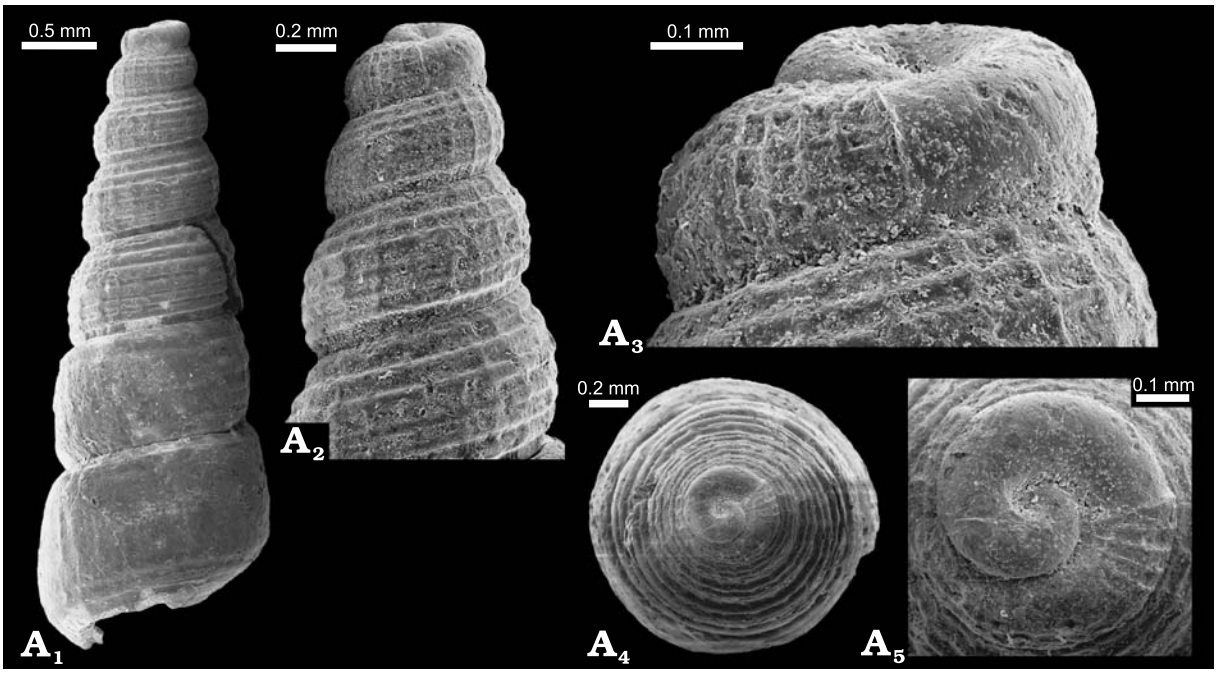


Fig. 125. The heterostroph *Turrithilda zlotniki* sp. n. from Wąwał, southern Mazowsze, Poland, Valanginian (Early Cretaceous). **A**. ZPAL Ga.9/234 (holotype) from sample E3; A_1 lateral view, A_2 close-up of the juvenile whorls, A_3 apex in lateral view, A_4 apical view, A_5 protoconch in umbilical view.

Turrithilda zlotniki sp. n.
(Fig. 125)

Holotype: ZPAL Ga.9/234, Fig. 125.

Type horizon: Sample E3, *Saynoceras verrucosum* Zone, Late Valanginian (Early Cretaceous).

Type locality: Wąwał, southern Mazowsze, Poland.

Derivation of the name: In honour of Michał Złotnik.

Material. — Six shells from the type locality.

Measurements. — The protoconch with about two whorls is 0.44 mm in diameter. The holotype consisting of six teleoconch whorls is 4.29 mm high and 1.45 mm in diameter.

Occurrences. — Type locality only.

Diagnosis. — Teleoconch long, multispiral, 2.95 times as high as broad. Whorls rounded. Protoconch hyperstrophic, coaxial, smooth. First teleoconch whorl with six spiral ribs. Spiral ribs on early whorls crossed by weaker axial ribs. Axial ribs becoming increasingly weaker on the later whorls and spiral ribs becoming broader until both spiral and axial ribs disappearing.

Description. — As in diagnosis.

Remarks. — *T. zlotniki* is similar to *T. dockeryi* Bandel, 1995 which is known exclusively from juvenile shells (Bandel 1995). The latter differs in having a smaller number of spiral ribs on the first whorl of the teleoconch.

Family **Stuoraxidae** Bandel, 1994

Genus *Stuoraxis* Bandel, 1996

Type species: *Stuoraxis lehmani* Bandel, 1996; monotypy. Early Carnian (Late Triassic), Stuores Alm, Italy.

Diagnosis. — Small shell (about 1mm) consisting of rounded, evolute whorls overlapping only slightly with each other, forming shallow dextral coil with wide umbilicus. Aperture almost round, of simple outline, vertically oriented. Protoconch consisting of low conical larval shell with sinistral coil twisting into planispiral coil in final portion of larval whorl ornamented by transversal folds. Apertural rim of pediveliger thickened (after Bandel 1996).

Discussion. — Bandel (1994a) established a new family Stuoraxidae to accommodate this genus. The diagnosis of the family is based mainly on the presence of axial folds on the protoconch. Similar folds also are present among other heterobranch groups, e.g., the omalogyrids (unpublished data of A. Warén) and even the mathildids (see above). Because of this, the status of the family remains unclear.

Range. — Late Triassic (Bandel 1996) to Mid Jurassic (herein).

Stuoraxis wareni sp. n.
(Fig. 124C)

Holotype: ZPAL Ga.9/204, Fig. 124C.

Type horizon: *Procerites progracilis* Zone, Mid Bathonian (Mid Jurassic).

Type locality: Faustianka, Częstochowa region, Poland.

Derivation of the name: In honour of Anders Warén.

Material. — Three shells from the type locality.

Measurements. — Protoconch 1 with about 0.75 whorls is 0.09 mm in diameter. The whole protoconch mesures 0.26 mm in diameter. The shell of the holotype consisting of 1.5 teleoconch whorls is 0.34 mm high and 1.04 mm in diameter.

Occurrences. — Type locality only.

Diagnosis. — Low shell, almost planispiral. Small protoconch 1, smooth. Sinistral, hyperstrophic protoconch 2 ornamented with strong, almost orthocline axial ribs and very fine spiral lirae. Terminal part of protoconch thickened. Teleoconch with orthocline growth lines, otherwise smooth.

Remarks. — *S. wareni* differs from *S. lehmanni* Bandel, 1996 in having stronger, orthocline axial ribs of the protoconch and by the presence of the ribs on the whole protoconch 2. It differs from *S. parvula* Gründel, 1998 by the smaller number of axial ribs on the protoconch.

Subclass **OPISTHOBRANCHIA** Milne-Edwards, 1848
Superfamily **Cephalaspidea** Fischer, 1883
Family **Cylindrobullinidae** Wenz, 1947
Genus *Cylindrobullina* Ammon, 1878

Type species: *Tornatella fragilis* Dunker, 1847; subsequent designation by Cossmann (1895b). Liassic (Early Jurassic), vicinity of Halberstadt, Germany.

Diagnosis. — Shell ovate with short conical spire. Whorls separated by flattened ramp. Aperture wide, constricted posteriorly and widened anteriorly. Inner lip covering slightly bent columella and forming low, narrow fold in its anterior part and narrow slit on spindle. Early whorls consisting of sinistrally coiled, low-spired shell attached to teleoconch at angle of about 90° (after Bandel 1994b).

Discussion. — *Cylindrobullina* Ammon, 1878 is very similar to *Actaeonina* d'Orbigny, 1847 and differs only in the wider adapical, subsutural ramp resulting in a more stair-like shell outline (see also Bandel 1994b; Schröder 1995; Gründel 1997b).

Range. — Carnian (Late Triassic; Bandel 1994b) to Valanginian (Early Cretaceous; herein).

Cylindrobullina schneideri Gründel, 1997
(Fig. 126)

1997. *Cylindrobullina schneideri* sp. n.; Gründel 1997b: 179, pl. 1: 1–7.

Holotype: Gründel 1997b: 179, pl. 1: 1–3.

Type horizon: Callovian, Mid Jurassic.

Type locality: Chrząszczewska Island, Western Pomerania, Poland.

Material. — Eight shells from Callovian of Łuków (block in glacial drift), Podlasie, Poland.

Measurements. — The protoconch with about two whorls is 0.27 mm high and 0.31 mm in diameter. A shell (MZ VIII Mg 4252/1) consisting of 2.5 teleoconch whorls is 1.36 mm high and 0.57 mm in diameter.

Occurrences. — Germany and Poland.

Emended diagnosis. — Elongated shell with relatively high whorls, 2.38 times as high as broad. Protoconch 1 and protoconch 2 umbilicus emerging above first teleoconch whorl. Teleoconch whorls high in rela-

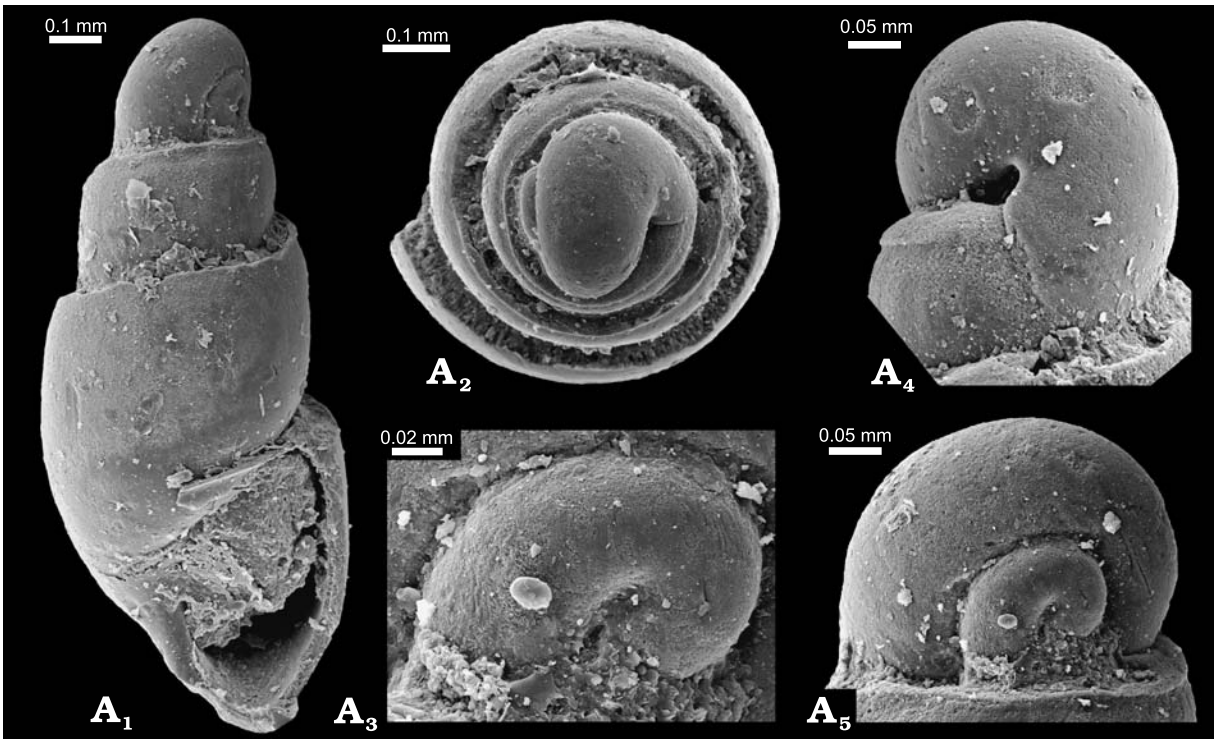


Fig. 126. *Cylindrobullina schneideri* Gründel, 1997 from Łuków (block in glacial drift), Podlasie, Poland, Callovian (Mid Jurassic). **A**. MZ VIII Mg 4252/1; A_1 lateral view, A_2 apical view, A_3 protoconch in umbilical view, A_4 close-up of the protoconch 1, A_5 protoconch in apical view.

tion to width, rounded only close to suture on both whorl sides. Ramp well pronounced with abapical furrow at border (modified after Gründel 1997b).

Description. — The protoconch is hyperstrophic, transaxial, and smooth. The teleoconch surface is smooth apart from the furrow at the ramp. The columellar area is covered by the inner lip.

Remarks. — For comparison to other species see Gründel (1997b).

Cylindrobullina valanginiana sp. n.
(Fig. 127)

Holotype: ZPAL Ga.9/298, Fig. 127A.

Type horizon: *Saynoceras verrucosum* Zone, Late Valanginian (Early Cretaceous).

Type locality: Wąwał, southern Mazowsze, Poland.

Derivation of the name: After the Valanginian stage.

Material. — 59 shells from the type locality.

Measurements. — The protoconch with about two whorls is 0.33 mm high and 0.36 mm in diameter. The shell of the holotype consisting of 2.25 teleoconch whorls is 1.54 mm high and 0.67 mm in diameter.

Occurrences. — Type locality only.

Diagnosis. — Shell elongated, spindle-like, 2.30 times as high as broad. Protoconch sunken to its half into first teleoconch whorl. Ramp narrow with no furrow at border. Teleoconch whorls rounded.

Description. — The protoconch is hyperstrophic, transaxial to weakly medioaxial and smooth. The teleoconch surface is smooth apart from the prosocyrt growth lines. The columellar area is covered by the inner lip.

Remarks. — *C. valanginiana* differs from *C. schneideri* by having a more rounded whorl, more sunken protoconch, narrower ramp, and by lacking the ramp furrow.

Genus *Sinuarbullina* Gründel, 1997

Type species: *Sinuarbullina ansorgi* Gründel, 1997; original designation. Bathonian (Mid Jurassic), Kłęby borehole 1/37, Western Pomerania, Poland.

