Acta Geologica Polonica, Vol. 62 (2012), No. 3, pp. 367–380

Faunal dynamics of gastropods in the Bathonian (Middle Jurassic) ore-bearing clays at Gnaszyn, Kraków-Silesia Homocline, Poland

ANDRZEJ KAIM[1, 2]

[1]*Institute of Paleobiology, Polish Academy of Sciences, Twarda 51/55, PL-00-818 Warszawa, Poland.*
E-mail: kaim@twarda.pan.pl
[2]*Bayerische Staatssammlung für Paläontologie und Geologie, Richard-Wagner-Str. 10, 80333 München, Germany.*
E-mail: a.kaim@lrz.uni-muenchen.de

ABSTRACT:

Kaim, A. 2012. Faunal dynamics of gastropods in the Bathonian (Middle Jurassic) ore-bearing clays at Gnaszyn, Kraków-Silesia Homocline, Poland. *Acta Geologica Polonica*, **62** (3), 367–380. Warszawa.

The succession of gastropods in the Gnaszyn section is quite monotonous and shows significant changes only in the proximity of concretion layers, at least partially because of diagenetic reasons. Otherwise, the section is dominated by gastropods (cylidrobullinids, bullinids, and mathildids) most of which preyed probably on sedentary organisms (polychaetes and/or coelenterates) that possibly flourished on the sea bottom at that time. The other groups of gastropods are represented by larval or juvenile shells. Their presence shows that the environmental conditions that were probably unfavourable for gastropods living directly on the sea bottom most likely because of a soupy substrate consistency, possible oxygen deficiency near the sediment-water interface and/or oxygen content fluctuations. Adult and/or subadult individuals of these gastropods occur only in the higher part of the section, reflecting a time when these conditions improved. A new heterostrophic gastropod species, *Promathildia gedli*, is described.

Key words: Poland; Gnaszyn; Ore-bearing clays; Jurassic; Bathonian; Palaeoecology; Gastropods.

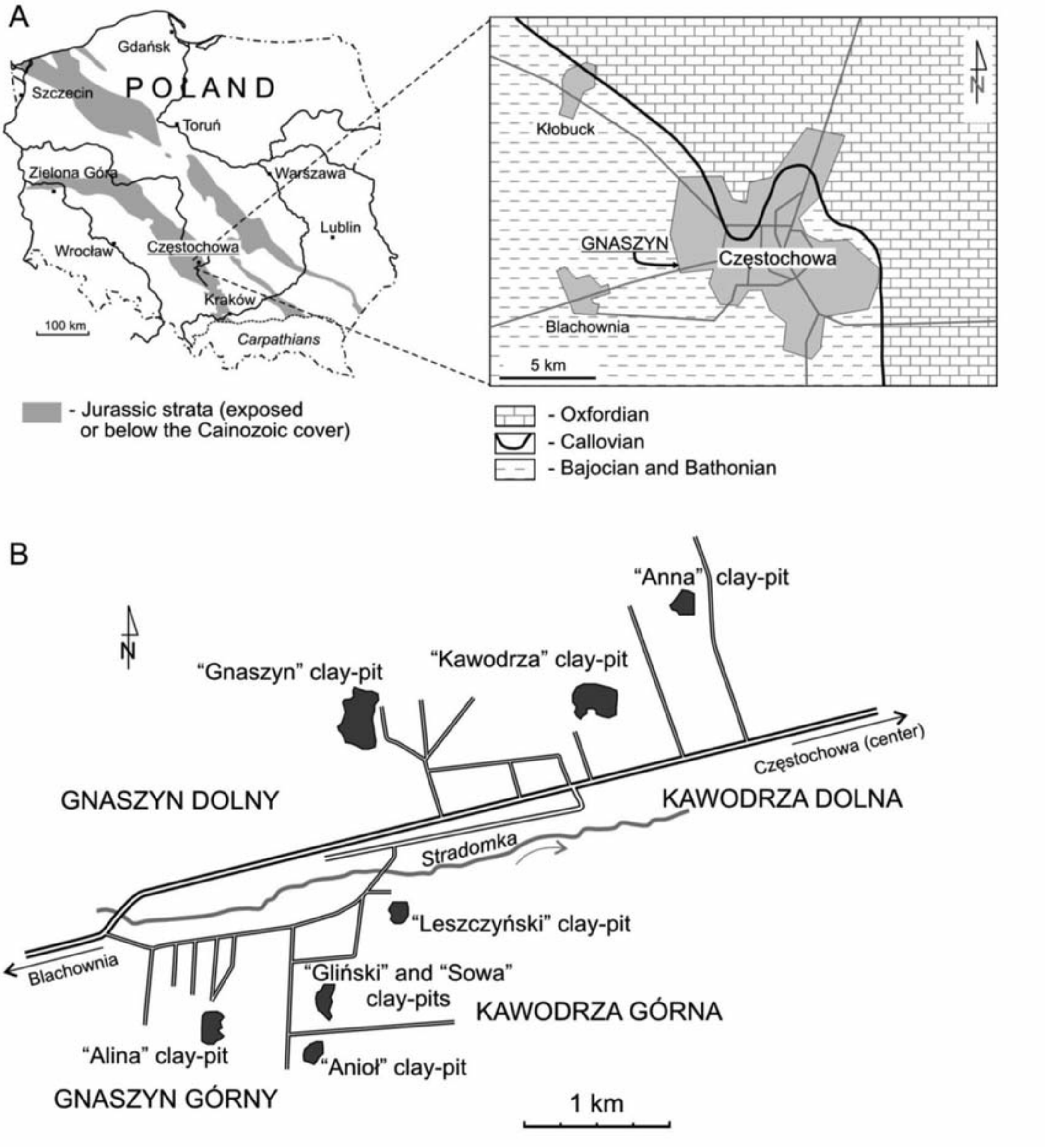
INTRODUCTION

Soft-bottom, mainly deep-water marine gastropods have been poorly known for a long time from both the fossil and Recent record. In the case of the fossils, the reason was their small size and the necessity of washing them on a sieve from the sediment, while in the modern seas it is the general difficulty in collecting from deep waters. It is mostly the extensive dredging of the sea bottom and an increasing interest in chemosynthesis-based communities that greatly contributed to our knowledge of such faunas. The Jurassic soft bottom gastropods remained poorly known until the studies of Joachim Gründel in the early 1970s (see Kaim 2004 for references). Although these gastropods have subsequently been the subject of detailed taxonomic treatments (Kaim 2004 and references therein), there have been few attempts to analyse their ecology (e.g., Nützel and Kiessling 1997; Nützel and Mapes 2001), despite the fact that studies of Early Cretaceous soft bottom associations have shown their usefulness in reconstructing palaeoenvironmental conditions (Kaim 2001, 2002). The goal of the present paper is the reconstruction of the faunal dynamics of gastropods of the Middle Bathonian ore-bearing clays (an informal lithostratigraphic unit comprising marine dark-coloured clay with layers of siderite concretions) in the Gnaszyn section. This analysis offers new insights into the reconstruction of the depositional environment of this lithostratigraphic unit.

