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Ammonite biostratigraphy in the Polish Jura sections (central Poland) as a clue for recognition of the uniform base of the Kimmeridgian Stage

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Abstract. The ammonite succession in the stratigraphical interval from the Bifurcatus Zone, through the Hypselum Zone, up to the lower part of the Bimammatum Zone corresponding to a large part of the Submediterranean Upper Oxfordian is studied in several sections of the Polish Jura in central Poland. The sections have yielded numerous ammonites of Submediterranean–Mediterranean affinity, but also, some of Boreal and Subboreal character. The co-occurrence of ammonites of different bioprovinces makes possible the correlation between the different zonal schemes – especially between the Subboreal/Boreal zonations and the Submediterranean/Mediterranean zonation. The correlation shows that the boundary of the Pseudocordata and Baylei zones (Subboreal) and its equivalent – the boundary of the Rosenkrantzi and Bauhini zones (Boreal), currently proposed as the primary standard of the Oxfordian-Kimmeridgian boundary within its GSSP at Staffin Bay (Isle of Skye, Scotland), runs in the Submediterranean/Mediterranean Upper Oxfordian near the base of the Bimammatum Zone. This discovery removes the main obstacle against the formal recognition of the Staffin Bay section as representing the uniform base of the Kimmeridgian Stage in the World and its GSSP.
The ammonite taxa recognized are commented on and/or described, and suggestions on their taxonomical and phylogenetical relations are given in the palaeontological part of the study. A new taxon is established: *Microbiplices anglicus vieluniensis* subsp. nov.

INTRODUCTION

The principal area of occurrence of Oxfordian and Lower Kimmeridgian deposits in central Poland is the Kraków–Częstochowa–Wieluń Upland, called also the Polish Jura (Fig. 1). This is the area of occurrence of the sponge megafacies represented by cyanobacteria-sponge bioherms and the well bedded limestones of the interbiohermal areas. The latter are very rich in ammonites, and reveal the full succession of the ammonite faunas discussed herein.

During most of the Late Jurassic the sponge megafacies, interpreted as an assemblage of deposits rich in siliceous sponges and cyanobacterial (microbial) structures, covered a deep-neritic part of the northern shelf of the Tethys. These deposits are known from southern Portugal (Algarve), south-eastern and eastern Spain and southern France, northern Switzerland, southern Germany (Swabia and Franconia), Bohemian Massif, central and southern Poland, south-western Ukraine and Romania (Dobruja) (Matyja, Pisera, 1991; Matyja, Wierzbowski, 1996; with earlier papers cited therein), as well as the northern Caucasus to the east (Guo *et al*., 2011). The sponge megafacies deposits, which generally correspond to the Submediterranean Province, were bordered on the south by the typical pelagic facies of the Mediterranean Province of the Tethys Ocean, whereas towards the north they passed into the siliciclastic (mainly clay and siltstone) facies or carbonate facies of the shallow-water carbonate platforms developed on the epicratonic shelf areas

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Fig. 1. Location of the sections studied in the Polish Jura

which represented the Subboreal Province; the latter was connected towards the north to the semi-enclosed Boreal Sea corresponding to the Boreal Province (see *e.g.* Fürsich, Sykes, 1977; Sykes, Callomon, 1979; Matyja, Wierzbowski, 1995).

The deposits studied in the Polish Jura yield abundant and diversified ammonite assemblages which make possible their detailed chronostratigraphical interpretation. Dominant in the interval studied are ammonites of the families Oppeliidae, Perisphinctidae, Ataxioceratidae and Aspidoceratidae, on which the Submediterranean/Mediterranean zonation is based. On the other hand, ammonites of the family Cardioceratidae typical of the Boreal Province, making possible recognition of the Boreal zones, occur fairly commonly in some stratigraphical intervals. Ammonites of the family Aulacostephanidae typical of the Subboreal Province which provide the Subboreal zonation appear in the middle and upper part of the succession. All these features of the succession make possible the detailed stratigraphical correlation between the particular sections studied, but also as a consequence of the overlapping of the ammonites faunas coming from different ammonite provinces enables general correlation between the separate zonal schemes recognized in different areas of Europe (*e.g.* Matyja, Wierzbowski, 1995; Matyja *et al.*, 2006). It is especially important for the recognition of the uniform boundary of the Oxfordian/Kimmeridgian boundary in the World and the formal acceptance of its GSSP (*cf.* Matyja *et al.*, 2006; Wierzbowski *et al.*, 2006; Wierzbowski, 2010; Wierzbowski, Matyja, 2014). The new biostratigraphical data supplement also the general knowledge on the lower part of the ammonite succession in the Upper Oxfordian and Lower Kimmeridgian – from the upper part of the Bifurcatus Zone up to the Hypselum Zone and the lowermost Bimammatum Zone. This is relatively poorly known when compared with the stratigraphically better recognized upper part of the succession which corresponds to the bulk of the Bimammatum Zone (including the Hauffianum Subzone), and the Planula Zone (Matyja, Wierzbowski, 1997, 2006b; Wierzbowski *et al.*, 2010).

DESCRIPTION OF THE SECTIONS

The deposits are well-bedded limestones with thin marly intercalations. These limestones are commonly either friable and chalky, or more hard and dense. They are generally of the wackestone to packstone type, with cherts, and with common benthic fossils (mostly siliceous sponges – preserved as calcareous mummies, brachiopods, serpulids, bryozoans, as well as occasional bivalves, crabs and echinoderms). Less commonly encountered are limestones more rich in micrite and showing a limited benthic fauna, as well as almost pure often friable micritic limestones of the mudstone type very poor in benthic fossils but yielding tests of planktonic organisms such as commonly encountered radiolarians. Ammonites and belemnites occur in all these limestone types.

Details of some small sections in local quarries which are no longer accessible, and the faunas contained have already been published. These include the Kamyk quarry (see Różak, Brochwicz-Lewiński, 1978), and the Syborowa Góra quarry (Matyja, Wierzbowski, 1992, 1994, 2006a). The ammonite material in the Syborowa Góra section described below has been markedly enriched in the course of the present work and some of the determinations given in older papers are revised in the present study. The full succession of the deposits and their faunal content presented herein is based, however, mostly on newly elaborated sections – such as the Katarowa Góra section at Łobodno, and the currently exposed oldest part of the Bobrowniki section near Działoszyn; these are supplemented by previously unpublished material from small quarries such as those at Morgi and Podzamcze near Ogrodzieniec, at Jaroszów-Zawada, at Biskupice near Olsztyn, and at Biała Dolna near Częstochowa (Fig. 1) which are now infilled. Ammonites were collected already in late 1980s, and the collections have been successively enlarged up to the last year by the authors. The ammonites are housed in the Museum of the Faculty of Geology, University of Warsaw (collection number MWG UW ZI/58/1-170) and the Museum of the Polish Geological Institute – National Research Institute (collection number MUZ PIG 1797.II.1-94).

SYBOROWA GÓRA SECTION

An old quarry, on Syborowa Hill, about 4 km north of Olkusz, no longer exists, being completely infilled with rubble. The section was accessible up to the early 2000s, when it yielded numerous ammonites studied by Matyja and Wierzbowski (1992, 1994, 2006a). The section displayed over 11 metres of well-bedded tuberolitic limestones of the wackestone type, locally with siliceous sponge mummies, and other benthic fossils (especially brachiopods), and was very rich in ammonites. Thin marly intercalations occurred between the particular limestone beds: from nearly indistinguishable ones up to about 5–10 cm in thickness. The succession of deposits described below was seen from the base, and it yielded the following ammonite faunas (Fig. 2):

Bed 1 (0.2 m seen, base not exposed) – limestone layer; about 5 cm thick marly intercalation (bed 2) at the top.

Bed 3 (0.84 m) – limestone layer with ammonite – *Perisphinctes* (*Dichotomoceras*) *bifurcatus* (Quenstedt) (Pl. 4: 6); a poorly visible marly intercalation at the top.

Bed 4 (0.60 m) – limestone layer with ammonites: *Perisphinctes* (*Dichotomoceras*) *bifurcatus* (Quenstedt) and *P.* (*D.*). sp.; a poorly visible marly intercalation at the top.

Bed 5 (0.64 m) – limestone layer with ammonites: *Sowerbyceras tortisulcatum* (d'Orbigny) (Pl. 1: 1), *Subdiscosphinctes mindowe* (Siemiradzki) (Pl. 4: 10), *Orthosphinctes* (*Pseudorthosphinctes*), *O.* sp.; moreover in the rubble from beds 1–5 were found: *Graefenbergites arancenis* (Meléndez) (Pl. 6: 2), and *G.* sp. – these were previously (Matyja and Wierzbowski 1992, 1994, 2006a) referred to as *Passendorferia* (*Enayites*); about 5 cm thick marly intercalation (bed 6) at the top.

Bed 7 (0.68 m) – limestone layer with ammonites: *Sowerbyceras tortisulcatum* (d'Orbigny), *Glochiceras* (*Coryceras*) *microdomum* (Oppel) (Pl. 1: 14), *G.* (*C.*) cf. *microdomum* (Oppel), *G.* (*C.*) *canale* (Quenstedt), *Taramelliceras* (*Taramelliceras*) cf. *externnodosum* (Dorn) including a specimen similar to forma *robusta* of Hölder (1958), *Amoeboceras ovale* (Quenstedt), *A.* aff. *ovale* (Quenstedt) (Pl. 2: 7), *A. marstonense* Spath, *A.* cf. *freboldi* Spath (Pl. 2: 9), *A.* aff. *freboldi* Spath, *Perisphinctes* (*Dichotomoceras*) *bifurcatus* (Quenstedt) (Pl. 4: 7), *P.* (*D.*) *crassus* Enay (Pl. 4: 8), *P.* (*D.*) cf. *microplicatilis* (Quenstedt) (Pl. 4: 9), *Subdiscosphinctes* ("*Aureimontanites"*) *mindowe* (Siemiradzki) (Pl. 5: 1), *Passendorferia* (*Enayites*) sp. juv.; an indistinct marly intercalation at the top.

Bed 8 (0.56 m) – limestone layer with ammonites: *Perisphinctes* (*Dichotomoceras*) *bifurcatus* (Quenstedt) (Pl. 4: 5), *P.* (*Perisphinctes*) sp., *Passendorferia* (*Enayites*) *gygii* (Brochwicz-Lewiński et Różak), *Orthosphinctes* (*Pseudorthosphinctes*) sp., *O.* sp.; a poorly visible marly intercalation at the top.

Bed 9 (0.64 m) – limestone layer showing different ammonite faunas in its lower and upper parts; the lower part yielded: *Glochiceras* (*Glochiceras*) *tectum* Ziegler (Pl. 1: 6), *Ochetoceras* (*Ochetoceras*) cf. *basseae* Fradin, *Perisphinctes* (*Dichotomoceras*) *bifurcatus* (Quenstedt) (Pl. 4: 4), *P.*(*D.*) sp.; the upper part yielded: *Glochiceras* (*Glochiceras*) *tectum* Ziegler, *Orthosphinctes* (*Pseudorthosphinctes*) sp., and fragmentary specimens possibly *Perisphinctes* (*Dichotomoceras*); an about 10 cm thick marly intercalation (bed 10) at the top yielded *Passendorferia* (*Enayites*) sp. juv.

The ammonite *Passendorferia* (*Enayites*) (m) (Pl. 5: 2) representing the dimorphic counterpart of *P.* (*Passendorferia*) *uptonioides* (Enay) (M) has been found in rubble coming from beds 1–9.

Bed 11 (0.68 m) – limestone layer with ammonites: *Ochetoceras* (*Ochetoceras*) *hispidiforme* (Fontannes), *O.* (*O.*) *semifalcatum* (Oppel) (Pl. 1: 4), *O.* (*O.*) *basseae* Fradin, *Glochiceras* (*Glochiceras*) *tectum* Ziegler (upper part of the bed), *Taramelliceras* ex gr. *externnodosum* (Dorn), ?*Decipia kostromensis* Głowniak *et al.* (Pl. 3: 5), *Orthosphinctes* (*Orthosphinctes*) sp., *O.* (*Pseudorthosphinctes*) sp., *Euaspidoceras striatocostatum* (Dorn) (Pl. 8: 3); a thin marly intercalation at the top (bed 12).

Bed 13 (0.80 m) – limestone layer with ammonites: *Ochetoceras* (*Ochetoceras*) *semifalcatum* (Oppel), *Taramelliceras* (*Taramelliceras*) *externnodosum* (Dorn) forma *mediocris* of Hölder (1958), *Graefenbergites* sp., *Orthosphinctes* (*Orthosphinctes*) sp., *Euaspidoceras varioornatum* (Dorn); a thin marly intercalation at the top (bed 14).

Bed 15 (0.60 m) – limestone layer with ammonites: *Ochetoceras* (*Ochetoceras*) *basseae* Fradin (Pl. 1: 3), *O.* (*O.*) *hispidiforme* (Fontannes) (Pl. 1: 5), *Taramelliceras* (*Richeiceras*) *tricristatum* (Oppel) (Pl. 1: 10a, b), *T.* (*R.*) cf. *tricristatum* (Oppel), *Glochiceras* (? *Lingulaticeras*) sp. nov. (Pl. 1: 18), *Taramelliceras*

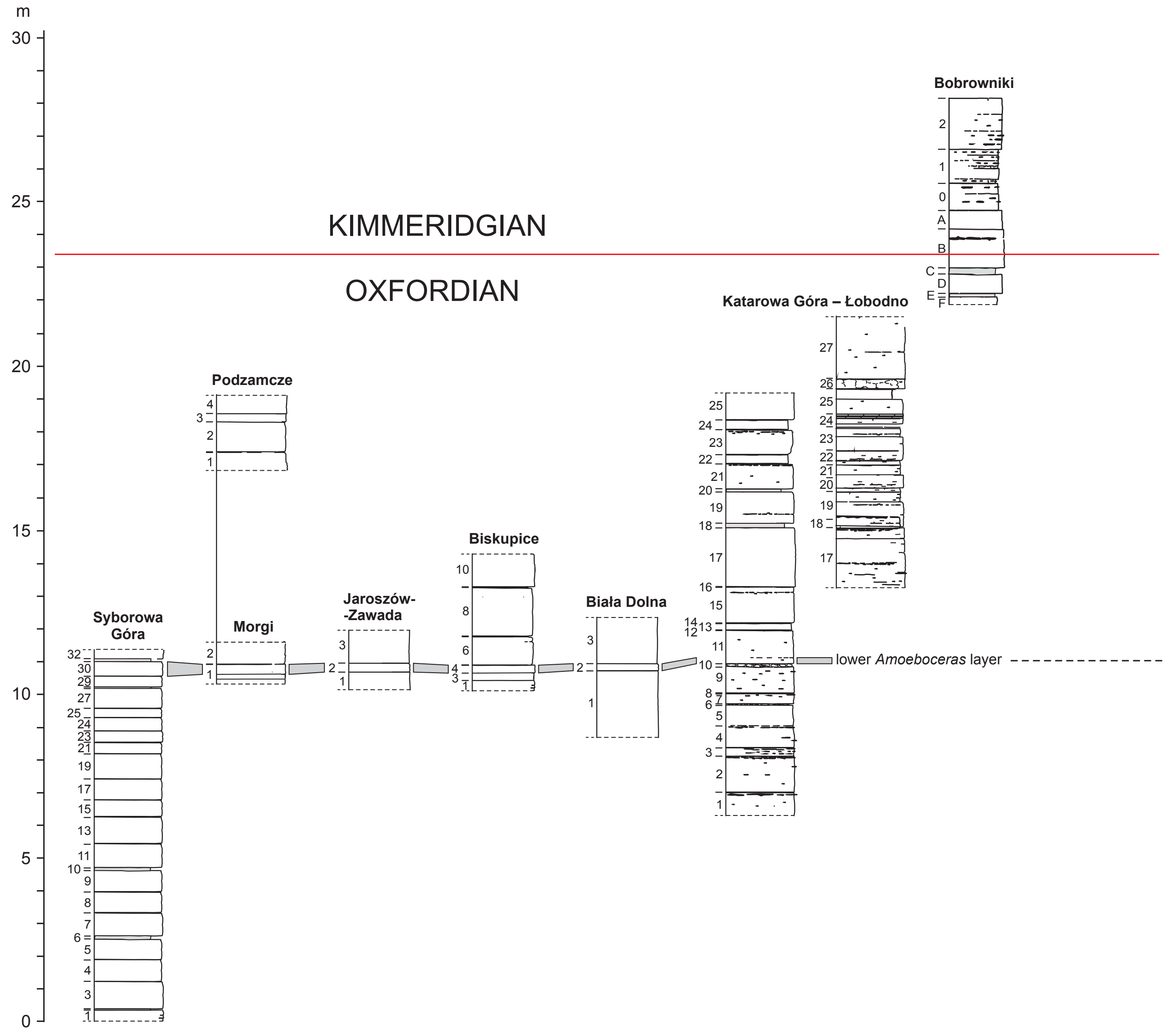

Fig. 2. Ammonite succession and chronostratigraphical interpretation of the sections studied in terms of the Submediterranean-Mediterranean, the Subboreal, and the Boreal subdivisions

Lithology is explained in the text; the position of the lower *Amoeboceras* layer – the local reference horizon – is indicated; dark blue – Oxfordian, light blue – Kimmeridgian

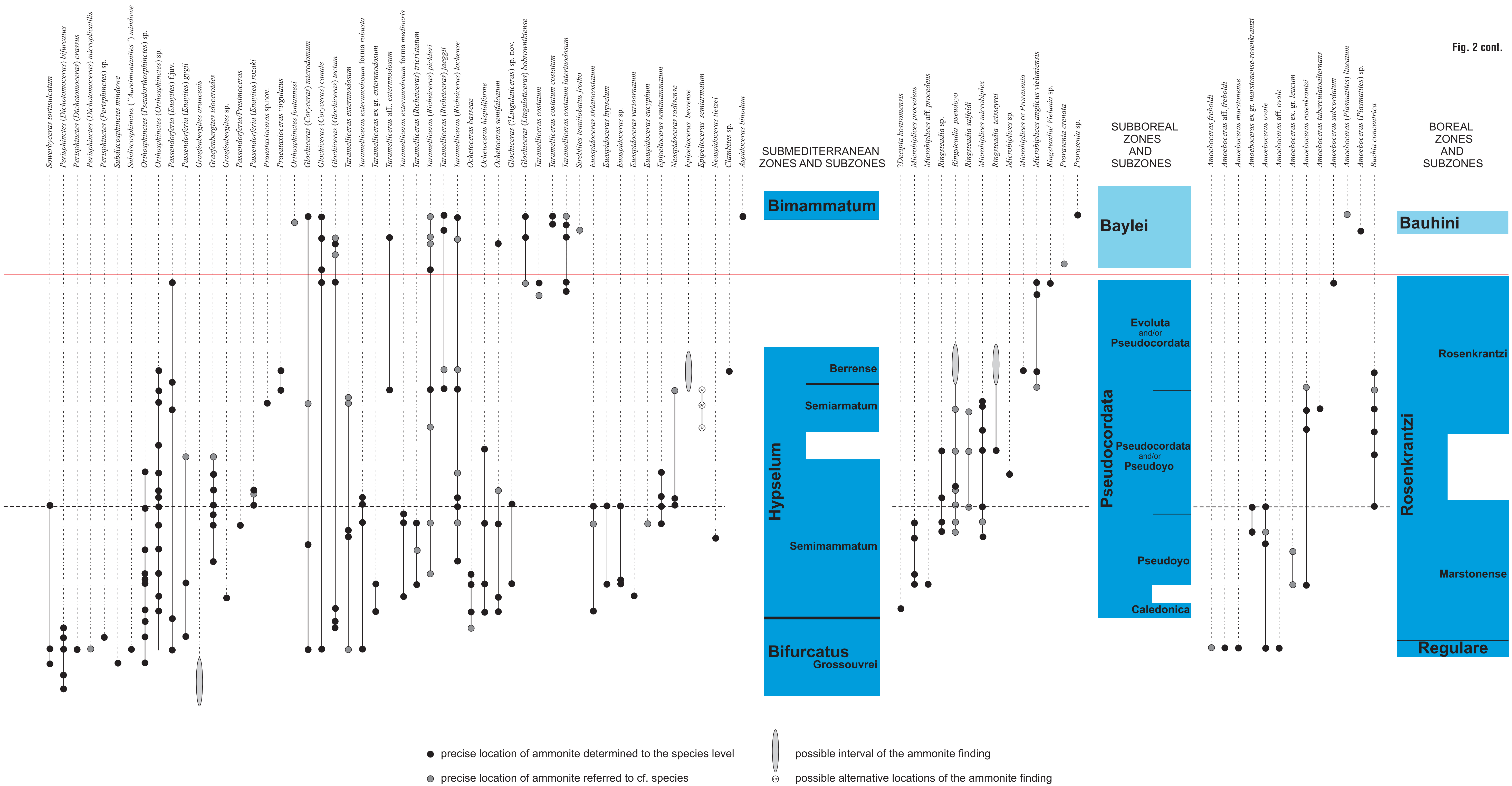
Sowerbyceras tortisulcatum
Perisphinctes (Dichotomoceras) bifurcatus
Perisphinctes (Dichotomoceras) crassus
Perisphinctes (Dichotomoceras) microplicatilis
Perisphinctes (Perisphinctes) sp.
Subdiscosphinctes mindowe
Subdiscosphinctes ("Aureimontanites") mindowe
Orthosphinctes (Pseudorthosphinctes) sp.
Orthosphinctes (Orthosphinctes) sp.
Passendorferia (Enayites) f.juv.
Passendorferia (Enayites) gygii
Graefenbergites aranceinis
Graefenbergites idoceroides
Graefenbergites sp.
Passendorferia/Presimoceras
Passendorferia (Enayites) rozaki
Praeataxioceras sp.nov.
Praeataxioceras virgulatus
Orthosphinctes fontannesi
Glochiceras (Coryceras) microdomum
Glochiceras (Coryceras) canale
Glochiceras (Glochiceras) tectum
Taramelliceras externnodosum
Taramelliceras externnodosum forma robusta
Taramelliceras ex gr. externnodosum
Taramelliceras aff.. externnodosum
Taramelliceras externnodosum forma mediocris
Taramelliceras (Richeiceras) tricristatum
Taramelliceras (Richeiceras) pichleri
Taramelliceras (Richeiceras) jaeggii
Taramelliceras (Richeiceras) lochense
Ochetoceras basseae
Ochetoceras hispidiforme
Ochetoceras semifalcatum
Glochiceras (?Lingulaticeras) sp. nov.
Glochiceras (Lingulaticeras) bobrownikiense
Taramelliceras costatum
Taramelliceras costatum costatum
Taramelliceras costatum laterinodosum
Streblites tenuilobatus frotho
Euaspidoceras striatocostatum
Euaspidoceras hypselum
Euaspidoceras sp.
Euaspidoceras varioornatum
Euaspidoceras eucyphum
Epipeltoceras semimammatum
Neaspidoceras radisense
Epipeltoceras berrense
Epipeltoceras semiarmatum
Neaspidoceras tietzei
Clambites sp.
Aspidoceras binodum
SUBMEDITERRANEAN ZONES AND SUBZONES
Bimammatum
Berrense
Semiarmatum
Hypselum
Semimammatum
Bifurcatus
Grossouvrei
?Decipia kostromensis
Microbiplices procedens
Microbiplices aff. procedens
Ringsteadia sp.
Ringsteadia pseudoyo
Ringsteadia salfeldi
Microbiplices microbiplex
Ringsteadia teisseyrei
Microbiplices sp.
Microbiplices or Prorasenia
Microbiplices anglicus vieluniensis
Ringsteadia/ Vielunia sp.
Prorasenia crenata
Prorasenia sp.
SUBBOREAL ZONES AND SUBZONES
Baylei
Evoluta
and/or
Pseudocordata
Pseudocordata
Pseudocordata
and/or
Pseudoyo
Pseudoyo
Caledonica
Amoeboceras freboldi
Amoeboceras aff. freboldi
Amoeboceras marstonense
Amoeboceras ex gr. marstonense-rosenkrantzi
Amoeboceras ovale
Amoeboceras aff. ovale
Amoeboceras ex. gr. leucum
Amoeboceras rosenkrantzi
Amoeboceras tuberculatoalternans
Amoeboceras subcordatum
Amoeboceras (Plasmatites) lineatum
Amoeboceras (Plasmatites) sp.
Buchia concentrica
BOREAL ZONES AND SUBZONES
Bauhini
Rosenkrantzi
Rosenkrantzi
Marstonense
Regulare
precise location of ammonite determined to the species level
precise location of ammonite referred to cf. species
possible interval of the ammonite finding
possible alternative locations of the ammonite finding

Fig. 2 cont.