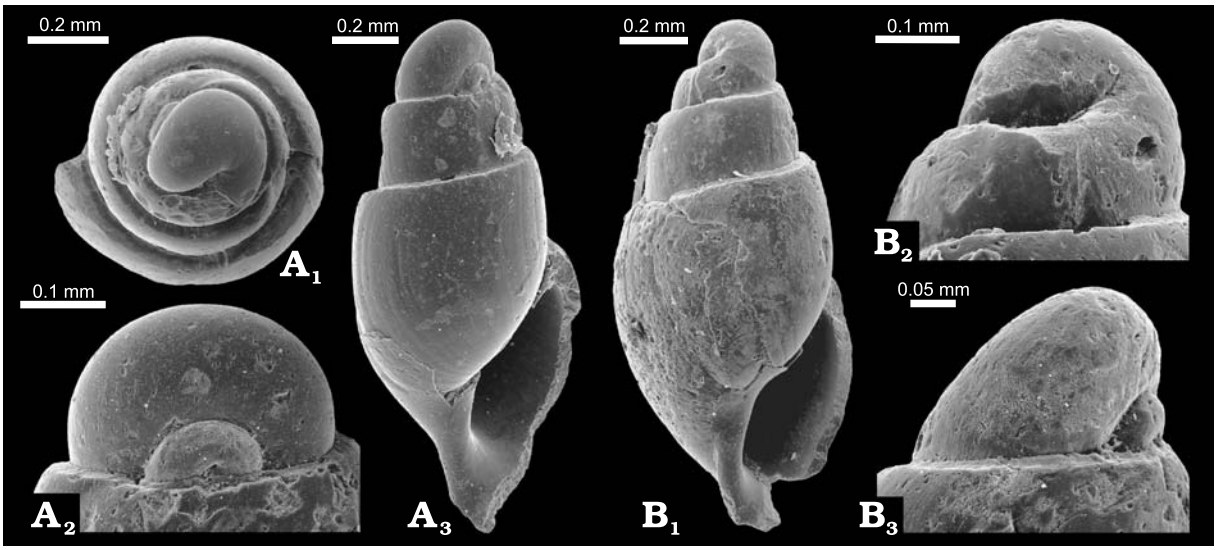


Fig. 127. *Cylindrobullina valanginiana* sp. n. from Wąwał, southern Mazowsze, Poland, Valanginian (Early Cretaceous). **A**. ZPAL Ga.9/298 (holotype); A_1 apical view, A_2 protoconch in apical view, A_3 lateral view. **B**. ZPAL Ga.9/285 from sample F3; B_1 lateral view, B_2 protoconch in umbilical view, B_3 protoconch in latero-apical view.

Diagnosis. — Spindle-like shell. Protoconch hyperstrophic, transaxial to medioaxial, smooth or with abapically enhanced growth lines. Protoconch deeply sunken into first teleoconch whorl. Teleoconch whorls with narrow, rounded ramp gradually changing into lateral flank of whorl. Teleoconch surface smooth apart from prosocyrtic growth lines strongly bent posteriorly before ramp, curved back to anterior at ramp. Peristome elongated, tear-drop shaped, narrowed posteriorly, rounded anteriorly. Columellar area covered by inner lip. Columellar folds missing (after Gründel 1997b).

Discussion. — *Sinuarbullina* differs from *Cylindrobullina* by having a rounded ramp and a protoconch, which is deeply sunken into the first teleoconch whorl.

Range. — Early to Mid Jurassic (Gründel 1997b, 1999b).

Sinuarbullina ansorgi Gründel, 1997
(Fig. 128A)

1997. *Sinuarbullina ansorgi* sp. n.; Gründel 1997b: 179, pl. 1: 16, 17, pl. 2: 1–3.

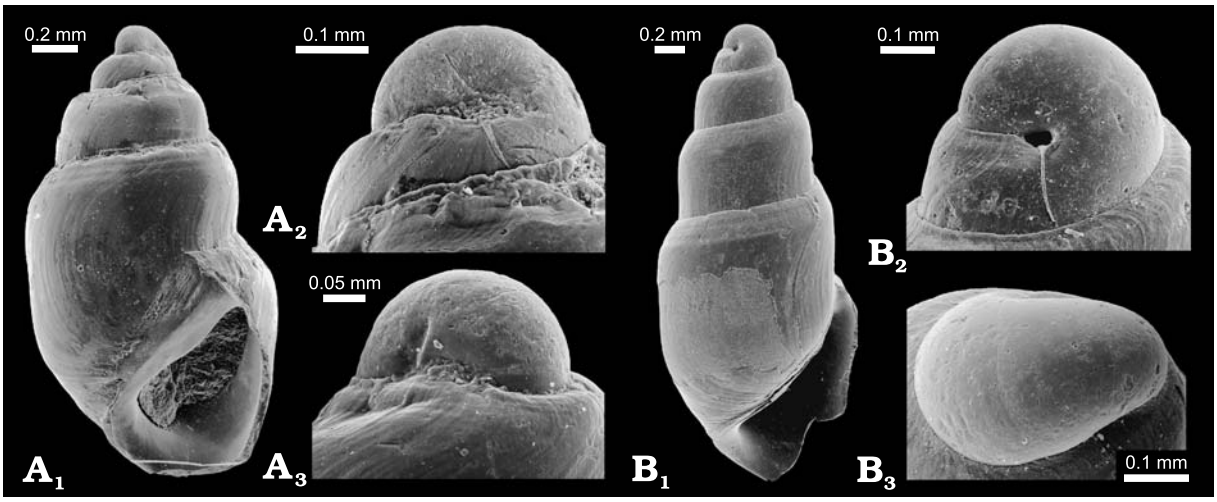


Fig. 128. Mid Bathonian (Mid Jurassic) cylindrobullinids *Sinuarbullina* from Częstochowa region, Poland. **A**. *Sinuarbullina ansorgi* Grundel, 1997, ZPAL Ga.9/284 from Faustianka; A_1 lateral view, A_2 protoconch in umbilical view; A_3 protoconch in apical view. **B**. *Sinuarbullina gnaszynensis* sp. n., ZPAL Ga.9/282 (holotype) from Gnaszyn; B_1 lateral view, B_2 protoconch in umbilical view, B_3 protoconch in lateral view.

Holotype: Gründel 1997b: 181, pl. 1: 16, 17, pl. 2: 1, 2.

Type horizon: Bathonian, Mid Jurassic.

Type locality: Kłęby borehole 1/37, Western Pomerania, Poland.

Material. — 17 shells from Bathonian of Faustianka, Częstochowa region, Poland.

Measurements. — The protoconch is 0.28 mm high and 0.31 mm in diameter. A shell (ZPAL Ga.9/284) consisting of 3.00 teleoconch whorls is 2.00 mm high and 1.09 mm in diameter.

Occurrences. — Germany and Poland.

Diagnosis. — Protoconch medium sized. Shell moderately broad with relatively low whorls. Outline of the teleoconch whorls clearly convex. (from Gründel 1997b).

Description. — The protoconch is hyperstrophic, transaxial to weakly medioaxial, smooth. The protoconch 1 is completely or almost completely sunken into the first teleoconch whorl. The teleconch is 1.80 (herein) to 1.95 (Gründel 1997b) times as high as broad. The teleoconch surface is smooth apart from sinuous growth lines. The columellar and the parietal areas are covered by the inner lip.

Remarks. — *S. ansorgi* differs from *S. cylindrica* by having a lower spire, a more robust shell and more convex whorls.

Sinuarbullina gnaszynensis sp. n.
(Fig. 128B)

Holotype: ZPAL Ga.9/282, Fig. 128B.

Type horizon: *Morrisiceras morrisi* Zone, Mid Bathonian, Mid Jurassic.

Type locality: Gnaszyn, Częstochowa region, Poland.

Derivation of the name: After type locality.

Material. — Over 100 shells from the type locality.

Measurements. — The protoconch is 0.28 mm high and 0.38 mm in diameter. The shell of the holotype consisting of 3.75 teleoconch whorls is 3.03 mm high and 1.32 mm in diameter.

Occurrences. — Type locality only.

Diagnosis. — Protoconch 1 almost completely sunken into first teleoconch whorl. Protoconch medium sized. Shell elongated, 2.29 as high as broad, with high-spired, cylindrical teleoconch whorls. Adapical sutural ramp passing gradually into whorl lateral flank.

Description. — The protoconch is hyperstrophic, transaxial to weakly medioaxial and smooth. The teleoconch surface is smooth apart from the sinuous growth lines. The columellar area is covered by a narrow inner lip.

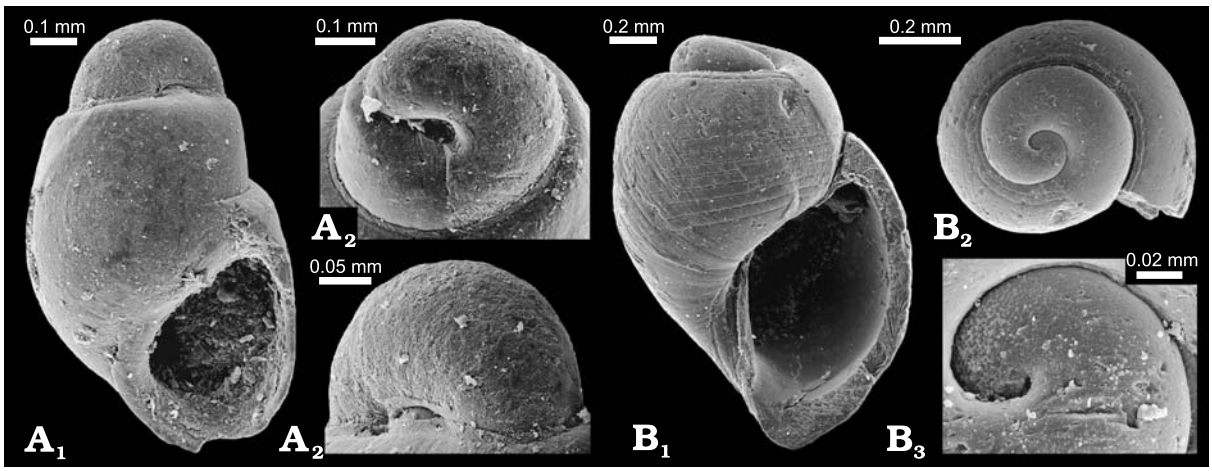


Fig. 129. Cephalaspids *Sinuarbullina* and *Sulcoactaeon* from Poland. **A**. *Sinuarbullina* sp., MZ VIII Mg 4253/1 from Łuków (block in glacial drift), Podlasie, Callovian (Mid Jurassic); A_1 lateral view, A_2 protoconch in umbilical view; A_3 protoconch in apical view. **B**. *Sulcoactaeon* sp., ZPAL Ga.9/320 from Wąwał, southern Mazowsze, Valanginian (Early Cretaceous); B_1 lateral view, B_2 protoconch in umbilical view, B_3 apical view.

Remarks. — *S. gnaszynensis* differs from *S. cylindrica* Gründel, 1997 in having much larger protoconch and a more gradual transition between the ramp and lateral flank of the whorl. It differs from *S. ansorgi* by a more elongated shell shape.

Sinuarbullina sp.
(Fig. 129A)

Material. — Four juvenile shells from Callovian of Łuków (block in glacial drift), Podlasie, Poland.

Measurements. — The protoconch is 0.35 mm in diameter. A shell (MZ VIII Mg 4253/1) consisting of about 1.5 teleoconch whorls is 0.95 mm high and 0.58 mm in diameter.

Description. — The shell is 1.63 times as high as broad. Protoconch 1 is almost completely sunken in first teleoconch whorl. The protoconch is smooth. The teleoconch surface is smooth apart from the sinuous growth lines. The columellar area is covered by the inner lip.

Remarks. — The shells described above represent the early ontogenetic stages of growth, which does not allow classifying them as the certain species of *Sinuarbullina*.

Family **Bullinidae** Gray, 1850

Genus *Sulcoactaeon* Cossmann, 1895
(*Parvulactaeon* Gründel, 1997)

Type species: *Actaeonina striato-sulcata* Zittel *et* Goubert, 1861; original designation. ?Oxfordian (Late Jurassic), Glos, Normandy, France.

Emended diagnosis. — Shell relatively high-spired, slim to broadly oval. Protoconch strongly medioaxial to coaxial, smooth. Teleoconch whorls with narrow, sometimes indistinct ramp, with rounded edge passing gradually into lateral whorl surface. Whorls ornamented with spiral striae, usually more numerous toward the base. Spiral striae often absent or sparcely distributed on surface between ramp and abapical suture. Growth lines prosocyrtic, bent from the suture to base center. Peristome narrowly oval, anteriorly channelled, posteriorly with short, broad notch. Outer lip evenly convex. Columellar region with umbilical chink or covered by broad projection of inner lip. Columellar folds missing (modified after Gründel 1997b).

Discussion. — Gründel (1997b) established the new family Sulcoactaeonidae based on the genus *Sulcoactaeon* and included the family in the superfamily Cylindrobullinoidea Wenz, 1947. This family has been synonymized with Bullinidae by Bandel *et al.* (2000). The genus *Parvulactaeon* established by Gründel (1997b) is very similar to *Sulcoactaeon* and the latter differs only in a less distinctive ramp. In practice it is difficult to determine which ramp should be recognized as typical of *Sulcoactaeon* and which as typical of *Parvulactaeon*, and therefore the two genera are treated jointly here.

Range. — Bajocian, Mid Jurassic (Hudleston 1896) to Valanginian, Early Cretaceous (herein).

Sulcoactaeon wawalensis sp. n.
(Fig. 130)

Holotype: ZPAL Ga.9/286, Fig. 130.

Type horizon: *Saynoceras verrucosum* Zone, Late Valanginian (Early Jurassic).

Type locality: Wąwał, southern Mazowsze, Poland.

Derivation of the name: After the type locality.

Material. — 2335 shells from the type locality.

Measurements. — A shell (ZPAL Ga.9/286) consisting of 4.5 whorls is 1.95 mm high and 1.29 mm in diameter.

Occurrences. — Type locality only.