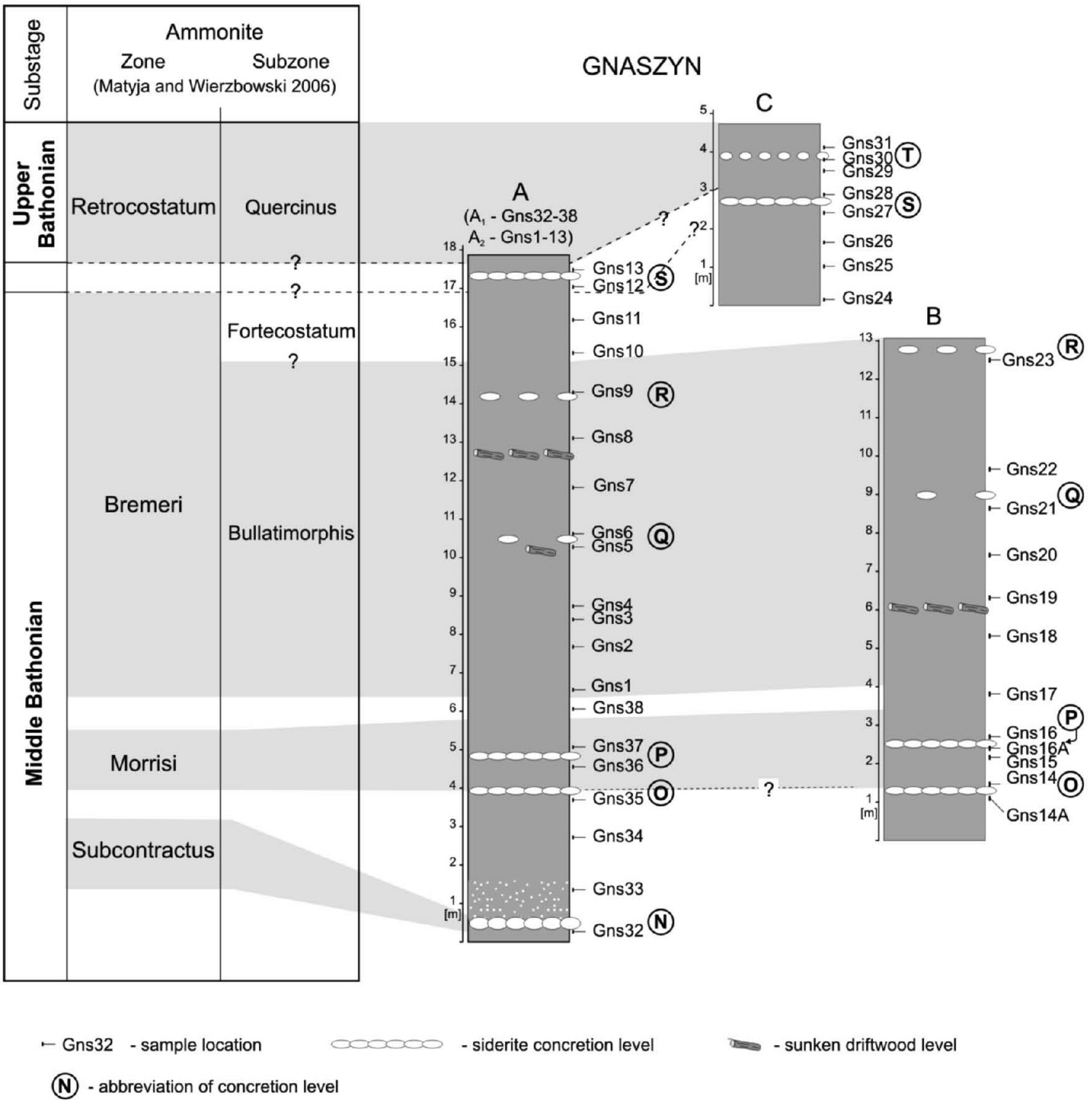
MATERIAL AND METHODS

The material analysed herein comes from the large brick-pit "Gnaszyn" located at Gnaszyn on the western outskirts of Częstochowa (Text-fig. 1). The section exposes mainly Middle Bathonian clays comprising the subcontractus, orrisi, and bremeri ammonite zones (Matyja and Wierzbowski 2006; Text-fig. 2). The samples from the Gnaszyn section were taken from three different quarry walls. Samples from section A (northeastern quarry wall; Text-fig. 2; samples Gns32–38 and Gns1–13) represent the lower and middle part of the succession. Samples from section C (southern part; Text-fig. 2; Gns24–31) document the uppermost part, and samples from section B (northwestern wall; Text-fig. 2; Gns14A–22) represent the middle part of the succession (for more details on sample location see Gedl and Kaim 2012 this issue).

The samples (approx. 5kg each) were taken from each lithologically distinct horizon of the succession. They were washed with hot water and washing powder on a sieve (mesh size 0.375 mm) and fossils were



Text-fig. 1. Simplified geological map of the town of Częstochowa and its vicinity (A – after Majewski 2000) and location of the Gnaszyn clay-pit (B – after Matyja and Wierzbowski 2003)

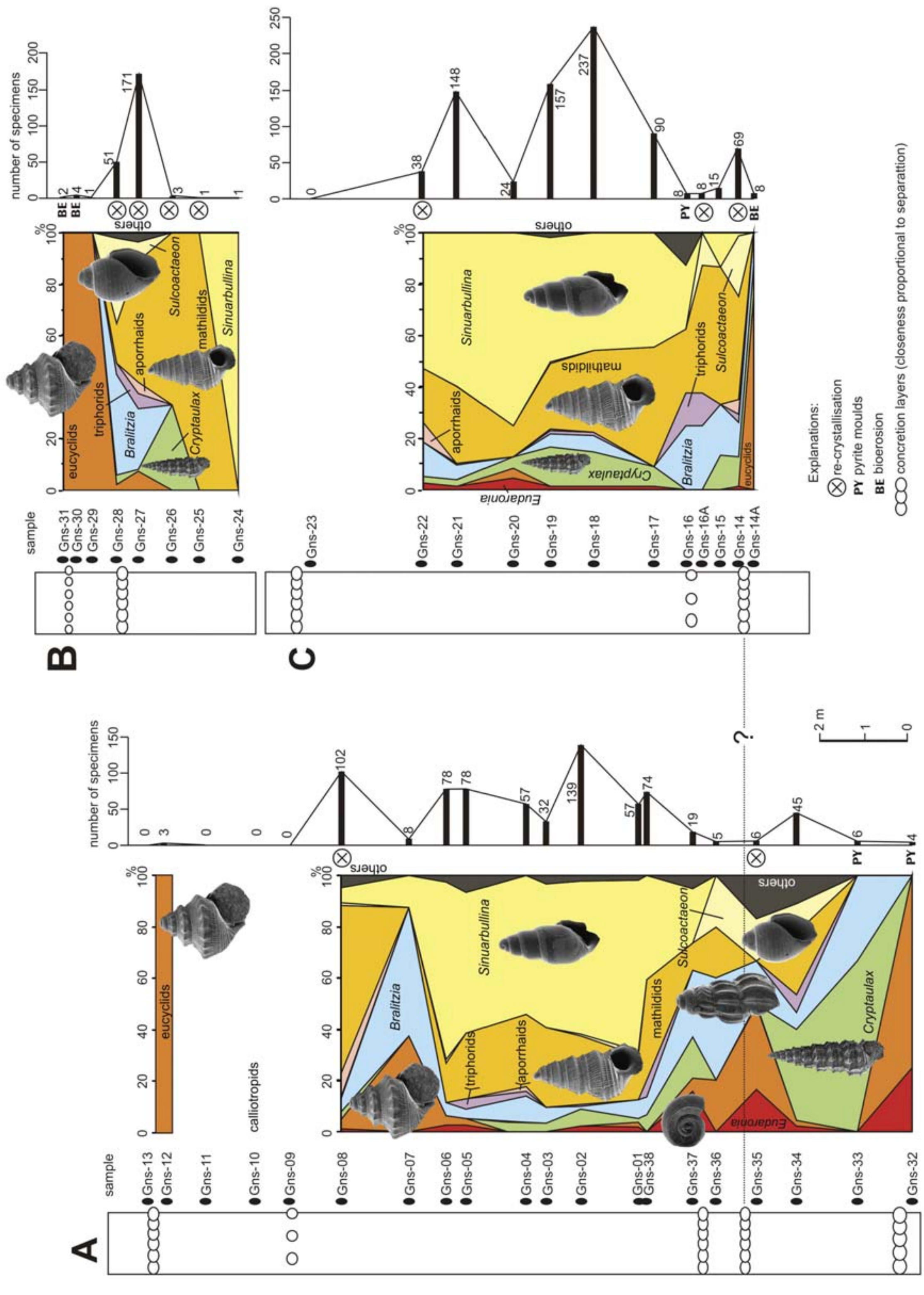


Text-fig. 2. Lithological logs of the Gnaszyn sections with sample positions indicated (from Gedl and Kaim 2012)

picked from residues under the microscope. All gastropods were counted and identified. Bivalves, scaphopods and shark teeth from the same samples were the subject of separate studies (Kaim and Sztajner 2012 this issue; Rees 2012 this issue).