(*Taramelliceras*) ex gr. *externnodosum* (Dorn), *Amoeboceras rosenkrantzi* Spath, *A.* ex gr. *leucum* Spath (Pl. 2: 8), *Microbiplices procedens* (Oppenheimer), *M.* sp. indet. aff. *procedens* (Oppenheimer) (Pl. 3: 8), *Passendorferia* (*Enayites*) *gygii* (Brochwicz-Lewiński et Różak), *Orthosphinctes* (*Pseudorthosphinctes*) sp., *Euaspidoceras hypselum* (Oppel), *E.* sp.; a thin marly intercalation at the top (bed 16) yielded *Orthospinctes* (*Pseudorthosphinctes*) sp., *Euaspidoceras* sp.

Bed 17 (0.44 m) – limestone layer with ammonites: *Ochetoceras* (*Ochetoceras*) *basseae* Fradin (Pl. 1: 2), *Taramelliceras* (*Richeiceras*) cf. *pichleri* (Oppel), *Glochiceras* (*Coryceras*) sp., *Microbiplices procedens* (Oppenheimer) (Pl. 3: 9), *Orthosphinctes* (*Orthosphinctes*) sp., *O.* (*Pseudorthosphinctes*) sp.; a thin marly intercalation at the top (bed 18).

Bed 19 (0.68 m) – limestone layer with ammonites: *Taramelliceras* (*Richeiceras*) *lochense* (Oppel) (Pl. 1: 7), *Graefenbergites idoceroides* (Dorn) (Pl. 7: 2); a thin marly intercalation at the top (bed 20).

Bed 21 (0.40 m) – limestone layer with ammonites: *Taramelliceras* (*Richeiceras*) cf. *tricristatum* (Oppel), *Amoeboceras* ex gr. *leucum* Spath., *Orthosphinctes* (*Orthosphinctes*) sp., *O.* (*Pseudorthosphinctes*) sp.; a thin marly intercalation at the top (bed 22).

Bed 23 (0.38 m) – limestone layer with ammonites: *Glochiceras* (*Coryceras*) *microdomum* (Oppel); a poorly visible marly intercalation at the top.

Bed 24 (0.44 m) – limestone layer with ammonites: *Taramelliceras* (*Taramelliceras*) *externnodosum* (Dorn); a poorly visible marly intercalation at the top.

Bed 25 (0.32) – limestone layer with ammonites: *Taramelliceras* (*Taramelliceras*) *externnodosum* (Dorn) forma *robusta* of Hölder (1958), *Amoeboceras* cf. *ovale* (Quenstedt), *Ringsteadia* sp., *Orthosphinctes* (*Orthosphinctes*) sp.; a thin marly intercalation at the top (bed 26).

Bed 27 (0.60 m) – limestone layer with ammonites: *Taramelliceras* (*Richeiceras*) *tricristatum* (Oppel), *T.* (*R.*) cf. *pichleri* (Oppel), *Taramelliceras* (*Taramelliceras*) *externnodosum* (Dorn) forma *robusta* (Pl. 1: 17a, b) and forma *mediocris* of Hölder (1958), *Passendorferia* / *Presimoceras* trans. form (Pl. 6: 1), *Ringsteadia* cf. *pseudoyo* Salfeld (Pl. 2: 15), *Ringsteadia* spp., *Microbiplices procedens* (Oppenheimer), (Pl. 3: 7), *M.* sp., *Epipeltoceras semimammatum* (Quenstedt) (Pl. 7: 9), *E.* cf. *semimammatum* (Quenstedt), *Euaspidoceras* cf. *eucyphum* (Oppel) (Pl. 8: 5), *E.* cf. *striatocostatum* (Dorn); some bivalves *Buchia concentrica* (Sowerby) have been also found; an about 5 cm thick marly intercalation (bed 28) at the top.

Bed 29 (0.80 m) – limestone layer; an indistinct marly intercalation at the top.

Bed 30 (0.48 m) – limestone layer with ammonites called the lower *Amoeboceras* layer after mass occurrence of the Boreal ammonites of the genus *Amoeboceras* which constitute over 80% of the total number of specimens (see Matyja, Wierzbowski, 1988, 1992, 1994, 2000, 2006a; Atrops *et al.*, 1993): *Taramelliceras* (*Richeiceras*) *lochense* (Oppel), *Amoeboceras ovale* (Quenstedt), *A.* ex gr. *A. marstonense* Spath – *A. rosenkrantzi* Spath (Pl. 2: 4), *Passendorferia* (*Enayites*) *rozaki* Melendez (Pl. 4: 11), *Ringsteadia* cf. *salfeldi* Dorn, *R.* cf. *pseudyo* Salfeld, *Microbiplices microbiplex* (Quenstedt) (Pl. 3: 10, 13), *Orthosphinctes* (*Orthosphinctes*) sp., *O.* (*Pseudorthosphinctes*) sp., *Epipeltoceras semimammatum* (Quenstedt) (Pl. 7: 8, 10), *Euaspidoceras hypselum* (Oppel), *E. striatocostatum* (Dorn) (Pl. 8: 4), *E.* sp.; also bivalves *Buchia concentrica* (Sowerby); about 5 cm thick marly intercalation (bed 31) at the top.

Bed 32 (0.20 m seen, top not exposed) – limestone layer with ammonites: *Taramelliceras* (*Richeiceras*) *lochense* (Oppel), *Taramelliceras* (*Taramelliceras*) *externnodosum* (Dorn) forma *robusta* Hölder (1958), *Orthosphinctes* (*Orthosphinctes*) sp., *Neaspidoceras radisense* (d'Orbigny) (Pl. 8: 2).

MORGI AND PODZAMCZE SECTIONS

The small quarries at Morgi and Podzamcze, east of Ogrodzieniec, studied by the authors in 1990s no longer exist. The quarry at Morgi was situated about 2 km southeast of Podzamcze at Morgi hamlet, whereas that at Podzamcze was about 1 km east of the village, on the Ogrodzieniec – Pilica road. Older deposits cropped out at Morgi, where the following succession was observed (from the base; Fig. 2):

Bed 1 (0.60 m seen, base not exposed) – limestone bed consisting of three limestone layers (0.15 m, 0.15 m, 0.30 m) subdivided by very thin (about 1 cm in thickness) marly layers. Ammonite include: *Sowerbyceras tortisulcatum* (d'Orbigny), *Amoeboceras ovale* (Quenstedt) – very numerous, *Ringsteadia* cf. *salfeldi* Dorn, *Microbiplices* cf. *microbiplex* (Quenstedt), *Euaspidoceras hypselum* (Oppel) (Pl. 8: 6). It is the lower *Amoeboceras* layer (see above).

Bed 2 (0.6 m seen, top not exposed) – limestone layer with ammonites: *Taramelliceras* (*Taramelliceras*) *externnodosum* (Dorn) forma *robusta* Hölder (1958), *Ringsteadia* sp., *Orthosphinctes* (*Orthosphinctes*) sp.; moreover in the rubble from beds 1–2 were found: *Epipeltoceras semimammatum*, *E.* cf. *semimammatum* (Quenstedt).

Much younger deposits cropped out at Podzamcze with the following succession (from the base):

Bed 1 (0.53 m, base not seen) – limestone layer with abundant spongy mummies at the top; overlying is a thin marly layer (about 3 cm in thickness) which yielded numerous bivalves of the genus *Buchia concentrica* (Sowerby).

Bed 2 (0.90 m) – composed of friable limestone, rich in micrite, and poor in benthic fossils; at the top a thin marly layer.

Bed 3 (0.25 m) – composed of friable micritic limestone which is underlain and overlain by thin (about 2 cm in thickness) marly layers; bivalves *Buchia* are common as are ammonites especially of the genera *Microbiplices* and *Orthosphinctes.*

Bed 4 (0.55 m, top not exposed) composed in the lower part (0.25 m) of friable micritic limestones, at the top – well above the level of black cherts – of limestones more rich in benthic fauna.

The ammonites: *Ringsteadia pseudoyo* Salfeld (Pl. 2: 16) and *R. teisseyrei* (Siemiradzki) (Pl. 2: 17) were found in the rubble. The succession did not reveal the presence of the characteristic lower *Amoeboceras* layer. Sadkiewicz (1970) who studied the section in the quarry reported that the deposits cropped out here attained about 3 m in thickness, but he did not notice also any bed rich in *Amoeboceras.* Of the ammonites recognized by him the occurrence of *Epipeltoceras berrense* (Favre) is remarkable.

JAROSZÓW-ZAWADA SECTION

This quarry no longer in existence, was located between Jaroszów and Zawada villages, and was studied by the present authors in 1990s, yielding the following succession (from the base; Fig. 2):

Bed 1 (0.5 m, base not exposed) composed of limestones rich in micrite matrix and containing rare sponge mummies, and cherts.

Bed 2 (0.25 m) composed of friable micritic limestones with poor benthic fauna; the bed is underlain and overlain by thin marly layers. Ammonites from the limestone bed include: *Taramelliceras* (*Richeiceras*) *lochense* (Oppel) (Pl. 1: 8), *T.* (*T.*) *externnodosum* Dorn forma *robusta* of Hölder (1955, 1958) (Pl. 1: 16), *Amoeboceras ovale* (Quenstedt) – very numerous, *Ringsteadia* cf. *salfeldi* Dorn (Pl. 2: 18), *Microbiplices microbiplex* (Quenstedt) (Pl. 3: 11), *Orthosphinctes* (*Orthosphinctes*) sp., *Neaspidoceras radisense* (d'Orbigny) (Pl. 8: 1); also bivalves *Buchia concentrica* (Sowerby). This is the lower *Amoeboceras* layer (see above).

Bed 3 (about 1m, top not exposed) friable micritic limestones with rare ammonites.

The ammonites *Amoeboceras* cf. *rosenkrantzi* Spath, and *Epipeltoceras semimammatum* (Quenstedt) (Pl. 7: 7) were found in the rubble.

BISKUPICE SECTION

In the southern part of Biskupice village, south of the town of Olsztyn, a small quarry, no longer in existence yielded a succession 4.15 m in thickness, studied by the present authors in the 1999s. It consisted of (from the base; Fig. 2):

Bed 1 (0.26 m, base not exposed) – limestone layer; thin marly intercalation (1–2 cm in thickness) at the top (bed 2).

Bed 3 (0.22 m) – limestone layer with rare *Amoeboceras* and *Epipeltoceras*; poorly visible marly intercalation at the top.

Bed 4 (0.20 m) limestone layer with ammonites: *Taramelliceras* (*Richeiceras*) cf. *lochense* (Oppel), *Glochiceras* (?*Lingulaticeras*) sp. nov. (Pl. 1: 19a, b), *Amoeboceras ovale* (Quenstedt) (Pl. 2: 5–6) – very numerous, *A.* ex gr. *A. marstonense* Spath – *A. rosenkrantzi* Spath, *Ringsteadia* sp., *Microbiplices* cf. *microbiplex* (Quenstedt), *Orthosphinctes* (*Orthosphinctes*) sp., *Euaspidoceras hypselum* (Oppel) (Pl. 8: 7); also bivalves *Buchia concentrica* (Sowerby). This is the lower *Amoeboceras* layer (see above). A thin marly intercalation (1–2 cm in thickness) occurs at the top (bed 5).

Bed 6 (0.85 m) – limestone layer with ammonites: *Ringsteadia* cf. *pseudoyo* Salfeld (topmost part of the bed); *Passendorferia* (*Enayites*) cf. *rozaki* Meléndez, *Graefenbergites idoceroides* (Dorn), *G.* sp., *Orthosphinctes* (*Orthosphinctes*) sp.; marly intercalation 4 cm in thickness at the top (bed 7).

Bed 8 (1.50 m) – limestone layer with ammonites: *Taramelliceras* (*Richeiceras*) cf. *lochense* (Oppel), *Graefenbergites idoceroides* (Dorn), *Microbiplices* sp., *Orthosphinctes* (*Orthosphinctes*) sp., *O.* (*Pseudorthosphinctes*) sp., *Epipeltoceras semimammatum* (Quenstedt); marly intercalation 4 cm in thickness at the top (bed 9).

Bed 10 (1.0 m, top not exposed) – limestone layer with ammonite: *Graefenbergites* cf. *idoceroides* (Dorn).

BIAŁA DOLNA SECTION

An old, now infilled quarry south of Biała Dolna village, on the road from Częstochowa to Działoszyn, yielded the following succession (from the base; Fig. 2):

Bed 1 (about 2 – 3 m without the possibility of distinguishing particular layers) – of friable micritic limestone with rare cherts and with ammonites: *Ochetoceras* (*Ochetoceras*) *hispidiforme* (Fontannes), *O.* (*O.*) *semifalcatum* (Oppel), *Taramelliceras* (*Richeiceras*) *tricristatum* (Oppel) (Pl. 1: 11), *T.* (*R.*) cf. *lochense* (Oppel), *Ringsteadia* cf. *pseudoyo* Salfeld; the ammonite *Graefenbergites idoceroides* (Dorn) (Pl. 7: 1, 3) was found in the topmost part.

Bed 2 (0.18 m) – limestone layer with ammonites: *Amoeboceras ovale* (Quenstedt) – very numerous, *Microbiplices microbiplex* (Quenstedt) (Pl. 3: 12), *M.* sp., *Ringsteadia* cf. *pseudoyo* Salfeld, *R.* sp., *Passendorferia* (*Enayites*) sp., *Orthosphinctes* (*Orthosphinctes)* sp., *Euaspidoceras hypselum* (Oppel); also bivalves *Buchia concentrica* (Sowerby). This is the lower *Amoeboceras* layer (see above). A thin marly intercalations (1–2 cm in thickness) occurred at the top and at the base of the bed.

Bed 3 (1.40 m) – highly weathered limestone with rare cherts and with ammonites: *Ochetoceras* cf. *semifalcatum* (Oppel), *Ringsteadia* sp., *Passendorferia* (*Enayites*) *rozaki* Meléndez, *Orthosphinctes* (*Orthosphinctes*) sp.

KATAROWA GÓRA SECTION

The abandoned quarry at the top of Katarowa Góra hill, south-east of Łobodno-Górki village, yields a complete well exposed succession of bedded limestones, especially in the eastern and southern faces of the northern part of the quarry (denoted as A-sections). The additional sections (B and C) in the central and southern parts of the quarry are generally poorly exposed, but nevertheless they are also described because they yield additional information on the upper, poorly fossiliferous part of the succession (Fig. 2). The quarry has been mentioned by Malinowska (1972a), and some ammonites found here were described and illustrated therein, but without any succession given.

The sections of the northern part of the quarry (A) are exposed along its eastern face – where the beds show a dip 15° towards the south-east (coordinates of the middle part are: N 50°55'54.4", E 19°00'43.7"), and on its southern face (coordinates of the middle part are: N 50°55'52.9", E 19º00’43.6") – where the beds show a dip 10° towards the east. Both sections differ somewhat in the development and thickness of particular beds, and both are described below.

The following section is exposed along the eastern face of the quarry from the base:

Bed 1 (0.7 m seen, base not exposed) – limestone layer with rare cherts, except the topmost part where flattened chert nodules are common; at the top a thin marly seam.

Bed 2 (0.85 m) – limestone layer with rare cherts; in the uppermost part flattened chert nodules occur commonly; at the top a thin marly seam.

Bed 3 (0.25 m) – limestone layer with rare cherts except in the topmost part where flattened chert nodules are common; at the top a thin marly seam.

Bed 4 (0.65 m) – massive limestone layer; cherts appear at the top, below a well marked upper boundary of the layer; ammonites include: *Amoeboceras ovale* (Quenstedt) – upper part of the bed, *Microbiplices procedens* (Oppenheimer) – from uppermost part of the bed, *Ringsteadia* sp.

Bed 5 (0.60 m) – massive limestone layer with fairly abundant ammonites: *Ochetoceras* (*Ochetoceras*) sp., *Amoeboceras ovale* (Quenstedt), *Microbiplices procedens* (Oppenheimer) (Pl. 3: 6) (lowermost part of the bed), *M. microbiplex* (Quenst.) – (lower part), *Ringsteadia* cf. *pseudoyo* Salfeld (Pl. 3: 2), *Ringsteadia* sp., *Neaspidoceras tietzei* (Neumayr) – (lower part).

Bed 6 (0.04 m) – marly intercalation containing rounded limestone nodules.

Bed 7 (0.33 m) – limestone layer with rare cherts which become more common in the topmost part; ammonites include: *Microbiplices* cf. *microbiplex* (Quenst.), *Graefenbergites idoceroides* (Dorn).

Bed 8 (0.02 m) – marly intercalation.

Bed 9 (0.78 m) – limestone layer with fairly common cherts; ammonites include: *Taramelliceras* (*Taramelliceras*) *externnodosum* (Dorn) forma *mediocris* (Hőlder, 1958), *Graefenbergites idoceroides* (Dorn) (Pl. 7: 4).

Bed 10 (0.10 m) – limestone nodules in the marly matrix; ammonites include: *Amoeboceras ovale* (Quenstedt).

Bed 11 (1.0 m) – limestone layer with rare cherts; the lowermost part of the bed, 0.18 m in thickness and indistinctly separated by fracture from the rest of the layer, represents the lower *Amoeboceras* layer (see description of the sections above) – the ammonites include: *Amoeboceras ovale* (Quenstedt) – very numerous, *Microbiplices* cf. *microbiplex* (Quenst.); also bivalves *Buchia concentrica* (Sowerby).

Bed 12 (0.01–0.02 m) – marly intercalation.

Bed 13 (0.20 m) – limestone layer.

Bed 14 (0.01 m) – marly intercalation.

Bed 15 (1.08 m) – limestone layer; a well defined horizon with common flattened chert nodules occurs in the topmost 0.15 m of the layer; the ammonites include: *Ringsteadia* sp., *Orthosphinctes* sp.

Bed 16 (0.01 m) – marly intercalation.

Bed 17 (1.80 m) – massive limestone layer with cherts sparsely placed; the ammonites include: *Ringsteadia* cf. *pseudoyo* Salfeld (Pl. 3: 3); moreover *Ringsteadia* cf. *salfeldi* was found in a loose block coming from beds 16–17.

Bed 18 (0.14 m) – marly-limestone layer.

Bed 19 (0.95 m) – massive limestone layer; a horizon with flattened chert nodules occurs 0.25 m above the base of the layer.

Bed 20 (0.10 m) – marly-limestone layer with rare small rounded cherts.

Bed 21 (0.75 m) – massive limestone layer with rare rounded cherts; at the top of the layer the cherts become common.

Bed 22 (0.30 m) – soft limestone layer with abundant micritic matrix, bordered from the base and the top by thin marly seams.

Bed 23 (0.75 m) – massive limestone layer, more friable in its lowermost (0.20 m) part; the top part of the layer (0.20 m thick) contains common flattened cherts.

Bed 24 (0.30 m) – soft limestone layer with abundant micritic matrix, flaggy weathered and containing occasional small rounded cherts; the limestone layer is bordered at the base and top by thin marly seams. Ammonites and belemnites are fairly common in the topmost part of the limestone layer: *Clambites* sp.

Bed 25 (at the top of the section seen to 0.80 m) – massive limestone layer.

The following section is exposed in the southern face of quarry (the bed numbers correspond to those of the eastern face of the quarry; Fig. 3):

Bed 17 (1.80 m seen, base not exposed) – chalky limestones with fairly abundant chert nodules generally randomly placed in the bed, subdivided into four layers (from the base): a well defined limestone layer (0.75 m in thickness) with common flattened chert nodules in its topmost part; and three younger layers, 0.60 m, 0.25 m, and 0.20 m in thickness, respectively; a horizon with flattened chert nodules occurs at the top of the bed; ammonites include: *Ochetoceras* (*Ochetoceras*) *hispidiforme* (Font.), *Microbiplices microbiplex* (Quenst.) (Pl. 3: 15), *Passendorferia* (*Enayites*) cf. *gygii* (Brochwicz-Lewiński et Różak) (lower part of the bed), *Ringsteadia* sp., *Ringsteadia teisseyrei* (Siemiradzki) (Pl. 3: 1) (about one meter below the top), *Orthosphinctes* (*Orthosphinctes*) sp., also bivalves *Buchia concentrica* (Sowerby)[1].

Bed 18 (0.35 m) – soft, friable limestones with abundant micritic matrix showing flaggy weathering which are subdivided into two limestone layers (0.15 m and 0.20 m in thickness); thin marly intercalations occur at the base of the bed, in between the limestone layers, and at the top of the bed – the latter marks irregularities at the top of the bed ranging up to 0.05 m in height; ammonites include: *Taramelliceras* (*Richeiceras*) cf. *pichleri* (Oppel), *Amoeboceras rosenkrantzi* Spath, *Microbiplices microbiplex* (Quenst.), *M.* cf. *microbiplex* (Quenst.), also bivalves *Buchia concentrica* (Sowerby) (Fig. 7: 1).

Bed 19 (0.77 m) – limestones subdivided into two layers (from the base): 0.37 m, and 0.40 m in thickness; the chert nodules occur commonly at the top of the lower limestone layer; rare chert nodules are encountered in the upper limestone layer; thin marly intercalations occur at the base of the bed, in between the limestone layers, and at the top of the bed – the latter is the most pronounced.

Bed 20 (0.40 m) – soft, friable limestones with rare spongy mummies and small rounded cherts, with abundant micritic matrix showing flaggy weathering; the limestones are subdivided into three layers (from the base): 0.12 m, 0.10 m, and 0.18 m in thickness; thin marly intercalations occur at the boundaries of the limestone layers (including the top and the base of the bed); ammonites include: *T.* (*Taramelliceras*) cf. *externnodosum* (Dorn), *Glochiceras* (*Coryceras*) cf. *microdomum* (Oppel), *Amoeboceras rosenkrantzi* Spath (Pl. 2: 12), *A. tuberculatoalternans* (Nikitin) (Pl. 2: 10, 11), *A.* cf. *tuberculatoalternans* (Nikitin), *Microbiplices microbiplex* (Quenst.) (Pl. 3: 14), *Ringsteadia* cf. *pseudoyo* Salfeld, *R.* cf. *salfeldi* Dorn (Pl. 3: 4), *Orthosphinctes* sp., *Praeataxioceras* sp. nov. (Pl. 7: 5), also bivalves *Buchia concentrica* (Sowerby) – *B.* cf. *concentrica* (Sowerby) (Fig. 7: 2–5).

Bed 21 (0.40 m) – hard, massive limestone layer; the spongy mummies and rare small cherts are present; ammonites include: *Microbiplices microbiplex* (Quenst.) and *Taramelliceras* (*Taramelliceras*) cf. *externnodosum* (Dorn) found in a loose block – almost certainly coming from that bed.

Bed 22 (0.40 m) – soft, friable limestones with rare spongy mummies and small rounded cherts, with abundant micritic matrix showing flaggy weathering, which are subdivided into two layers (from the base): 0.23

[1] See Appendix by V. Zakharov on bivalves *Buchia* added to this study

Fig. 3. Quarry at Katarowa Góra, part A, southern face (numbers of beds indicated)

m and 0.17 m in thickness; thin marly intercalations occur at the base of the bed, in between the limestone layers, and at the top of the bed; ammonites include: *Taramelliceras* (*Richeiceras*) *lochense* (Oppel), *T.* (*R.*) cf. *lochense* (Oppel), *T.* (*R.*) *pichleri* (Oppel), *T.* (*R.*) *jaeggii* Quereilhac (Pl. 1: 13), *Amoeboceras* cf. *rosenkrantzi* Spath, also bivalves *Buchia concentrica* (Sowerby) – *B.* cf. *concentrica* (Sowerby) (Fig. 7: 6).

Bed 23 (0.70 m) – more hard limestone layer; a horizon with chert nodules occurs about 0.20 m above the base of the bed; bivalves *Buchia concentrica* (Sowerby) (Fig. 7: 7).

Some ammonites were found in the rubble and they cannot be precisely located in the section beyond the general statement that they come from beds 17–23. They include: *Taramelliceras* (*Taramelliceras*) cf. *externnodosum* (Dorn) – this may come from beds 17, 19, 21 or 23 (after the lithology of the matrix); *Epipeltoceras* cf. *semiarmatum* (Quenstedt) (Pl. 7: 11) – this may come from beds 18, 20 or 22 (after the lithology of the matrix).