Diagnosis. — Protoconch not clearly demarcated from teleoconch. Shell broadly spindle-like, 1.51 as high as broad. Early whorls smooth apart from weak, posteriorly bent abapical folds. Three spiral striae on visible part of third whorl. Deepest and broadest stria situated close to very narrow ramp at adapical suture. Two weaker striae situated close to abapical suture. Additional striae visible at base. Teleoconch whorls rounded. Peristome D-shaped. columellar area with narrow inner lip and wide umbilical chink.

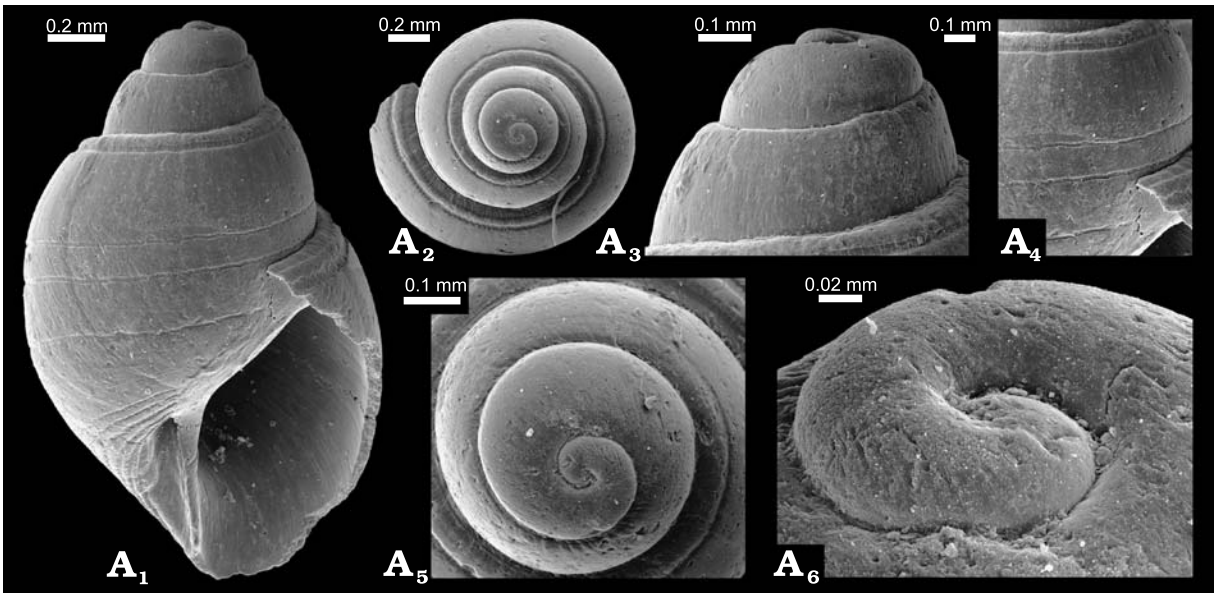


Fig. 130. The bullinid *Sulcoactaeon wawalensis* sp. n. from Wąwał, southern Mazowsze, Valanginian (Early Cretaceous). **A**. ZPAL Ga.9/286 (holotype); A_1 lateral view, A_2 apical view, A_3 apex in lateral view, A_4 details of the teleoconch ornamentation, A_5 apex in apical view, A_6 close-up of the protoconch.

Remarks. — *S. wawalensis* is similar in shell shape to *S. raresculpta* Gründel, 1997 but differs with regard to the pattern of ornamention and the presence of an umbilical chink. Also similar is *S. pulloides* (Hudleston, 1896) which has a less distinctive ramp, more elongated shell shape, and no umbilical chink.

Sulcoactaeon polonicus sp. n.
(Fig. 131)

Holotype: ZPAL Ga.9/283, Fig. 131.
Type horizon: *Procerites progracilis* Zone, Mid Bathonian, Mid Jurassic.
Type locality: Faustianka, Częstochowa region, Poland.
Derivation of the name: After Poland.

Material. — 17 shells from Bathonian of Faustianka, Częstochowa region, Poland.

Measurements. — The protoconch is 0.45 mm in diameter. The shell of the holotype consisting of 2.25 teleoconch whorls is 2.44 mm high and 1.53 mm in diameter.

Occurrences. — Type locality only.

Diagnosis. — Protoconch clearly demarcated from teleoconch, almost coaxial, smooth. Shell broadly spindle-like, 1.53 times as high as broad. Teleoconch starting with two distinct adapical striae and two to three weakly visible lateral spirae. Later shell with well developed, evenly spaced lateral striae (including on base). Teleoconch whorls rounded with narrow, well pronounced adapical ramp. Peristome elongated. Columellar area with narrow inner lip. Umbilical chink narrow.

Remarks. — *S. polonicus* resembles *S. latestriatus* (Walther, 1951) but differs in having evenly spaced spiral striae and broader subsutural ramp.

Sulcoactaeon sp.
(Fig. 129B)

Material. — One juvenile shell from *Saynoceras verrucosum* Zone of late Valanginian, Wąwał, southern Mazowsze, Poland.

Measurements. — The protoconch is 0.40 mm in diameter. A shell (ZPAL Ga.9/320) consisting of one teleoconch whorl is 0.89 mm high and 0.68 mm in diameter.

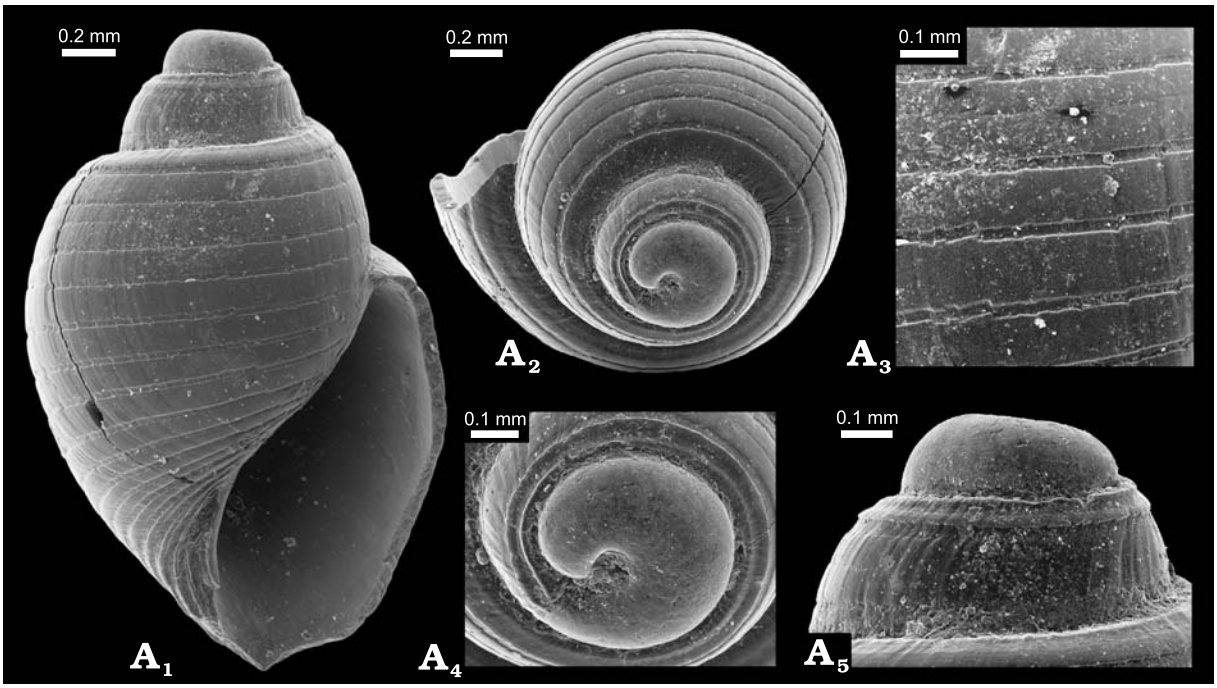


Fig. 131. The bullinid *Sulcoactaeon polonicus* sp. n. from Faustianka, Częstochowa region, Poland, Mid Bathonian (Mid Jurassic). **A**. ZPAL Ga.9/283 (holotype); A_1 lateral view, A_2 apical view, A_3 details of the teleoconch ornamentation, A_4 close-up of the apex in apical view, A_5 close-up of the apex in lateral view.

Description. — The shell is 1.38 times as high as broad. The protoconch is coaxial. Protoconch 1 is ornamented by remnants of the granular pattern. Protoconch 2 is smooth and well demarcated from the teleoconch. The teleoconch is ornamented by two prominent spiral striae situated close to the adapical suture and evenly spaced fine lateral striae. Both sets of striae are separated by an unornamented surface. The ramp is indistinct. Abapical part of the base has no striae. The inner lip is thin. The umbilical chink is narrow.

Remarks. — The shell described above differs from the known early whorls of other *Sulcoactaeon* species but it is left in open nomenclature because of the still unknown later whorls of the teleoconch.

Family **Acteonidae** d'Orbigny, 1842

Genus *Tornatellaea* Conrad, 1860

Type species: *Tornatellaea belle* Conrad, 1860; monotypy. Eocene (Paleogene), Mississippi or Alabama, USA.

Emended diagnosis. — Protoconch strongly medioaxial to almost coaxial, smooth. Subovate shell, spire generally less than half total shell height. Suture impressed to channeled. Sculpture consisting of pitted spiral furrows, narrower than interspaces. Shape of pits hexagonal. Aperture posteriorly narrowed, roundly submarginate anteriorly. Outer lip thickened and crenulate or lirate within. Inner lip callused over columellar surface, bearing two oblique, sharp folds (modified after Sohl 1964; and Gründel 1997b).

Discussion. — The type species of Conrad (1960) came from the Eocene of Mississippi or Alabama. Species of this genus were also found in the Cretaceous (Wade 1926, herein) and Jurassic (Gründel 1997b).

Range. — Jurassic to Miocene (Cossmann 1895b).

Tornatellaea gazdzickii (Schröder, 1995)
(Fig. 132)

1995. *Actaeon gazdzickii* sp. n.; Schröder 1995: 62, pl. 11: 1–6, pl. 15: 18.

Holotype: Schröder 1995: 62, pl. 11: 1.

Type horizon: Valanginian, Early Cretaceous.

Type locality: Wąwał, southern Mazowsze, Poland.

Material. — 996 shells from the type locality.

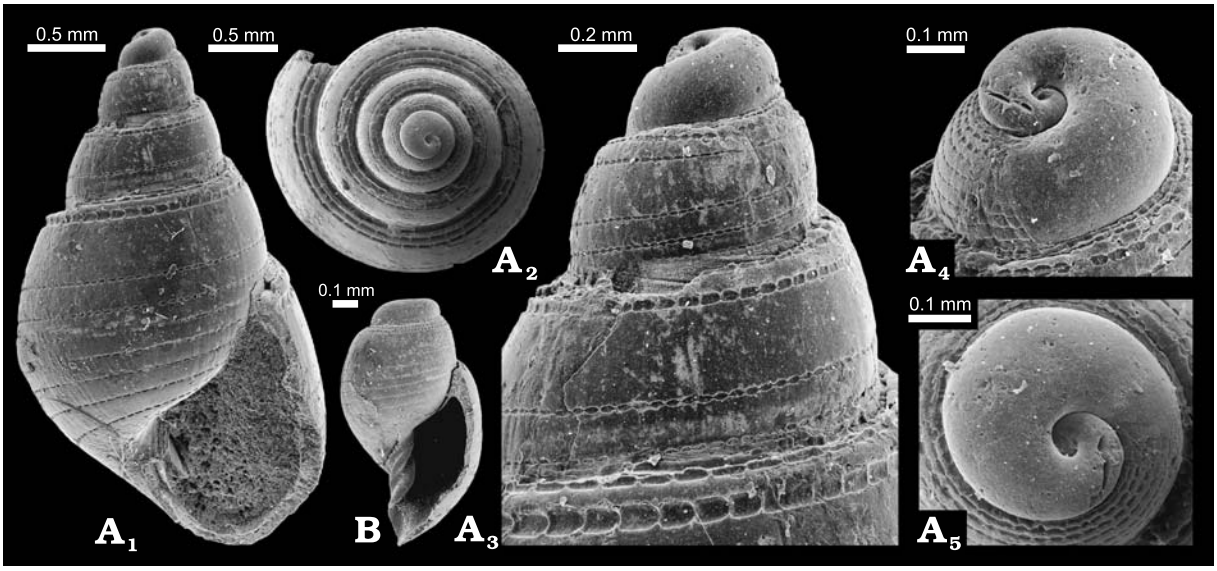


Fig. 132. The acteonid *Tornatellaea gazdzickii* (Schröder, 1995) from Wąwał, southern Mazowsze, Valanginian (Early Cretaceous). **A**. ZPAL Ga.9/316 from sample E2; A_1 lateral view, A_2 apical view, A_3 apex in lateral view, A_4 demarcation between protoconch and teleoconch, A_5 apex in apical view. **B**. ZPAL Ga.9/304 juvenile from sample O1; lateral view.

Measurements. — The protoconch with 0.39 mm in diameter. A shell (ZPAL Ga.9/316) consisting of 3.5 teleoconch whorls is 3.46 mm high and 2.03 mm in diameter.

Occurrences. — Type locality only.

Emended diagnosis. — Protoconch of about two whorls, almost coaxial, smooth. Shell conoidal, 1.70 times as high as broad. Whorls weakly rounded with subsutural, narrow ramp. Teleoconch ornamented with two adapical and two-three abapical spiral pitted striae. Shape of pits hexagonal. During ontogeny, some adapical stria moving to ramp and others forming wide, pitted furrow. Base covered with evenly spaced spiral, pitted striae. Peristome with two oblique folds. Umbilical chink absent.

Remarks. — This species was described by Schröder (1995) and placed in the genus *Acteon*. Species of the latter have rhomboidally or rectangularly shaped pits and only one columellar fold which is visible on the fully grown shells. The two folds of *T. gazdzickii* are clearly visible even on the juvenile shells (Fig. 132B).