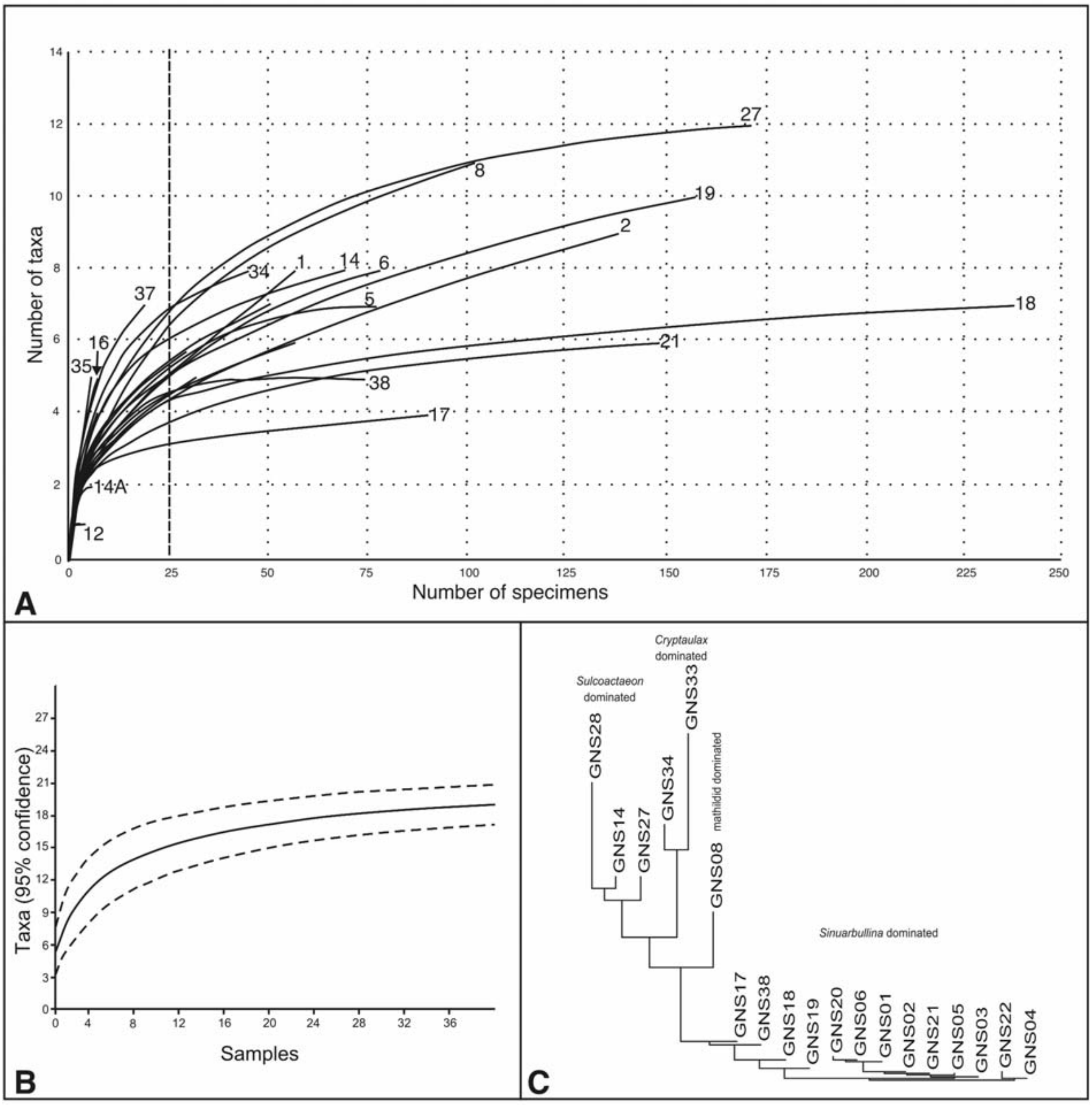
THE SUCCESSION OF GASTROPOD ASSEMBLAGES IN THE GNASZYN SECTION

The gastropods in the Gnaszyn collection are represented by 1749 specimens from more than twenty genera. The number of species has not been estimated for practical reasons; most of the gastropods counted in the samples are juveniles and are difficult (if not impossible) to classify below generic level. In most cases (see below) their shells are preserved as primary aragonite. The gastropods in the Gnaszyn section are moderately common, of low diversity, and the number of specimens in individual samples ranges from 0 to 237. Many samples yielded no or only a few gastropods (Gns9–14A, Gns15–16, Gns23–26, Gns29–33, and Gns35–36). Only a few samples provided more than 100 specimens (Text-fig. 3) and this usually coincides with the mass occurrence of the cylindrobullind *Sinuarbullina* (38% of all gastropods), which is most likely represented by a single species, *S. gnaszynensis* Kaim, 2004, and the mathildids *Promathildia*,



Text-fig. 3. Vertical variations in relative abundance (%) of the most common gastropods in the Bathonian (Middle Jurassic) ore-bearing clays at Gnaszyn. For stratigraphy see Matyja and Wierzbowski (2006), and Gedl and Kaim (2012.). **A** – Section A, northeastern quarry wall; **B** – Section C, northwestern quarry wall; **C** – Section B, southern part of the quarry wall

Carinathilda, and *Mathilda* (32% altogether). Less common, but in some samples quite abundant, are the rissoid *Bralizia* (9.2%), the cerithiid *Cryptaulax* (7.3%), the bullinid *Sulcoactaeon* (3.4%), the eucyclids *Eucycloscala*, *Parvitomella*, and *Turcica* (2.9%). Uncommon are skeneimorphs (*Eudaronia*), ptenoglossans (*Cosmocerithium, Azyga,* and *Pseudomelania*), and aporrhaids (*Spiniloma*, *Dicroloma*). *Astandes, Bandellina*, pleurotomariids, and possible cocculinoids are rare. The rarefaction analysis performed on the samples from Gnaszyn (Text-fig. 4A) has shown that in the more diverse samples (e.g., Gns8, Gns27) 75% of taxa are contained in a subsample of approximately 100 specimens while in the less diverse samples (Gns17, Gns18, Gns21, Gns38) a subsample size of 30 specimens contains almost the full diversity. Out of 40 samples investigated only 19 contain more than 23 specimens. The flattening-off



Text-fig. 4. Rarefaction curves and neighbour joining clustering for gastropod samples containing more that 23 specimens in Gnaszyn obtained using PAST software (Hammer *et al*. 2001). **A** – Curves for individual samples. Not all curves enumerated, prefix Gns omited from the sample numbers for the clarity of image. **B** – Sample rarefaction curve of the analysed gastropod samples from Gnaszyn with 95% confidence intervals. Note that the curve flattens up after the 8th sample but does not reach full diversity even after the 36th sample. **C** – Neighbour joining clustering, Morisita similarity measure with root final branch algorithm. Note good clustering of the *Sinuarbullina*-dominated samples next to a cluster containing *Sulcoactaeon*-*Cryptaulax*-dominated samples of some of the rarefaction curves (e.g. Gns 12, GNS 14A) (Text-fig. 4A) is apparently a taphonomic bias (see also below). Some of the other seemingly unbiased samples (e.g. Gns16, Gns35, Gns37) are clearly to small (Text-fig. 4A) to represent the full diversity of their layer. The sample rarefaction (Text-fig. 4B) indicates that processing eight samples is necessary to attain 75% of the gastropod diversity of the Gnaszyn locality, though even after 35 samples a new taxon is likely to appear. The gastropods from Gnaszyn are represented mainly by individuals of minute species or its larval forms (cylindrobullinds, mathildids, rissoids, cerithiids, bullinids, skeneimorphs, and ptenoglossans) while juveniles of larger species (eucyclids, aporrhaids, and *Astandes*) are uncommon. Surface collecting was also attempted, however, larger specimens of gastropods are excessively rare in Gnaszyn and only a few specimens of pleurotomariids and eucyclids have been recovered.

The succession starts with samples (Gns32 and Gns33) that contain only a few shells belonging mainly to *Cryptaulax*, *Bralitzia*, *Eudaronia*, and eucyclids (Text-fig. 3A). In the next higher samples (Gns34–36) the assemblage is supplemented by *Sulcoactaeon*. Still higher upsection, the bullinid *Sulcoactaeon* is replaced by the cylindrobullinid *Sinuarbullina*, which becomes the dominant taxon of the assemblage. This is well seen in two sample sets encompassing this part of the section (samples Gns37–36 and Gns16–22; see Text-fig. 3A and 3C). Above the *Sinuarbullina*-dominated part of the succession, there is an interval devoid of gastropod shells or in which the gastropod fauna is significantly impoverished (samples Gns9–13 and Gns23–26). In two higher samples (Gns27–28) *Sulcoactaeon* returns and declines in numbers a little higher upsection. The gastropods in these samples are represented also by adults and/or subadults but the shells are poorly preserved because their aragonite has started to re-crystallise into calcite. In the highest samples (Gns29–31) only a few, mostly crushed, eucyclids were found.

GASTROPOD AUTECOLOGY IN THE GNASZYN SECTION

It seems that, in contrast to their shallow-water counterparts, the gastropods from relatively deep-water and soft-bottom environments have not changed significantly since the Middle Jurassic (Kaim 2004). This chapter summarises information on the ecology of the gastropods occurring in the Gnaszyn section by comparisons with their living counterparts.

Skeneimorph Seguenzioidea: *Eudaronia pusilla* (Gründel, 2000) (Text-fig. 5A) is known from many Middle Jurassic localities in Poland and Germany (Gründel 2000; Kaim 2004) and appears exclusively in clayey facies. This species has been assigned to *Eudaronia* by Kaim (2004), based on its extraordinary similarity to Recent species of this genus. These gastropods are known from deep waters of Recent oceans (Cotton 1945; Warén 1991; Kano *et al.* 2009) and were traditionally classified as Skeneidae. The recent investigations of Kano *et al.* (2009) have shown that they should be classified as Seguenziidae, which are deposit feeders on very fine sediment (Hickman 1998). In Recent oceans they occur only in deep waters, mostly on outer shelf soft bottoms (Cotton 1945; Warén 1991).