Bed 24 (0.40 m) – soft, friable limestones with abundant micritic matrix showing flaggy weathering; the following succession is recognized from the base: 0.01 m – marly intercalation, 0.25 m – limestone layer, a thin marly seam, 0.05 m – limestone layer, 0.02 m – marly intercalation, 0.05 m – limestone layer, a thin marly seam. The fauna includes: ammonites – *Taramelliceras* (*Richeiceras*) cf. *lochense* (Oppel), *T.* (*R.*) cf. *jaeggii* Quereilhac, aulacostephanid microconch (*Microbiplices* or *Prorasenia*), *Praeataxioceras virgulatus* (Quenstedt), *Orthosphinctes* sp.; also bivalves *Buchia concentrica* (Sowerby) (Fig. 7: 8).

Bed 25 (0.75 m) – a further hard limestone layer with rare cherts.

Bed 26 (0.30 m) – nodular limestones with abundant micritic matrix; at the base and the top – thin marly intercalations.

Bed 27 (0.85 m) and bed 28 (at the top of the section visible up to 0.77 m) – massive limestones with cherts possibly forming originally one thick layer; the limestones show marked splitting at the top of quarry due to their weathering– which part is distinguished as bed 28.

The central part of the quarry (denoted as B) shows the following section (numbers of beds correspond to those of the A-part of the quarry, but the local numbers are given in brackets; the beds show a dip 12° towards south-east):

Bed 20 (bed B1) (0.30 m seen, base not exposed) – soft friable limestones with abundant micritic matrix, showing flaggy weathering; ammonites include: *Taramelliceras* (*Richeiceras*) cf. *lochense* (Oppel).

Bed 21 (bed B2) (0.80 m) – hard, massive limestone layer.

Bed 22 (bed B2/B3) (0.25 m) – soft friable limestones with abundant micritic matrix, showing flaggy weathering; ammonites include: *Taramelliceras* (*Richeiceras*) *lochense* (Oppel) (Pl. 1: 9), *T.* (*R.*) cf. *lochense* (Oppel), *T.* (*R.*) *pichleri* (Oppel), *T.* (*R.*) cf. *pichleri* (Oppel), *T.* (*T.*) aff. *externnodosum* (Dorn) (Pl. 1: 20), *Microbiplices* cf. *anglicus vieluniensis* Wierzbowski et Matyja subsp. nov., *Praeataxioceras virgulatus* (Quenstedt) (Pl. 7: 6), *Orthosphinctes* sp., *Neaspidoceras* cf. *radisense* (d'Orbigny); also bivalves *Buchia concentrica* (Sowerby) – *B.* cf. *concentrica* (Sowerby) (Fig. 7: 9, 10).

Bed 23 (bed B3) (0.7 m) – hard, massive limestone layer.

Bed 24 (bed B4) (0.4–0.5 m) – soft friable limestones with abundant micritic matrix, showing flaggy weathering; a thin marly intercalations and cherts occur in the middle part of the bed; ammonites include: *Glochicers* (*Lingulaticeras*) sp.

Bed 25 (beds B5–B6) (at the top of the section visible up to 0.7–0.8 m) – massive limestones, at the top showing flaggy weathering.

The southern part of the quarry (denoted as C – coordinates: N 50°55'50.0", E 19°00'43.4") shows a fragment of the succession whose correlation with those exposed in parts A and B is less clear due to a larger distance and poor exposure. Nevertheless the beds denoted here from C1 to C7 possibly correlate with beds 19 to 27 from the A-part of the quarry (see chapter on stratigraphy). The beds show a dip 15° towards south-east. The following section is recognized here (from the base):

Bed C1 (1.10 m, base not exposed) – limestones with common spongy mummies, cherts occur commonly at about 0.70 m below the top of the bed.

Bed C2 (0.86 m) – massive limestone layer; a thin (0.1 m) marly limestone layer at the top yielded ammonites: *Amoeboceras rosenkrantzi* Spath (Pl. 2: 13), *A.* cf. *rosenkrantzi* Spath; about 0.4 m below the top – *Passendorferia* (*Enayites*) sp.

Bed C3 (0.92 m) – subdivided into several layers (from the base): a – marly limestone layer (0.1 m) yielding the ammonites: *Amoeboceras* cf. *rosenkrantzi* Spath; b – limestone layer (0.14 m); c – limestones with common spongy mummies (0.16 m); d – limestones with common spongy mummies (0.36 m); e – marly limestone layer (0.16 m); other ammonites in the bed include: *Glochiceras* (*Coryceras*) cf. *canale* (Quenstedt), *Passendorferia* (*Enayites*) sp.

Bed C4 (0.16 m) – soft friable limestones with abundant micritic matrix, showing flaggy weathering; ammonites include: *Glochiceras* (*Coryceras*) *canale* (Quenstedt). ?*Microbiplices* sp., *Orthosphinctes* sp.

Bed C5 (1.04 m) – subdivided into several layers (from the base): a – marly limestone layer (0.04 m), b – marly limestone layer (0.10 m), c – limestone layer (0.11 m), d – limestone layer (0.79 m); the horizon with flattened chert nodules occurs about 0.2–0.3 m below the top of the bed.

Bed C6 (0.22 m) – marly layer (0.04 m) followed by soft friable limestones with abundant micritic matrix (0.18 m).

Bed C7 (0.54 m) – (at the top of the section visible up to 0.54 m) – limestones showing flaggy weathering; cherts common at the base of the bed.

BOBROWNIKI SECTION

A large abandoned quarry, about 0.5 km to the north of the main road in Bobrowniki village (denoted as Pj 92) was described in detail by Wierzbowski *et al.* (2010), and presents the succession of beds 1–8, about 9.5 m in thickness (Fig. 2). A newly exposed part of the succession shows the older beds, about 4 m in thickness (Fig. 4). These are described below (from the base):

Bed F (visible down to 0.2 m) – hard limestone layer.

Bed E (0.1 m) – consisting of the following layers (from the base): marly layer (0.02 m), limestone layer with sponge mummies, nautiloids and numerous ammonites (0.06 m), thin marly layer (at the top of the bed); ammonites include: *Taramelliceras* (*Taramelliceras*) cf. *costatum* (Quenstedt), *Glochiceras* sp., *Microbiplices anglicus vieluniensis* Wierzbowski et Matyja subsp. nov. (Pl. 3: 16), *M.* cf. *anglicus vieluniensis* Wierzbowski et Matyja subsp. nov.

Bed D (0.55 m) – hard, fine-grained limestones with a monotonous fauna (small haploceratid ammonites, crabs) and rare rounded cherts; ammonites include: *Glochiceras* sp., *Taramelliceras* (*Taramelliceras*) *costatum laterinodosum* Karvé-Corvinus.

Bed C (0.20 m) – limestone layer overlain and underlain by thin marly intercalations (the upper one is a more pronounced) with an abundant fauna (ammonites, nautiloids, brachiopods, gastropods); the fossils are covered with thin dark manganese coatings; sponge mummies occur commonly in a lower part of the limestone layer. Ammonites include: *Glochiceras* (*Glochiceras*) *tectum* Ziegler, *G.* (*Coryceras*) *canale* (Quenstedt), *G.* (*C.*) cf. *canale* (Quenstedt), *Taramelliceras* (*Taramelliceras*) *costatum laterinodosum* Karvé-Corvinus (Pl. 2: 2), *Taramelliceras costatum* (Quenstedt), *Glochiceras* (*Lingulaticeras*) cf. *bobrownikiense* Wierzbowski et Głowniak, *G.* sp., *Amoeboceras subcordatum* (d'Orbigny, 1845) sensu Salfeld (1916) (Pl. 2: 14a, b), *Microbiplices anglicus vieluniensis* Wierzbowski et Matyja subsp. nov. (Pl. 3: 17; Pl. 4: 1–2), *M.* cf. *anglicus vieluniensis* Wierzbowski et Matyja subsp. nov., *Ringsteadia/Vielunia* sp. *Passendorferia* (*Enayites*) sp.

Bed B (1.20 m) – hard, fine-grained limestones with a monotonous fauna (small haploceratid ammonites, nautiloids, brachiopods, bivalves) similar to those of bed D; a well marked chert horizon occurs about 0.3 m below the top of the bed; the ammonites become more common in the topmost part of the bed: *Taramelliceras* (*Richeiceras*) *pichleri* (Oppel) (Pl. 1: 12), *Glochiceras* (*Coryceras*) *canale* (Quenstedt) (Pl. 1: 15), *G.* sp., *Prorasenia* cf. *crenata* (Quenstedt) (Pl. 4: 3).

Bed A (0.58 m) – hard, fine-grained limestones with a monotonous fauna (small haploceratid ammonites, rare sponge mummies) similar to those of beds D and B; ammonites include: *Glochiceras* (*Glochiceras*) cf. *tectum* Ziegler.

Bed 0 (0.80 m) – consisting of two limestone layers with cherts (from the base): b – 0.50 m with ammonites: *Ochetoceras* (*Ochetoceras*) *semifalcatum* (Oppel), *Glochiceras* (*Glochiceras*) *tectum* Ziegler, *T.* (*R.*) cf. *pichleri* (Oppel) ; a – 0.30 m with ammonites: *Taramelliceras* (*Richeiceras*) cf. *lochense* (Oppel), *T.* (*R.*) cf. *pichleri* (Oppel), *Glochiceras* (*Coryceras*) *canale* (Quenstedt), *Taramelliceras* (*Taramelliceras*) *costatum laterinodosum* Karvé-Corvinus, *T.* (*T.*) aff. *externnodosum* (Dorn) (Pl. 1: 21), *Glochiceras* (*Lingulaticeras*) *bobrownikiense* Wierzbowski et Głowniak, *G.* (*Glochiceras*) cf. *tectum* Ziegler, *G.* sp.; marly seams occur at the boundaries of the limestone layers.

Bed 1 (1.07 m) – consisting of several layers (from the base): a – limestone layer with cherts (0.12 m), b – hard limestone layer without cherts (0.32 m), c – marly limestone layer (0.07 m), d – friable limestone layer with cherts (0.15 m), e – friable limestone layer (0.15 m), f – friable limestone layer with cherts (0.16 m). The upper and middle parts of this bed of a total thickness of 0.8 m were distinguished formerly (Wierzbowski *et al.*, 2010) as bed 1; a fragment of this interval, corresponding to bed f as recognized herein, yielded abundant ammonites (Wierzbowski *et al*., 2010, p. 51, pl. 1: 1, pl. 5: 1–2, pl. 6: 1, pl. 12: 3): *Taramelliceras* (*Taramelliceras*) cf. *costatum laterinodosum* Karvé-Crovinus, *Glochiceras* (*Lingulaticeras*) *bobrownikiense* Wierzbowski et Głowniak, *Taramelliceras* (*Richeiceras*) *lochense* (Oppel), *T.* (*R.*) cf. *pichleri* (Oppel), *T.* (*R.*) *jaeggii* Quereilhac, *Glochiceras* (*Coryceras*) *canale* (Quenstedt), *G.* (*C.*) *microdomum* (Oppel), *Aspidoceras binodum* (Oppel), *Orthosphinctes* cf. *fontannesi* (Choffat), *Prorasenia* sp., *Amoeboceras* (*Plasmatites*) cf. *lineatum* (Quenstedt); moreover in the same stratigraphical position has been found recently *Taramelliceras* (*Taramelliceras*) *costatum costatum* (Quenstedt) forma *aurita.* (Pl. 2: 1). The ammonites coming from the lower part of the bed (1a–1b) described herein include: *Taramelliceras* (*Richeiceras*) *jaeggii* Quereilhac, *Streblites* cf. *tenuilobatus frotho* (Oppel), *Amoeboceras* (*Plasmatites*) sp.; whereas those of the middle part of the bed (1c) include: *Taramelliceras* (*Taramelliceras*) *costatum costatum* (Quenstedt) and *T.* (*T.*) *costatum laterinodosum* Karvé-Corvinus (Pl. 2: 3).

Fig. 4. Quarry at Bobrowniki – lowermost part of the section (numbers of beds indicated)

The position of the Oxfordian/Kimmeridgian boundary of the Subboreal and Boreal subdivisions is arrowed

STRATIGRAPHY

SUBMEDITERRANEAN/MEDITERRANEAN AMMONITE SUCCESSION

The ammonites occurring in the sections studied are predominantly Submediterranean in character, and bulk of them is common both in Submediterranean and Mediterranean areas. Moreover, there ocur also some ammonites of purely Mediterranean character. It should be remembered therefore, that there is no problem in the correlation of the ammonite successions of the Upper Oxfordian between the Submediterranean and the Mediterranean areas – and the ammonite zonation based originally on the Submediterranean sections may be easily recognized in the Mediterranean succession (see *e.g.* Cariou *et al.*, 1997). The ammonites enable the recognition of the following Submediterranean ammonite zones and subzones of the Upper Oxfordian – the Bifurcatus Zone with the Grossouvrei Subzone, the Hypselum Zone with the Semimammatum Subzone, the Semiarmatum Subzone, and the Berrense Subzone, as well as the Bimammatum Zone with the Bimammatum Subzone – the latter possibly corresponding already to the Boreal-Subboreal lowermost Kimmeridgian (Fig. 2; see Wierzbowski, Matyja, 2014).

The upper part of the Bifurcatus Zone corresponding to the Grossouvrei Subzone may be easily recognized in the Syborowa Góra section where it corresponds to beds 3 to 9 (beds 1–2 are thin and/or fragmentarily exposed, and did not yield any ammonites – see Matyja, Wierzbowski, 1994; Matyja, Wierzbowski, 2006a). The deposits of the Grossouvrei Subzone seen in the section are about 4 m in thickness. The subzone is characterized in the section studied by the common occurrence of *Perisphinctes* (*Dichotomoceras*) *bifurcatus* (Quenstedt), which is associated with *P.* (*D.*) *crassus* Enay as well as small-sized *P.* (*D.*) *microplicatilis* (Quenstedt) in some upper part of the stratigraphical interval in question (bed 7). The assemblage of *Dichotomoceras* is similar to that of the Grossouvrei Subzone of many other sections, *e.g.* of the Effinger Member at Hinterstein (Aargau Canton of Switzerland) described in detail by Enay and Gygi (2001). Another feature in common between the two sections is the occurrence of representatives of the genus *Subdiscosphinctes* in the Grossouvrei Subzone, but it should be remembered that the section studied yielded especially well preserved representatives of *Subdiscosphinctes mindowe* (Siemiradzki) – both micro and macroconch. These are possibly the stratigraphically highest records of the genus.

The characteristic feature of this stratigraphical interval of the Syborowa Góra section attributed to the Grossouvrei Subzone is also the fairly common occurrence of representatives of the Passendorferiinae: *Graefenbergites* and *Passendorferia* (*Enayites*) – which comprise a form close to *G. arancensis* (Meléndez), and the alleged microconch of *P. uptonioides* (Enay) – both well known from the Grossouvrei Subzone (Meléndez, 1989). An interesting feature is also the occurrence of small-sized phylloceratids – *Sowerbyceras tortisulcatum* (d'Orbigny) found in some middle and upper parts of the interval studied (beds 5 and 7), which become rare in the younger deposits of the succession studied.

Ammonites of the family Oppeliidae are not very common, being represented by *Taramelliceras* (*Taramelliceras*) cf. *externnodosum* (Dorn), *Glochiceras* (*Coryceras*) *microdomum* (Oppel), *G.* (*C.*) *canale* (Quenstedt), and *Glochiceras* (*Glochiceras*) *tectum* Ziegler (microconch) – *Ochetoceras* (*Ochetoceras*) cf. *basseae* Fradin (macroconch) (see paleontological part of the study) in the upper part of the stratigraphical interval (beds 7 and 9) of the Syborowa Góra section. These species are commonly cited from the upper part of the Bifurcatus Zone (*e.g.* Enay, Gygi, 2001), but all of them continue their ranges into the younger Upper Oxfordian beds.

It should be remembered that the interval of the Syborowa Góra section studied yielded also in its middle and upper parts (beds 5, 8 and 9) the first representatives of the family Ataxioceratidae – both *Orthosphinctes* (microconchs) and *Pseudorthosphinctes* (macroconchs). The specimens generally resemble very much the specimen referred to as *Orthosphinctes* (?*Pseudorthosphinctes*) sp. by Matyja (1977, pl. 9) from the upper part of the Bifurcatus Zone of the Holy Cross Mts section of Poland. These findings indicate that the Ataxioceratidae lineage appeared already in the Submediterranean succession during the late Bifurcatus Chron. The specimens studied resemble the first *Orthosphinctes* species – *O. ariniensis* (Mélendez) of the Grossouvrei Subzone of the Bifurcatus Zone (see Mélendez, 1989, p. 149–151, pl. 7: 3a, b, pl. 8: 1) "still keeping many features of its presumed Passendorferiinae ancestors" (Mélendez *et al*., 2006, 2009).

The Hypselum Zone, originally distinguished as a subzone of the Bimammatum Zone, is treated herein as an independent zone. This results both from the well-defined character of its ammonite fauna (*e.g.* Mélendez *et al*., 2006) as well as from the necessity of the separate treatment of this unit for correlation purposes between the particular zonal schemes, and the recognition of a uniform Oxfordian/Kimmeridgian boundary (see below). Bonnot *et al.* (2009) have distinguished the Semiarmatum Subzone (which corresponds to the Hypselum Zone as treated herein), and subdivided it into three faunistic horizons (from the base): the *Semimammatum* horizon, the *Semiarmatum* horizon and the *Berrense* horizon. These horizons are recognized herein as the following subzones of the Hypselum Zone: the Semimammatum Subzone, the Semiarmatum Subzone, and the Berrense Subzone (see Wierzbowski, Matyja, 2014). It should be remembered that the Semimammatum Subzone and the Berrense Subzone have been distinguished also before within the Bimammatum Zone as independent subzones (see *e.g.* Cariou *et al.*, 1997) – but the range of the Berrense Subzone as recognized therein differs somewhat from that proposed in this study because it corresponds approximately jointly to the *Semiarmatum* horizon and the *Berrense* horizon of Bonnot *et al.* (2009).

The Semimammatum Subzone defined by occurrence of *Epipeltoceras semimammatum* (Quenstedt) was originally proposed by Enay and Tintant (*in*: Mouterde *et al.*, 1971; see also Cariou *et al.*, 1997) as a horizon directly below the *Berrense* horizon, or the *Schichten mit Epipeltoceras berrense* of Zeiss (1966). The base of this subzone is placed at the level corresponding to the marked turnover of the ammonite faunas – the total disappearance of Perisphinctinae with its last representatives *Perisphinctes* (*Dichotomoceras*) which is replaced by newly developed Ataxioceratidae with *Orthosphinctes*, as well as the appearance of the genus *Epipeltoceras* (see *e.g.* Cariou *et al.*, 1997).

The Semimammatum Subzone includes the following stratigraphical intervals in the sections studied: in the Syborowa Góra section – beds 11–32, in the Morgi section – beds 1–2, in the Jaroszów-Zawada section – beds 1–3, in the Biskupice section – beds 1–8, in the Biała Dolna section – beds 1–3, and in the Katarowa Góra section beds – 1–15. Such an interpretation is based on the following premises – the base of the subzone is recognized in the Syborowa Góra section at the base of bed 11 which yielded *Euaspidoceras striatocostatum* (Dorn) typical of the Hypselum Zone (see Dorn, 1931; Bonnot *et al.*, 2009) – directly above bed 9 with last occurrence of *Perisphinctes* (*Dichotomoceras*); the subzone ranges up to bed 8 of the Biskupice section which marks the highest occurrence of *Epipeltoceras semimammatum* (Quenstedt) typical of the subzone, as well as its time equivalents in the other sections. It should be remembered that the last occurrence of the species in question is placed in the Biskupice section at the top of the second limestone bed above the characteristic "lower *Amoeboceras* layer" which is recognized in all the sections studied, and which is isochronous over wider areas of the Submediterranean Province (Matyja, Wierzbowski, 1988; Atrops *et al.*, 1993; Matyja, Wierzbowski, 2000). The total thickness of the deposits attributed to the Semimammatum Subzone ranges about 9 metres.

Ammonites of the family Aspidoceratidae occur fairly abundantly in the Semimammatum Subzone in the sections studied (about 15% of the whole ammonite number). The most stratigraphically important is *Epipeltoceras semimammatum* (Quenstedt) (beds 27 and 30 of the Syborowa Góra section, bed 8 of the Biskupice section, and beds 1–2 of the Morgi section – rubble, and beds 1–3 of the Jaroszów-Zawada section – rubble) which is typical of the subzone; moreover there occur representatives of *Euaspidoceras*, such as *E. striatocostatum* (Dorn) – beds 11, 27 and 30 of the Syborowa Góra section, *E.* cf. *eucyphum* (Oppel) – bed 27 of the Syborowa Góra section, *E. varioornatum* (Dorn) – bed 13 of the Syborowa Góra section, *E. hypselum* (Oppel) – beds 15 and 30 of the Syborowa Góra section, bed 1 of the Morgi section, bed 4 of the Biskupice section, and bed 2 of the Biała Dolna section – all these forms have a wide stratigraphical ranges being known from nearly the whole Hypselum Zone (Dorn, 1931; Enay, 1962), but the common occurrence of *E. hypselum* is typical of the Semimammatum Subzone (Bonnot *et al.*, 2009). Special attention has to be paid to the occurrence of representatives of the genus *Neaspidoceras*, especially the species *N. radisense* (d'Orbigny), which was stated in bed 2 of the Jaroszów-Zawada section, and in bed 32 of the Syborowa Góra section. The species occurs commonly in the Semiarmatum and the Berrense subzones (Bonnot *et al.*, 2009), and its occurrence in the uppermost part of the deposits attributed to the Semimammatum Subzone in the sections studied suggests the proximity of the upper boundary of the Subzone.

The deposits attributed to the Semimammatum Subzone have yielded also some Ataxioceratidae (*Orthosphinctes*) and Passendorferiinae. The latter are represented by *Graefenbergites idoceroides* (Dorn) known mostly from the deposits attributed to this subzone in the sections studied (bed 19 of the Syborowa Góra section, beds 6–8 of the Biskupice section but also younger bed 10, and beds 7, 9 of the Katarowa Góra section); it should be remembered that this species has been so far reported also from the Semimammatum Subzone (Schairer, Schlampp, 2003; see also Mélendez, 1989). Of the two microconch species – *Passendorferia* (*Enayites*) *gygii* (Brochwicz Lewiński et Różak), and *P.* (*E.*) *rozaki* Mélendez – the former has a wider stratigraphic range occurring somewhat below and above the succession attributed to the Semimammatum Subzone herein (beds 8 and 15 of the Syborowa Góra section, and bed 17 of the Katarowa Góra section), but the latter was recognized in the succession studied in the upper part of the Semimammatum Subzone only (bed 30 of the Syborowa Góra section, bed 6 of the Biskupice section, and bed 3 of the Biała Dolna section). It should be remembered, however, that *P.* (*E.*) *rozaki* has been also reported from younger deposits of the Hypselum Zone up to a lower part of the Bimammatum Zone (Mélendez, 1989; Bonnot *et al.*, 2009). An interesting specimen referred to as *Passendorferia-Presimoceras* transitional form was found in bed 27 of the Syborowa Góra section corresponding to an upper part of the Semimammatum Subzone.

Representatives of the family Oppeliidae are commonly encountered in the deposits of the Semimammatum Subzone studied (nearly 35% of the whole number of specimens, except the lower *Amoeboceras* layer – where they become rare constituting only about 2% of the specimens). The following species are recognized: *Ochetoceras* (*Ochetoceras*) *hispidiforme* (Fontannes), *O.* (*O.*) *bassae* Fradin, *O.* (*O.*) *semifalcatum* (Oppel) – and their microconch counterpart – *Glochiceras* (*Glochiceras*) *tectum* Ziegler; *Taramelliceras* (*Taramelliceras*) *externnodosum* (Dorn) and its probable microconch counterpart *Glochiceras* (?*Lingulaticeras*) sp. nov.; *Taramelliceras* (*Richeiceras*) *tricristatum* (Oppel), *T.* (*R.*) *pichleri* (Oppel), *T.* (*R.*) *lochense* (Oppel) – and some of the corresponding microconchs – *Glochiceras* (*Coryceras*) *microdomum* (Oppel) (see comments in the paleontological part of the study). The stratigraphical ranges of the bulk of these forms are markedly wider than the subzone in question because they range up to the Bimammatum Zone (see Wierzbowski *et al.*, 2010). The species *T.* (*R.*) *tricristatum* is the exception because it is reported in the succession studied in the Semimammatum Subzone only. This species is known also from the lowermost part of the Hypselum Zone (treated as the subzone of the Bimammatum Zone) in the Kcynia IG 4 borehole in northern Poland (Matyja, Wierzbowski, 1998, pl. 1: 4). On the other hand, the stratigraphical range of *T.* (*R.*) *tricristatum* according to the interpretation of Enay (1962) is possibly somewhat wider because it is reported (but without illustration) somewhat above the stratigraphical range of *Epipeltoceras semimammatum* (Quenstedt). It should be also remembered that although the stratigraphical range of *Taramelliceras* (*T.*) *externnodosum* (Dorn) is fairly wide – from the Grossouvrei Subzone of the Bifurcatus Zone up to the Semiarmatum Subzone of the Hypselum Zone above – it is especially common in the Semimammatum Subzone in the succession studied.