Tornatellaea matura (Schröder, 1995)
(Fig. 133)

1995. *Ringicula matura* sp. n.; Schröder 1995: 69, pl. 13: 1–4, 15.

Holotype: Schröder 1995: 69, pl. 13: 1, 4.

Type horizon: Valanginian (Early Cretaceous).

Type locality: Wąwał, southern Mazowsze, Poland.

Material. — 72 shells from the type locality.

Measurements. — The protoconch measures 0.31 mm in diameter. A shell (ZPAL Ga.9/291) consisting of 3.5 teleoconch whorls is 3.68 mm high and 1.96 mm in diameter.

Occurrences. — Type locality only.

Emended diagnosis. — Protoconch strongly medioaxial, smooth. Shell spindle-like, 1.88 times as high as broad. Whorls rounded, ramp absent. Teleoconch ornamented with 7–8 spiral, evenly spaced pitted striae. Shape of pits hexagonal. Base ornamented with evenly spaced spiral, pitted striae. Peristome with two oblique folds. Umbilical chink absent.

Remarks. — This species was described by Schröder (1995) and placed in the genus *Ringicula*. Species of the latter have an adult shell peristome with a thickened inner and outer lip.

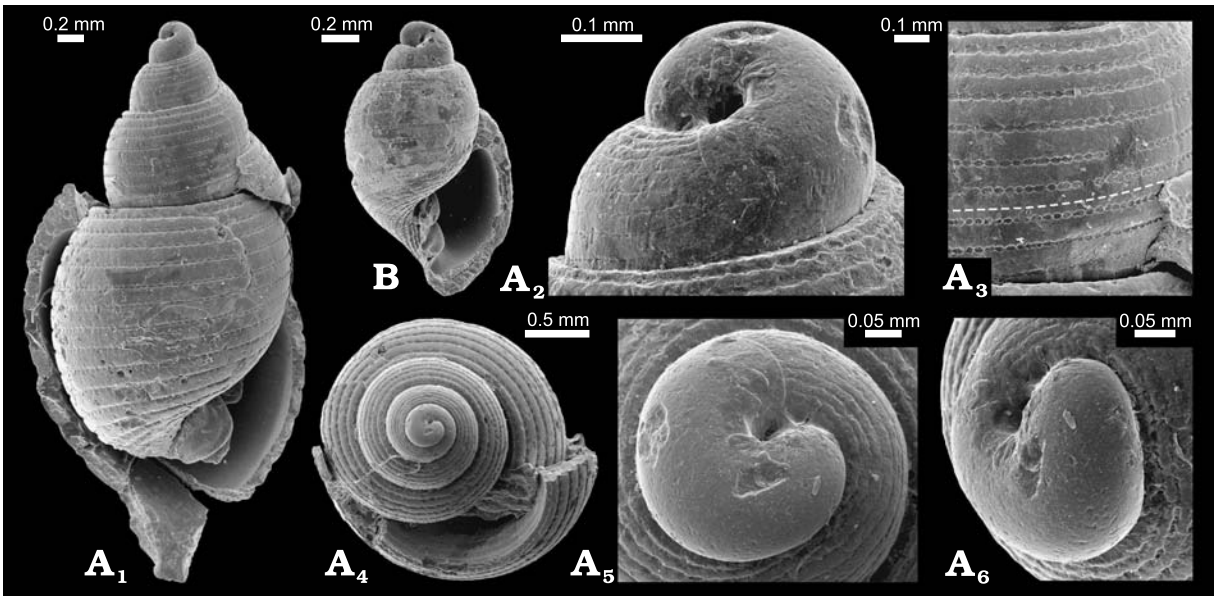


Fig. 133. The acteonid *Tornatellaea matura* (Schröder, 1995) from Wąwał, southern Mazowsze, Valanginian (Early Cretaceous). **A**. ZPAL Ga.9/291; A_1 lateral view, A_2 demarcation between the protoconch and teleoconch A_3 details of the teleoconch ornamentation, A_4 apical view A_5 protoconch in umbilical view, A_6 protoconch in lateral view. **B**. Juvenile ZPAL Ga.9/292; lateral view.

Family **Ringiculidae** Philippi, 1853

Genus *Ringicula* Deshayes, 1838

Type species: *Auricula ringens* Lamarck, 1804; subsequent designation by Gray (1847).

Diagnosis. — Small low-spired globose to subglobose shells. Sculpture smooth or with incised spiral lines or furrows. Aperture narrow; outer lip thickened, smooth or denticulate within; inner lip heavily callused. Columella with two strong folds and parietal wall with single denticle or fold (from Sohl 1964).

Discussion. — The oldest reported ringiculid, *Ringicula buchholzi* Gründel, 1997 comes from the Callovian (Mid Jurassic; Gründel 1997b). *Ringicula matura* reported by Schöder (1995) from the Valanginian (Early Cretaceous) is actually a species of *Tornatellaea* (see above), and thus the species described below is the second oldest, true ringiculid known from the fossil record. Ringiculids became more common in the Late Cretaceous (see e.g., Sohl 1964).

Range. — Callovian (Mid Jurassic; Gründel 1997b) to Recent.

Ringicula blaszyki sp. n.

(Fig. 134)

Holotype: ZPAL Ga.9/293, Fig. 134.

Type horizon: *Saynoceras verrucosum* Zone, Late Valanginian (Early Cretaceous).

Type locality: Wąwał, southern Mazowsze, Poland.

Derivation of the name: In honour of Janusz Błaszyk.

Material. — One fully grown shell without a protoconch.

Measurements. — The shell of the holotype consisting of three teleoconch whorls is 3.27 mm high and 2.61 mm in diameter.

Occurrences. — Type locality only.

Diagnosis. — Globose shell, 1.25 times as high as broad. Teleoconch ornamented with evenly spaced, weakly pitted spiral striae. Shape of the pits narrowly hexagonal on juvenile and subadult whorls and rhomboidal to rectangular on body whorl. Base ornamented with the same type of striae as on the lateral part of whorls. Teleoconch whorls rounded, ramp absent. Peristome narrow, elongated with well developed anterior channel. Inner lip callused with two thick folds. Parietal ridge well developed. Outer lip thickened with two delicate folds in the lower part, corresponding to the fold on the inner lip.

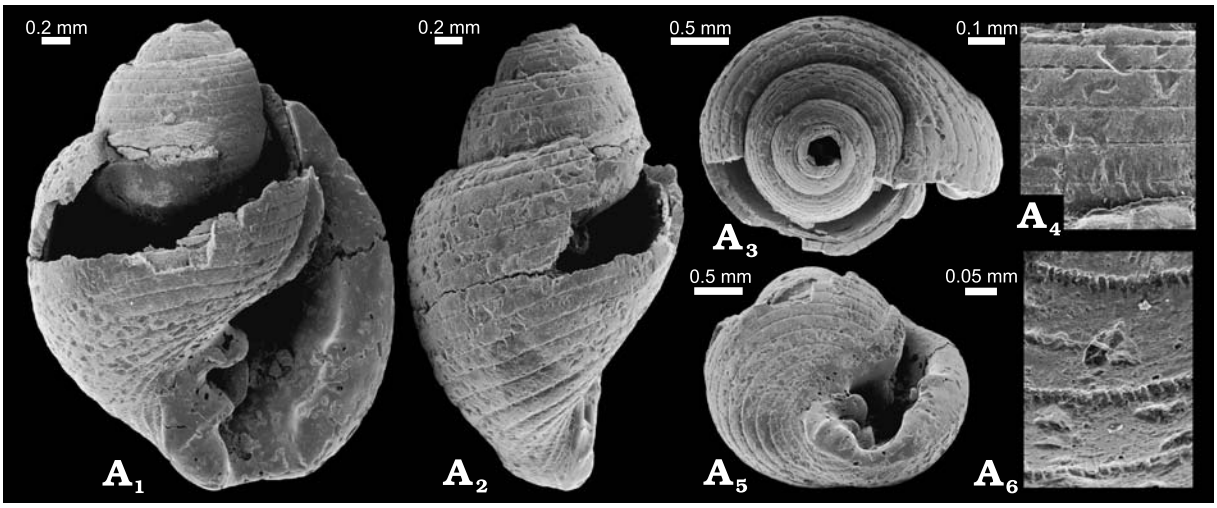


Fig. 134. *Ringicula blaszyki* sp. n. from Wąwał, southern Mazowsze, Valanginian (Early Cretaceous). **A**. ZPAL Ga.9/293 (holotype); A_1, A_2 lateral views, A_3 apical view, A_4 details of the teleoconch ornamentation, A_5 latero-umbilical view, A_6 details of the body whorl ornamentation.

Remarks. — *Ringicula buchholzi* Gründel, 1997 differs in having higher whorls and straight spiral striae (with no pits).

Subclass **PULMONATA** Cuvier, 1817
Superfamily **Basommatophora** Schmidt, 1855
Family **Siphonariidae** Gray, 1827
Genus *Anisomyon* Meek *et* Hayden, 1860a

Type species: *Helcion patelliformis* Meek *et* Hayden, 1857; subsequent designation by Meek and Hayden (1860b). Cretaceous, Nebraska, USA.

Diagnosis. — Medium-sized, thin, asymetrically conical patelliform shells; surface generally smooth except for concentric growth lines and occasional faint ribs radiating. Apex subcentral, curved backwards. Muscle scars horseshoe shaped, interrupted on left anterior and occasionally broken into intermittent patches of attachment on right posterior (from Sohl 1964).

Discussion. — According to Sohl (1964), *Anisomyon* is distinguished from *Siphonaria* Sowerby, 1823 by the band of muscle attachment being interrupted on the left anterior instead the right and by the occasional interruption of that band on the right posterior.

Range. — Valanginian, Early Cretaceous (herein) to Late Cretaceous (e.g., Sohl 1964; Dockery 1993).

Anisomyon sp.
(Fig. 135)

Material. — One protoconch with small part of juvenile teleoconch from *Saynoceras verrucosum* Zone of Late Valanginian, Wąwał, southern Mazowsze, Poland.

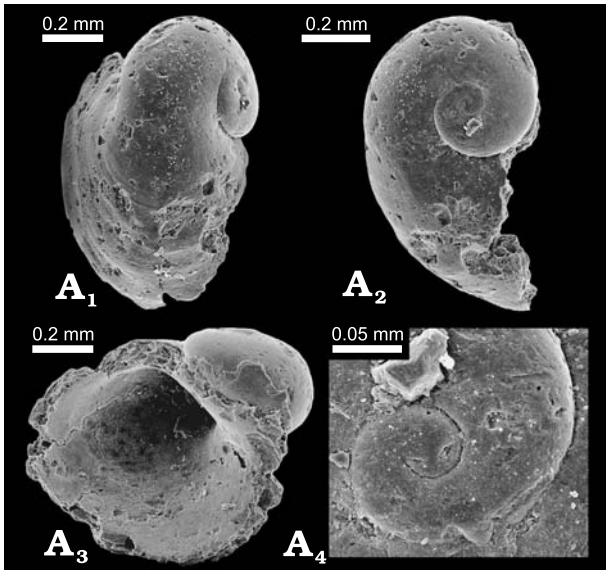


Fig. 135. Siphonariid *Anisomyon* sp. from Wąwał, southern Mazowsze, Valanginian (Early Cretaceous) **A**. ZPAL Ga.9/290 from sample E3; A_1 apical view, A_2 lateral view, A_3 umbilical view, A_4 close-up of the protoconch.

Measurements. — Protoconch (ZPAL Ga.9/290) of 2.5 teleoconch whorls is 0.54 mm in diameter.

Description. — The protoconch is sinistrally coiled and smooth. The teleoconch expands into an asymmetric limpet, smooth apart from the growth lines.

Remarks. — The shell described here resembles that of *Anisomyon* sp. described by Dockery (1993).

EVOLUTION CHANGES IN THE GASTROPOD CONCH ONTOGENY

The hypothesis that planktotrophy is plesiomorphic for Mollusca or even for all Metazoa has a long history (Jägersten 1968, 1972; Nielsen 1985, 1987, 1998) but it has never been fully accepted (e.g., Haszprunar 1995; Haszprunar *et al.* 1995; Bandel 1997). While rejecting this concept, those authors refer to the knowledge of the larval development among extant mollusks. Among eight extant mollusk classes only bivalves and gastropods are known to be planktotrophic, whereas the others have lecithotrophic or direct development (Haszprunar 1995). However, those mollusks that have a good Paleozoic fossil record (that is gastropods, bivalves, cephalopods, and monoplacophorans), show profound evolutionary changes in their ontogeny. Although extant cephalopods have exclusively lecithotrophic or direct development, the early Paleozoic cephalopod shell morphologies suggest two distinct stages in their early development (see pls 4–5 of Ristedt 1968). These stages can be ascribed to the embryonic and veliger stages (Dzik 1993). According to Dzik (1993), cephalopods most probably had a common ancestor with hyoliths, which apparently had a similar type of development (Dzik 1978, 1993). Although Paleozoic monoplacophorans are known to have lecithotrophic development (see fig. 30A in Dzik 1994a), the earliest (Tommotian) monoplacophoran-like larval shells could be planktotrophic (Dzik 1994a: 265, fig. 12A). All this suggests that the Jägersten's (1968, 1972) concept of planktotrophic mode of life of the ancestral mollusc should be at least reconsidered.

Larval planktotrophy is present among three large, high-level extant gastropod taxa, namely Neritopsina, Caenogastropoda and Heterostropha (e.g., Bandel 1982; Haszprunar 1995). The planktotrophy of the last two is probably inherited after their common ancestor (Haszprunar 1995), whereas Neritopsina is believed to have acquired planktotrophy independently (e.g., Bandel 1982; Haszprunar 1995). The larval shells of Patellina and Trochina consist of only an organic embryonic shell, which is calcified by the cells of the shell field invagination before, at, or shortly after the tortion of the larvae (Collin and Voltzow 1998), and not exclusively before torsion, as it was postulated by Bandel (1982). The observations of Collin and Voltzow (1998) contradict the Bandel's (1982) concept that the archaeogastropod larval shell coiling occurs for strictly mechanical reasons.