Eucyclid Seguenzioidea: *Eucycloscala*, *Parvitomella*, *Turcica*. These three genera (Text-fig. 5B–D) are closely related to each other and all are related to Recent Calliotropini (Kaim 2004) recently reinterpreted by Kano (2008) as seguenzioids. Recent Calliotropini are distributed world-wide, predominantly in bathyal to abyssal depths and live on fine-grained unconsolidated sediment (Hickman 1998). Selective deposit-feeding of Recent eucyclids (i.e. Calliotropini) has been documented by Hickman (1981).

Cerithioidea: *Cryptaulax* (Text-fig. 5F). The majority of Recent cerithiids live in shallow waters but there are also some deep-water genera containing a few species each (Healy and Wells 1998). Among such deep-water genera there are two (*Argyropeza* and *Varicopeza*) which are interpreted as the closest counterparts of the Jurassic genus *Cryptaulax* (Gründel 1976). Those Recent deep-water cerithiids are microphagous detritivores or perhaps filter feeders as well (Houbrick 1980a, b). *Cryptaulax* possibly had the same mode of life.

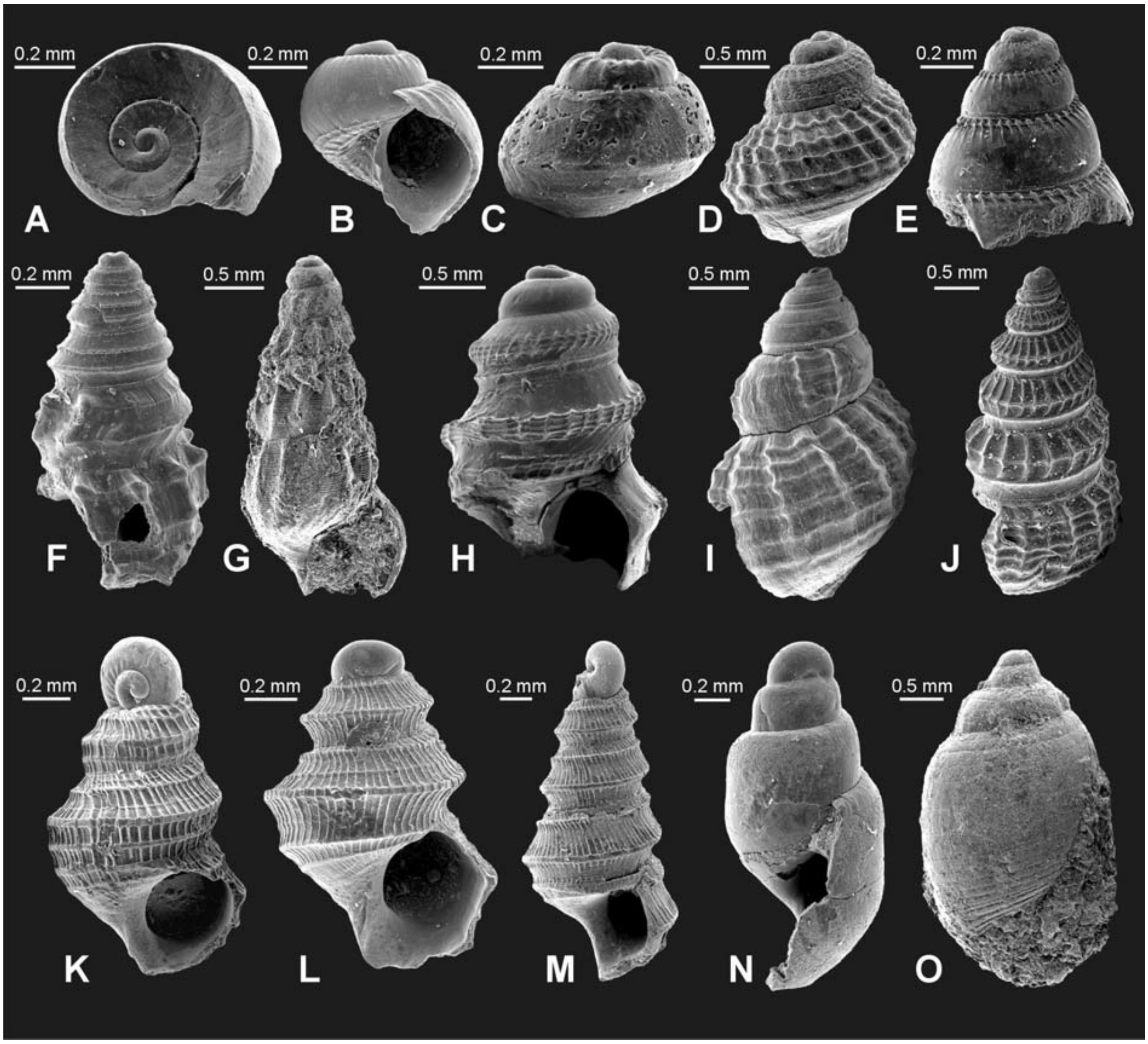
Rissoidae: *Bralitzia* (Text-fig. 5G). Most of the marine rissoids live in shallow waters, especially in mid- to lower littoral zones, with some species living on continental slopes but rarely any deeper (Ponder and Keyzer 1998). They occur on algae and beneath rocks (Ponder and Keyzer 1998) and feed either on the diatomaceous film covering these algae or on foraminifers (Warén 1996; Ponder and Keyzer 1998). It is quite likely that *Bralitzia* fed on the foraminifers that occur abundantly throughout the section (Smoleń 2012).

Triphoroidea: *Cosmocerithium* (Text-fig. 5J). All triphoroideans are primarily sponge feeders but their juveniles may feed on diatoms and other surface films (Wells 1998). *Cosmocerithium* is extremely common in the wood-fall communities found in Gnaszyn (Kaim 2008, 2010). Kaim (2011) hypothesized that *Cosmocerithium* could graze on bacterial mats covering wood and the surrounding sediment surface.

Pseudomelaniidae: *Pseudomelania*. Pseudomelaniids have similar shells to parasitic Eulimidae and possibly they may represent intermediate forms between zygopleurids and eulimids (Kaim 2004) and also have a similar mode of life (Kaim 2001).

Zygopleuridae: *Azyga* (Text-fig. 5E). Zygopleurids are extinct gastropods, possibly ancestors of primitive ptenoglossans (Nützel 1998; Kaim 2004). The ecology of zygopleurids is poorly known so far. They possibly fed on polychaetes and coelenterates.

Aporrhaidae: *Spinigera*, *Pietteia*, and *Dicroloma* (Text-fig. 5H). Recent aporrhaids are infaunal or seasonal burrowers (Barnes and Bagenal 1952; Perron 1978) and graze on diatoms and decaying remains of



Text-fig. 5. Most common or characteristic gastropods of the Bathonian (Middle Jurassic) ore-bearing clays at Gnaszyn. **A** – *Eudaronia pusilla* (Gründel, 2000), subadult from sample Gns18; **B** – *Parvitomella* sp., juvenile from sample GNS-01; **C** – *Eucycloscala* sp., juvenile from sample Gns30; **D** – *Turcica wareni* Kaim, 2004, juvenile from sample Gns5; **E** – *Azyga* sp., juvenile from sample Gns2; **F** – *Cryptaulax* sp., protoconch with first teleoconch whorl from sample Gns18; **G** – *Bralitzia faustiankensis* Kaim, 2004, subadult from sample Gns28; **H** – *Dicroloma* sp., juvenile from unregistered sample; **I** – *Astandes ticurelatus* (Gründel, 2001), protoconch and early juvenile from sample Gns16; **J** – *Cosmocerithium antiquum* (Gründel, 2001), protoconch with first teleoconch whorl from sample Gns5; **K** – *Mathilda* sp., juvenile from sample Gns18; **L** – *Carinathilda* sp., juvenile from sample Gns18; **M** – *Promathildia concava* Walther,1951, subadult from sample Gns6; **N** – *Sinuarbullina gnaszynensis* Kaim, 2004, subadult from sample Gns17; **O** – *Sulcoactaeon* sp., subadult from sample Gns28. Note that the aragonite of G and O has already begun to re-crystallise and C bears traces of bioerosion on its lateral surface macroalgae (Perron 1978). Most probably the Mesozoic aporrhaids had a similar behaviour (Kaim 2001). In view of the absence of diatoms in the Jurassic, the aporrhaids from Gnaszyn most probably fed on decaying organic remains.

Maturifusidae: *Astandes* (Text-fig. 5I). Maturifusids are most probably an ancestral (Riedel 2000; Kaim 2004) or sister (Kaim and Beisel 2005) group of the neogastropods. Their mode of life is unknown yet. Kaim (2008, 2011) revealed that *Astandes* is a very common gastropod on Jurassic wood-falls, where it forms distinctive associations with *Cosmocerithium.*

Mathildidae: *Mathilda*, *Promathildia*, and *Carinathilda* (Text-fig. 3K–M). This family is nowadays a relict group. However, during the Mesozoic it was one of the most prominent groups of marine gastropods (e.g., Kaim 2004). The biology and ecology of the Mathildidae is poorly known but as far as it is known most of the Recent mathildids live in deep-waters (Bieler 1995) and feed on coelenterates (Bandel 1995), chiefly on corals (Healy 1998). It is not clear what constituted the source of food for Mesozoic mathildids as they occur in rocks in which corals have never been recorded (Kaim 2001). It seems likely that they were able to feed on soft-bodied corals (or other organisms) which have not been preserved as fossils.