Directly younger deposits crop out at Katarowa Góra (beds 17–22). These deposits, about 4 meters in thickness, have yielded but a few stratigraphically important ammonites, thus their interpretation is more troublesome. A single ammonite *Epipeltoceras* cf. *semiarmatum* (Quenstedt) found in the rubble but coming possibly from beds 18, 20 or 22 indicates the Semiarmatum Subzone of the Hypselum Zone. On the other hand, the presence of *Praeataxioceras virgulatus* (Quenstedt) in bed 22 suggests already the higher ammonite subzone – the Berrense Subzone of the Hypselum Zone (see Zeiss, 1966; Bonnot *et al.*, 2009); the same bed yielded also: *Taramelliceras* (*Richeiceras*) *jaeggii* (Quereilhac) and *Neaspidoceras radisense* (d'Orbigny). It should be remembered, moreover, that bed 20 yielded the ammonite referred to herein as *Praeataxioceras* sp. nov., which is similar to the form described as "Perisphinctinae *indéterminé*" by Bonnot *et al.* (2009, pl. 1: 7) coming from the Semiarmatum Subzone (*recte Semiarmatum* horizon). These data indicate that the deposits studied correspond, at least partly (except bed 17 which did not yield any stratigraphically important ammonites, and a part or the total of bed 22) to the Semiarmatum Subzone. The other ammonites occurring here belong to the family Oppeliidae – *Ochetoceras* (*Ochetoceras*) *hispidiforme* (Fontannes), *Taramelliceras* (*Taramelliceras*) cf. *externnodosum* (Dorn), *T.* (*Richeiceras*) *pichleri* (Oppel), *T.* (*R.*) *lochense* (Oppel), *Glochiceras* (*Coryceras*) *microdomum* (Oppel), *G.* (*C.*) *canale* (Quenstedt); the family Ataxioceratidae – *Orthosphinctes* spp., and the family Perisphinctidae – subfamily Passendorferiinae represented by poorly preserved and specifically indeterminable *Passendorferia* (*Enayites*). All these forms are known as well from the underlying deposits of the Semimammatum Subzone.

A still higher interval in the Katarowa Góra section includes beds 23 and 24 (as well as possibly bed 22) which show the occurrence of some ammonites indicative of the Berrense Subzone. These are: *Praeataxioceras virgulatus* (Quenstedt) in beds 22 and 24 (see also above), as well as *Clambites* sp. in bed 24 whose occurrence was reported together with *Epipeltoceras berrense* (Favre) in the German sections (see Schuler, 1965). It should be remembered that the aspidoceratids are very rare in the interval of the section studied and the most indicative ammonite for the subzone – *E. berrense* – has not been found so far in the Polish Jura sections with the exception of a single specimen reported but not illustrated from the Podzamcze section by Sadkiewicz (1970). The beds yielded also the first specimens of *Taramelliceras* (*Richeiceras*) *jaeggii* Quereilhac. The total thickness of the beds in question in the Katarowa section is about 1.5–2.0 m. The youngest deposits in the Katarowa Góra section (beds 25–28), about 2.70 m in thickness, are barren, and cannot be assigned directly to any of the chronostratigraphical units, except the general statement that they represent the upper part of the Berrense Subzone of the Hypselum Zone, and/or a lower part of the Bimammatum Zone.

The uppermost part of the succession studied crops out in the Bobrowniki section. The deposits attain about 4.5 m in thickness (beds F, E, D, C, B, A, O, and lower and middle parts of bed 1) and yielded numerous ammonites especially of the family Oppeliidae (83.5% of the whole number of collected specimens). These include: *Taramelliceras* (*Taramelliceras*) *costatum laterinodosum* Karvé-Corvinus – occurring in nearly the whole stratigraphical interval, and *T.* (*T.*) *costatum costatum* (Quenstedt) appearing in the middle part of bed 1 at the top of interval studied, as well as their dimorphic counterpart *Glochiceras* (*Lingulaticeras*) *bobrownikiense* Wierzbowski et Głowniak; commonly encountered *Taramelliceras* (*Richeiceras*) *pichleri* (Oppel) – *T.* (*R.*) cf. *pichleri* (Oppel), *T.* (*R.*) *lochense* (Oppel) – *T.* (*R.*) cf. *lochense* (Oppel), *T.* (*R.*) *jaeggii* Quereilhac, as well as of their dimorphic counterparts such as – *Glochiceras* (*Coryceras*) *canale* (Quenstedt); and occurring less commonly *Ochetoceras* (*Ochetoceras*) *semifalcatum* (Oppel) and its dimorphic counterpart *Glochiceras* (*Glochiceras*) *tectum* Ziegler (see palaeontological part of the study); in the upper part of this interval has been found a single specimen of *Streblites* cf. *tenuilobatus frotho* (Oppel). Of other groups of ammonites there occur *Passendorferia* (*Enayites*). The detailed stratigraphical interpretation of the deposits in question due to the lack of any representatives of the family Aspidoceratidae is difficult. The occurrence of *Taramelliceras costatum* indicates either the Berrense Subzone of the Hypselum Zone (Zeiss, 1966), or the Bimammatum Subzone of the Bimammatum Zone (*e.g.* Wierzbowski *et al.*, 2010). The precise recognition of the two zones, and their boundary, is thus so far not possible in the succession studied. It should be remembered, however, that the overlying deposits in the Bobrowniki section yielded ammonites indicative of the Bimammatum Subzone – including *Aspidoceras binodum* (Oppel) recognized already in the upper part of bed 1 (Wierzbowski *et al.*, 2010; see also Olóriz *et al.*, 1999, and earlier papers cited therein). These and younger deposits of the Bimammatum Subzone are well represented in the section studied (beds 1 to 7; see Wierzbowski *et al.*, 2010) attaining about 9.5 meters in thickness.

SUBBOREAL AMMONITE SUCCESSION

The deposits studied yielded ammonites of the family Aulacostephanidae making possible the recognition of the Pseudocordata Zone and the Baylei Zone of the standard Subboreal subdivision. The boundary between these zones corresponds to the boundary of the Oxfordian and Kimmeridgian as originally proposed by Salfeld (1913), and emended recently by Matyja *et al.* (2006) (see also Wierzbowski, Matyja, 2014). Ammonites of the family Aulacostephanidae occur almost continuously in the succession studied, except the oldest deposits attributed to the Submediterranean Bifurcatus Zone where they are totally absent (Fig. 2). The ammonites recognized in the succession studied show a marked similarity to representatives of the family from the Subboreal Province, although beginning from the earliest Kimmeridgian Baylei Chron there appeared some differences in evolutionary development of the family Aulacostephanidae between the western and eastern parts of the Subboreal Province, and some adjoining areas of the Submediterranean Province (Enay, 1980; Matyja, Wierzbowski, 1995).

The oldest representative of Aulacostephanidae is the ammonite referred to as ?*Decipia kostromensis* Głowniak *et al.* The ammonite comes from bed 11 of the Syborowa Góra section. The species was described originally from the Decipia Zone of the Subboreal succession from the Mikhalenino section on the Russian Platform (Głowniak *et al.*, 2010), and treated as a "primitive" aulacostephanid of the perisphinctoidal appearance. Although the specimen has been found originally at the base of the Upper Oxfordian, the occurrence of the same species in much younger deposits in the section studied, directly below a well define assemblage of *Ringsteadia* and *Microbiplices*, indicates a wider stratigrapical range of the form in question within the Aulacostephanidae lineage. The stratigraphical interpretation of this ammonite has to be considered together with interpretation of all the aulacostephanid findings in deposits of similar age in other sections in Subboreal-Boreal and Submediterranean areas.

The oldest representative of the genus *Ringsteadia* is the species *R. caledonica* Sykes et Callomon (see Sykes, Callomon, 1979, pp. 890–893, pl. 121: 8–13) described from the Staffin Bay section of the Isle of Skye, northern Scotland. Although the species has been originally interpreted as indicative of the oldest *Ringsteadia* horizon (Sykes, Callomon, 1979), distinguished later as the lowest subzone of the Pseudocordata Zone (Wright, 2003), it has never been found in other sections elsewhere. The position of *R. caledonica* in the Staffin Bay section has been well defined by Matyja *et al.* (2006; see also discussion in the sub-chapter on the Boreal ammonite succession below) who have shown that the species precedes the appearance of the *Ringsteadia pseudoyo* (Salfeld) group which is represented by an assemblage of macro and microconchs differing in ornamentation of their outer whorls – and recognized as the two "dimorphic" subgenera – *Ringsteadia* and *Microbiplices.* It should be noted that the species *Ringsteadia caledonica* Sykes et Callomon shows quite a different type of dimorphism when compared with the bulk of the *Ringsteadia* species –because it is represented by similarly ornamented micro and macroconchs differing only in shell sizes and the presence of lappets in microconchs (Sykes, Callomon, 1979, pl. 121: 8–13). Such a type of dimorphism is typical of the oldest member of the Aulacostephnidae lineage – the genus *Decipia* (see Arkell, 1947; Surlyk *et al.*, 1973, pl. 1: 1–2; Wright, 1996). The species *R. caledonica* differs from other species both of the genera *Decipia* and *Ringsteadia* in the smaller size in both microconchs and macroconchs, and in the irregularity of the ribbing marked by common discontinuities in shell growth preceded by vestigial constrictions. The first representatives of the genus *Ringsteadia* known from the Submediterranean succession are macroconchs which have a somewhat similar in style ribbing, but which "is consistently sharper, stronger, and more regular", however (Sykes, Callomon, 1979, p. 892).

The specimen studied referred to as ?*Decipia kostromensis* Głowniak *et al.* from the Syborowa Góra section is a fairly large microconch with a well preserved peristome with lappets and the ornamentation consisting of bi- and triplicate ribs on the final part of the last whorl, thus both in shell size and ornamentation quite different from *Microbiplices.* The ornamentation of the inner whorls of the specimen in question is fairly dense and consists of dominating biplicate ribs, whereas the whorls are moderately tightly coiled – at the involute/evolute coiling boundary. These features resemble somewhat the coiling and ornamentation of the first "true" Submediterranean *Ringsteadia* species like *R. salfeldi* Dorn occurring in deposits overlying those with the specimen discussed, which, however, show usually a higher number of secondary ribs already at small diameters. It should be remembered that such a type of ornamentation with a high number of secondary ribs is characteristic also of the specimen referred to as *Ringsteadia* aff. *salfeldi* Dorn by Schairer (1989, pp. 124–125, pl. 3: 6) which comes from the upper part of the Bifurcatus Zone of the Sengenthal section in southern Germany, *i.e.* from deposits older than the specimen ?*D. kostromensis* discussed. On the other hand, incomplete specimens (phragmocones) referred to as *Ringsteadia* sp. by Schairer and Schlampp (2003, p. 28, pl. 3: 3–4) from the Semimammatum Subzone of the Gräfenberg section of southern Germany, are similar in density of ribbing and in the dominance of biplicate ribs on the inner whorls to the specimen of ?*D. kostromensis* studied. A small-sized but similar specimen referred to as *Ringsteadia* sp. has been found in the lowermost part of the Pseudocordata Zone of the Mikhalenino section on the Russian Platform (Głowniak *et al.*, 2010, p. 22, pl. 4: 14).

It results from the aforegoing that the oldest *Ringsteadia* fauna is still poorly known, and cannot be classified unequivocally. It possibly consists of forms intermediate in character between the oldest aulacostephanid assemblages – somewhat similar to earlier forms of *Decipia*, but also transitional to the first true *Ringsteadia.* These forms could be tentatively recognized as corresponding to the "Caledonica Subzone" of Wright (2003), and placed in the lowermost part of the Pseudocordata Zone.

A still younger assemblage of aulacostephanids occurs in the Syborowa Góra section (from bed 15 to bed 27), and in the Katarowa Góra section (from beds 4 and 5). The most characteristic element of this faunistic assemblage is the microconch species *Microbiplices procedens* (Oppenheimer) which shows weakly evolute coiling and fairly dense ribbing (also in the inner whorls); a single specimen referred to as *M.* sp. indet. aff. *procedens* (Oppenheimer) from bed 15 of the Katarowa Góra section differs in having triplicate ribs on the outer whorl. The macroconchs are represented by *Ringsteadia* including *R. pseudoyo* Salfeld, and *R.* cf. *salfeldi* Dorn. These deposits attain about 4 m in thickness in the Syborowa Góra section where are the best characterized faunistically. The assemblage characterized by the occurrence of the first *Microbiplices* ammonites has not been distinguished so far in any of the other sections both in Submediterranean and in Subboreal areas. It seems, however, highly probable that some of the oldest representatives of *Microbiplices* found in the Pseudoyo Subzone of the Pseudocordata Zone in the British sections may correspond to this assemblage. This is the case with the densely ribbed and moderately evolute specimens from the Marston Ironstone near Swindon, Wiltshire, England described as *Perisphinctes* (*Otosphinctes*) sp. and referred to the Pseudoyo Subzone (Wright, 2003, pp. 115–116, fig. 10: e–f), as well as *Microbiplices* sp. compared with *M. microbiplex* (Quenstedt) from the lower part of the Pseudoyo Subzone of the Pseudocordata Zone of the Staffin Bay section, Scotland (Matyja *et al.*, 2006, p. 391, fig. 4: a).

A younger assemblage of aulacostephanids was recognized in the Syborowa Góra section (bed 30), Morgi section (beds 1–2), Podzamcze section (not the defined part of the section but with ammonites found in the rubble), Jaroszów-Zawada section (bed 2), Biskupice section (beds 4–8), Biała Dolna section (beds 1–3), and in the Katarowa Góra section (beds 7 to 21). The most characteristic element of the assemblage is the microconch species *Microbiplices microbiplex* (Quenstedt) – an evolute, and moderately densely ribbed form – which may appear already at the top of the older assemblage where it co-oocurs with last *M. procedens.* The macroconchs are represented by *Ringsteadia* including *R. pseudoyo* Salfeld – *R.* cf. *pseudoyo* Salfeld, *R.* cf. *salfeldi* Dorn which are in common with the older assemblage, and additionally appearing higher in the succession (in bed 17 of the Katarowa Góra section) – *R. teisseyrei* (Siemiradzki). These deposits attain about 7.5 m in thickness in the Syborowa Góra section where they are the best characterized faunistically. The species *R. pseudoyo* Salfeld and *R. salfeldi* Dorn – the latter close to the Subboreal *R. brandesi* Salfeld (Głowniak and Wierzbowski, 2007, p. 121) – both commonly occur in the Pseudoyo Subzone of the Pseudocordata Zone (Wright, 2010); but *R. teisseyrei* (Siemiradzki) is similar to the Subboreal species *Ringsteadia pseudocordata* (Blake and Hudleston) (see Głowniak and Wierzbowski, 2007), which occurs commonly both in the Pseudoyo and the Pseudocordata subzones of the Pseudocordata Zone (Wright, 2010). Because *Microbiplices microbiplex* (Quenstedt) occurs from the Pseudoyo Subzone to the Pseudocordata Subzone (Matyja *et al.*, 2006), the stratigraphical postion of the interval studied may correspond in its lower part to the Pseudoyo Subzone, and in the upper part to the Pseudoyo Subzone and/or Pseudocordata Subzone of the Pseudocordata Zone of the Subboreal subdivision.

The youngest *Microbiplices* microconch represents the newly established subspecies *Microbiplices anglicus vieluniensis* Wierzbowski et Matyja subsp. nov. which is close to *M. anglicus anglicus* Arkell in the presence of sharp but loosely spaced ribs, but differs in its less evolute coiling. The species has been possibly recognized in bed 22 of the Katarowa Góra section (where it is refered to as *cf*. species), and is well represented and numerous in beds E and C of the Bobrowniki section. Other aulacostephanid ammonites are represented by poorly preserved and specifically not identifiable fragments of macroconchs. The occurrence of the microconch species *M. anglicus*, and of a very close *Microbiplices*/*Prorasenia* transitional form (sensu Matyja *et al.*, 2006) are typical of the middle and upper parts of the Pseudocordata Zone – the Pseudocordata Subzone and the Evoluta Subzone (Matyja *et al.*, 2006).

Overlying deposits in the Bobrowniki section, about 10.5 m in thickness, yielded ammonite microconchs of the genus *Prorasenia* already in uppermost part of bed B. When better preserved such microconchs are allocated to the species *P. crenata* (Quenstedt) – but referred to here as *cf*. species. *Prorasenia* sp. occurs in beds 1; and *P. crenata* at the boundary of beds 4 and 5, and upwards (Wierzbowski *et al.*, 2010, pp. 71–72, pl. 10: 1–5). This assemblage is the microconchiate counterpart of *Vielunia* – a recently established genus (Wierzbowski *et al.*, 2010) – which groups the forms formerly treated as representing the Submediterranean end members of the *Ringsteadia* lineage (*e.g.* Matyja, Wierzbowski, 1997, and earlier papers cited therein). The similarity of *Vielunia* (as well as co-occurring allied genus *Vineta*) to the Subboreal *Pictonia*, the similarity of the associated microconchs (*Prorasenia*) which occur both in the Subboreal and the Submediterranean areas, strongly suggests the correlation of the stratigraphical interval in question of the sections studied with the Subboreal Baylei Zone of the lowermost Kimmeridgian (Wierzbowski *et al.*, 2010).

BOREAL AMMONITE SUCCESSION

The Boreal ammonites of the family Cardioceratidae are representatives of the genus *Amoeboceras* (subgenera *Amoeboceras* and *Plasmatites*). The Boreal zonation was established by Sykes and Callomon (1979) – with a few later modifications (*e.g.* Matyja *et al.*, 2006 with earlier papers cited therein). The deposits studied correspond to the Regulare Zone, and the Rosenkrantzi Zone of the Upper Oxfordian, and the Bauhini Zone of the lowermost Kimmeridgian. Ammonites of the genus *Amoeboceras* are usually occasional in their occurrence in the succession studied – but become quite common at certain levels (Fig. 2). The occurrence of small-sized but fully grown representatives of the genus is a common feature in the deposits of the Submediterranean Province studied which was related to special environmental conditions affecting the invasive Boreal *Amoeboceras* faunas (Matyja, Wierzbowski, 2000).

Before any description of the detailed stratigraphical interpretation of the succession studied, some comments on the definition of the Regulare Zone seem necessary. The Zone when introduced was defined by occurrence of regularly ribbed *Amoeboceras* – mostly such as forms *A. regulare* Spath and *A. freboldi* Spath. The type locality was designated the Staffin Bay section – from bed 33 about 9.5 above its base up to the base of bed 35. The upper part of the Zone, from about 3.4 m below bed 34 upwards was designated, moreover, as the *Caledonica* horizon characterized by the common occurrence of *Ringsteadia caledonica* Sykes et Callomon (Sykes, Callomon, 1979). The study of the section by Matyja *et al.* (2006) gives, however, a somewhat different interpretation of this Zone. The highest occurrence of *R. caledonica* was recognized markedly lower in bed 33 – 8.3 m below bed 34, *i.e.* about 5 meters lower than postulated Sykes and Callomon (1979). The stratigraphical interval above the highest occurrence of *R. caledonica* which yielded some specimens of *Amoeboceras regulare*, was placed also in the Regulare Zone by Matyja *et al.* (2006, fig. 3). Recent detailed study of the material gathered reveals, however, the co-occurrence of *A. regulare* with a form similar to *Amoeboceras marstonense* Pringle, and this suggests that the interval in question above the occurrence of *R. caledonica* should be placed rather in the lower part of the Rosenkrantzi Zone than in the Regulare Zone. Such a stratigraphical interpretation assumes that the species *A. regulare* continues into the lower part of the Rosenkrantzi Zone. This interpretation is more plausible because it better explains the occurrence in the stratigraphical interval in question of such forms as *Ringsteadia brandesi* Salfeld, and early forms of *Microbiplices*, which were not reported, together with *R. caledonica.* It should be remembered, however, that according to Sykes and Callomon (1979, p. 893), the species *R. caledonica* ranges up into the lowest part of the Rosenkrantzi Zone.

The oldest *Amoeboceras* fauna (fauna 1 – see a paleontological description) occurs in bed 7 of the Syborowa Góra section where it constitutes 28% of the total ammonite number. It consists of larger-sized *Amoeboceras marstonense* Spath, as well as *Amoeboceras* cf. *freboldi* Spath, but also of smaller-sized specimens – ranging from a form very close to *Amoeboceras ovale* (Quenstedt), and a form in which the course of its secondary ribs is weakly rursiradiate to even rectiradiate and which is referred to as *Amoeboceras* aff. *ovale* (Quenstedt). This fauna presents a faunistically uniform assemblage in the terms of a "horizontal classification" and occupies a somewhat intermediate position between the typical fauna of the Regulare Zone, and the early fauna of the Rosenkrantzi Zone – thus it could be treated as indicative of the boundary beds between the two zones (see also Matyja, Wierzbowski, 1994).

The second *Amoeboceras* fauna is represented by rare specimens found in beds 15 and 21 of the Syborowa Góra section. The most important of them is a large typical specimen of *Amoeboceras rosenkrantzi* Spath (Matyja, Wierzbowski, 1994) associated with a single small-sized *Amoeboceras* ex gr. *leucum* Spath in bed 15, the latter form also occurs higher in bed 21. These ammonites are indicative of the Rosenkrantzi Zone (Matyja *et al.*, 2006).

The third *Amoeboceras* fauna is composed mostly of small-sized *Amoeboceras ovale* (Quenstedt). The mass occurrence of these specimens attaining up to about 80% of the whole number of ammonites is typical of the so-called "lower *Amoeboceras* layer" (Matyja, Wierzbowski, 1988; Matyja, Wierzbowski, 2000, with earlier papers cited therein) which is recognized in many of the sections studied: the Syborowa Góra section (bed 30), the Morgi section (bed 1), the Jaroszów-Zawada section (bed 2), the Biskupice section (bed 4), the Biała Dolna section (bed 2), and the Katarowa Góra section (bed 11). Less commonly this species occurs also in some of the underlying beds in the Syborowa Góra section (bed 25) and in the Katarowa Góra section (beds 4, 5, 10). These small-sized specimens of *A. ovale* may possibly be interpreted as representing a wide spectrum of dwarfed-like and dwarfed forms of the *A. marstonense* – *A. rosenkrantzi* group (see comments in the palaeontological part of the study). It may be noted, however, that larger specimens referred to as *Amoeboceras* cf. *rosenkrantzi* Spath, and *A.* ex gr. *A. marstonense* Spath – *A. rosenkrantzi* Spath, are found occasionally also in the beds yielding *A. ovale.* The character of the ammonite fauna indicates correlation with the lower part of the Rosenkrantzi Zone – the Marstonense Subzone (Matyja *et al.*, 2006).

The fourth *Amoeboceras* fauna is represented by some specimens (about 5% of the total number of ammonites) coming from beds 18–22 from the Katarowa Góra section in the northern (A) part of the quarry, as well as possibly coeval beds C2 and C3 from the southern (C) part of the quarry. The fauna consists of *Amoeboceras rosenkranzi* (Spath) – *A.* cf. *rosenkrantzi* (Spath) found in all these beds, and of small-sized *Amoeboceras tuberculatoalternans* (Nikitin) – *A.* cf. *tuberculatoalternans* (Nikitin) found only in bed 20. Here belongs possibly also a single small incomplete specimen found in the still younger bed C of the Bobrowniki section. This specimen shows a marked similarity in ornamentation of the whorl sides to some representatives of the subgenus *Plasmatites* such as *A.* (*P.*) *praebauhni* (Salfeld) but it differs in the character of the ventral side – mostly in the presence of ventral sulci along the keel, being thus closer to *A. tuberculatoalternans*, and especially to an akin but poorly defined form referred to as *Amoeboceras subcordatum* (d'Orbigny) sensu Salfeld (1916) (see palaeontological part of the study). The *Amoeboceras* fauna in question may be correlated with the Rosenkrantzi Zone – the Rosenkrantzi Subzone – and as shown by the occurrence of *Amoeboceras tuberculatoalternans* (Nikitin) and its allies – the uppermost part of the Rosenkrantzi Zone in the younger beds of the interval studied (see Matyja *et al.*, 2006; Głowniak *et al.*, 2010).