In some references (e.g., Smith 1935; Crofts 1937; Anderson, 1962; Scharenberg in Bandel 1997) archaeogastropod larvae are reported to have the ability to feed during their veliger stage. Although the reliability of these references was questioned by Haszprunar *et al.* (1995), it is also possible that the behavior of these larvae may have been a reminiscent of the reduced, fully planktotrophic, larval stage.

ARCHAEOGASTROPODA

Pleurotomariina. — The protoconch and initial whorls of extant pleurotomariids are unlike those of the Paleozoic ones. The juvenile Paleozoic pleurotomariids illustrated by Dzik (1978, 1994a; Fig. 136A) and Yoo (1988, 1994) have a multispiral protoconch. Such a protoconch is usually interpreted as a mark of planktotrophic development. Extant and Mesozoic vetigastropods all have a short veliger stage, which is usually non-planktotrophic during their life. The presence of multispiral protoconchs, suggestive of planktotrophic development among the slit-bearing, Paleozoic gastropods, strengthens the hypothesis that the veliger stage of extant vetigastropods has been secondarily lost.

Pleurotomarioidean gastropods are easy to recognize by their dextral, conispiral shells with a nacreous layer and a selenizone (Harasewych 2002). The protoconch of extant pleurotomariids consists of about 1.00–1.25 smooth whorls (Fig. 136C; Sasaki 1998; Harasewych 2002). The demarcation from the teleoconch is abrupt and pronounced by the appearance of a weak spiral- and stronger axial sculpture (Harasewych 2002). The selenizone is formed shortly after metamorphosis (Fig. 136C). The initial whorls of Mesozoic pleurotomariids are little-known, apart from those of the Late Triassic *Wortheniella*-group (Schwardt 1991). Those gastropods and the Oxfordian (Late Jurassic) *Bathrotomaria reticulata* (Sowerby, 1821) have the

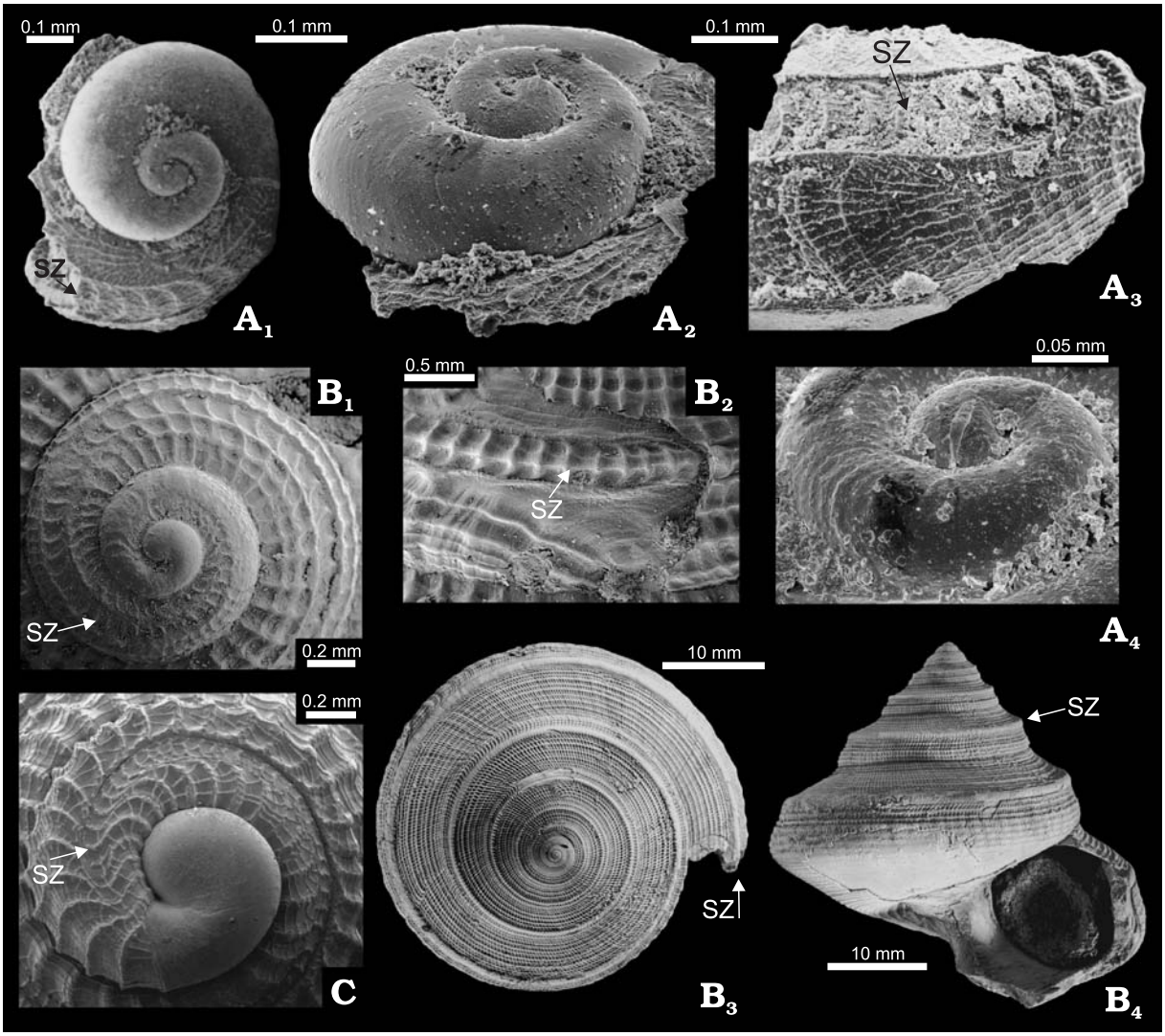


Fig. 136. Fossil and Recent pleurotomarioideans. Note the multispiral protoconch of the Devonian eotomariid and the lecithotrophic protoconch of the Jurassic and Recent pleurotomariids. **A**. An undetermined eotomariid, possibly *Mourlonia* sp. from Łagów-Dule, Poland; (Famennian, Late Devonian), the specimen already figured by Dzik (1978, 1994a); A_1 apical view, A_2 oblique view of the protoconch, A_3 lateral view of the teleoconch; note the ornamentation and the selenizone typical of geologically younger pleurotomariids, A_4 close-up of protoconch 1. **B**. *Bathrotomaria reticulata* (Sowerby, 1821) from Nikitino, Rjazanskaya oblast', Russia (Oxfordian, Late Jurassic), specimen courtesy of V. Mitta; B_1 apex in apical view, B_2 shell repair after possible unsuccessful predator attack, B_3 apical view, B_4 lateral view. **C**. Juvenile *Mikadotrochus* from off of New Caledonia, Recent; apical view of the apex, courtesy of A. Warén. SZ indicates the selenizone.

same type of protoconch and early teleoconch whorls as the extant pleurotomarids (Fig. 136B_1). The only difference is the smaller size of the former (compare Fig. 136B_1 and C).

In the Mesozoic black clays of Poland the pleurotomariids are very rare. Only a few badly preserved adult specimens have been collected (but not included in the taxonomic part of this paper). Their rarity suggests that a hard substrate and/or specific food resources were not available for the pleurotomariids.

Extant pleurotomariids live on the rocky bottom of the tropical/temperate deep sea (Harasewych 2002 and references therein) feeding predominantly and selectively on sponges (Harasewych *et al.* 1988). Additionally, they may also eat stalked crinoids (Anseeuw and Goto 1996) and octocorals (Harasewych 2002).

The shells of extant pleurotomariids bear numerous shell repairs, suggesting a high rate of unsuccessful predator attacks (Harasewych 2002). Observations in an aquarium have shown (see review by Harasewych 2002) that pleurotomariids may secrete a repellent that causes predators to release their prey. I observed a similar degree of attempted attacks on the shells of Late Jurassic pleurotomariids from the Russian Platform

(Fig. 136B_2, collection of V. Mitta, Moscow). This suggests that this defensive mechanism was already functional at this time.

Patellina. — Extant patellogastropods have a protoconch with the embryonic whorl only. The veliger stage is very short and usually non-feeding.

The fossil record of definite patellinids is more than scarce prior to the Albian (Late Cretaceous). In fact, only the Late Triassic *Patella costulata* Münster, 1844 can be convincingly interpreted as a patellinid limpet (Hedegaard *et al.* 1997), based on its shell microstructure. In phylogenies based on morphology, the Patellina are interpreted as a sister taxon to all other gastropods (e.g., Haszprunar 1988; Ponder and Lindberg 1997). The rRNA sequence analyses have given ambiguous results. Although Tillier *et al.* (1992) supported the notion that the patellids are a sister taxon of all the other gastropods, subsequent investigation (Tillier *et al.* 1994) revealed another possibility: the monophyly of Patellina and Vetigastropoda. As evaluated by Hedegaard *et al.* (1997), the minimum origination time of these clades is in the Cambrian. This implies that the Patellidae were a ghost lineage for 320 Ma.

Neritopsina. — Neritopsina (Neritimorpha) are the only extant non-apogastropods with separate embryonic and larval shells (e.g., Bandel 1982). The soft part characters of extant neritopsines place the group between Patellina and Vetigastropoda (e.g., Haszprunar 1988; Ponder and Lindberg 1997). Because the more derived extant vetigastropods have non-feeding, short-living veliger larvae, therefore the larval development of Neritopsina is believed to have been acquired independently of Apogastropoda (e.g., Bandel 1982; Haszprunar 1995). This can be accepted if planktotrophic development is truly derived in the gastropods. If not, all the three major groups with planktotrophy may have evolved from a common ancestor.

Among the Neritopsina, the two extant families (i.g., Neritopsidae and Neritidae) have the longest fossil record (Bandel and Frýda 1999). Although the Recent Neritidae are very common, especially in shallow water environments (e.g., Bandel 2001; Sasaki 2001), the Neritopsidae is a relic family represented only by two marine species (Ponder 1998b). The soft parts of this crucial group of the Neritopsina are still little-known about. The sole source of information remains unpublished (Holthuis 1995). Those data and analysis by Kano *et al.* (2002) suggest that the Neritopsinidae is the most primitive group of Neritopsina and the most closely related to the shell-less, slug-like Titiscaniidae.

The protoconch of the extant *Neritopsis radula* Linné, 1758 is apparently lecithotrophic (Kaim and Sztajner in preparation) and the teleoconch is composed of two wholly aragonitic layers (Suzuki *et al.* 1991). *Neritopsis* has a distinctive trapezoidal operculum, composed of both aragonite and calcite (Kaim and Sztajner in preparation). These gastropods do not dissolve their internal wall (Wenz 1938; Suzuki *et al.* 1991).

The protoconch of the Neritidae is usually planktotrophic (e.g., Bandel 1982) and the teleoconch is composed of three calcified layers: the outer layer is calcitic, whereas middle and inner layers are aragonitic (Gainey and Wise 1980; Suzuki *et al.* 1991). The neritids usually dissolve the inner wall of their shell (both protoconch and teleoconch) and only the columellar margin remains as the result. The operculum is semi-circular and fully aragonitic (Suzuki *et al.* 1991; Sasaki 2001). It also bears a peg-like apophysis, a structure expanding the surface of the muscle attachment (Ponder 1998b; Sasaki 2001). Due to this modification, the muscle scars are situated asymmetrically on the operculum.

The planktotrophic protoconch of extant Neritopsina are strongly convoluted with a resorbed inner wall, a feature that is unique among the Gastropoda (Bandel 1982, 2001; Bandel and Frýda 1999). According to Ponder and Lindberg (1997), this could be a result of the extensive modification of the larval shell which is caused by the intracapsular development of extant neritoid larvae (but see Bandel 2001). The protoconchs of Mesozoic neritids are little-known, mainly because in their predominantly shallow water habitat, protoconchs are usually imperfectly preserved. Although this type of protoconch is well known from the early Paleogene (Bandel 2001) or even the late Cretaceous (Dockery 1993), it possibly appeared in the Permian or perhaps the Triassic (Kaim and Sztajner in preparation). Similar well-preserved protoconchs are known in the extinct family Cortinellidae (Bandel 2000). This family is closely related to the Neritopsinidae, or is perhaps intermediate between the Neritopsinidae and the Neritidae by having the ability to resorb the internal wall of the protoconch but lacking the calcitic outer wall (Bandel 2000).

The ancestors of modern neritopsines were probably *Naticopsis*-like, operculate gastropods, possibly with a protoconch more similar to that of caenogastropods than of extant neritopsines (Kaim and Sztajner in preparation). Both the Neritopsinidae and Neritidae diverged from the *Naticopsis–Trachydomia* stem in the

Triassic (Kaim and Sztajner in preparation). The platyceratitid gastropods are most probably not closely related to Neritopsina — as it was supposed by Bandel (1992) and Bandel and Frýda (1999) — at least not more closely than to the other early Paleozoic gastropods with an openly coiled protoconch. The gastropods with a fishhook-like protoconch, which have two distinctive stages of larval development (Bandel and Frýda 1999), possibly represent an independent group derived from *Pararaphistoma*-like gastropods (see Fig. 140).

Trochina. — The Trochina are gastropods with a conispiral shell, which lacks a slit or emargination in the outer lip (Hickman 1998). This reflects the loss of the right ctenidium (Hickman 1998). The trochoideans have a protoconch, which consists exclusively of the embryonic whorl. The veliger stage is short and non-planktotrophic. Similar gastropods are known to have existed already in the Ordovician (Hynda 1986; Dzik 1994a, b) although their trochoidean affinities have to be better constituted.

Mesozoic trochoideans do not differ from the extant counterparts in this respect. The fossil record of the definite Trochoidea is well-known since the Permian. It starts with the Liotiinae, a subfamily of the Turbinidae (Hickman and McLean 1990) and becomes common in the Triassic (e.g., Bandel 1993b).