Cylindrobullinidae: *Sinuarbullina gnaszynensis* Kaim, 2004 (Text-fig. 5N). Cylindrobullinidae is a group of extinct marine gastropods that was most probably ancestral to all other cephalaspideans (e.g., Kaim 2004). Cylindrobullinids appeared abundantly on Jurassic soft-bottoms (e.g., Kaim 2004) and probably fed on polychaete annelids similarly to their descendants, e.g. acteonids and bullinids (Burn and Thompson 1998).

Bullinidae: *Sulcoactaeon* (Text-fig. 5O). It is a family represented in Recent seas by a single genus, *Bullina* (Burn and Thompson 1998). The best known species, *Bullina lineata*, lives in tropical and warm temperate shallow waters and feeds on sedentary polychaetes (Burn and Thompson 1998).

Other heterostrophic gastropods: *Bandellina riedeli* (Gründel, 1998). Bandel (1996, 2002) refers species of *Bandellina* group to the Valvatoidea but this assignment is debated (Bieler *et al.* 1998). Thus, reconstructing the mode of life of these gastropods would be highly speculative at the moment.

LIMITING FACTORS

There are two categories of limiting factors which control the occurrence, abundance and distribution of gastropods in the Gnaszyn section. The primary factors are salinity, oxygen content, food availability, type of substratum, and rate of sedimentation. The secondary factors include reworking of sediment, bioturbation, diagenesis, and weathering of the rock. The factors from the first category control the appearance of particular gastropod species according to their ecological preferences while the secondary factors bias their fossil record.

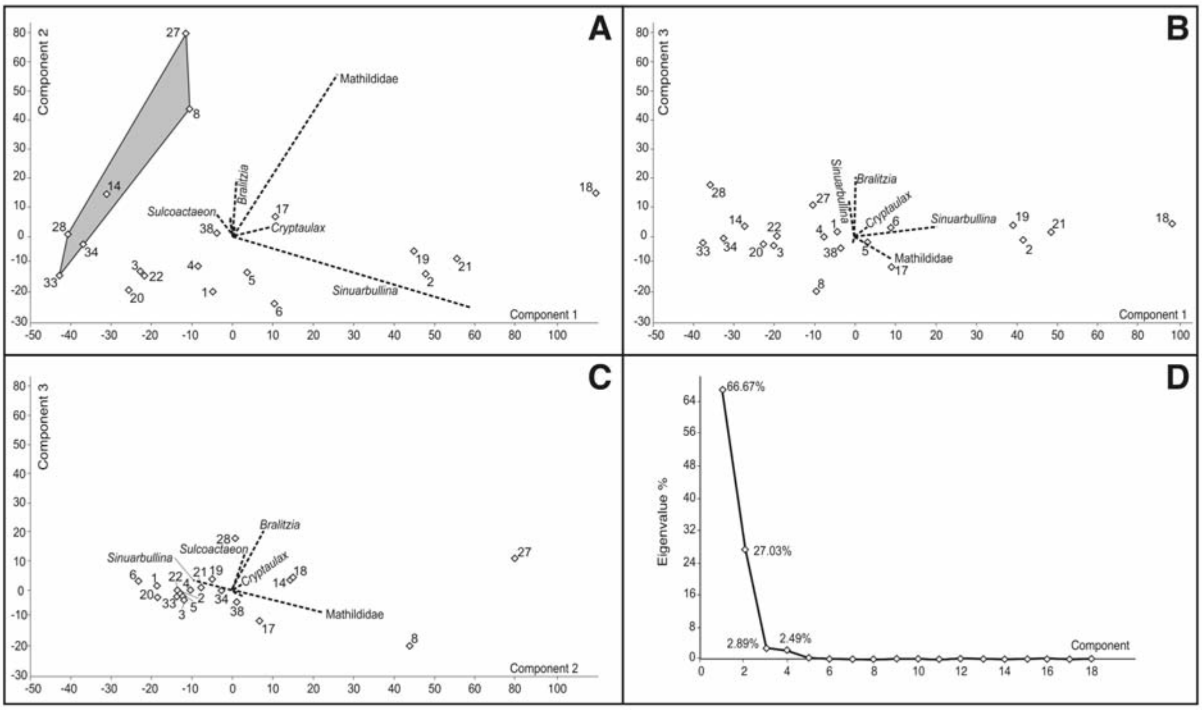
Primary factors

The full-marine salinity of the section is supported by the continuous presence of diverse echinoderm fossils (Gedl *et al.* 2003, 2006), including ophiuroids, crinoids, holothurians, crinoids and asteroids. The surface of the sediment seems to have been well oxygenated as it was settled continuously by scaphopod molluscs (apart from samples Gns9, Gns23 and Gns35; see Kaim and Sztajner 2012), which rapidly decline in oxygen-depleted conditions (Wignall 1990). Moreover, the majority of the geochemical environmental indices: (TOC/S, Ni/Co, V/Cr, U/Th, (Cu+Mo)/Zn ratios, the content of authigenic uranium, and the relationship between TOC-Fe-S) point to oxic conditions of the sediment surface (Szczepanik *et al.* 2007). Nevertheless, it is likely that the deeper sediment was anoxic or dysoxic, as suggested by the DOP (degree of pyritization) and V/V+Ni indices (Szczepanik *et al*. 2007), with seasonal variation of the oxygenation affecting periodically also the superficial level (see e.g., Oschmann 1994). Nonetheless, it seems that the most important primary factors controlling the distribution and abundance of gastropods in the Gnaszyn section seem to have been food availability and the type of substratum. The bottom of the Bathonian sea in Gnaszyn was presumably soft during most of the time. Most of the gastropods found in Gnaszyn probably could not live on a soft bottom and most likely had to utilise secondary substrates (e.g., surface of other animals). As mentioned in the autecology section, the cylindrobullinds, bullinids, mathildids, triphorids, zygopleurids, and pseudomelaniids, which are interpreted as preying on sedentary organisms, most probably used the prey bodies as a substratum. Cerithiids, rissoids, aporrhaids, and eucyclids that could live on the sediment surface but appeared in larger number only when the sediment was less clayey and had a soupy character, allowing microbial films and epigrowths to develop on the sediment surface. The skeneimorph *Eudaronia*, which typically lives on a soft substratum, has a rather scattered occurrence on the bottom and does not appear in larger concentrations. However, its occurrence throughout the section points to a relatively deep water environment in the basin, most probably a few hundred metres deep.

Meaningful analysis of the gastropod associations from Gnaszyn section is hindered by the low shell numbers in the samples. As discussed above, less than half of the samples have the appropriate number of specimens (>23) for statistical analysis. Nonetheless, two different sets of samples are clearly discernible in both neighbour joining clustering (Text-fig. 4C) and principal component analysis (PCA) (Text-fig. 6). The *Sinuarbullina*-dominated samples (Gns1–6, Gns17–22, Gns 38) from the middle part of the section form a distinctive cluster which contrasts with the remaining samples collected from the lower and upper parts of the section. These samples form two clusters, one containing *Sulcoactaeon*-dominated samples (Gns14, Gns27–28) and the other consisting of *Cryptaulax*-dominated samples (Gns33–34). The PCA shows a distinct grouping of *Sinuarbullina*/*Cryptaulax*-dominated samples along the mathildid loading, especially clearly visible on the PC1-PC2 graph (shaded area in Text-fig. 6A). The remaining samples are distributed almost linearly along the *Sinuarbullina* loading. Therefore, it seems plausible that the factors controlling the distribution of mathildids and *Sinuarbullina* are the most important for the sample composition. The first two components in the PCA are responsible for as much as 93.7% of the entire variation (Text-fig. 6D).