The youngest *Amoeboceras* fauna is represented by rare specimens found in bed 1 of the Bobrowniki section: *Amoeboceras* (*Plasmatites*) cf. *lineatum* (Quenstedt) and *A.* (*Plasmatites*) sp. It is typical already of the lowermost part of the Bauhini Zone of the lowermost Boreal Kimmeridgian (Matyja *et al.*, 2006; see also Wierzbowski *et al.*, 2010).

GENERAL REMARKS

The comparison of the ammonite successions described above: the Submediterranean and the Mediterranean, the Subboreal, and the Boreal ones, makes possible the detailed correlation between the particular zonal schemes typical of different faunal provinces (Fig. 5). These new data supplement the correlations as discussed previously (see *e.g.* Sykes, Callomon, 1979; Schweigert, Callomon, 1997; Matyja, Wierzbowski, 1997; Matyja *et al.*, 2006; Głowniak *et al.*, 2010; Wierzbowski *et al.*, 2010; Wierzbowski, Matyja, 2014).

The most important results of this new study are as follows: (1) the boundary between the Boreal Regulare Zone and the Rosenkrantzi Zone runs in the upper part of the Grossouvrei Subzone of the Bifurcatus Zone of the Submediterranean subdivision; (2) possibly some upper parts of the Grossouvrei Subzone, as well as the lowermost part of the Semimammatum Subzone of the Hypselum Zone of the Submediterranean subdivision correspond to the poorly defined lowermost part of the Pseudocordata Zone (= "Caledonica Subzone") of the Subboreal subdivision; (3) the bulk of the Semimammatum Subzone of the Hypselum Zone correlates with the Pseudoyo Subzone of the Pseudocordata Zone of the Subboreal subdivision; the same stratigraphical interval corresponds to the Rosenkrantzi Zone of the Boreal subdivision – mostly its lower part – the Marstonense Subzone; (4) the stratigraphical interval corresponding mostly to the Semiarmatum Subzone of the Hypselum Zone of the Submediterranean subdivision corresponds to some upper parts of the Pseudoyo Subzone and the Pseudocordata Subzone of the Pseudocordata Zone of the Subboreal subdivision, as well as to some upper parts of

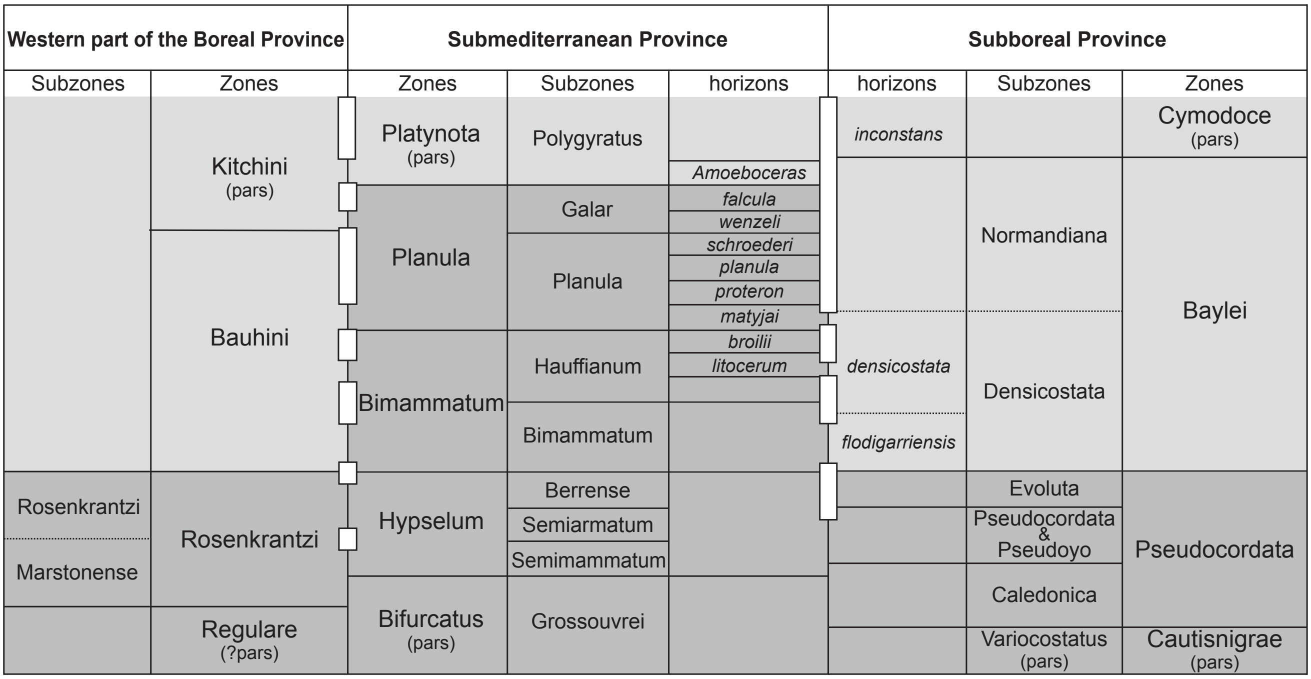

Fig. 5. Correlation of the Submediterranean zonal scheme with the Subboreal and Boreal zonal schemes (after Wierzbowski and Matyja, 2014, slightly modified)

White blocks indicate the interval of uncertain correlation, dark gray – Oxfordian, light gray – Kimmeridgian

the Rosenkranzti Zone (the Rosenkrantzi Subzone) of the Boreal subdivision; (5) the Berrense Subzone of the Hypselum Zone of the Submediterranean subdivision corresponds in its lower part to the Pseudocordata and/or Evoluta subzones of the Pseudocordata Zone of the Subboreal subdivision, and some uppermost parts of the Rosenkrantzi Zone of the Boreal subdivision; (6) the stratigraphical interval corresponding to uppermost part of the Pseudocordata Zone plus the lowermost part of the Baylei Zone of the Subboreal subdivision corresponds to some upper parts of the Berrense Subzone of the Hypselum Zone and/or the lowermost part of the Bimammatum Zone; (7) the lower part of the Bimammatum Zone correlates with some lower parts of the Bauhini Zone of the Boreal subdivision.

These data indicate that the Subboreal Oxfordian/Kimmeridgian boundary placed at the base of Baylei Zone defined by the *flodigarriensis* horizon, which corresponds to the base of the Boreal Bauhini Zone which is defined by the first appearance of the subgenus *Plasmatites* (see Matyja *et al.*, 2006), may in general be well recognized in the succession studied in Poland. The boundary seems to be placed very near the boundary of the Submediterranean ammonites zones – the Hypselum Zone, and the Bimammatum Zone. This is also in agreement with the occurrence of *Amoeboceras* (*Plasmatites*) *praebauhini* (Salfeld) along with forms akin to *A. rosenkranzti* in the *Bimammatum* horizon (or the Bimammatum Subzone as interpreted herein) in southern Germany (Schweigert, 2000; *cf*. also Wierzbowski, 2010). This indicates that the correlation potential of the *flodigarriensis* horizon is quite large, and that it may be treated as the convenient horizon for the recognition of the uniform Oxfordian/Kimmeridgian boundary (see Wierzbowski, 2010).

As the consequence of the new correlation leading to recognition of the boundary of the Hypselum and Bimammatum zones in the Submediterranenean/Mediterranean subdivisions as the boundary of Oxfordian and Kimmeridgian stages, there appears the problem of the stratigraphical classification of the interval represented by the Bimammatum Zone, the Hauffianum Zone (or Subzone), and the Planula Zone traditionally recognized as corresponding to the Submediterranean Upper Oxfordian. A bulk of this stratigraphical interval is very well defined from the top by the base of the Galar Subzone – a level of especially high correlation potential shown not only by changes in the ammonite faunas in the Submediterranean succession, but also by changes in the Boreal faunas – the appearance of the subgenus *Amoebites* – with its oldest species *Amoeboceras* (*Amoebites*) *bayi* Birkelund et Callomon. This species marks the base of the Bayi Subzone of the Kitchini Zone in the Boreal subdivision, and consequently the boundary of the Boreal Bauhini and Kitchini zones (*cf.* Schweigert, Callomon, 1997; Matyja, Wierzbowski, 2002; Matyja *et al.*, 2006; Wierzbowski, Rogov, 2013). It results from the aforegoing that the retention as a stratigraphical entity of the interval from the Bimammatum Zone up to the top of the Planula Zone corresponding to the base of the Galar Subzone seems in order. The suggestion for the future is to distinguish this interval as corresponding to the Lower Kimmeridgian, with re-naming of the currently recognized Submediterranean Lower Kimmeridgian (Platynota to Divisum zones) and its counterparts as the Middle Kimmeridgian – the solution proposed already by Główniak *et al.* (2008).

SYSTEMATIC PALAEONTOLOGY

The following abbreviations are used in the descriptions of the ammonites: D – diameter of the specimen in mm; Wh – whorl height as percentage of D; Ud – umbilical diameter as percentage of D; Wb – whorl breadth as percentage of D; PR – number of primary ribs per whorl (or half a whorl when indicated); SR/PR – secondary/primary rib ratio (calculated by counting the secondaries per 5 primary ribs at a given diameter).

Specific names are used in the sense of "morphospecies" having vertical ranges as opposed to isochronous "horizontal" assemblages thought to represent the variable "biospecies" members in the particular lineages. Generic names are used in a similar morphogeneric sense. Dimorphism, when strongly marked in shell morphology as is encountered especially within Oppeliidae and Aulacostephanidae, is traditionally expressed morphotaxonomically at the generic and species level. The dimorphism of particular groups of ammonites studied both at the generic, and if possible, species level, is, however, interpreted and discussed below. Aside from the interpretatations of the "morphospecies" and "morphogenera" presented – an attempt of a "horizontal" interpretatation of the faunistic assemblages is also given in the description below – just to make possible the recognition of general evolutionary directions in the particular lineages.

Family Phylloceratidae Zittel, 1884

A few specimens of ***Sowerbyceras* Parona et Bonarelli, 1895** (type species *Ammonites tortisulcatus* d'Orbigny, 1849) have been discovered in beds 5 and 7 of the Syborowa Góra section (Pl. 1: 1), and a single specimen in the *Amoeboceras* layer of the Morgi section. All of them are small, attaining about 22–25 mm in final diameter.

Family Oppeliidae Bonarelli, 1894

Genus *Ochetoceras* Haug, 1885 (type species *Ammonites canaliculatus* von Buch, 1831) as macroconch. Three species are recognized in the material studied in beds 9, 11, 13, 15 and 17 in the Syborowa Góra section and in beds 1 and 3 in the Biała Dolna section, as well as in bed 17 of the Katarowa Góra section and in bed 0b in the Bobrowniki section (not all the species occur in the same bed): *Ochetoceras* (*Ochetoceras*) *semifalcatum* (Oppel), *O.* (*O.*) *hispidiforme* (Fontannes) and *O.* (*O.*) *basseae* Fradin (Pl. 1: 2–5). The latter two are close to each other, and it is likely that they represent two morphs of a single species (Bonnot *et al.*, 2009, p. 380). The corresponding microconchs are representatives of ***Glochiceras* (*Glochiceras*) Hyatt, 1900** (type species *Ammonites nimbatus* Oppel, 1863) – *Glochiceras* (*Glochiceras*) *tectum* Ziegler (see Schweigert, Callomon, 1997; Bonnot *et al.*, 2009; Pl. 1: 6, herein) commonly encountered in beds 9, and rarely in bed 11 of the Syborowa Góra section which yielded also the specimens of *Ochetoceras*, as well as in beds C, A, and 0 of the Bobrowniki section.

Genus *Taramelliceras* Del Campana, 1905 (type species *Ammonites trachynotus* Oppel, 1863) for macroconchs. One group of specimens represents the **subgenus *Richeiceras* Jeannet, 1951** (type species *Ammonites pichleri* Oppel, 1863). It includes *T.* (*R.*) *tricristatum* (Oppel) (Pl. 1: 10a, b–11) – found in beds 15, 21 and 27 in the Syborowa Góra section, and in Biała Dolna section – down to about 3 m below the *Amoeboceras* layer. Here also belongs *T.* (*R.*) *lochense* (Oppel) (Pl. 1: 7–9) – found in beds 19, 30 (*Amoeboceras* layer) and 32 in the Syborowa Góra section, in beds 4 (*Amoeboceras* layer) and 8 in the Biskupice section, in the *Amoeboceras* layer in the Jaroszów-Zawada section, as well as in the Biała Dolna section – down to about 3 m below the *Amoeboceras* layer, moreover, in beds 20, 22 and 24 of the Katarowa Góra section, and in beds 0–1 of the Bobrowniki section. The species *T.* (*R.*) *pichleri* (Oppel) (Pl. 1: 12) is found only in beds 17 and 27 in the Syborowa Góra section, but occurs also in the Katarowa Góra section (beds 18 and 22), and in the Bobrowniki section (beds B, 0, and 1). Another species of the same group is *T.* (*R.*) *jaeggii* Quereilhac (see Quereilhac, 2009; see also Wierzbowski *et al.*, 2010) which appears in bed 22 (Pl. 1: 13), and occurs fairly abundantly (although represented by poorly preserved specimens referred to *cf.* species) in bed 24 of the Katarowa Góra section, as well as in bed 1 of the Bobrowniki section. The microconch counterparts of *Richeiceras* are representatives of *Glochiceras* – the **subgenus *Coryceras* Ziegler, 1958** (type species *Ammonites microdomus* Oppel, 1863), such as *G.*(*C.*) *microdomum* (Oppel) (Pl. 1: 14) and *G.* (*C.*) *canale* (Quenstedt) (Pl. 1: 15) (see Wierzbowski *et al.*, 2010, and earlier papers cited therein). The former was found in beds 7 and 23 in the Syborowa Góra section and in bed 20 in the Katarowa Góra section (referred to *cf.* species); the latter in bed 7 of the Syborowa Góra section, in beds C3 and C4 of the Katarowa Góra section (referred to *cf.* species) and in beds 0a, B and C of the Bobrowniki section.

Another group of ammonites of the genus *Taramelliceras* is represented by *T. externnodosum* (Dorn). This species shows a marked variability as already indicated by Hölder (1955, 1958). In the material studied the most common forms are heavily ornamented specimens which are the most typical of the species (forma *robusta* of Hölder, 1958) which have been encountered in beds 7, 24, 25, 27 and 32 of the Syborowa Góra section; in the *Amoeboceras* layer of the Jaroszów Zawada section, and about 0.3–0.6 m above the *Amoeboceras* layer in the Morgi section. These show variation from small, strongly ribbed specimens attaining maturity at about 35 mm diameter as indicated by crowding of ribs at the end of the body chamber, to much larger ones represented by phragmocones in the collection studied, about 55–70 mm in diameter (Pl. 1: 16–17a, b). Similar differences in final size of the specimens attributed to *T. externnodosum* have been recognized by Quereilhac (2009, pl. 18–19) who distinguished: a large *Taramelliceras externnodosum* (Dorn) morphe *externnodosum* Dorn, and a small *T. externnodosum* morphe *orbignyi* Quereilhac.

On the other hand, there exist weakly ornamented specimens which were placed also within the species *T. externnodosum* by Hölder (1958). Such specimens which correspond to the forma *mediocris* of Hölder (1958) have been encountered in beds 13 and 27 of the Syborowa Góra section, and in bed 9 of the Katarowa Góra section, as well as possibly (because of poor preservation referred to *cf.* species) in beds 20 and 21 of the latter section. These specimens show additionally the presence of a ventral groove on the final body chamber. This feature is observed in a specimen about 100 mm in diameter, and also in a still larger, although fragmentarily preserved specimen attaining about 120 mm in diameter.

The marked variability of *Taramelliceras externnodosum* results probably from its special phyletic position within the *Taramelliceras* lineage. The species gave rise to the earliest forms of ***Streblites*** **Hyatt, 1900** (type species *Ammonites tenuilobatus* Oppel, 1862), concerning which a specimen indistinguishable from *Streblites tenuilobatus frotho* (Oppel) has been found together with specimens of *Taramelliceras externnodosum* in the Bifurcatus Zone of Central Poland (Matyja, 1977, pl. 3: 13); some of the specimens of the latter species show the presence of a ventral groove on the body chamber and this additionally manifests their transitional character between *Taramelliceras* and *Streblites*. It should be remembered that Hölder (1955), when introducing the subgeneric name *Strebliticeras* for *Taramelliceras tegulatum* (Quenstedt) – as the type species, and *T. externnodosum* (Dorn), was impressed by the close phyletic relation between the ammonites in question and the genus *Streblites*; the name *Strebliticeras* has been recognized later a younger synonym of the name *Streblites* (see Ziegler, 1974, p. 34–35). A single, large, but poorly preserved specimen, consisting of the phragmocone (up to 55 mm diameter) and a part of the body chamber, showing a very narrow umbilicus, and the narrow ventral side with keel, as well as fairly strongly developed ribs in the outer parts of whorl, was found in the Bobrowniki section (bed 1a); it can be easily compared with *Streblites*, and is referred herein to as *S.* cf. *tenuilobatus frotho* (Oppel).

On the other hand, there exists a marked similarity between weakly ornamented specimens of *Taramelliceras externnodosum*, such as a forma *tenera*, and small-sized specimens of the subgenus *Richeiceras* (see Hölder, 1958, pp. 64–65); the close similarity between *Taramelliceras pichleri*, *T. lochense* (both representatives of *Richeiceras*) and *T. externnodosum* has been stressed also by Bonnot *et al* (2009) who suggested the occurrence of a single type of microconch for all these species corresponding to *Glochiceras* (*Coryceras*) *microdomum* (Oppel).

At least, the heavy ornamented specimens of *T. externnodosum* of the forma *robusta* could be interpreted as possible forerunners of the species *Taramelliceras costatum* (Quenstedt) known from the Berrense Subzone and the Bimammatum Subzone: its oldest subspecies – *Taramelliceras costatum laterinodosum* Karvé-Corvinus shows a marked similarity to *T. externnodosum*, differing mostly in the presence of rounded and even weakly longitudinally elongated ventrolateral tubercles (see Wierzbowski *et al.*, 2010, p. 61, pl. 1: 4–6; Pl. 2: 2–3, herein). It should be remembered that the newly described microconch – *Glochiceras* (?*Lingulaticeras*) sp. nov. (see below) – is similar to *G.* (*Lingulaticeras*) *bobrownikiense* Wierzbowski et Głowniak, 2010 – an alleged microconch of *Taramelliceras costatum* (Quenstedt) (see Wierzbowski *et al.*, 2010). The microconchs of the subgenus *Taramelliceras* are representatives of ***Lingulaticeras*** **Ziegler, 1958** (type species *Ammonites nudatus* Oppel, 1863). This suggests the dimorphic status of the microconch G. (?*L.*) sp. nov. and the macroconch *Taramelliceras externnodosum.*

Two specimens, one coming from bed 22 of the Katarowa Góra section, and the other from bed 0a from the Bobrowniki section can be interpreted as transitional between *T. externnodosum* and *T. costatum*, and they are referred to as *Taramelliceras* (*Taramelliceras*) aff. *externnodosum* (Dorn) (Pl. 1: 20–21). These specimens attain about 35–40 mm in diameter, and are represented by phragmocones with body chambers partly preserved. The ornamentation consists of primary ribs ending with a mid-lateral tubercle and numerous secondary ribs (about 3–5 per one primary). The characteristic feature of these specimens is the presence of elongated ventrolateral tubercles, sometimes showing a tendency to loop to the neighbouring secondary ribs near the venter. Whereas the general character of ornamentation is similar to that of *T. externnodosum*, the presence of well developed ventrolateral tubercles resembles *T. costatum.* Not very distant in morphology is the specimen referred to as *Taramelliceras externnodosum* (Dorn) by Bonnot *et al.* (2009, pl. 6: 23ab) which differs only from the specimens studied in its somewhat weaker ventrolateral tubercles. It should be also remembered that the specimens discussed seem similar to *Taramelliceras kobyi* (Choffat), especially to specimen of Choffat (1893, p. 23–24, pl. 13a–b) which shows also well developed ventrolateral tubercles on the body-chamber. It is also worth noting that the species *Taramelliceras kobyi* (Choffat) differs markedly both in morphology and in stratigraphic position from the *Taramelliceras* "*kobyi* (Choffat)" sensu Dieterich (1940; see also Hőlder, 1955, 1958; Wierzbowski *et al.*, 2010).

The species *T. costatum* occurs abundantly in the Bobrowniki section, down to beds C and D, and possibly E. The specimens in the lowermost part of the section are represented exclusively by *Taramelliceras costatum laterinodosum* Karvé-Corvinus (Pl. 2: 2–3) which has been discussed by Wierzbowski *et al.* (2010, p. 61). It should be remembered that the subspecies in question is represented by two groups of specimens which differ markedly in their final sizes: (1) smaller specimens attaining about 40–55 mm in diameter as shown by appearance of final ornamentation consisting of fairly thin and densely spaced ribs which replace strong, widely-spaced primary ribs with mid-lateral tubercles typical of the subspecies, and (2) larger specimens usually about 80–90 mm in diameter showing the same development of the ornamentation ending with similar subdued, densely placed ribs, but occurring at a much larger diameter. This differentiation in size corresponds well to that described in the subspecies *Taramelliceras costatum costatum* (Quenstedt) by Hőlder (1955) which was also recognized in the upper part of the Bobrowniki section (Pl. 2: 1).

Glochiceras (?*Lingulaticeras*) sp. nov.

(Pl. 1: 18–19a, b)

Diagnosis: Medium sized lappeted microconchs showing well developed ornamentatation of the ventrolateral area of whorl; ventral side of phragmocone with a row of small tubercles.

Material. – Two specimens with peristome preserved one coming from bed 15 of the Syborowa Góra section, and the second from the *Amoeboceras* layer (bed 4) of the Biskupice section. Because of small number of specimens the new species for the time being is given in an open nomenclature.

Description. – Specimens attain about 25–27 mm in diameter. Coiling is moderately involute (at D = 22–27 mm: Wh is about 41–42, and Ud is about 28–29.6). The whorl section is high-oval with flattened whorl sides. The ribbing is distinct on the ventrolateral side of the whorl where it consists of densely placed concave ribs; a median lateral groove is present but rather weakly developed. The ventral side of phragmocone bears a row of small rounded tubercles; a weakly developed groove continues sometimes on the end part of the body chamber.

The body chamber is about half a whorl long. The peristome shows the presence of lappets; in the dorsolateral area the peristome shows a perpendicular course towards the umbilicus. The ventrolateral area of the peristome is weakly concave; the character of its ventral part is, however, unknown, and it is uncertain whether it continues forwards forming a small ventral rostrum or not.

Discussion. – The new species shows some similarity to *Glochiceras* (*Coryceras*) *microdomum* (Oppel) in the presence of rounded tubercles on the ventral side of the phragmocone (*cf.* Ziegler, 1958), but it differs in some other features such as the well developed ornamentation of the ventrolateral part of whorls, the presence of a lateral groove and a somewhat wider umbilicus – which suggest affinity with subgenus *Lingulaticeras.* The species in question seems very close to *Glochiceras* (*Lingulaticeras*) *bobrownikiense* Wierzbowski et Głowniak (see Wierzbowski *et al.*, 2010), differing mostly in the presence of rounded tubercles on the ventral side of phragmocone.

The species together with *G.* (*L.*) *bobrownikiense* fills a gap between the subgenus *Coryceras* – the species *Glochiceras* (*C.*) *microdomum* (Oppel) and the subgenus *Lingulaticeras* – the species *G* (*L.*) *lingulatum* (Quenstedt) – *G.* (*L.*) *nudatum* (Oppel) (*cf.* Ziegler, 1974; Wierzbowski *et al.*, 2010). It is possibly a microconch of the direct forerunner of *T. costatum* – the species *T. externnodosum.*

Family Cardioceratidae Siemiradzki, 1891

Genus *Amoeboceras* Hyatt, 1900 (type species *Ammonites alternans* von Buch, 1831). This is represented by five ammonite faunas which are found in well-separated faunal horizons (Matyja, Wierzbowski, 1994).