Of the three families of Trochoidea recognized by Hickman and McLean (1990), the Skeneidae is the least-known. Recent contributions have shown that the family is a polyphyletic group (Hickman and McLean 1990; Hickman 1998). Some gastropods classified as Skeneidae have not changed significantly since the Mid Jurassic. Both the protoconch and the teleoconch morphology of the Jurassic and Cretaceous taxa are very similar to the extant ones (Figs 2, 3). The similarity is so close that it allows the classification of the Mesozoic species in extant genera (e.g., *Eudaronia*, *Aequispirella*, and *Adeuomphalus*). Apparently, these skeneid-like gastropods represent conservative lineages, the so-called "living fossils".

Turbinidae are the most ancient group of the Trochoidea known from the fossil record since the Permian (Hickman and McLean 1990). Although turbinids from many different habitats are known, they have a tendency to be restricted to calcium carbonate substrates (Hickman and McLean 1990). The same tendency most probably already existed in the Mesozoic. The turbinids described in this paper are restricted exclusively to two species of one genus. Both species have early whorls markedly different from the adult sculpture of the shell. This character is typical of extant Turbininae (Hickman and McLean 1990).

The Trochidae was the most diversified family of Trochoidea (and Vetigastropoda overall) during the Mesozoic. Most of the open sea trochids can be classified in the subfamily Eucyclinae. Hickman and McLean (1990) have divided the Eucyclinae into three tribes, which seems to be disputable (see p. 17). The trochids from the Jurassic black clays are so similar to the extant eucyclinins, that particular species can be classified in extant genera (predominantly the deep-water genera such as *Calliotropis* and *Turcica*). McLean (1982) regards these genera (and some others, see p. 17) as the most primitive members of Trochacea, since they lack the afferent membrane along the greater length of the ctenidium.

CAENOGASTROPODA

Cerithioidea. — The Cerithioidea is one of the largest and most species-rich superfamilies of the Caenogastropoda (Healy and Wells 1998). They are known to have lived in variety of marine and fresh-water habitats (Houbrick 1992; Lydeard *et al.* 2002). Cerithioideans can be distinguished from all other caenogastropods by a suite of anatomical characters (Healy and Wells 1998), although the group is rather poorly supported by apomorphies (Ponder and Lindberg 1997). In the phylogenetic analysis (e.g., Ponder and Lindberg 1997) the superfamily is usually placed at the base of Caenogastropoda.

The fossil record of definite cerithioids ranges back to the Late Triassic (Bandel 1993; Nützel and Senowbari-Daryan 1999; Nützel 2002b; Nützel *et al.* 2003). The Mesozoic cerithioids are commonly included to the family Procerithiidae (e.g., Nützel 2002b; see also discussion on p. 31). The procerithiids (the taxonomic position of the type genus remains unclear, see Gründel 1997c) typically have an ornament of spiral cords (e.g., *Cryptaulax*). A similar pattern on the protoconch is observed in the extant *Argyropeza*, but the joining of these two genera, which have developed separately from the *Bittium*-like gastropods since the Jurassic (Gründel 1976b), into a family, seems to be disputable at least (Houbrick 1993).

Nützel and Bandel (2000) suggested that the Mesozoic and younger cerithioids derived from the Palaeozoic Orthonemidae.

Ampullospiridae. — The Ampullospiridae are represented by the single living species *Cernina fluctuata* (Sowerby, 1825). This gastropod has been shown by Kase and Ishikawa (2003) to be herbivorous. The ex-

tinct species of this family are often classified in the carnivorous Naticidae (see summary Kase and Ishikawa 2003). The anatomy of *C. fluctuata* suggests a relative primitiveness of the group (Kase 1990) and a relationship to freshwater Ampullaridae and the marine Campanilidae (Kase and Ishikawa 2003) rather, than to the higher caenogastropods.

The Jurassic ampullospirids, especially *Pictavia* and *Oonia* (see e.g., Gerasimov 1992; and Gründel 2001) resemble the late Paleozoic "subulitids", especially the members of the family Soleniscidae (see Nützel *et al.* 2000). This may suggest that the Ampullospiridae are descendants of the Soleniscidae. The being true, the early Palaeozoic subulitids (the type species is Ordovician) most probably represent another group.

Ptenoglossa. — The ptenoglossans are a group of mainly carnivorous gastropods, which feed on sponges (Triphoroidea) and coelenterates (Janthinoidea), or are parasitic (Eulimoidea), and mostly live on echinoderms. The Triphoroidea and Janthinoidea have a distinctive parasperm (Healy 1988, 1990), whereas the Eulimoidea have no parasperm (Healy 1988) and their relationship to other ptenoglossans is doubtful (Healy 1988; Ponder and Warén 1988; Bandel 1993a; Ponder 1998a).

The undisputed members of the latter superfamily are unknown in the fossil record until the Late Cretaceous (Warén 1985; Bandel 1993a). The other groups are known at least since the Jurassic (Nützel 1998). The most characteristic feature of the ptenoglossan shell (excluding Eulimoidea) is the ornament of the larval shell, consisting of collabral ribs, a character that is regarded by Nützel (1998) as the apomorphy of the Ptenoglossa.

Although the identification of the Jurassic and the Cretaceous ptenoglossans is not difficult, if the protoconch is preserved, the affinity of Mesozoic taxa to extant families and superfamilies is much more difficult to establish. The variation in the morphology of the ptenoglossan protoconch is so wide (see e.g., Marshall 1978, 1993; Nützel 1998) that the comparisons between fossil and extant taxa should be made with special caution. Nevertheless, the conclusion that at least the Eumetulidae and the Nystiellidae were present in the Jurassic–Early Cretaceous seems to be well-founded. The fossil superfamily Zygopleuroidea contains mainly Palaeozoic (but see pp. 70–71) Pseudozygopleuridae, Mesozoic Zygopleuridae and Pommerozygidae, and Mesozoic-to-Recent Janthinoidea (Nützel 1998). Nützel (1998) interpreted the Zygopleuridae as a sister taxon to the Janthinoidea and the Pseudozygopleuridae as the sister taxon to a clade comprising the latter two. The Palaeozygopleuridae are by definition gastropods with a paucispiral protoconch (Horný 1955), indicative of non-planktotrophic development. Thus, their protoconchs are hardly comparable with the protoconchs of other zygopleuroids (Nützel 1998) and so the Palaeozygopleuridae were excluded by some authors (e.g., Frýda and Bandel 1997) from Caenogastropoda.

Stromboidea. — The Stromboidea are composed of four extant (Ponder and Warén 1988) and some fossil families. The deepest roots are those of Aporrhaidae, which appeared in the Early Jurassic. The Strombidae and Struthiolariidae originated in the Late Cretaceous (Roy 1994), or perhaps as late as the Paleocene (Kiel and Bandel 1999). The aporrhaid gastropods are easily identifiable in the fossil record, due to their modified and expanded outer lip.

The oldest undisputable aporrhaid is the Early Jurassic *Spinigera* (Wenz 1940). In the Mid Jurassic, the Aporrhaidae were already abundant and diverse (see pp. 70–79). Their protoconch is not clearly demarcated from the teleoconch. Their early whorls are smooth. Later in ontogeny, spiral ornamentation appears (Fig. 137). In *Spinigera* (Fig. 137A), the ornamentation is expressed by a row of spiral nodes, whereas *Dicroloma* (Fig. 137B, C) possesses spiral ribs, some of which may change into a keel. The axial ornament is absent or appears later in ontogeny. In geologically younger forms, the axial ornament appears simultaneously with the spiral ornament (Fig. 137D–G) except in the case of *Pterocerella* (Kiel and Bandel 2002). The extant species of *Aporrhais* (Fig. 137H) have clearly visible but weakly expressed axial and spiral ribs.

The protoconchs of early aporrhaids to some degree resemble the protoconchs of the Jurassic and Early Cretaceous rissoids. The latter were even interpreted as the protoconchs of aporrhaids, before the adult shells were found (e.g., Bandel 1993a; Schröder 1995; Kaim 2001). The protoconchs of rissoinids are usually well demarcated from the teleococh (see pp. 79–95). These similarities suggest a close relationship between the early aporrhaids and early rissoinids,possibly two sister groups.

Rissooidea. — The Rissooidea is the largest neotaenioglossan family and one of the largest gastropod groups (Ponder and Keyzer 1998). They have rather simple shells, often similar in appearance, so that many taxa have been recognized only due to anatomical studies (Ponder and Keyzer 1998).

The oldest undisputed rissoinids are known from the Mid Jurassic (pp. 79–95). They already have the teleoconch and protoconch similar to those of the extant species. The only difference is a more flattened apex

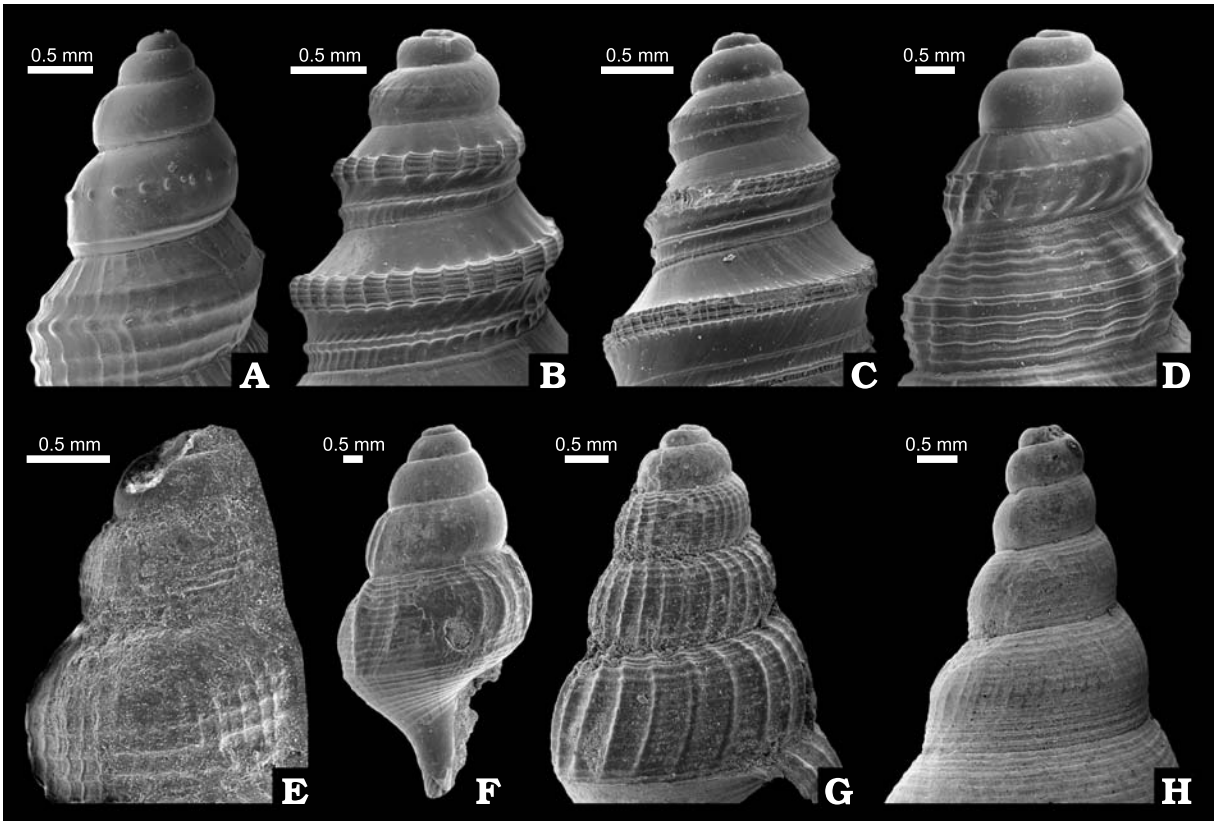


Fig. 137. Changes in the ornamentation of aporrhaid gastropods since the Mid Jurassic. The sculpture of Bajocian/Bathonian aporrhaids starts with spiral a ornament; the axial ornament appers later in ontogeny. Since the Callovian, the axial ornament appears simultaneously with the spiral ornament. The extant species have clearly visible but weakly expressed axial and spiral ribs. **A**. *Spinigera* sp. from Faustianka, Poland (Bathonian, Mid Jurassic). **B**. *Dicroloma nudispira* sp. n. from same locality. **C**. *Dicroloma cochleata* (Quenstedt, 1858) from Łuków, Poland (Callovian, Mid Jurassic). **D**. *Pietteia subbicarinata* (Münster, 1853) from same locality. **E**. *Quadrinervus elegans* (Piette, 1867) from Wąwał, Poland (Valanginian, Early Cretaceous). **F**. Aporrhaidae gen. et sp. indet. from same locality. **G**. *Anchura* sp. from Vasjuganskij borehole, Western Siberia (Maastrichtian, Late Cretaceous), specimen courtesy of A.L. Beisel. **H**. *Aporrhais pespelecani* (Linné, 1766) from Korytnica, Poland (Miocene), specimen courtesy of W. Bałuk.

of the protoconch, the character used by Gründel and Kowalke (2002) to diagnose their new family Palaeorissoinidae (see p. 79). Ponder (1985) indicated the Pseudomelaniidae as the possible ancestors of the rissoinids. It is more probable that the pseudomelaniids represent an independent lineage which had evolved from the Zygopleuridae, especially the lineage of the mainly Triassic *Azyga*-group (pp. 66–68) and/or the mainly Paleozoic *Knightella* (pp. 95–96).

The possible ancestors of the Rissooidae (and Aporrhaidae) are the pseudozygopleurids. The Jurassic *Plocezyga gruendeli* (pp. 70–71) has characters intermediate between the Palaeozoic pseudozygopleurids and the Jurassic/Cretaceous rissoinids. The tilted protoconch with axial ribs is typical of the ptenoglossans, whereas the fine ornament of oblique riblets is characteristic of some rissoids.

NEOGASTROPODA

Neogastropods resembling modern forms are well-known and diverse since the Late Cretaceous (e.g., Bandel 1993a; Riedel 2000). Earlier records are scarce and need confirmation (see discussion by Bandel 1993a). The juvenile muricoidean-like shell described herein (pp. 101–102, Fig. 82A) extends this record back to the Valanginian (Early Cretaceous). Possible stem-group representatives of modern neogastropods are the Triassic-Cretaceous Maturifusidae (Riedel 2000; Figs 83–85). The Triassic–Jurassic Purpurinidae are related to the Maturifusidae (Bandel 1993a; Figs 86, 87) and thus they are also suspected of being ancestral to the neogastropods.