Secondary factors

The gastropods that have predominantly aragonite shells have a lower fossilisation potential than organisms having calcite shells. The aragonite of gastropod shells tends to undergo many diagenetic processes that alter the fossil record of gastropods (e.g., Kidwell and Bosence 1991). The gastropod shells from most palaeoenvironments are dissolved or re-crystallised. Gastropod aragonite is so unstable that it commonly dissolves prior to replacement by silica, as was described for bimineralic opercula composed of both calcite and aragonite (Kaim and Sztajner 2005). The gastropod shells found in black clays were enveloped by fine-grained sediment, and commonly by hydro-



Text-fig. 6. Principal component analysis (PCA) of the Middle Jurassic gastropod assemblages from Gnaszyn, Poland performed using PAST software (Hammer *et al*. 2001). **A-C** – Biplots of scores and loadings of principal component analysis (PCA) on the variance-covariance matrix with singular value decomposition (SVD). Dashed lines indicate loadings for particular taxa used in the analysis. Shaded convex hull indicates the smallest convex polygon containing all *Sinuarbullina*/*Cryptaulax*-dominated samples (upper left cluster in Text-fig. 4C). Prefix Gns omitted from the sample numbers for the clarity of image. **D** – Scree plot showing the variance in the dataset as explained by each principal component. PC1 explains 66.67%, PC2 27.03%, and PC3 2.89% of the variation carbon fluids, tightly enough to preserve their original aragonite. Such shells usually provide information even about its finest ornamentation and, what is especially important for taxonomic purposes, have well-preserved apices. However, even in black clays, the gastropods are absent or poorly preserved at some levels due to diagenetic processes. The most important factors that could bias or distort the record of the gastropods are (1) fragmentation due to high-energy events and compaction; (2) bioerosion; (3) cracking of the shells related to extensive mould pyritisation; (4) re-crystallisation of aragonite into calcite; and (5) Holocene weathering of the rock.

Shell abrasion and fragmentation affected mainly specimens found at levels close to siderite concretion horizons. These processes resulted in low numbers of identifiable shells and a shift towards the presence of thick-shelled gastropods (e.g., eucyclids). This can be observed in samples Gns32, Gns12, Gns14A, Gns29–31). Bioerosion (Text-fig. 7) is commonly associated with the aforementioned processes and indicates prolonged exposure of the shell on the sea bottom prior to burial (e.g., samples Gns14A, Gns30; Text-fig. 3). The extensive pyritization of gastropod infillings resulted in cracking the shells and their final decomposition during sample washing. Such a process was encountered in two samples (Gns33 and Gns16), both just above concretion horizons. The gastropods in those samples are represented by internal pyrite moulds and peeled-off fragments of shells.

Recrystallisation of gastropod shells (Text-fig. 5G, 5O) took place commonly in the upper part of the succession and apparently has not significantly affected the fossil content of certain samples (Gns8, Gns14, Gns22, and Gns26–28) as the gastropods there were found in large numbers.

The last important factor that could bias the record of gastropods in the Gnaszyn section is late diagenetic dissolution (weathering of the rock) of aragonitic fossils in the highest parts of the section. Gastropods are absent (or very rare) in the uppermost samples in all three sections which are directly overlain by Quaternary deposits. This process might especially concern samples Gns9–13 and Gns23.

SELECTED TAXONOMY

Phylum Mollusca Linné, 1758
Class Gastropoda Cuvier, 1797
Subclass Heterobranchia Gray, 1840
Order Heterostropha Fischer, 1885
Superfamily Pyramidelloidea Gray, 1840
Family Mathildidae Dall, 1865
Genus *Promathildia* Andreae, 1887

Promathildia gedli sp. nov.
(Text-fig. 8)

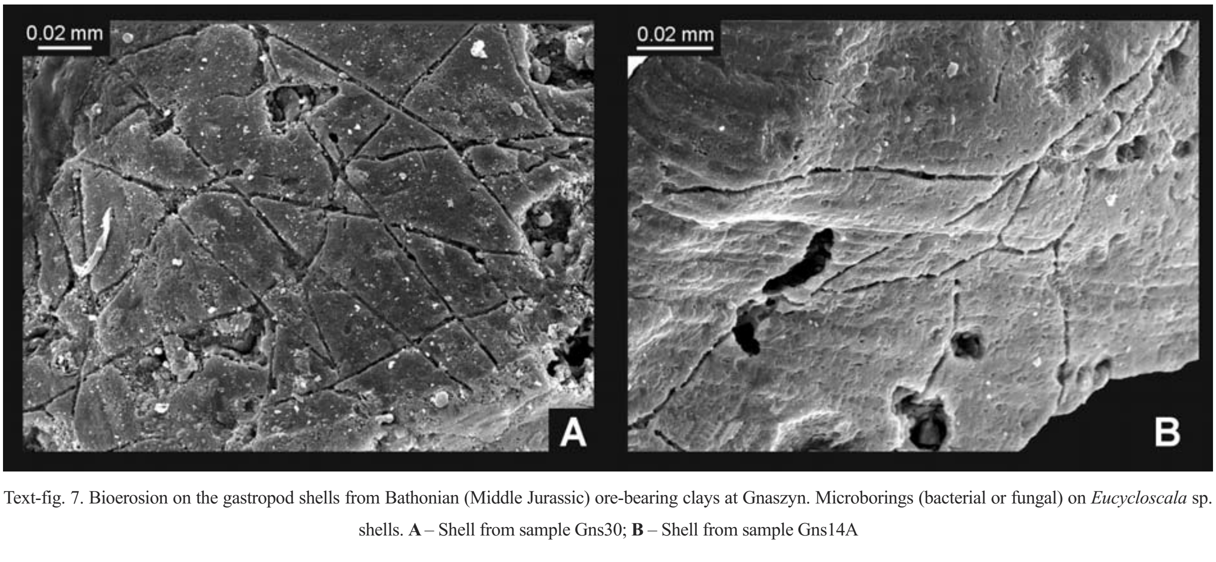
2004. *Promathildia* sp.; Kaim, p. 127, fig. 106.

HOLOTYPE: ZPAL Ga.9/324

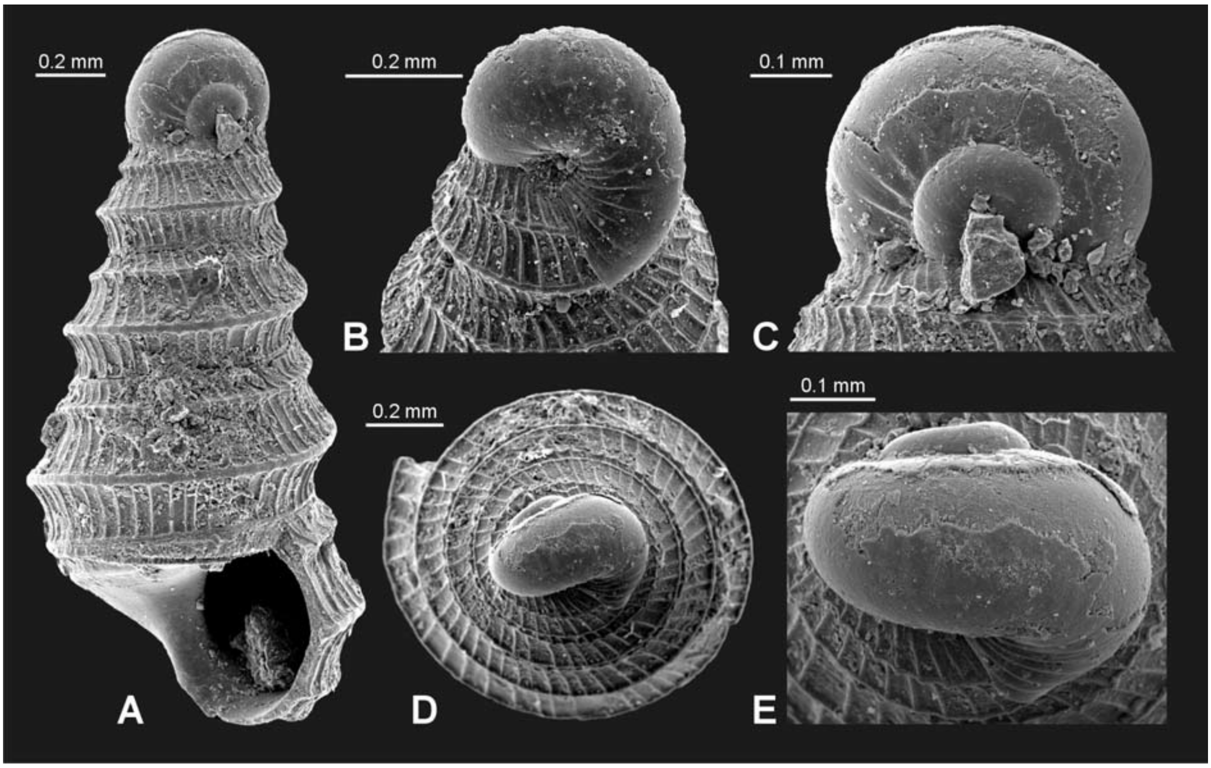
TYPE HORIZON: Sample Gns2, ore-bearing clays, Cadomites bremeri Zone, Middle Bathonian, Middle Jurassic.

TYPE LOCALITY: Gnaszyn, Częstochowa region, Poland

DERIVATION OF NAME: In honour of Przemysław GEDL.