The first fauna, found in bed 7 of the Syborowa Góra section, consists both of fairly large specimens (macroconchs) from about 50 to 60 mm in diameter, and smaller specimens about 30 mm in final diameter (microconchs). The former have been referred to as *Amoeboceras* ex gr. *freboldi-marstonense* Spath (see Matyja, Wierzbowski, 1994): in the assemblage studied there occur both specimens of *Amoeboceras marstonense* Spath with markedly rursiradiate secondary ribs (Matyja, Wierzbowski, 1994, pl. 1: 10) as well as of *Amoeboceras* cf. *freboldi* Spath with more rectiradiate, strongly accentuated secondary ribs (Pl. 2: 9), and possibly the specimens illustrated by Matyja and Wierzbowski (1994, pl. 1: 8–9). On the other hand, the smaller-sized specimens show also some variability – ranging from a form very close to *Amoeboceras ovale* (Quenstedt) with markedly rursiradiate secondary ribs (Matyja, Wierzbowski, 1994, pl. 1: 5) to forms in which the course of secondary ribs is weakly rursiradiate to even rectiradiate (Matyja, Wierzbowski, 1994, pl. 1: 6–7; Pl. 2: 7). The former are referred to as *Amoeboceras ovale* (Quenstedt), the latter to as *Amoeboceras* aff. *ovale* (Quenstedt) in "vertical" classification, but in terms of " horizontal" classification the whole assemblage represent a single phyletic member of the lineage which precedes the appearance of a uniform assemblage of *Amoeboceras ovale.*

The second *Amoeboceras* fauna was found in bed 15 of the Syborowa Góra section where a nicely preserved, large (attaining about 75 mm in diameter) specimen of *Amoeboceras rosenkrantzi* Spath was illustrated by Matyja and Wierzbowski (1994, pl. 1: 13a–c). In the same level was found a single fragmentary preserved specimen about 25 mm in diameter (Pl. 2: 8). It shows prorsiradiate primary ribs ending with prominent lateral tubercle at about 2/3 of whorl height; the secondary ribs are rectiradiate and strongly accentuated at the ventrolateral margin; a smooth spiral band runs on the whorl side dividing the primary and secondary ribs. Although the specimen is small and incomplete, it appears to be closely related to *Amoeboceras leucum* Spath (see Mesezhnikov, 1967; see also Matyja *et al*., 2006, p. 395, fig. 6b) and it is referred to as *A.* ex gr. *leucum*. Another, poorly preserved specimen showing similar ornamentation was found in bed 21 of the Syborowa Góra section. These specimens are also similar to *Amoeboceras lorioli* (Oppenheimer) (see Oppenheimer, 1907, p. 239–240, pl. 21; 3–3a) but differ in having more slender whorl section.

The third *Amoeboceras* fauna comes mostly from a single, widely distributed layer ("lower *Amoeboceras* layer" – see Matyja, Wierzbowski, 1988; Atrops *et al.*, 1993; Matyja, Wierzbowski, 1994, 2000) crowded with *Amoeboceras ovale* (Quenstedt) (Pl. 2: 5–6), but similar forms are less commonly found in some underlying beds. The fauna was recognized in the Syborowa Góra section (beds 25 and 30), in the Biskupice section (bed 4), in the Morgi section (bed 1), in the Jaroszów-Zawada section (bed 2) in the Biała Dolna section (bed 2) and in the Katarowa Góra section (beds 4, 5, 10 and 11; see also Malinowska, 1972a, pl. 9: 7).

The ornamentation of the specimens of *Amoeboceras ovale* is generally of the isocostate type with slight modification on the one-third to half of the last whorl. It consists of fairly numerous ribs – sharp and more loosely spaced, and markedly accentuated on the ventrolateral part of the inner whorls, and more dense, less distinct, and somewhat irregular on the last part of the outer whorl with generally short secondaries; for more detailed description and illustrations of the species in question see: Matyja and Wierzbowski (1988, p. 423–424, pl. 1), Atrops *et al.* (1993, p. 216–218, fig. 2, pl. 1: 9–13) and Matyja and Wierzbowski (1994, pl. 1: 11–12a, b). The ornamentation of *A. ovale* is generally similar to that of the microconchs of Boreal/Subboreal *Amoeboceras.* The main difference is in the development of a major sector of phragmocone with crowded septa which may occupy from three-quarters up to one whorl in length in *A. ovale*. This feature, related with very low growth rate of the shell, is the result of the attainment of a prolonged stage of maturity due to environmental conditions. The occurrence of a long sector of shell with crowded septa was tentatively classified as "dwarfism" – because it has affected the advanced stage of growth only without any change in morphological characters normally typical of the final stage of adult forms, such as a smooth outer whorl (Matyja, Wierzbowski, 2000). It should be remembered that some specimens of *A. ovale* show also some weakening of the ornamentatation on the final body chamber (see Pl. 2: 4; see also Matyja and Wierzbowski, 1994, pl. 1: 12a, b = Matyja and Wierzbowski, 2000, fig. 7a, b) which suggest their affinity with large Boreal *Amoeboceras* macroconchs such as *A. marstonense* Spath and *A. rosenkrantzi* Spath (see Sykes and Callomon, 1979, pl. 119: 8; pl. 120: 3–4). The small-sized specimens of *A. ovale* attaining mostly from about 20 to 35 mm in final diameter, from the "lower *Amoeboceras* layer" in the sections studied, may be thus possibly interpreted as representing a wide spectrum of dwarfed-like and dwarfed forms of the *A. marstonense* – *A. rosenkrantzi* group. It may be noted, however, that larger specimens referred to as *Amoeboceras* cf. *rosenkranzti* Spath were found occasionally in beds yielding *A. ovale.*

The fourth *Amoeboceras* fauna comes from beds 18–22 from the Katarowa Góra section in the northern (A) part of the quarry, as well as possibly coeval beds C2 and C3 from the southern (C) part of the quarry. It consists of *Amoeboceras rosenkranzi* (Spath) – cf. *rosenkrantzi* (Spath) (Pl. 2: 12–13) found in all the indicated beds, and of *Amoeboceras tuberculatoalternans* (Nikitin) – cf. *tuberculatoalternans* (Nikitin) (Pl. 2: 10–11) found only in bed 20 of the northern part of the quarry. The former are represented by specimens very close to the typical moderately ribbed representatives of the species with long almost straight secondaries which do not turn forwards until very near the venter (Sykes and Callomon, 1979, pl. 119: 9–10, pl. 120: 3–5; Matyja *et al.*, 2006, fig. 6: c, e); they attain up to about 35–

55 mm in diameter near the end of the body-chamber or about 30 mm still on the phragmocone – thus, they are generally similar in size to smaller representatives of *Amoeboceras rosenkrantzi* (Spath) from the Boreal areas (*cf.* Sykes and Callomon, 1979). Of the two minature specimens attaining about 16 mm in diameter and attributed to *A. tuberculatoalternans* (Nikitin) – one is possibly a fully grown specimen as shown by crowding of the ribs at the end of the shell, whereas the other represents the phragmocone with the initial part of the body chamber; the ornamentation consists of sparsely placed rectiradiate primary ribs (PR is about 15 at D = 15 mm) splitting into two rursiradiate secondary ribs at about two-thirds of the whorl height; the division is marked, with lateral tubercles and ventral to these, a spiral band where the ornamentation becomes weaker; the keel at the venter is bordered by lateral sulci. The species was redescribed by Mesezhnikov *et al.* (1989, p. 81, 84–85, pl. 24: 5–7, 13–17), and subsequently reported in some papers (Matyja, Wierzbowski, 1998, p. 45–46, pl. 1: 8, see also Malinowska, 1991, pl. 2: 8; Głowniak *et al*., 2010, pl. 4: 8).

Possibly to the fourth *Amoeboceras* fauna belongs also a small single specimen found in bed C of the Bobrowniki section. The specimen (Pl. 2: 14a, b) represents a fragment of body-chamber with a subrectangular whorl-section, covered with rursiradiate ribbing consisting of long primary ribs which end in small tubercles at about two-thirds of the whorl height, and short tuberculate secondary ribs which turn forwards at the transition to the venter; a smooth spiral band is observed in between the primary and secondary ribs; the venter has a crenulated keel bordered by shallow ventral sulci. This interesting specimen shows a marked similarity in ornamentation of the whorl sides to some representatives of the subgenus *Plasmatites* (see below) like *A.* (*P.*) *praebauhini* (Salfeld) but it differs in the character of the venter – mostly in presence of ventral sulci along the keel. It is also similar to *A. tuberculatoalternans* but it differs in its the high whorl section. Similar specimens referred to as "*Cardioceras subcordatum* d'Orbigny" were described and illustrated by Salfeld (1916, pp. 160–162, pl. 17: 3a, b), and by Dorn (1931, p. 79–80, pl. 35: 7a, b, ?6). A comparison of the specimen studied, as well as those of Salfeld (1916) and Dorn (1931) discussed above, with the type specimen of "*Cardioceras subcordatum*" of d'Orbigny (1845, p. 434, pl. 34: 6–7) shows, however, marked differences in ornamentation of the last whorl in the latter, which consists of fairly strong single ribs on the last whorl without any weakening in their course. This is the reason that the specimen studied is referred to as *Amoeboceras subcordatum* (d'Orbigny) sensu Salfeld (1916).

The fifth ammonite fauna consists of small representatives of the **subgenus *Plasmatites* Buckman, 1925** (type species *Plasmatites crenulatus* Buckman, 1925) found in bed 1 of the Bobrowniki section – such as *Amoeboceras* (*Plasmatites*) cf. *lineatum* (Quenstedt) – see Wierzbowski *et al.*, 2010 (p. 67, pl. 6: 1a–b) and *A.* (*Plasmatites*) sp. Typical features of ammonites attributed to this subgenus are generally their small final size, and the character of the venter where the secondary ribs run up onto a coarsely crenulated keel without any ventral sulci, which resembles somewhat the older *Cardioceras* (see *e.g.* Salfeld, 1916; Matyja *et al.*, 2006).

Summarizing the observations, the phylogeny of the ammonites of the genus *Amoeboceras* in the section studied is shown by the succession of normal-sized forms in faunas 1–4 which compares well with the Boreal representatives (see *e.g.* Sykes, Callomon, 1979; Callomon, 1985), occurring together their "miniaturized" representatives – which is typical of some of the Submediterranean areas. Miniaturization was caused by a relatively slow growth rate of the specimens as a result of their occurrence in more peripheral areas having a specially stressed environmental conditions (Matyja, Wierzbowski, 2000). The occurrence of the small-sized representatives of the subgenus *Plasmatites* in the youngest (5) fauna is a wider phenomenon, however, being common for both the Boreal-Subboreal and some Submediterranean areas (Wierzbowski, Rogov, 2013).

Family Aulacostephanidae Spath, 1924

Genus ***Decipia* Arkell, 1937** (type species *Ammonites decipiens* Sowerby, 1821)**.** The unique specimen belonging possibly to this genus comes from bed 11 of the Syborowa Góra section. The specimen (Pl. 3: 5) attains 75 mm in diameter and is fully grown microconch with lappets preserved. The body chamber is between half a whorl and three quarters of whorl long (a part of the body chamber is not preserved). The coiling of the inner whorls is weakly evolute to weakly involute (at D = 66 mm, Wh = Ud = 34.4), the coiling of the outer whorl is evolute (at D = 75 mm, Wh = 34.7, Ud = 41.3). The number of primary ribs in the inner whorls is high (PR attains about 55 at D = 40 mm), and it diminishes in the outer whorl (PR = 45 at D = 75 mm). The ribs mostly bifurcate on the phragmocone, but they divide into two or three secondary ribs at the last part of the body chamber preserved (SR = 2.7 at D = 75 mm). The specimen studied shows large similarity to the recently distinguished species ?*Decipia kostromensis* Głowniak *et al*. This species was originally referred to the genus *Decipia* with some reservation, mostly due to the dominance of bifurcating ribs in its inner and middle whorls, and the lack of obliteration of the ribbing at the division point; these features suggest affinity of the species in question to some of its early Middle Oxfordian perisphinctid ancestors (see Głowniak *et al.*, 2010, pp. 21–22, pl. 2: 8–9). It should be remembered that the specimen studied shows, however, a marked similarity in its dimorphism type to that of *Decipia* with parallel development of ornamentation on early stages both in micro and macroconchs (see Arkell, 1947; Surlyk *et al.*, 1973; Wright, 1996); such a development of the ornamentation occurs also in the specimens referred to as *Ringsteadia caledonica* Sykes et Callomon – the earliest representative of the genus *Ringsteadia* (Sykes, Callomon, 1979, pp. 890–893, pl. 121: 8–13). The occurrence of a fairly large specimen of *Ringsteadia* with presumed lappets was reported also by Brochwicz-Lewiński and Różak (1976a, pl. 32: 1) from the ?Hypselum Zone at Biskupice in the Polish Jura. On the other hand, the younger representatives of the genus *Ringsteadia* show a quite different type of dimorphism – with small-sized and variocostate microconchs of the *Microbiplices* type – with biplicate ribs on the body chamber, and a large macroconchs of the *Ringsteadia sensu stricto* type. It results from the aforegoing that *Ringsteadia caledonica* cannot be coupled with the younger microconch genus *Microbiplices*, and thus it cannot be treated as a "candidate for an intersexual microconch" (see Parent *et al.*, 2008, p. 186).

Two generic names are used in the sense of "morphogenera" within typical representatives of *Ringsteadia*: ***Ringsteadia*** **Salfeld, 1913** (type species: *Ammonites pseudocordatus* Blake and Hudleston, 1877) for macroconchs, and ***Microbiplices*** **Arkell, 1936** (type species: *Ammonites microbiplex* Quenstedt, 1877) for microconchs.

Genus *Ringsteadia* Salfeld, 1913. The ammonites of the genus *Ringsteadia* are represented mostly by fragmentary and small-sized specimens. The better preserved specimens were found in the Syborowa Góra section (beds 27 and 30 – *Amoboceras* layer), in the Morgi section (bed 1 – *Amoeboceras* layer), in the Biała Dolna section (bed 1 and 2– *Amoeboceras* layer), in the Jaroszów-Zawada section (bed 2 – *Amoeboceras* layer), in the Biskupice section (bed 6), and in the Katarowa Góra section (beds 5, 17 and 20). The specimens may be subdivided into two groups: (1) showing strongly involute coiling (at D = 32–62 mm, Wh = 40.6–49.2, Ud = 19.3–32.8), generally more dense ribbing and a discoidal section, or (2) showing moderately involute coiling (at D = 33–43 mm, Wh = 37.2–43.9, Ud is about 35), usually less dense ribbing, and high oval whorl section. The former are referred to as *Ringsteadia* cf. *pseudoyo* Salfeld (Pl. 2: 15; Pl. 3: 2–3), the latter to as *R.* cf. *salfeldi* Dorn (Pl. 2: 18; Pl. 3: 4) (see Dorn, 1926, pp. 529–534, pl. 22: 1–3). It should be remembered that the latter species is very close if not conspecific with *Ringsteadia brandesi* Salfeld (see Głowniak, Wierzbowski, 2007, p. 121; see Wright, 2010, p. 30).

More complete specimens coming from the Podzamcze area include: (1) very involute (at D = 62–82 mm, Wh = 48.8–49.2, Ud = 19.5), discus-like specimen with dense ribbing (about 30 primary ribs) and narrow constrictions (Pl. 2: 16) which compare well with *Ringsteadia pseudoyo* Salfeld (see Wright, 2010, pp. 26–28, pl. 1: 1,3; pl. 5: 2–3; pl. 7: 4); and, (2) a more evolute (at D = 60–65 mm, Wh = 44.2–46.1, Ud = 25.4–30.8), oval in whorl section (Pl. 2: 17) specimen showing fairly regular ribbing consisting of fairly densely placed biplicate and triplicate ribs with the point of furcation located fairly high on the whorls side (at D = 60 mm, PR = 35, whereas SR/PR = 2.3). A similar specimen was found in bed 17 of the Katarowa Góra section: the specimen (Pl. 3: 1) shows somewhat more involute coiling (at D = 74 mm, Wh = 41.2, Ud = 28.4) and a similar type of ribbing (at D = 75 mm, PR = 32, SR/PR = 2.5). Both differ from *R. salfeldi* in their more dense and regular ribbing and smaller secondary/primary rib ratio. Both these specimens seem very similar to *Ringsteadia teisseyrei* (Siemiradzki) as recently redefined and emended by Głowniak and Wierzbowski (2007, fig. 74: 2, pp. 119); note also that the *Ringsteadia salfeldi* Dorn of Gygi (1995, fig. 23a–b, pp 46–49), should be placed in the synonymy of *R. teisseyrei*. It should be remembered that the lectotype of *Ringsteadia teisseyrei* (Siemiradzki) is similar to the Subboreal species *Ringsteadia pseudocordata* (Blake et Hudleston) (see Wright, 2010, p. 32, *cf.* also Głowniak, Wierzbowski, 2007).

Two specimens of the genus *Ringsteadia* coming from, and close to, the *Amoeboceras* layer in the Kamyk section at Częstochowa were referred in the past to as *Ringsteadia* sp. (Różak, Brochwicz-Lewiński, 1978, pl. 4: 3a–b) and *Ringsteadia involuta* (Quenstedt) (Różak, Brochwicz-Lewiński, 1978, pl. 4: 4). Because the quality of photographs of the specimens is poor their equivocal interpretation is difficult, but the former looks similar to *Ringsteadia pseudoyo* Salfeld (see Wright, 2010), whereas the latter seems closer to *R. teisseyrei* (Siemiradzki).

The younger specimens of the collection studied which may be attributed to the genus *Ringsteadia* are fragmentary and poorly preserved. A small sized specimen about 40 mm in diameter shows sparcely placed rather strong primary ribs (about 20 at D = 20 mm) and it may be attributed to any of the more heavy ornamented representatives of the genus. The specimen is, however too small for closer comparison, and because it was found in the rubble (Katarowa Góra section – beds 17–23) – difficult for stratigraphical interpretation. Two fragments of whorls of large specimens showing weakly developed secondary ribs near the narrow ventral side, and high oval whorl section from bed C of the Bobrowniki section, belong either to the genus *Ringsteadia* or to the closely allied genus *Vielunia.*

Genus *Microbiplices* Arkell, 1936 (type species *Ammonites microbiplex* Quenstedt, 1887). The oldest specimens of the genus coming from beds 15, 17 and 27 of the Syborowa Góra section, and from beds 4 and 5 of the Katarowa Góra section show fairly involute coiling in the body chamber (at D = 30–35 mm, Wh = 35–38, Ud = 36–38), and very densely ribbed inner whorls (Pl. 3: 6,7, 9; Fig. 6) – the specimens may be referred to as *Microbiplices procedens* (Oppenheimer) and/or *Microbiplices guebhardi* (Oppenheimer) – the latter differing mostly in its somewhat more dense ribbing (see Oppenheimer 1907, p. 254–255, pl. 3: 3, 10). The material studied shows (Fig. 6), that the specimens comparable to both these forms are so close each other, that they should be recognized as representing a single species – *Microbiplices procedens* (Oppenheimer) as treated herein, with the name *M. guebhardi* interpreted as its subjective synonym. Additional, a single specimen (Pl. 3: 8) coming from bed 15 of the Syborowa Góra section shows the presence of triplicate ribs on the outer whorls differing in this feature from typical specimens of *M. procedenes-guebhardi*; it is referred to as *Microbiplices* aff. *procedens* (Oppenheimer). The presence of triplicate ribs on the outer whorl of the specimen in question resembles somewhat forms described as "*Prorasenia*" by Schairer and Schlampp (2003), and commented below at the description of *M. microbiplex*.

Ammonites of the genus *Microbiplices* are represented commonly by *Microbiplices microbiplex* (Quenstedt): fairly large number of specimens of this species enables presentation of its variability (see below).

Microbiplices microbiplex (Quenstedt, 1887)

(Pl. 3: 10–15; Fig. 6)

1962. *Microbiplices microbiplex* (Quenstedt); Enay, pp. 43–44, pl. 2: 4a–d (with given synonymy).

Moreover:

1972a. *Perisphinctes* (*Microbiplices*) *anglicus* Arkell; Malinowska, p. 26, pl. 9: 4.

1972a. *Rasenia* (*Prorasenia*) *stephanoides* (Oppel); Malinowska, pl. 9: 6.

1972a. *Perisphinctes* (?*Microbiplices*) sp. B; Malinowska, p. 26–27, pl. 9: 8.

?1972a. *Rasenia* sp., Malinowska, pl. 10: 6.

1988. *Microbiplices anglicus* Arkell; Malinowska, p. 344, pl. 150: 4.

Non 1988. *Microbiplices microbiplex*; Malinowska, p. 344, pl. 146: 5 [= *Prorasenia crenata* (Quenstedt), see Matyja and Wierzbowski, 1998, p. 40].

2003. *Microbiplices microbiplex* (Quenstedt); Schairer and Schlampp, p. 20–22, pl. 2: 7–8.

Material. – 20 specimens coming from a single layer (*Amoeboceras* layer) at the Syborowa Góra (bed 30), Biskupice (bed 4), Biała Dolna, Morgi and Jaroszów-Zawada sections. Moreover 10 specimens attributed to that species (and additionally 5 fragmentarily preserved referred to with reservation) came from the Katarowa Góra section from a wider stratigraphical interval from bed 5 up to bed 20.

Description. – Specimens range up usually to about 30–40 mm diameter, but the largest one attains 53 mm in diameter. The coiling of inner whorls is moderately evolute (Wh = 33–39, Ud = 38–44) and it becomes markedly evolute on the outer whorl (Wh = 30–37, Ud = 40–50). The ribbing of inner whorls (phragmocone) consists of about 22–30 primary ribs per whorl which split into two-three secondary ribs at about two-thirds of whorl height; constrictions are common (up to 2–3 per one whorl); the ribbing of outer whorl consists of regularly bifurcating ribs (20–33 per whorl); peristome with lappets.

Discussion. – There is a wide continuous range of variability of specimens attributed to the species in question both in degree of coiling, as well as the number of primary ribs per whorl. The species differs from the younger *Microbiplices anglicus* Arkell in its generally thinner and more numerous primary ribs in the inner whorls. On the other hand, *Microbiplices microbiplex* differs markedly from the still younger *Prorasenia* in its markedly thinner primary ribs, and lower point of their division (*cf.* Matyja *et al.*, 2006). Such a distinction results in the placing herein in the synonymy of *Microbiplices microbiplex* of several specimens attributed erroneously in the past both to *M. anglicus* and *Prorasenia* and coming from the Hypselum Zone of the Polish Jura area of Central Poland.

Schairer and Schlampp (2003, pl. 2: 3, 5–6) described from the same stratigraphical level of southern Germany several small-sized specimens referred by them to other species of the genus *Microbiplices* – such as *M. varians* (Oppenheimer) or *M.* cf. *guebhardi* (Oppenheimer); the specimens seem, however, not very distant from those placed herein in the species *M. microbiplex*. Of special interest, are, however, other specimens coming from the same level and attributed by Schairer and Schlampp (2003, pl. 2: 2, 12, 13) to the genus *Prorasenia.* All these specimens show the presence of triplicate ribs up to the end of the last whorl, *i.e.* up to 40–45 mm diameter; because the specimens are almost surely microconchs – they represent the type of microconchs with isocostate ribbing, different from that consisting of triplicate ribs on the inner whorls and biplicate ribs on the outer whorl of *Microbiplices.* Such a type of microconch is recognized in the oldest *Ringsteadia* species – *Ringsteadia caledonica* Sykes and Callomon (Sykes and Callomon, 1979, pp. 890–893, pl. 121: 9–13), as well as in still older aulacostephanids of the genus *Decipia* (see also comments above). The specimens in question show thin ribs and thus they cannot be assigned to the genus *Prorasenia.*

The youngest specimens of the genus coming mostly from beds E and C of the Bobrowniki section are recognized herein as the new subspecies *Microbiplices anglicus vieluniensis* Wierzbowski et Matyja, described below.