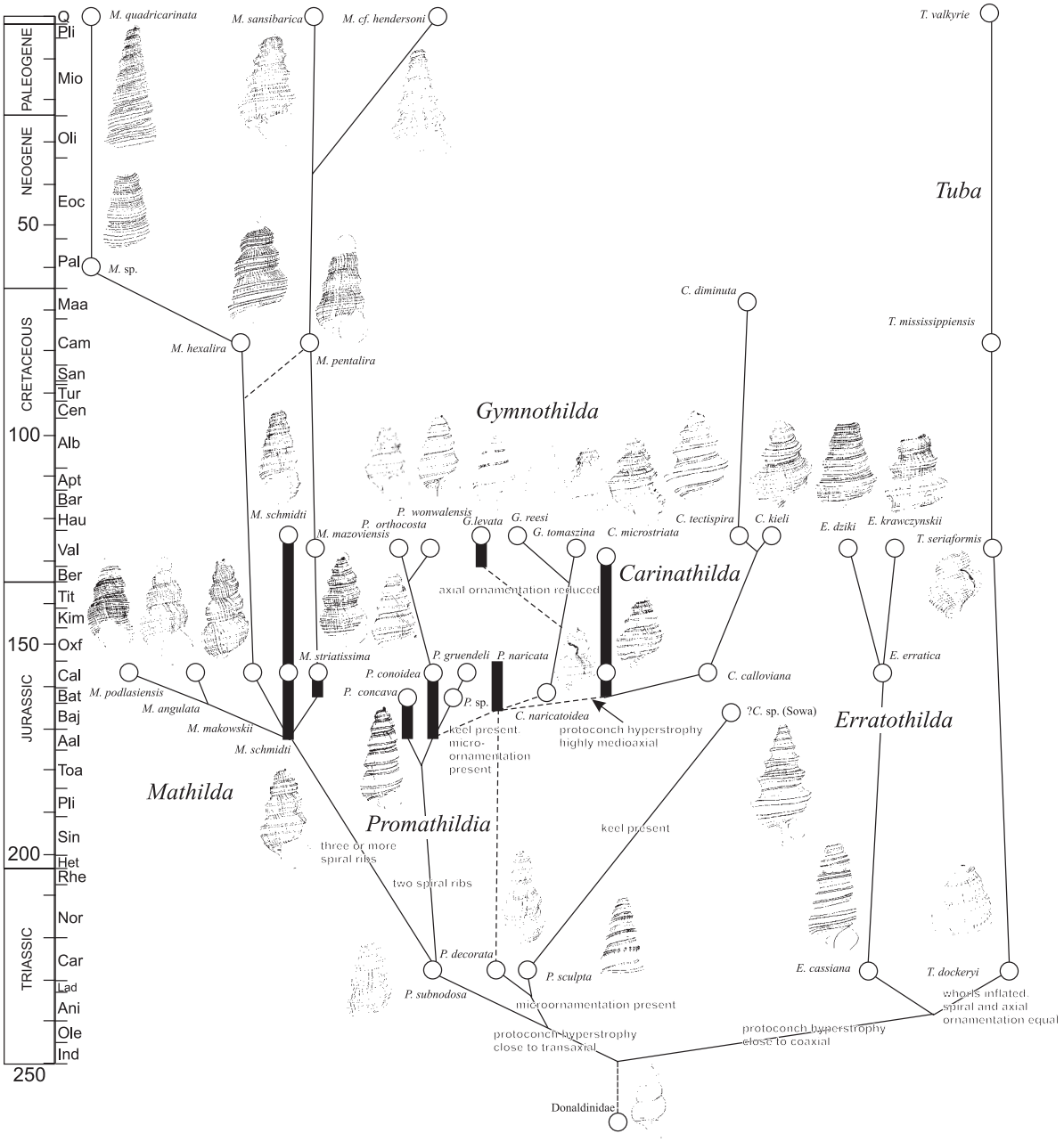


Fig. 138. Possible phylogenetic relatioships between the fossil and Recent members of Mathildidae. The mathildids most probably originated from the Late Palaeozoic *Donaldina*-like gastropods. The main lineages of the group have originated already in the Triassic. The species of *Tuba* have inflated whorls and equally prominent spiral and axial ornamentation. The species of *Erratothilda* have a protoconch that is close to hyperstrophic and a weakly incised suture. The presence of two spiral ribs and the absence of the microornament characterize the *Promathildia*, whereas in *Carinathilda*, microornamentation is present, and the keel is well developed. The *Gymnothilda* has reduced spiral ornamentation, whereas *Mathilda* has three or more spiral ribs, the protoconch close to the transaxial and microoranmentation absent. Only *Mathilda* and *Tuba* survived the Mesozoic times and live in the Recent seas.

HETEROSTROPHA

Although some hypotheses explaining the emergence of Heterostropha exist (e.g., Ponder 1990; Ponder and Lindberg 1997; see also Bandel 2002a), it is still a mystery. Most probably Heterostropha have a common ancestor with Caenogastropoda as postulated by Haszprunar (1988). Gastropods with a heterostrophic protoconch, which is most the striking feature of the heterostrophic gastropod shells, are documented from

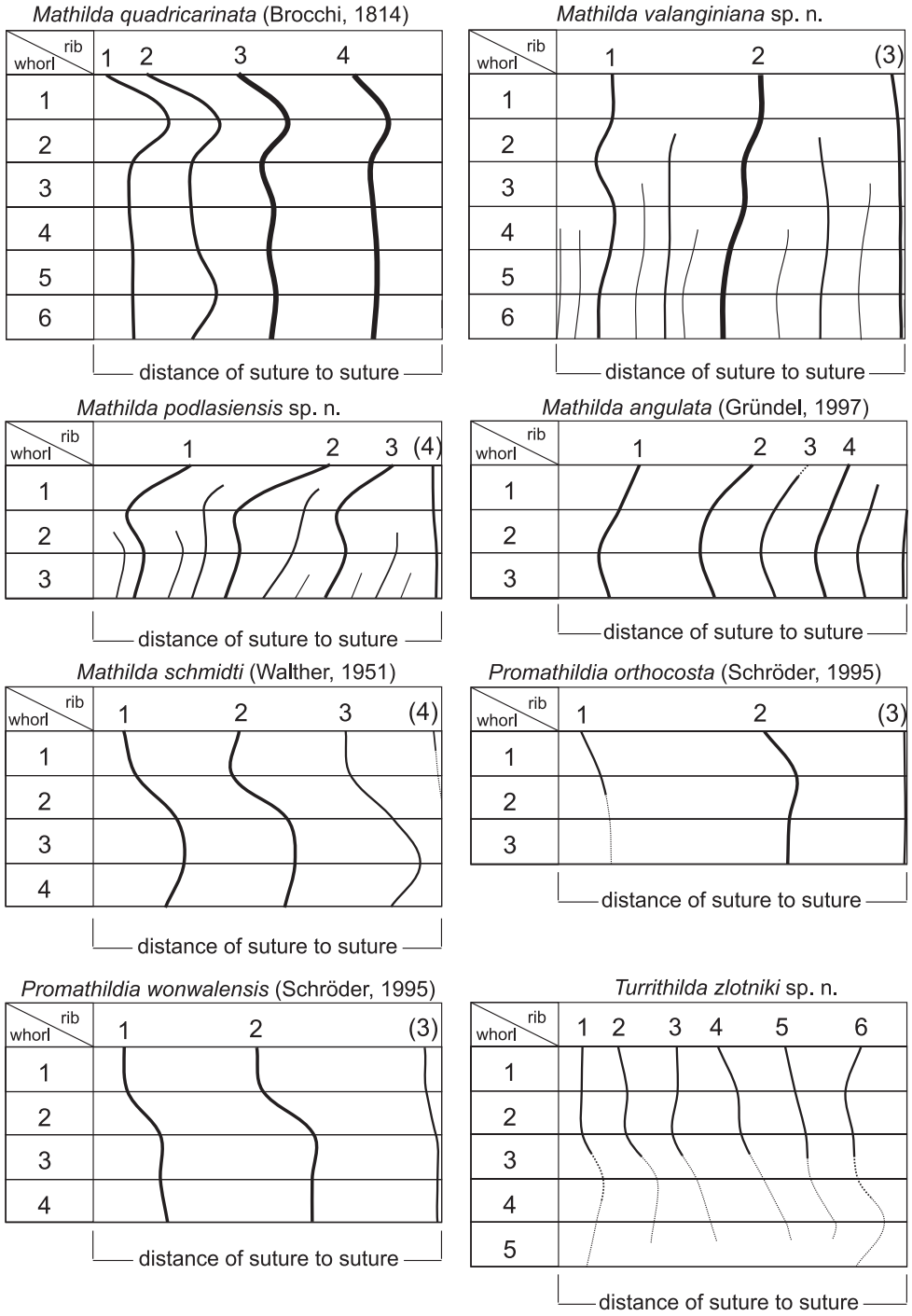


Fig. 139. The early ontogeny of the teleconch sculpture among the mathildids and related species. The Promathildia species have two spiral ribs in the ontogenetically early teleoconchs whereas the *Mathilda* species have three or more primary ribs. The species of *Turrithilda* may not be closely related to the *Promathildia*/*Mathilda* stem.

the Early Devonian (Frýda and Blodgett 2001). Similar forms were also found in the Mid Devonian (Bandel and Heidelberger 2002; Heidelberger 2002) and referred by Bandel (2002a) to Valvatoidea (see also discussion on p. 144).

During the Carboniferous heterostrophic gastropods of the families Streptacididae and Donaldinidae appeared. Their shells are similar to some Recent and Mesozoic Ebalidae (e.g., *Ebala*) and Pyramidellidae (e.g., *Chrysallida*, p. 110) respectively. The difference between the members of the two families lies mainly in the lack or presence of teleoconch ornamentation (Bandel 2002). It is very likely that the two families represent a


Achaeogastropoda
Caenogastropoda
Heterostropha
Opisthobranchia
Neritopsina
Pleurotomariidae
Trochoidea
Docoglossa
Euomphaloidea
Platyceratoidea
Eotomariidae
trochoidean-like gastropods
Goniasmidae
Orthonemidae
Cerithioidea
Soleniscidae
Ampullospiridae
Pseudomelaniidae
Zygopleuridae
modern Ptenoglossa
Pseudozygopleuridae
Stromboidea
Rissooidea
Purpurinidae
Maturifusidae
Neogastropoda
Loxonematidae
Bandellina-group
Valvatoidea
Tofanellidae
Graphis
Mathildidae
Amathinidae
Pyramidellidae
Donaldinidae
Ebalidae
Streptacidae
Cylindrobullinidae
Bullinidae
Acteonidae
Ringiculidae
most primitive gastropods
spired monoplacophorans
torsion
LECITHOTROPHIC PROTOCONCH
OPENLY-COILED PROTOCONCH
ORTHOSTROPHIC PROTOCONCH
HYPERSTROPHIC PROTOCONCH
hook-like protoconch
fish-hook like protoconch bearing gastropods
protoconch tightly coiled
non-feeding veliger
protoconch without umbilical opening
penis present
protoconch with oblique ribs
hyperstrophic protoconch
Q
Neogene
Paleog.
Cretaceous
Jurassic
Triassic
Permian
Penn.
Miss.
Carboniferous
Devonian
Silur.
Ordovician
Cambr.