Text-fig. 7. Bioerosion on the gastropod shells from Bathonian (Middle Jurassic) ore-bearing clays at Gnaszyn. Microborings (bacterial or fungal) on *Eucycloscala* sp. shells. **A** – Shell from sample Gns30; **B** – Shell from sample Gns14A



Text-fig. 8. Mathildid *Promathildia gedli* sp. nov. (holotype ZPAL Ga.9/324) from Gnaszyn, Częstochowa region, Poland; sample Gns2, remeri Zone, Middle Bathonian, Middle Jurassic. **A** – Lateral view; **B** – Protoconch in umbilical view; **C** – Protoconch in apical view; **D** – Apical view; **E** – Protoconch in lateral view

MATERIAL: 133 shells, mostly juveniles.

DIMENSIONS: The holotype, consisting of 3.5 teleoconch whorls, is 2.05 mm high and 0.98 mm wide. The protoconch, consisting of about two whorls, is 0.35 high and 0.45 wide.

DIAGNOSIS: Shell cone-shaped, approximately two times as high as broad. Protoconch large (about 0.45 mm in diameter), transaxial, ornamented by adapical and abapical axial folds. Teleoconch starting with two prominent and one subsutural spiral ribs. Whorls angulated at, almost keel-like, medial rib. Spiral ribs crossed by dense opisthocyrtic axial ribs.

DESCRIPTION: As in diagnosis. The number of axial ribs varies from 42 to 69 per whorl. The peristome is unknown.

REMARKS: The new species differs from other species of *Promathildia* in having the largest protoconch, which is in less than its half covered by the teleoconch. This species was previously described as *Promathildia* sp., based on a single specimen from Gnaszyn. The newly collected material enabled the establishment of a new species for this gastropod.

OCCURRENCES: Middle Bathonian (Middle Jurassic) of Gnaszyn section.

CONCLUSIONS

The gastropod assemblage in the Gnaszyn section indicates an outer-shelf environment below the photic zone in a region of high input of fine-grained clastics. The substrate consistency seems to be the main primary factor controlling the distribution of gastropods in the succession. Most of the succession reflects soupy-bottom conditions (poorly diversified, juvenile but well preserved gastropods in the middle part of the section). The succession of gastropods is quite monotonous and shows significant changes only at levels close to siderite concretion horizons, which occur in intervals of coarser sediment. At these levels, the gastropods were adolescent or adult, better diversified but poorly preserved, dominated by thick-shelled eucyclids. This might be caused by post-mortem processes, as is also indicated by their poor preservation. Otherwise the succession is dominated by gastropods (cylidrobullinids, bullinids, and mathildids) preying on sedentary organisms (polychaetes and/or coelenterates) that possibly flourished on the sea bottom. The

	Eudaronia	*Eucycloscala*	*Parvitomella*	*Turcica*	*Cryptaulax*	*Bralitzia*	*Cosmocerithium*	*Azyga*	*Pietteia/Dicroloma*	*Spiniloma*	*Astandes*	*Bandellina*	*Pseudomelania*	Mathildidae	*Sulcoactaeon*	*Sinuarbullina*	Pleurotomariidae	others	Total
GNS38					5	5	5							29		30			74
GNS37	3	1			3	5								2		4	1		19
GNS36		1				2								1	1				5
GNS35	1		2			1									1			1	6
GNS34	1	1			16	3		3				5		11	5				45
GNS33					4	2													6
GNS32	1	3																	4
GNS31		2																	2
GNS30		4																	4
GNS29		1																	1
GNS28		1			2	20							2	8	17			1	51
GNS27		10	2		2	40	6	1	8		4		3	80	13			2	171
GNS26					1									2					3
GNS25														1					1
GNS24																1			1
GNS23																			0
GNS22	1				1	5				3				8		20			38
GNS21	2				4	8	1							44		89			148
GNS20	1		1		1									3		18			24
GNS19	2				24	8	2			1	1	2		40	1	76			157
GNS18	3				31	16	2	1						75		109			237
GNS17	1				7									42		40			90
GNS16						2	1				1			2		2			8
GNS16A						2	1							4	1				8
GNS15					2	3								8		2			15
GNS14	1				8	9	2			4				28	16	1			69
GNS14A		6			1	1													8
GNS13																			0
GNS12		3																	3
GNS11																			0
GNS10																			0
GNS09																			0
GNS08	1	3	1		3	5	1		9					67	1	6		5	102
GNS07		1	2			4										1			8
GNS06	2	1	2			4					2			12	1	54			78
GNS05	2			2		3	3				4			20		43			77
GNS04					2	6	1		1					16		31			57
GNS03					1	2					1			10		18			32
GNS02	3				9	2		1			1			37	1	83		1	138
GNS01	1		1		1	4					1			10	1	38			57
Total	26	38	11	2	128	162	25	6	18	8	15	7	5	560	59	666	1	10	1747
Total %	1.5	2.2	0.6	0.1	7.3	9.3	1.4	0.3	1.0	0.5	0.9	0.4	0.3	32.1	3.4	38.1	0.1	0.6	100

Table 1. Counts of gastropods in the samples from Gnaszyn

other gastropod fossils are represented by larval or juvenile shells and apparently this environment was unfavourable for them. Most probably they could not tolerate the soupy bottom conditions. Adult and/or subadult individuals of these gastropods appeared higher in the succession where the sediment is coarser. The lack or rarity of gastropods in the the uppermost parts of the section might be caused by Quaternary weathering of the sediments.

Acknowledgements

I wish to thank to P. Gedl (Kraków) and A. Boczarowski (Sosnowiec) for assistance in fieldwork. A. Bakuła, A. Gronkowska, and G. Matriba (all Warsaw) are acknowledged for washing the samples and picking the specimens. A. Nützel (Munich) and J. Szabó (Budapest) are thanked for their constructive comments on the manuscript. The SEM micrographs were taken in the SEM laboratory of the Institute of Paleobiology PAN (Warsaw) using a Philips XL-20 scanning electron microscope. This research was supported by Institute of Paleobiology PAN, the Japan Society for the Promotion of Science (JSPS) Postdoctoral Fellowship for Foreign Researchers, JSPS research grant number 17.05324 (project number 050500000614), the Polish Ministry of Science and Higher Education research grant N N307 116635 and completed during the tenure of a Humboldt Fellowship.

REFERENCES

Bandel, K. 1995. Mathildoidea (Gastropoda, Heterostropha) from the Late Triassic St Cassian Formation. *Scripta Geologica*, **111**, 1–83.

Bandel, K. 1996. Some heterostrophic gastropods from Triassic St. Cassian Formation with a discussion on the classification of the Allogastropoda. *Paläontologische Zeitschrift*, **70**, 325–365.

Bandel, K. 2002. About the Heterostropha (Gastropoda) from the Carboniferous and Permian. *Mitteilungen aus dem Geologisch-Paläontologischen Institut der Universität Hamburg*, **86**, 45–80.

Barnes, H. and Bagenal, T.B. 1952. The habits and habitat of *Aporrhais pes-pelicani* (L.). *Journal of the Malacological Society*, **29**, 101–105.

Bieler, R. 1995. Mathildidae from New Caledonia and the Loyalty Islands (Gastropoda: Heterobranchia). *Mémoires du Muséum National d'Histoire Naturelle*, **167**, 595–641.

Bieler, R., Ball, A. D. and Mikkelsen, P. M. 1998. Marine Valvatoidea - comments on anatomy and systematics with description of a new species from Florida (Heterobranchia: Cornirostridae). *Malacologia*, **40**, 305–320.

Burn, R. and Thompson, T.E. 1998. Order Cephalaspidea. In: P.L. Beesley, G.J.B. Ross and A. Wells (Eds), Mollusca: The Southern Synthesis. Fauna of Australia, **5**, 943–959. CSIRO Publishing; Melbourne.

Cotton, B.C. 1945. Southern Australian Gastropoda Part I. Streptoneura. *Transactions of the Royal Society of South Australia*, **69**, 150–171.

Gedl, P. and Kaim, A. 2012. An introduction to palaeoenvironmental reconstruction of Bathonian (Middle Jurassic) ore-bearing clays at Gnaszyn, Kraków-Silesia Homocline, Poland. *Acta Geologica Polonica*, **62** (3), 267–280.

Gedl, P., Kaim, A., Boczarowski, A., Kędzierski, M., Smoleń, J., Szczepanik, P., Witkowska, M., and Ziaja, J. 2003. Rekonstrukcja paleośrodowiska sedymentacji środkowojurajskich iłów rudonośnych Gnaszyna (Częstochowa) — wyniki wstępne. *Tomy Jurajskie*, **1**, 19–27.

Gedl, P., Boczarowski, A., Dudek, T., Kaim, A, Kędzierski, M., Leonowicz, P., Smoleń, J., Szczepanik, P.,Witkowska, M. and Ziaja, J. 2006. Stop B1.7 — Gnaszyn clay pit (Middle Bathonian-lowermost Upper Bathonian). Lithology, fossil assemblages and palaeoenvironment. In: A. Wierzbowski, R. Aubrecht, J. Golonka, J. Gutowski, M. Krobicki, B.A. Matyja, G. Pieńkowski and A. Uchman (Eds), Jurassic of Poland and adjacent Slovakian Carpathians. Field trip guidebook of 7th International Congress on the Jurassic System, pp. 155–156. Polish Geological Institute; Warszawa.