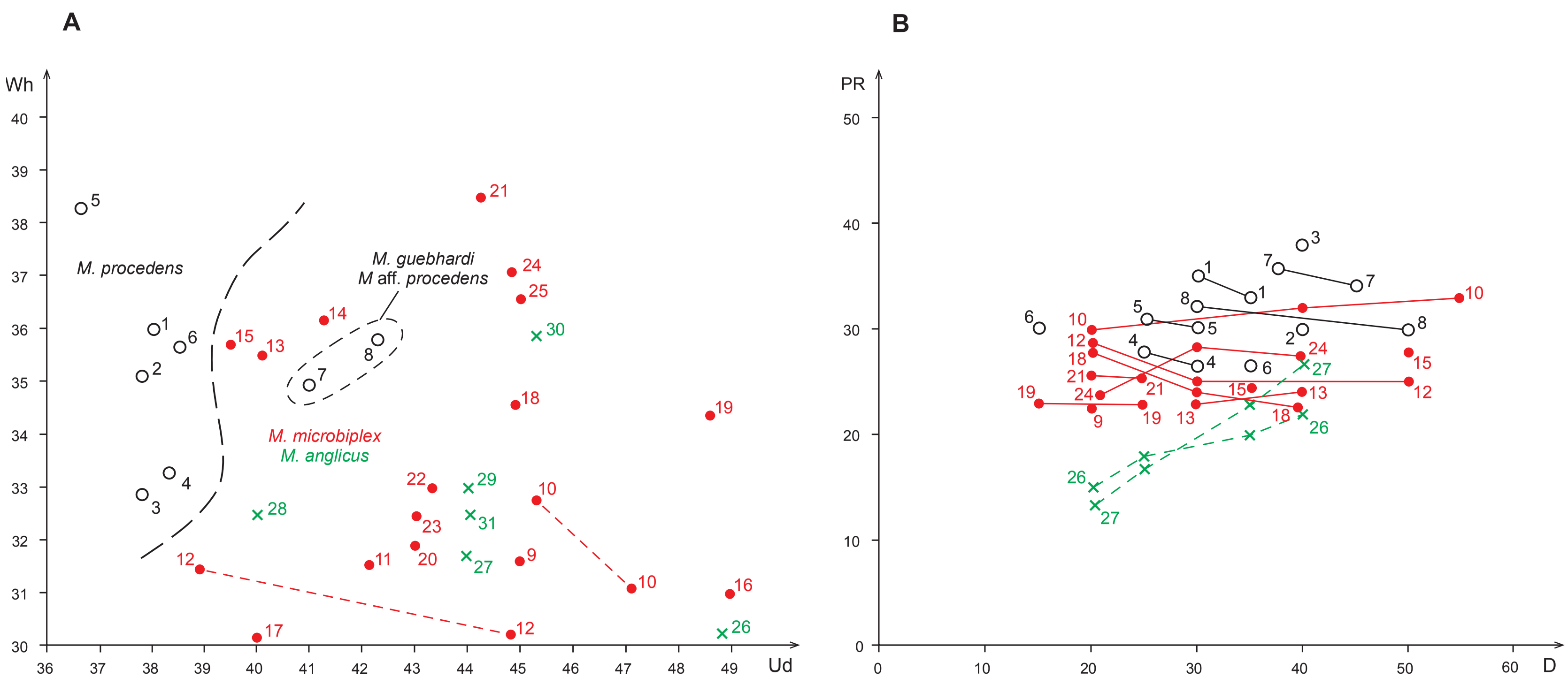

Fig. 6 A. Plots of the ratios of whorl heights (Wh) against umbilical diameter (Ud) expressed as a percentage of the shell diameter; B. Primary ribs number (PR) against shell diameter (D) for the *Microbiplices* species (*M. procedens*, *M. microbiplex* and *M. anglicus vieluniensis*)

M. procedens and allies: 1 – holotype (Oppenheimer, 1907, pl. 3: 3); 2 – specimen no. MWG UW ZI/58/026; 3 – specimen no. MWG UW ZI/58/165; 4 – specimen no. MWG UW ZI/58/017; 5 – specimen no. MUZ PIG 1797.II.82; 6 – specimen no. MUZ PIG 1797.II.81;

M. guebhardi: 7 – holotype (Oppenheimer, 1907, pl. 3: 10); 8 – *M.* aff. *procedens* – specimen no. MWG UW ZI/58/166;

M. microbiplex: 9 – holotype (Quenstedt, 1887, pl. 94: 36); 10 – specimen no. MWG UW ZI/58/021; 11 – specimen no. MWG UW ZI/58/024; 12 – specimen no. MWG UW ZI/58/025; 13 – specimen no. MUZ PIG 1797.II.83; 14 – specimen no. MUZ PIG 1797.II.84; 15 – specimen no. MUZ PIG 1797.II.85; 16 – specimen no. MUZ PIG 1797.II.87; 17 – specimen no. MUZ PIG 1797.II.60; 18 – specimen no. MWG UW ZI/58/006; 19 – specimen no. MWG UW ZI/58/007; 20 – specimen no. MWG UW ZI/58/011; 21 – specimen no. MWG UW ZI/58/012; 22 – specimen no. MWG UW ZI/58/016; 23 – specimen no. MUZ PIG 1797.II.59; 24 – specimen no. MUZ PIG 1797.II.61; 25 – specimen no. MWG UW ZI/58/008;

M. anglicus: 26 – holotype (Fig. A), and paratype (Fig. B) (Arkell, 1947, pl. 86: 6, 7); *M. anglicus vieluniensis* subsp. nov.; 27 – holotype – specimen no. MUZ PIG 1797.II.80; 28 – paratype – specimen no. MUZ PIG 1797.II.01; 29 – specimen no. MUZ PIG 1797.II.02; 30 – specimen no. MUZ PIG 1797.II.03; 31 – specimen no. MUZ PIG 1797.II.04.

Microbiplices anglicus vieluniensis Wierzbowski et Matyja subsp. nov.

(Pl. 3: 16–17; Pl. 4: 1–2; Fig. 6)

?1972a. *Rasenia* (*Prorasenia*) *stephanoides* (Oppel); Malinowska, pl. 7: 5.

2010. *Microbiplices* cf. *anglicus* Arkell; Głowniak *et.al.*, p. 22, pl. 4: 15.

Type material: Holotype (MUZ PIG 1797.II.80 figured in Pl. 3: 16, paratype (MUZ PIG 1797.II.01) figured in Pl. 3: 17.

Type area and locality: Wieluń Upland, Bobrowniki Village (quarry Pj 92).

Type horizon: Upper Oxfordian, the uppermost Hypselum Zone (the upper Berrense Subzone) and/or the lowermost Bimammatum Zone (beds E and C of the Bobrowniki section).

Derivation of the name: after Wieluń Upland (named after Wieluń Town; Latin Vielun) where the ammonites studied come from.

Diagnosis: Microconchs showing sparsely placed strong ribs in inner whorls, and moderately evolute coiling of the outer whorl.

Material. – Four fairly complete specimens coming from beds E and C of the Bobrowniki section, and four additional fragmentary preserved from the same beds and locality, as well as from the Katarowa Góra section (bed 22) referred to *cf.* subspecies.

Description. – Specimens range up from about 32 mm to about 40–50 mm in diameter, and although the complete aperture is nowhere preserved, the changes in ornamentation and coiling at the end of the shell preserved indicate the proximity of the aperture. The coiling is moderately evolute: on the last whorl at D = 32–50 mm, Wh = 32–36, and Ud = 40–45. The ribbing of the inner whorls (phragmocone) consists of 14–18 primary ribs which are strongly developed and prorsiradiate: the primary ribs split into 2–3 secondary ribs at the mid-height of the whorl, continuing in the rectiradiate course. The ornamentation of the last whorl consists of thinner, biplicate, fairly densely placed ribs (about 25–30 primaries per whorl). Constrictions are not observed.

Discussion. – The Polish specimens show a marked similarity to the English species *Microbiplices anglicus* Arkell (see Arkell, 1947, p. 378, pl. 76: 6a, b–7a, b; see also Wright, 2010, p. 43, pl. 1: 6–8, pl. 2: 7–8, pl. 4: 6) in the character of ornamentation – especially the development of the ribbing of the inner whorls. The primary ribs of the inner whorls in all these forms are markedly stronger and less numerous than in *M. microbiplex*, but not swollen as in representatives of the genus *Prorasenia.* On the other hand the British specimens of *M. anglicus* differ from the specimens studied in the generally more evolute coiling of the whorls. This difference make possible the distinction on the subspecies level: a more evolute nominative subspecies *Microbiplices anglicus anglicus* Arkell, and a moderately evolute *Microbiplices anglicus vieluniensis* established herein. The Russian specimen referred to as *Microbiplices* cf. *anglicus* (see synonymy) seems closer to the latter subspecies. Also, a fragmentary specimen from the Katarowa Góra referred to as *R. stephanoides* by Malinowska (1972a, see synonymy) shows fairly strong and distant primary ribs in the inner whorls and it seems similar to the subspecies in question.

Genus *Prorasenia* Schindewolf, 1925 (type species *Prorasenia quenstedti* Schindewolf, 1925). Although some authors have treated the names *Microbiplices* and *Prorasenia* as synonyms, there are marked differences between the two taxa justifying their separate treatment (see *e.g.* Matyja *et al.*, 2006). Generally the representatives of *Prorasenia* show swollen primary ribs – much thicker than in *Microbiplices* on the inner whorls, which divide below the mid-height of the whorl. The first *Prorasenia* in the section studied is *Prorasenia crenata* (Quenstedt) showing some similarity to the Subboreal species *Prorasenia bowerbanki* Spath (see Matyja and Wierzbowski, 1998, pp. 87–88). The species has been found in the Bobrowniki section in the marly intercalation between beds 4 and 5, but a poorly preserved specimen of *Prorasenia* sp. has been reported from bed 1 (Wierzbowski *et al.*, 2010). The specimen (Pl. 4: 3) described herein referred to as *Prorasenia* cf. *crenata* (Quenstedt) comes from the upper part of bed B: it is about 25 mm in diameter and shows strongly protruding and sparsely placed, triplicate ribs in the inner part of the outer whorl, replaced by the biplicate ribs on the last half of the whorl; the number of primary ribs is about 16 at D = 25 mm.

Family Perisphinctidae Steinmann, 1890

Genus Perisphinctes Waagen, 1890 (type species *Ammonites variocostatus* Buckland, 1836) is represented by two subgenera: the subgenus *Perisphinctes* (M) represented by fragments of whorls and specifically indeterminable (Syborowa Góra, bed 8), and the **subgenus *Dichotomoceras* Buckman, 1919** (type species *Dichotomoceras dichotomum*) (m). The latter subgenus is represented by the well known species: *Perisphinctes* (*Dichotomoceras*) *bifurcatus* (Quenstedt) found in beds 3, 4, 7, 8 and 9 (lower part) (Pl. 4: 4–7) and *P.* (*D.*) *crassus* Enay found in bed 7 (Pl. 4: 8) both of the Syborowa Góra section; moreover, a small densely ribbed, possibly fully grown specimen referred to as *P.* (*D.*) cf. *microplicatilis* (Quenstedt) has been found in bed 7 of the same section (Pl. 4: 9).

Genus *Subdiscosphinctes* Malinowska, 1972 (type species *Perisphinctes kreutzi* Siemiradzki, 1891) is represented by two specimens from the Syborowa Góra section. A smaller specimen from bed 5 is represented by the phragmocone with a part of the body chamber; it is about 50 mm in diameter (Pl. 4: 10) and covered by dense biplicate and single ribs (about 65 ribs at D = 50 mm) showing typical ornamentation of the microconchs of the genus. A large specimen from bed 7 is a macroconch, about 170 mm in final diameter including the phragmocone (up to 100 mm diameter) and a large part of the body chamber – but the middle part of which is broken away (Pl. 5: 1). The final simple peristome is preserved. The ornamentation of the inner whorls consists of very dense biplicate, but also sometimes single ribs (PR is 68 at D = 55 mm, and 73 at D = 80 mm). At the end of the phragmocone / beginning of the body chamber the ribbing becomes less dense, the ribs become bi- and triplicate, but the point of rib division is somewhat blurred. On the last part of the body chamber the secondary ribs are blurred, but the primary ribs still exist on lower half of the whorl. The coiling at the phragmocone/body chamber boundary is very weakly evolute (at D = 97 mm, Wh = 37.1, Ud = 38.7), but it becomes more evolute on the body chamber (at D = 152 mm, Wh = 31.6, Ud = 42.1).

The character of ornamentation and coiling is similar to that of *Subdiscosphinctes mindowe* (Siemiradzki) and the specimens studied are referred to that species. The specimens of this species known so far are generally microconchs, whereas the macroconchs are represented by a few large but incomplete specimens (Malinowska, 1972b, pl. 29 – phragmocone about 215 mm in diameter; Głowniak and Wierzbowski, 2007, fig. 10 – phragmocone with a part of the body chamber about 160 mm in diameter): they show the triplicate ornamentation at the end of the last whorl, but without the final simple ornamentation at the end of the body chamber preserved. The specimen studied from the Syborowa Góra section, because of its smaller size, is thus the most completely preserved macroconch of *S. mindowe.* It should be remembered that the macroconchs of the genus *Subdiscosphinctes* and especially the best known of them of *Subdiscosphinctes kreutzi* (Siemiradzki) – (see Brochwicz-Lewiński, 1972, pl. 4; Malinowska, 1972b, pl. 27: 1–2) show a marked modification of the ornamentation of the outer whorls when compared with their microconchs – and were grouped in a separate macroconch subgenus *Aureimontanites* by Brochwicz-Lewiński (1975). The necessity of giving separate names for micro and macroconchs has been, however, questioned nowadays, and the corresponding micro and macroconchs are grouped in the same species (see *e.g.* Głowniak, Wierzbowski, 2007). The name *Aureimontanites* for macroconchs of *Subdiscosphinctes* has been retained by Gygi (2001) but none of the specimens illustrated by him reveals the typical features of the final body-chamber of this subgenus with a "tendency to obliteration of ribbing, and particularly of secondary ribs" (see Brochwicz-Lewiński, 1975, p. 92).

Genus *Passendorferia* Brochwicz-Lewiński, 1973 (type species *Passendorferia teresiformis* Brochwicz-Lewiński, 1973) is represented almost exclusively by its microconchs which are attributed usually to the **subgenus *Enayites* Brochwicz-Lewiński and Różak, 1976** (type species *Ammonites birmensdorfensis* Moesch, 1867). A fairly large specimen, about 100 mm in final diameter, having the peristome with lappets, coming from beds 1–9 (rubble) of the Syborowa Góra section (Pl. 5: 2) fits very well to the form referred to as the microconch of *Passendorferia uptonioides* (Enay) (see Meléndez *et al.*, 2009 with references given). Other smaller specimens are representatives of the densely ribbed *Passendorferia* (*Enayites*) *gygii* (Brochwicz-Lewiński and Różak) found in beds 8 and 15 of the Syborowa Góra section, and possibly referred to as *cf.* species from bed 17 of the Katarowa Góra section. A more coarsely ribbed *P.* (*E.*) *rozaki* Meléndez (Pl. 4: 11), was found in bed 30 of the Syborowa Góra section, bed 6 of the Biskupice section, and directly over the *Amoeboceras* layer in the Biała Dolna section. The latter species is based on a heavy-ribbed specimen from the Częstochowa area referred originally to as *Nebrodites* (*Enayites*) cf. *gygii* by Brochwicz-Lewiński and Różak (1976b, pl. 37: 3), but the species *P. rozaki* is also very close to "*Perisphinctes*" *latumbonatus* of Oppenheimer (1907, p. 248–249. pl. 22: 12–12a) according to Meléndez (1989, p. 178).

A unique macroconchiate specimen related to the Passendorferiinae has been found in bed 27 of the Syborowa Góra section. The specimen is about 200 mm in diameter and it consists of the phragmocone (up to 160 mm diameter) and partly preserved body chamber. The inner whorls, although poorly preserved, show fairly dense ribbing (PR = 45 at D = 55 mm and PR = 42 at D = 90 mm) and very evolute coiling. On the outer whorl, the ribbing becomes more distant and coarse, attaining about 30 primary ribs per whorl; the whorl section is subcircular; the secondary ribs (two/three per primary rib) up to the initial part of the body chamber are weakly developed but still visible on the ventral side where they cross in a zig-zag manner. The last preserved part of the body-chamber after a well-marked constriction shows strongly developed primary ribs which bear well developed tubercles on the ventral side (Pl. 6: 1). The specimen studied shows marked similarity to macroconchs of *Passendorferia* as described *e.g.* by Brochwicz-Lewiński (1973) and Meléndez (1989) in the coiling of the whorls and ornamentation of the phragmocone. The ribbing is, however, generally less dense than in the bulk of representatives of *Passendorferia*, and the presence of ventro-lateral nodes on the final part of the body chamber is never encountered in that genus. On the other hand, these features suggest a possible relation between the specimen studied and early representatives of simoceratids – such as ***Presimoceras* Sarti, 1990**. It should be remembered that close phylogenetic relation between the genus *Passendorferia* and early simoceratids has been indicated by Brochwicz-Lewiński (1973), and Brochwicz-Lewiński and Różak (1976b, fig. 1). The specimen studied is the oldest specimen known so far showing the intermediate character between the genus *Passendorferia* and the genus *Presimoceras* (*cf.* Sarti, 1990, fig. 12), although some similar specimens coming from somewhat younger deposits have been reported previously (*e.g.* Zeiss, 1962).

Genus *Graefenbergites* Schairer and Schlampp, 2003 (type species *Perisphinctes idoceroides* Dorn, 1930) includes, according to the original definition of the authors: "*Evolute Makrokonche und Mikrokonche mit Subnebrodites-änlicher Berripung*" (Schairer, Schlampp, 2003, p. 32). These ammonites occupy an intermediate position between true *Passendorferia* and Ataxioceratinae, being possible forerunners of the genus *Subnebrodites* (see Schairer, Schlampp, 2003; Meléndez *et al.*, 2009, fig. 3). The ammonites coming from beds 1–5 of the Syborowa Góra section are represented by fragmentary preserved highly evolute, densely ribbed specimens; these are referred to as *Graefenbergites arancensis* (Meléndez) (Pl. 6: 1). Much better preserved and complete specimens coming from bed 19 of the Syborowa Góra section, beds 6, 8 and 10 of the Biskupice section, beds 7 and 9 of the Katarowa Góra section, as well as those found near the *Amoeboceras* layer of the Biała Dolna section can be safely attributed to *Graefenebergites idoceroides* (Dorn) (Pl. 7: 1–4). The specimens range in size from about 50–70 mm up to about 130 mm, and although they do not have aperture preserved, they most probably represent both the micro- and macroconchs of the species (*cf.* Schairer, Schlampp, 2003). The coiling of the specimens studied is generally moderately evolute (Wh = 31–35, Ud = 45–48), but some specimens are less evolute (Wh = 29–35, Ud = 39.5–42); the same difference in coiling has been recognized by Schairer and Schlampp (2003) in the assemblage of *G. idoceroides* studied by them from southern Germany.

Family Ataxioceratidae Buckman, 1921

Genus *Orthosphinctes* Schindewolf, 1925 includes both micro and macroconchs usually distinguished under separate subgeneric names: ***Orthosphinctes*** for microconchs (type species *Ammonites tiziani* Oppel, 1863), and ***Pseudorthosphinctes* Enay, 1966** for macroconchs (type species *O.* (*P.*) *alternans* Enay, 1966). Both subgenera are represented in the material studied, but the detailed identification of the particular species is not easy mostly due to the large variability in the genus, and the general difficulty in finding the leading features in its phylogeny. It should be remembered, however, that the forms studied herein generally correspond to the *O. tiziani* group which differs from the younger *O. polygyratus* group (or the *Planites* group) in several features of its morphology (see Meléndez *et al.*, 2006). Also the occurrence of macroconchs of the *Lithacosphinctes* type (type species *Ammonites lictor evolutus* Quenstedt, 1888) is confined to the latter group.

Genus *Praeataxioceras* Atrops, 1982 (type species *Perisphinctes laufenensis* Siemiradzki, 1899) differs in several features from *Orthosphinctes* which make possible its recognition as an independent genus transitional between passendorferinids of the genus *Graefenbergites* and ataxioceratids of the genus *Subnebrodites* (*cf.* Schweigert, Callomon, 1997; Schairer, Schlmpp, 2003; Meléndez *et al.*, 2009). A single microconch specimen with lappets preserved, referred to as *Praeataxioceras* sp. nov. (Pl. 7: 5), coming from bed 20 of the Katarowa Góra section seems to confirm such an interpretatation. The specimen shows very evolute coiling of the inner whorls changing to moderately evolute coiling on the outer whorl (at D = 58 mm, Wh = 34.5, Ud = 46.5). The ribbing is fairly dense (at D = 50 mm, PR = 44, at D = 67 mm, PR = 53) with a marked forward inclination of the secondary ribs on the ventral side (resembling *Graefenbergites*), but with irregularities in the development of the primary ribs resembling very much those encountered in *Praeataxiceras.* A similar specimen coming from a nearly coeval stratigraphical interval in western France was referred to as "*Perisphinctinae indéterminé, à formations paraboliques fréquentes, probablement microconque*" by Bonnot *et al.* (2009, p. 394, pl. 1: 7a, b).

The most common species in the material studied is *Praeataxioceras virgulatus* (Quenstedt) (Pl. 7: 6) recognized in the Katarowa Góra section (beds 22 and 24). This species is close to the somewhat younger *P. laufenensis* (Siemiradzki), but it differs in its denser ribbing, and more involute coiling (Wierzbowski *et al.*, 2010).

Family Aspidoceratidae Zittel, 1895

Genus *Epipeltoceras* Spath, 1924 (type species *Ammonites bimammatus* Quenstedt, 1858) is represented by *Epipeltoceras semimammatum* (Quenstedt). The range of the species is treated according to Bonnot *et al.* (2009), and the bulk of the specimens collected correspond well to its most typical variant (Pl. 7: 7–10). The specimens come from the Syborowa Góra section (beds 27 and 30), the Biskupice section (bed 8), and the Morgi and Jaroszów-Zawada sections (rubble). A single specimen referred to as *Epipeltoceras* cf *semiarmatum* (Quenstedt) was found in the rubble (from beds 18, 20 or 22 of the Katarowa Góra section – according to position and lithology); the specimen (Pl. 7: 11) is a fragmentary imprint about 20 mm in diameter, showing the presence of rectiradiate single ribs. The genus *Epipel-*

toceras was placed in the subfamily Epipeltoceratinae distinguished by Donovan *et al*. (1980, p. 151, note 7) for "a rather well-defined side branch in the Oxfordian" in which "the dimorphism in the higher members is however not clear", because "all the known forms from the Bimammatum Zone appear to be microconchs only". More recently Schweigert (1995) suggested a possible dimorphic relation between *Epipeltoceras* (m) and *Clambites* (M), whereas according to Bonnot *et al.* (2009) *Epipeltoceras* (m) should be paired with *Euaspidoceras* and *Clambites* (M) (see also comments below).

Genus *Euaspidoceras* Spath, 1931 (type species *Ammonites perarmatus* J. Sowerby, 1822) is represented mostly by forms which are already heavy-tuberculated on inner whorls like *Euaspidoceras hypselum* (Oppel) (Pl. 8: 6, 7) found in bed 15 of the Syborowa Góra section as well as in the *Amoeboceras* layer in the Syborowa Góra, Biskupice, Morgi and Biała Dolna sections. Another large, heavy tuberculated specimen found in bed 27 of the Syborowa Góra section shows loosely spaced tubercles on the inner whorls (Pl. 8: 5) which makes it close to *Euaspidoceras eucyphum* (Oppel) (see *e.g.* comments on these species by Dorn, 1931, and more recently by Bonnot *et al.*, 2009). Another group of species is represented by a large specimen found in bed 13 of the Syborowa Góra section which shows weakly developed inner tubercles elongated in the rib direction, and with sparsely placed and stronger outer tubercles, as well as wide ribs developed on the body chamber joining the inner and outer tubercles; the specimen studied is very close to *Euaspidoceras varioornatum* (Dorn), especially the lectotype of the species (Dorn, 1931, pl. 25: 1) as designated by Enay and Gygi (2001, p. 468). Small-sized specimens about 25–30 mm in diameter showing the presence of fasciculate ribs joining the inner – weakly developed tubercles, and the outer much stronger tubercles can be referred to as *Euaspidoceras striatocostatum – E.* cf. *striatocostatum* (Dorn) (Pl. 8: 3,4); they come from beds 11, 27–30 of the Syborowa Góra section.