Fig. 140. Possible relationships among fossil and extant taxa of gastropods based on the assumption that veliger planktotrophy is a synapomorphy of all gastropods. Black inscriptions describe the appearance of shell characters, white inscriptions describe the possible appearance of soft-body characters. The thick, black solid lines show the ranges of particular taxa in the fossil record. The numbers in circles correspond to the shell illustrations; *1. Aldanella* sp., drawing from Dzik (1993), 2. '*Straparollus*' sp. from Lesieniec borehole, eastern Poland; early Caradoc, Ordovician. Redrawn from Dzik (1994a), 3. Undetermined protoconch, possibly *Pararaphistoma* sp., Ordovician erratic boulder, Poland. Redrawn from Dzik (1994a), 4. *Orthonychia parva* (Swallow, 1858), from St. Louis, Missouri, USA; Pennsylvanian. Redrawn from Bandel and Frýda (1999), 5. *Platyceras* sp. from Celonetta Lavinerinne, Carnic Alps, Austria; Ludlow, Silurian. Redrawn from Dzik (1994a), 6. *Euomphalus* sp. from Spergen Hill Limestone, Indiana, USA; Tournaisian, Mississippian. Redrawn from Nützel (2002a), 7. *Naticopsis buttsi* Gordon *et* Yochelson, 1982 from Bandy's Chapel, Virginia, USA; Visean, Mississippian. Redrawn from Gordon and Yochelson (1982), 8. *Trachydomia nodosa* (Meek *et* Worthen, 1861) Illinois, USA; Mid Pennsylvanian. Redrawn from Knight *et al.* (1960), 9. *Neritopsis radula* Linné, 1758 from Indo-Pacific, Recent. Redrawn from Ponder (1998b), 10. Undetermined eotomariid, possibly *Mourlonia* sp. from Łagów-Dule, Poland; Famennian, Devonian. Redrawn from Dzik (1994a), 11. *Mikadotrochus* sp., Recent off of New Caledonia. Redrawn from original (courtesy of A. Warén). 12. *Cyclonema*? sp. from Mójcza, Poland; Caradoc, Ordovician. After Dzik (1994b), 13. *Eucycloscala izabellae* sp. n. from Faustianka, Poland; Bathonian, Mid Jurassic. Redrawn from original, 14. *Calliotropis ottoi* (Philippi, 1844) from Mediterranean; Recent. Redrawn from original (courtesy of A. Warén), 15. *Patella costulata* Münster, 1844 from Campo, Italy; Carnian, Late Triassic. Redrawn from Zardini (1978), 16. *Loxonema* sp. from Rauchkofel Süd, Carnic Alps, Austria; Ludlow, Silurian. Redrawn from Dzik (1994a), 17. *Goniasma* sp. from Buckhorn Asphalt, Oklahoma, USA; Desmoinesian, Pennsylvanian. Redrawn from Bandel *et al.* (2002), 18. *Orthonema* sp. from Buckhorn Asphalt, Oklahoma, USA; Desmoinesian, Pennsylvanian. Redrawn from Bandel *et al.* (2002), 19. *Cryptaulax quenstedti* (Walther, 1951) from Faustianka, Poland; Bathonian, Mid Jurassic. Redrawn from original, 20. *Argyropeza divina* Melvill *et* Standen, 1901 from Refugio Island, Philippines; Recent. Redrawn from Houbrick (1993), 21. *Soleniscus* cf. *typicus* Meek *et* Worthen, 1861 from Stephens County, Texas, USA; Virgilian, Pennsylvanian. Redrawn from Nützel *et al.* (2000), 22. *Pictavia* sp. from Moscow-Mnievniki, Russia; Oxfordian, Late Jurassic. Redrawn from originial, 23. *Cernina fluctuata* (Sowerby, 1825) from Cuyo Island, Philippines; Recent. Redrawn from Kase and Ishikawa (2003), 24. *Pseudozygopleura* sp. from St. Louis, Missouri, USA; Pennsylvanian. Redrawn from Bandel (2002a), 25. *Plocezyga gruendeli* sp. n. from Gnaszyn, Poland; Bathonian, Mid Jurassic. Redrawn from original, 26. *Opaliopsis boucheti* sp. n. from Wąwał, Poland; Valanginian, Early Cretaceous. Redrawn from original, 27. *Zygopleura campoensis* Nützel, 1998 from Campo, Italy; Carnian, Late Triassic. Redrawn from Nützel (1998), 28. *Azyga faustiankensis* sp. n. from Faustianka, Poland; Bathonian, Mid Jurassic. Redrawn from original, 29. *Pseudomelania paucispira* sp. n. from Wąwał, Poland; Valanginian, Early Cretaceous. Redrawn from original, 30. *Dicroloma cochleata* (Quenstedt, 1858) from Łuków, Poland; Callovian, Mid Jurassic. Redrawn from original, 31. *Aporrhais pespelecani* (Linné, 1766) from Korytnica, Poland; Miocene, Neogene. Redrawn from Bałuk (1995), 32. *Bralitzia faustiakensis* sp. n. from Faustianka, Poland; Bathonian, Mid Jurassic. Redrawn from original, 33. *Rissoina inca* d'Orbigny, 1840 from Bahia Herradura, Chile; Recent. Redrawn from Ponder (1985), 34. *Purpurina formosa* (Eichwald, 1868) from Łuków, Poland; Callovian, Mid Jurassic. Redrawn from original, 35. *Astandes conspicuus* (Eichwald, 1868) from Łuków, Poland; Callovian, Mid Jurassic. Redrawn from original, 36. *Latirus rugosissimus* (Locard, 1897) from Hyères Bank, North Atlantic; Recent. Redrawn from original (courtesy S. Gofas and Muséum National d'Histoire Naturelle in Paris), 37. *Palaeocarboninia jankei* Bandel *et* Heidelberger, 2002 from Soetenich, Germany; Givetian, Mid Devonian. Redrawn from Bandel and Heidelberger (2002), 38. *Bandellina miniperforata* (Gründel, 1998) from Łuków, Poland; Callovian, Mid Jurassic. Redrawn from original, 39. *Hyalogyra zibrowii* Warén, 1997 from Iles d'Hyères, Mediterranean; Recent. Redrawn from Warén *et al.* (1997), 40. *Donaldina* sp. from Buckhorn Asphalt, Oklahoma, USA; Desmoinesian, Pennsylvanian. Redrawn from Bandel *et al.* (2002), 41. *Cristalloella boczarowskii* sp. n. from Wąwał, Poland; Valanginian, Early Cretaceous. Redrawn from original, 42. *Graphis albida* (Kanmacher, 1798) from the Mediterranean coast of Turkey; Recent. Redrawn from Van Aartsen (2002), 43. *Promathildia decorata* (Klipstein, 1843) from Alpe di Specie, Italy; Carnian, Late Triassic. Redrawn from Bandel (1995), 44. *Mathilda schmidti* (Walther, 1951) from Łuków, Poland; Callovian, Mid Jurassic. Redrawn from original, 45. *Mathilda quadricarinata* (Brocchi, 1814) from Aci-Trezza, Sicily, Italy; Recent. Redrawn from Gründel (1976), 46. *Chrysallida minuera* (Gründel, 1998) from Faustianka, Poland; Bathonian, Mid Jurassic. Redrawn from original, 47. *Chrysallida sarsi* Nordsieck, 1972 from North Atlantic; Recent. Redrawn from original (courtesy of A. Warén), 48. *Cyclothyca valanginiana* sp. n. from Wąwał, Poland; Valanginian, Early Cretaceous. Redrawn from original, 49. *Amathina tricarinata* (Linné, 1758) from Indo-Pacific; Recent. Redrawn from original (courtesy of A. Warén), 50. *Streptacis whitfieldi* Meek, 1871 from Mineral Wells, Texas; Pennsylvanian. Redrawn from Bandel (2002b), 51. *Ebala varsoviensis* sp. n. from Łuków, Poland; Callovian, Mid Jurassic. Redrawn from original, 52. *Ebala* sp. from Hadera, Israel; Recent. Redrawn from original (courtesy of A. Warén), 53. *Cylindrobullina valanginiana* sp. n. from Wąwał, Poland; Valanginian, Early Cretaceous. Redrawn from original, 54. *Sulcoactaeon polonicus* sp. n. from Faustianka, Poland; Bathonian, Mid Jurassic. Redrawn from original, 55. *Bullina lineata* Gray, 1825 from Indo-Pacific; Recent. Redrawn from Burn and Thompson (1998), 56. *Tornatellaea matura* (Schröder, 1995) from Wąwał, Poland; Valanginian, Early Cretaceous. Redrawn from original, 57. *Acteon tornatilis* (Linné, 1758) from the North Atlantic; Recent. Redrawn from original (courtesy of A. Warén), 58. *Ringicula blaszyki* sp. n. from Wąwał, Poland; Valanginian, Early Cretaceous. Redrawn from original, 59. *Ringicula* sp. from Indo-Pacific; Recent. Redrawn from Burn and Thompson (1998).

group of closely related gastropods ancestral to pyramidellids (as classified by Knight *et al.* 1960) and possibly to other pyramidellacean families (Bandel 2002).

Pyramidellidae. — Undisputed pyramidellids were already present in the Mid Jurassic (see p. 110). This strongly suggests that the Paleozoic *Donaldina*-like gastropods were direct ancestors of the Pyramidellidae.

Amathinidae. — The members of this little- known family are usually placed into the Capulidae (e.g., Stearns 1890), due to the cap-like shape of their teleoconch. Ponder (1987) recognized their pyramidelloidean affinities and grouped them as the family of Heterostropha. The earliest known members of this family were found in the Mid Jurassic (Gründel 1998b), but it is likely that some other cap-like Mesozoic fossil gastropods may be interpreted as amathinids.

Ebalidae. — The shells, which can be interpreted as members of this family, are well-documented since the Early Jurassic (Schröder 1995), but most probably, some Triassic forms may also belong to this family (Bandel 1996). The group has most probably evolved from *Streptacis*-like gastropods (Bandel 2002), from which they are difficult to distinguish on the basis of shell characters.

Mathildidae. — In the Mesozoic Mathildidae was the most numerous and diverse family of the Heterostropha. In the Late Triassic fauna of St. Cassian, the mathildids were already highly diversified (Bandel 1995). In the Mid Jurassic and Early Cretaceous, they are one of the most common components of the gastropod faunas of the open sea environments (Kaim 2001). In the Tertiary and recently they are a relic family with only a few genera.

An attempt to establish a possible phylogenetic relationship between the members of Mathildidae is presented here (Figs 138, 139). The mathildids most probably originated from the Late Palaeozoic *Donaldina*-like gastropods, which were still common in the Late Triassic (Bandel 1996). In the Triassic and Jurassic, the ancestral mathildids diverged into several lineages of similar shell morphology (Fig. 138). Most of these lineages became extinct in the Late Cretaceous (Fig. 138).

Tofanellidae. — Members of this small Mesozoic family are most probably the ancestors of the little-known extant gastropods of the genus *Graphis*, most commonly included in the family Aclididae (e.g., Van Aartsen 2002).

***Bandellina* group**. — The members of this group are represented by the oldest known heterostrophs (Frýda and Blodgett 2001; Bandel and Heidelberger 2002). Their shells are usually featureless and hard to classify. Bandel (2002a) refers the group to Valvatoidea but this needs further proof (see discussion p. 144).

CEPHALASPIDEAN OPISTHOBRANCHS

The shells of cephalaspidean gastropods are usually featureless and similar across the high level taxa. As a result, it is difficult to establish a reliable phylogeny for them. Although the Cylidrobullinidae are well demarcated from the other cephalaspids by their extreme simplicity, the latter may have developed several convergent lineages.

Cylindrobullinidae. — The oldest and most widely accepted (e.g., Nützel *et al.* 2003) opisthobranch gastropods are known from the earliest Triassic (Batten and Stokes 1986). The older findings, although convergent in teleoconch morphology, are shown to have an orthostrophic protoconch (Bandel 2002; Nützel *et al.* 2003). The Cylindrobullinidae most probably originated from *Streptacis*-like gastropods. The earliest Triassic *Jiangxispira* may represent an intermediate form (Pan *et al.* 2003). The late Triassic cylindrobullinids have their typical form (Zardini 1978; Bandel 1994b) and during the Jurassic they were a common and rich component of soft-bottom gastropod fauna. The youngest cylindrobullinid known, is from the Early Cretaceous (p. 148).

Bullinidae. — The family Bullinidae is represented by the single living genus *Bullina* (Burn and Thompson 1998). The shell is very similar to the shell of Acteonidae but the latter has columellar folds on the inner lip, whereas Bullinidae have a smooth inner lip. The fossil record of the Bullinidae ranges back to the Mid Jurassic and the group most probably originated from the cylindrobullinids.

Acteonidae. — The fossil Acteonidae are known since the Mid Jurassic (Gründel 1997b). The earliest known genus of the family is *Tornatellaea*, and typically has two columellar folds on its inner lip. The Acteonidae most probably derived from the simpler Bullinidae, or both families have a common ancestor.

Ringiculidae. — The shells of ringiculid gastropods are one of the easiest to identify among the Cephalaspidea. The most striking feature, which makes it possible to distinguish ringiculids from the

other cephalaspids, is the thickened outer lip in the adult (Burn and Thompson 1998). Gastropods with this feature are known since the Callovian (latest Mid Jurassic) and may have evolved from *Tornatellaea*-like acteonids.

OUTLINE OF THE GASTROPOD PHYLOGENY

The early Paleozoic gastropods are extraordinary homogenous in their protoconch and early teleoconch morphologies (see e.g., Dzik 1994a: fig. 23). Most of the protoconchs is openly coiled with a clearly visible embryonic whorl. Most commonly the shell produced by the veliger is not well demarcated from the teleoconch. This is also encountered among the hyoliths (Dzik 1978) and may reflect a more gradual transition from larvae to adult, a pattern that is inferred to be the ancestral condition in crustaceans (Strathmann 1993). It seems most probable that the most important lineages of the archaeogastropods and ancestral caenogastropods had already evolved from gastropods with this type of larval ontogeny in the late Cambrian/early Ordovician (Fig. 140).

The main taxonomic groups of gastropods were already present in the Palaeozoic (Archaeogastropoda, Caeonogastropoda, and Heterostropha) or have originated during the transitional period between the Palaeozoic and the Mesozoic (Opisthobranchia).

The caenogastropod-like gastropods had already appeared in the Ordovician period. These gastropods, referred to the Loxonematidae here, had already given rise to the several groups of the so-called "lower caenogastropods", at the beginning of the Devonian. During this time, the Orthonemidae appeared, and are believed to be ancestral to Cerithioidea and Soleniscidea, most probably the predecessors of Ampullospiridae. At the same time, the Pseudozygopleuridae had also originated, most probably ancestral to the rest of Caenogastropoda.

Simultaneously, or even a little after the diversification of the Caenogastropoda, the first heterostrophic gastropods appeared. The earliest such gastropods known have very simple shells similar to that of the extant Valvatoidea. Although some authors (e.g., Bandel and Heidelberger 2002) link both groups, there are still suspicions that this is only a convergence in morphology. A little later, the first pyramidelloidean gastropods appeared.

The Triassic was a period of significant diversification among the Caenogastropoda and Heterostropha. The cephalaspidean opisthobranchs are known from this time. Among the caenogastropods, the Zygopleuridae, Purpurinidae, and Maturifusidae appeared, whereas Heterostropha was enlarged by the emergence of the first architectonoidean gastropods (i.g., Mathildidae and Tofanellidae). In the Early Jurassic, modern groups of caenogastropods appeared (Triphoroidea, Janthinoidea, Stromboidea, and Rissooidea). The Jurassic is also a period of cephalaspidean diversification. During this time the Bullinidae, Acteonidae, and Ringiculidae originated almost simultaneously.

From the Mid Jurassic until the Late Cretaceous, there was a period of relative stability among most groups of open sea gastropods. The only large group, which experienced significant radiation during this time, was the Neogastropoda. The earliest record of muricoidean gastropods is known from the Early Cretaceous and since this time, the group has rapidly diversified. In the Late Cretaceous, the neogastropods were already a dominating component of gastropod faunas.

The opposite tendency can be observed among the Mesozoic vetigastropods. These gastropods apparently have not undergone any significant diversification during this era. Some of them can be easily classified into genera based on extant species. Similarly to the extant members of the group, the pleurotomariids have had lecithotrophic protoconchs at least since the Jurassic.

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