Gründel, J. 1976. Zur Taxonomie und Phylogenie der Bittium-Gruppe (Gastropoda, Cerithiacea). *Malakologische Abhandlungen Staatliches Museum für Tierkunde in Dresden*, **5**, 33–59.

Gründel, J. 2000. Archaeogastropoda aus dem Dogger Norddeutschlands und des nordwestlichen Polens. *Berliner Geowissenschaftliche Abhandlungen, Reihe E*, **34**, 205–253.

Hammer, Ø., Harper, D.A.T., and P. D. Ryan, 2001. PAST: Paleontological Statistics Software Package for Education and Data Analysis. *Palaeontologia Electronica*, **4**, 1–9.

Healy, J.M. 1998. Superfamily Architectonoidea. In: P.L. Beesley, G.J.B. Ross and A. Wells (Eds), Mollusca: The Southern Synthesis. Fauna of Australia, **5**, 858–862. CSIRO Publishing; Melbourne.

Healy, J.M. and Wells, F.E. 1998. Superfamily Cerithioidea. In: P.L. Beesley, G.J.B. Ross and A. Wells (Eds), Mollusca: The Southern Synthesis. Fauna of Australia, **5**, 707–733. CSIRO Publishing; Melbourne.

Hickman C.S. 1981. Selective deposit feeding by the deep-sea archaeogastropod *Bathybembix aeola*. *Marine Ecology Progress Series*, **6**, 339–342.

Hickman C.S. 1998. Superfamily Trochoidea. In: P.L. Beesley, G.J.B. Ross and A. Wells (Eds), Mollusca: The Southern Synthesis. Fauna of Australia, **5**, 671–692. CSIRO Publishing; Melbourne.

Houbrick, R.S. 1980a. Reappraisal of the gastropod genus *Varicopeza* Gründel (Cerithiidae: Prosobranchia). *Proceedings of the Biological Society of Washington*, **93**, 525–535.

Houbrick, R.S. 1980b. Review of the deep-sea genus *Argyropeza* (Gastropoda: Prosobranchia: Cerithiidae). *Smithsonian Contributions to Zoology*, **321**, 1–30.

Kaim, A. 2001. Faunal dynamics of juvenile gastropods and associated organisms across the Valanginian transgression-regression cycle in central Poland. *Cretaceous Research*, **22**, 333–351.

Kaim, A. 2002. Gradual evolution of the Early Cretaceous marine gastropod *Rissoina* lineage in central Poland. *Acta Palaeontologica Polonica*, **47**, 667–672.

Kaim, A. 2004. The evolution of conch ontogeny in Mesozoic open sea gastropods. *Palaeontologia Polonica*, **62**, 3–183.

Kaim, A. 2008. A review of gastropods from a Callovian (Middle Jurassic) glacial drift at Łuków, Eastern Poland. *Neues Jahrbuch für Geologie und Paläontologie Abhandlungen*, **247**, 161–176.

Kaim, A. 2011. Non-actualistic wood-fall associations from Middle Jurassic of Poland. *Lethaia*, **44**, 109–124.

Kaim, A. and Beisel, A.L. 2005. Mesozoic gastropods from Siberia and Timan (Russia). Part 2: Neogastropoda and Heterobranchia. *Polish Polar Research*, **26**, 41–64.

Kaim, A. and Sztajner, P. 2005. The opercula of neritopsid gastropods and their phylogenetic importance. *Journal of Molluscan Studies*, **71**, 211–219.

Kaim, A. and Sztajner, P. 2012. Faunal dynamics of bivalves and scaphopods in the Bathonian (Middle Jurassic) ore-bearing clays at Gnaszyn, Kraków-Silesia Homocline, Poland. *Acta Geologica Polonica,* **62** (3), 381–395.

Kano, Y. 2008. Vetigastropod phylogeny and a new concept of Seguenzioidea: independent evolution of copulatory organs in the deep-sea habitats. *Zoologica Scripta*, **37**, 1–21.

Kano, Y., Chikyu, E., and Warén, A. 2009. Morphological, ecological and molecular characterization of the enigmatic planispiral snail genus *Adeuomphalus* (Vetigastropoda: Seguenzioidea). *Journal of Molluscan Studies*, **75**, 397–418.

Kidwell, S.M. and Bosence, D.W.J. 1991. Taphonomy and time-averaging of marine shelly faunas In: P.A. Allison and D.E.G. Briggs (Eds), Taphonomy: Releasing the data locked in the fossil record. Topics in Geobiology, **9**, 115–209. Plenum Press; New York.

Majewski, W. 2000. Middle Jurassic concretions from Częstochowa (Poland) as indicators of sedimentation rates. *Acta Geologica Polonica*, **50**, 431–439.

Matyja, B.A. and Wierzbowski, A. 2003. Biostratygrafia amonitowa formacji częstochowskich iłów rudonośnych (najwyższy bajos-górny baton) z odsłonięć w Częstochowie. *Tomy Jurajskie*, **1**, 3–6.

Matyja, B.A. and Wierzbowski, A. 2006. Field Trip B1 – Biostratigraphical framework from Bajocian to Oxfordian. Stop B1.7 – Gnaszyn clay pit (Middle Bathonian – lowermost Upper Bathonian). In: A. Wierzbowski, R. Aubrecht, J. Golonka, J. Gutowski, M. Krobicki, B.A. Matyja, G. Pieńkowski and A. Uchman (Eds), Jurassic of Poland and adjacent Slovakian Carpathians. Field trip guidebook, 154–155. 7th International Congress on the Jurassic System, 6–18 September 2006, Kraków, Poland.

Nützel, A. 1998. Über die Stammesgeschichte der Ptenoglossa (Gastropoda). *Berliner Geowissenschaftliche Abhandlungen, Reihe E*, **26**, 1–229.

Nützel, A. and Kießling, W. 1997. Gastropoden aus dem Amaltheenton (oberes Pliensbachium) von Kalchreuth. *Geologische Blatter für Nordost Bayern und Angrenzende Gebiete*, **47**, 381–414.

Nützel, A. and Mapes, R.H. 2001. Larval and juvenile gastropods from a Carboniferous black shale: palaeoecology and implications for the evolution of the Gastropoda. *Lethaia*, **34**, 143–162.

Oschmann, W. 1994. Der Kimmeridge Clay von Yorkshire als ein Beispiel eines fossilien Sauerstoff-kontrollierten Millieus. *Beringeria*, **9**, 1–153.

Perron, F.E. 1978. Seasonal burrowing behavior and ecology of *Aporrhais occidentalis* (Gastropoda: Strombacea). *Biological Bulletin,* **154**, 463–471.

Ponder, W.F. and Keyzer, R.G. de 1998. Superfamily Rissooidea. In: In: P.L. Beesley, G.J.B. Ross and A. Wells (Eds), Mollusca: The Southern Synthesis. Fauna of Australia, **5**, 745–766. CSIRO Publishing; Melbourne.

Rees, J. 2012. Palaeoecological implications of neoselachian shark teeth from the Bathonian (Middle Jurassic) ore-bearing clays at Gnaszyn, Kraków-Silesia Homocline, Poland. *Acta Geologica Polonica*, **62** (3), 397–402.

Riedel, F. 2000. Ursprung und Evolution der "höheren" Caenogastropoda. *Berliner Geowissenschaftliche Abhandlungen, Reihe E*, **32**, 1–240.

Smoleń, J. 2012. Faunal dynamics of foraminiferal assemblages in the Bathonian (Middle Jurassic) ore-bearing clays at Gnaszyn, Kraków-Silesia Homocline, Poland. *Acta Geologica Polonica*, **62** (3), 403–419.

Szczepanik, P., Witkowska, M. and Sawłowicz, Z. 2007. Geochemistry of Middle Jurassic mudstones (Kraków-Częstochowa area, southern Poland): interpretation of the depositional redox conditions. *Geological Quarterly*, **51**, 57–66.

Warén, A. 1991. New and little known Mollusca from Iceland and Scandinavia. *Sarsia*, **76**, 53–124.

Warén, A. 1996. Ecology and systematics of the North European species *Rissoa* and *Pusillina* (Prosobranchia: Rissoidae). *Journal of the Marine Biological Association of the United Kingdom*, **76**, 1013–1059.

Wells, F.E. 1998. Superfamily Triphoroidea. In: P.L. Beesley, G.J.B. Ross and A. Wells (Eds), Mollusca: The Southern Synthesis. Fauna of Australia, **5**, 808–811. CSIRO Publishing; Melbourne.

Wignall, P.B. 1990. Benthic palaeoecology of the late Jurassic Kimmeridge Clay of England. *Special Papers in Palaeontology*, **43**, 1–74.

Manuscript submitted: 01st August 2010
Revised version accepted: 31st August 2012