Genera: *Neaspidoceras* Spath, 1931 (type species *Aspidoceras tenuispinatum* Waagen, 1875) and ***Clambites* Rollier, 1922** (type species *Ammonites clambus* Oppel, 1863). Four of the specimens collected (one from the *Amoeboceras* layer of the Jaroszów Zawada section, two from bed 32 of the Syborowa Góra section, and one from bed 24 of the Katarowa Góra section) are mostly phragmocones about 25 – 53 mm in diameter; the coiling is involute (Wh = 38–42.8, Ud = 28.6–31.1), the whorl section is oval with a wide ventral side; the ornamentation consists of sheaves of thin ribblets branching from well developed peri-umbilical tubercles (17–18 per whorl), whereas small outer tubercles occur only on the inner whorls (up to 20–25 mm diameter). These specimens can be safely placed in the species *Neaspidoceras radisense* (d'Orbigny) (see Hantzpergue, 1994, p. 175, pl. 75: 8a–b; see also Dorn, 1931, p. 23, pl. 22: 4, 8; Pl. 8: 1, 2, herein). A single specimen from bed 5 of the Katarowa Góra section is about 50 mm in diameter and is represented by the phragmocone and a part of the body-chamber preserved; the coiling is involute (at D = 46 mm, Wh = 45.6, Ud = 31.5), the whorl section is high oval with flattened whorl sides; the ornamentation of the phragmocone consists of strongly developed umbilical tubercles and weaker ventrolateral tubercles visible up to about 40 mm diameter; sheaves of thin ribblets beginning with a periumbilical swelling, and accentuated at the ventrolateral shoulders, are visible on the body-chamber. These features make possible the attribution of the specimen in question to *Neaspidoceras tietzei* (Neumayr) as interpreted by Neumayr (1871, p. 374–375, pl. 18; 8–9; see also Dorn, 1931, p. 14–15, pl. 17: 4, 5, 7, 8). The species differs from *N. radisense* in the generally longer persistence of the bi-tuberculate stage of ornamentation on the inner whorls.

It should be remembered that the species in question are placed either in the genus *Euaspidoceras* (see *e.g.* Hantzpergue, 1994; Bonnot *et al.*, 2009), or in the widely interpreted genus *Clambites* which includes also *Neaspidoceras* (see *e.g.* Enay, Gygi, 2001). The separate treatment of the genus *Neaspidoceras* is accepted herein because it corresponds better to the suggested phylogenetical relations within the aspidoceratid lineage (see also Checa Gonzales, 1985).

It is worth mentioning that: (1) the origin of bituberculated *Aspidoceras* Zittel, 1868 (type species *Ammonites rogoznicensis* Zeuschner, 1846) and the subfamily Aspidoceratinae took place during Bimammatum Chron from *Euaspidoceras* such as "*Euaspidoceras babeanum* (d'Orbigny) sensu Dorn (1931)" (see Checa Gonzales, 1985, p. 266) – in fact very close to *Euaspidoceras hypselum* (*cf*. Dorn, 1931, p. 140); (2) the origin of *Pseudowaagenia* Spath, 1925 (type species *Ammonites haynaldi* Neumayr, 1873), and *Physodoceras* Hyatt, 1900 (type species *Ammonites circumspinosus* Quenstedt, 1858) and the subfamily Physodoceratinae took place also in the Bimammatum Chron from the *Neaspidoceras* of the *tietzei* (Neumayr) – *radisense* (d'Orbigny) group (see Checa Gonzales, 1985, p. 283). The material studied confirms the opinion that the two lineages arose from a single ancestral stock of *Euaspidoceras.*

The roots of the genus *Clambites* are also in the genus *Euaspidoceras.* The representatives of the genus *Clambites* show single ribs with indistinct swellings at the umbilicus and at the ventrolateral shoulders which persist from the inner to outer whorls (*C. clambus*) or ribs with markedly developed ventrolateral tubercles such as in *C. schwabi* (Oppel) (see Oppel, 1863, p. 228, pl. 63: 4a, b). It should be remembered that single ribs similar to those of *Clambites* are recognized also in the innermost whorls of some *Euaspi-*

doceras, such as *Euaspidoceras striatocostatum* (Dorn) which suggests a close phylogenetical relation between these two groups of ammonites; it seems thus highly probable that the microconch counterparts of the *Euaspidoceras* – *Clambites* lineage are representatives of the genus *Epipeltoceras* (see *e.g.* Bonnot *et al.*, 2009).

The presence of the genus *Clambites* in the material studied has not been unequivocally proved. Poorly preserved specimens attaining about 60–70 mm in diameter found in bed 24 of the Katarowa Góra section show the presence of sets of thin ribblets on the outer whorl side with indistinct swellings at the umbilicus. These specimens seem similar to some *Clambites*, especially the *C. clambus* (Oppel) (see Oppel, 1863, p. 225–226, pl. 63: 1a–c).

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PLATE 1

Fig. 1. *Sowerbyceras tortisulcatum* (d'Orbigny), body-chamber; MWG UW ZI/58/116; Syborowa Góra section, bed 5; Grossouvrei Subzone, Bifurcatus Zone

Fig. 2. *Ochetoceras* (*Ochetoceras*) *basseae* Fradin, phragmocone; MWG UW ZI/58/029; Syborowa Góra section, bed 17; Semimammatum Subzone, Hypselum Zone

Fig. 3. *Ochetoceras* (*Ochetoceras*) *basseae* Fradin; MWG UW ZI/58/030; Syborowa Góra section, bed 15; Semimammatum Subzone, Hypselum Zone

Fig. 4. *Ochetoceras* (*Ochetoceras*) *semifalcatum* (Oppel); MWG UW ZI/58/035; Syborowa Góra section, bed 11; Semimammatum Subzone, Hypselum Zone

Fig. 5. *Ochetoceras* (*Ochetoceras*) *hispidiforme* (Fontannes), phragmocone; MWG UW ZI/58/034; Syborowa Góra section, bed 15; Semimammatum Subzone, Hypselum Zone

Fig. 6. *Glochiceras* (*Glochiceras*) *tectum* Ziegler; MWG UW ZI/58/039; Syborowa Góra section, bed 9; Grossouvrei Subzone, Bifurcatus Zone

Fig. 7. *Taramelliceras* (*Richeiceras*) *lochense* (Oppel); MWG UW ZI/58/051; Syborowa Góra section, bed 19; Semimammatum Subzone, Hypselum Zone

Fig. 8. *Taramelliceras* (*Richeiceras*) *lochense* (Oppel); MWG UW ZI/58/057; Jaroszów-Zawada section, bed 2; Semimammatum Subzone, Hypselum Zone

Fig. 9. *Taramelliceras* (*Richeiceras*) *lochense* (Oppel); MUZ PIG 1797.II.21; Katarowa Góra section, bed 22 (B2/B3); Semiarmatum Subzone or Berrense Subzone, Hypselum Zone

Fig. 10a, b. *Taramelliceras* (*Richeiceras*) *tricristatum* (Oppel), lateral and ventral view; MWG UW ZI/58/048; Syborowa Góra section, bed 15; Semimammatum Subzone, Hypselum Zone

Fig. 11. *Taramelliceras* (*Richeiceras*) *tricristatum* (Oppel); MWG UW ZI/58/056; Biała Dolna section, bed 1; Semimammatum Subzone, Hypselum Zone

Fig. 12. *Taramelliceras* (*Richeiceras*) *pichleri* (Oppel); MUZ PIG 1797.II.44; Bobrowniki section, bed B; Berrense Subzone (Hypselum Zone) or Bimammatum Subzone (Bimammatum Zone)

Fig. 13. *Taramelliceras* (*Richeiceras*) *jaeggii* Quereilhac; MUZ PIG 1797.II.26; Katarowa Góra section, bed 22; Semiarmatum Subzone or Berrense Subzone, Hypselum Zone

Fig. 14. *Glochiceras* (*Coryceras*) *microdomum* (Oppel); MWG UW ZI/58/041; Syborowa Góra section, bed 7; Grossouvrei Subzone, Bifurcatus Zone

Fig. 15. *Glochiceras* (*Coryceras*) *canale* (Quenstedt); MUZ PIG 1797.II.22; Bobrowniki section, bed B; Berrense Subzone (Hypselum Zone) or Bimammatum Subzone (Bimammatum Zone)

Fig. 16. *Taramelliceras* (*Taramelliceras*) *externnodosum* (Dorn) forma *robusta* of Hőlder (1958), phragmocone; MWG UW ZI/58/062; Jaroszów-Zawada section, bed 2; Semimammatum Subzone, Hypselum Zone

Fig. 17a, b. *Taramelliceras* (*Taramelliceras*) *externnodosum* (Dorn) forma *robusta* of Hőlder (1958), phragmocone, lateral and ventral view; MWG UW ZI/58/064; Syborowa Góra section, bed 27; Semimammatum Subzone, Hypselum Zone

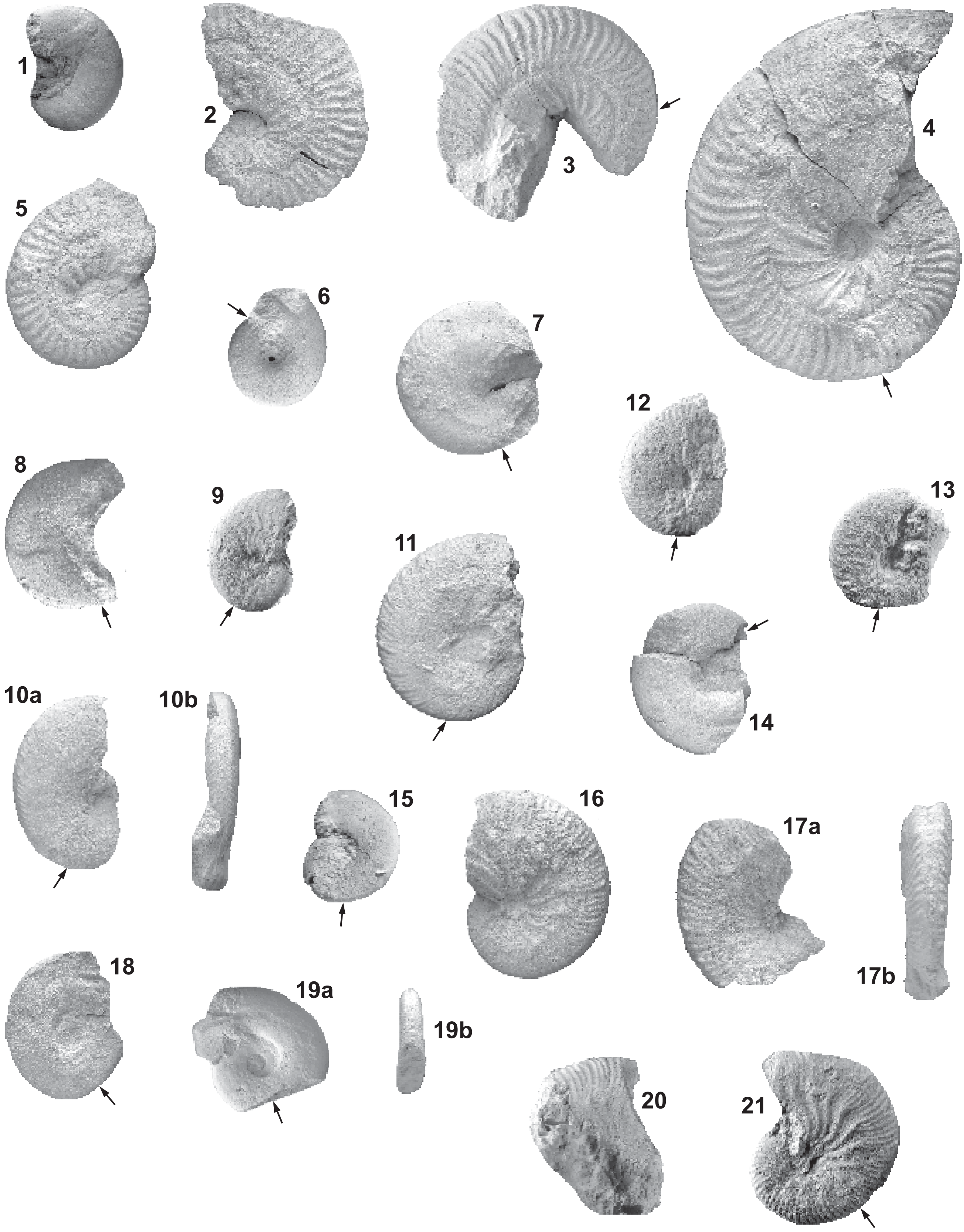
Fig. 18. *Glochiceras* (?*Lingulaticeras*) sp. nov.; MWG UW ZI/58/047; Syborowa Góra section, bed 15; Semimammatum Subzone, Hypselum Zone

Fig. 19a, b. *Glochiceras* (?*Lingulaticeras*) sp. nov., lateral and ventral view; MWG UW ZI/58/058; Biskupice section, bed 4; Semimammatum Subzone, Hypselum Zone

Fig. 20. *Taramelliceras* (*Taramelliceras*) aff. *externnodosum* (Dorn), body-chamber; MUZ PIG 1797.II.40; Katarowa Góra section, bed 22 (B2/B3)); Semiarmatum Subzone or Berrense Subzone, Hypselum Zone

Fig. 21. *Taramelliceras* (*Taramelliceras*) aff. *externnodosum* (Dorn); MUZ PIG 1797.II.39; Bobrowniki section, bed 0; Berrense Subzone (Hypselum Zone) or Bimammatum Subzone (Bimammatum Zone)

All ammonites in natural size; the phragmocone/body chamber boundary is arrowed



Andrzej WIERZBOWSKI, Bronisław A. MATYJA — Ammonite biostratigraphy in the Polish Jura sections as a clue for recognition of the uniform base of the Kimmeridgian Stage

PLATE 2

Fig. 1. *Taramelliceras* (*Taramelliceras*) *costatum costatum* (Quenstedt) forma *aurita*; MUZ PIG 1797.II.29; Bobrowniki section, bed 1f; Bimammatum Subzone (Bimammatum Zone)

Fig. 2. *Taramelliceras* (*Taramelliceras*) *costatum laterinodosum* Karvé-Corvinus; MUZ PIG 1797.II.32; Bobrowniki section, bed C; Berrense Subzone (Hypselum Zone) or Bimammatum Subzone (Bimammatum Zone)

Fig. 3. *Taramelliceras* (*Taramelliceras*) *costatum laterinodosum* Karvé-Corvinus; MUZ PIG 1797.II.27; Bobrowniki section, bed 1c; Bimammatum Subzone (Bimammatum Zone)

Fig. 4. *Amoeboceras* ex gr. *A. marstonense* Spath –*A. rosenkrantzi* Spath; MWG UW ZI/58/101; Syborowa Góra section, bed 30; Semimammatum Subzone, Hypselum Zone

Fig. 5. *Amoeboceras ovale* (Quenstedt); MWG UW ZI/58/094; Biskupice section, bed 4; Semimammatum Subzone, Hypselum Zone

Fig. 6. *Amoeboceras ovale* (Quenstedt); MWG UW ZI/58/095; Biskupice section, bed 4; Semimammatum Subzone, Hypselum Zone

Fig. 7. *Amoeboceras* aff. *ovale* (Quenstedt); MWG UW ZI/58/067; Syborowa Góra section, bed 7; Grossouvrei Subzone, Bifurcatus Zone

Fig. 8. *Amoeboceras* ex gr. *leucum* Spath, body-chamber; MWG UW ZI/58/079; Syborowa Góra section, bed 15; Semimammatum Subzone, Hypselum Zone

Fig. 9. *Amoeboceras* cf. *freboldi* Spath, body-chamber; MWG UW ZI/58/070; Syborowa Góra section, bed 7; Grossouvrei Subzone, Bifurcatus Zone

Fig. 10. *Amoeboceras tuberculatoalternans* (Nikitin); MUZ PIG 1797.II.71; Katarowa Góra section, bed 20, Semiarmatum Subzone, Hypselum Zone

Fig. 11. *Amoeboceras tuberculatoalternans* (Nikitin); MUZ PIG 1797.II.72; Katarowa Góra section, bed 20, Semiarmatum Subzone, Hypselum Zone

Fig. 12. *Amoeboceras rosenkrantzi* Spath, body-chamber; MUZ PIG 1797.II.74; Katarowa Góra section, bed 20, Semiarmatum Subzone, Hypselum Zone

Fig. 13. *Amoeboceras rosenkrantzi* Spath, body-chamber; MUZ PIG 1797.II.76; Katarowa Góra section, bed C2, Semiarmatum Subzone, Hypselum Zone

Fig. 14a, b. *Amoeboceras subcordatum* (d'Orbigny) sensu Salfeld (1916), body-chamber, lateral and ventral view; MUZ PIG 1797.II.79; Bobrowniki section, bed C; Berrense Subzone (Hypselum Zone) or Bimammatum Subzone (Bimammatum Zone)

Fig. 15. *Ringsteadia* cf. *pseudoyo* Salfeld; MWG UW ZI/58/002; Syborowa Góra section, bed 27; Semimammatum Subzone, Hypselum Zone

Fig. 16. *Ringsteadia pseudoyo* Salfeld; MWG UW ZI/58/004; Podzamcze section, rubble; Hypselum Zone

Fig. 17. *Ringsteadia teisseyrei* (Siemiradzki); MWG UW ZI/58/005; Podzamcze section, rubble; Hypselum Zone

Fig. 18. *Ringsteadia* cf. *salfeldi* Dorn; MWG UW ZI/58/019; Jaroszów-Zawada section, bed 2; Semimammatum Subzone, Hypselum Zone

All ammonites in natural size; the phragmocone/body chamber boundary is arrowed

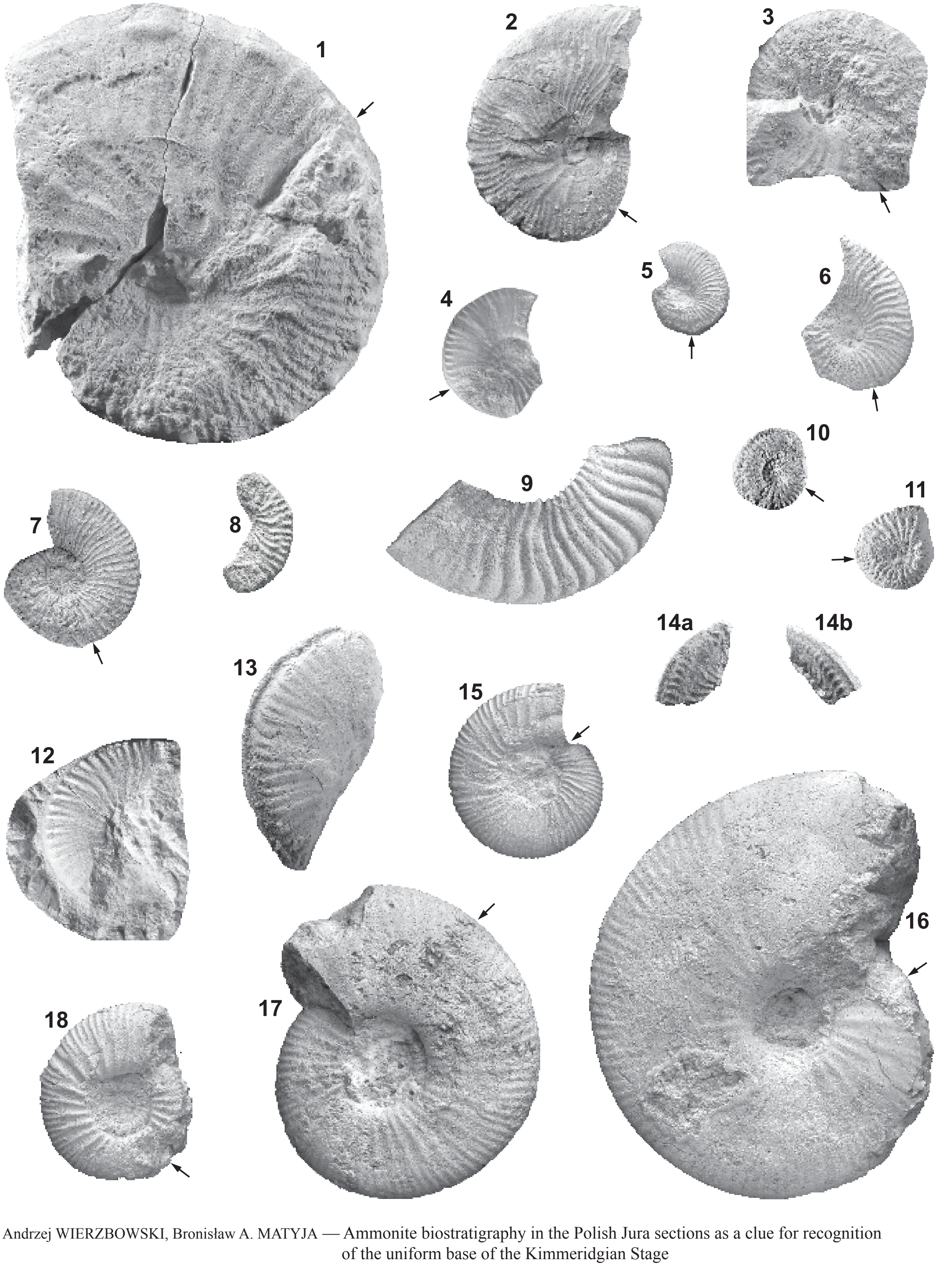

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PLATE 3

Fig. 1. *Ringsteadia teisseyrei* (Siemiradzki); MUZ PIG 1797.II.50; Katarowa Góra section, bed 17; Semimammatum Subzone or Semiarmatum Subzone, Hypselum Zone

Fig. 2. *Ringsteadia* cf. *pseudoyo* Salfeld; MUZ PIG 1797.II.63; Katarowa Góra section, bed 5; Semimammatum Subzone, Hypselum Zone

Fig. 3. *Ringsteadia* cf. *pseudoyo* Salfeld; MUZ PIG 1797.II.65; Katarowa Góra section, bed 17; Semimammatum Subzone or Semiarmatum Subzone, Hypselum Zone

Fig. 4. *Ringsteadia* cf. *salfeldi* Dorn; MUZ PIG 1797.II.66; Katarowa Góra section, bed 20; Semiarmatum Subzone, Hypselum Zone

Fig. 5. ?*Decipia kostromensis* Głowniak *et al.*, phragmocone/body chamber boundary is within missing part of the last whorl; MWG UW ZI/58/164; Syborowa Góra section, bed 11; Semimammatum Subzone, Hypselum Zone

Fig. 6. *Microbiplices procedens* (Oppenheimer); MUZ PIG 1797.II.82; Katarowa Góra section, bed 5; Semimammatum Subzone, Hypselum Zone

Fig. 7. *Microbiplices procedens* (Oppenheimer); MWG UW ZI/58/017; Syborowa Góra section, bed 27; Semimammatum Subzone, Hypselum Zone

Fig. 8. *Microbiplices* aff. *procedens* (Oppenheimer), phragmocone/body chamber boundary is within missing part of the last whorl; MWG UW ZI/58/166; Syborowa Góra section, bed 15; Semimammatum Subzone, Hypselum Zone

Fig. 9. *Microbiplices procedens* (Oppenheimer); MWG UW ZI/58/165; Syborowa Góra section, bed 17; Semimammatum Subzone, Hypselum Zone

Fig. 10. *Microbiplices microbiplex* (Quenstedt), phragmocone; MWG UW ZI/58/012; Syborowa Góra section, bed 30; Semimammatum Subzone, Hypselum Zone

Fig. 11. *Microbiplices microbiplex* (Quenstedt); MWG UW ZI/58/021; Jaroszów-Zawada section, bed 2; Semimammatum Subzone, Hypselum Zone

Fig. 12. *Microbiplices microbiplex* (Quenstedt); MWG UW ZI/58/025; Biała Dolna section, bed 2; Semimammatum Subzone, Hypselum Zone

Fig. 13. *Microbiplices microbiplex* (Quenstedt); MWG UW ZI/58/007; Syborowa Góra section, rubble (?bed 30); Semimammatum Subzone, Hypselum Zone

Fig. 14. *Microbiplices microbiplex* (Quenstedt), phragmocone/body chamber boundary is within missing part of the last whorl ; MUZ PIG 1797.II.87; Katarowa Góra section, bed 20; Semiarmatum Subzone, Hypselum Zone

Fig. 15. *Microbiplices microbiplex* (Quenstedt); MUZ PIG 1797.II.87; Katarowa Góra section, bed 17; Semimammatum Subzone or Semiarmatum Subzone, Hypselum Zone

Fig. 16. *Microbiplices anglicus vieluniensis* Wierzbowski et Matyja subsp. nov., holotype; MUZ PIG 1797.II.80; Bobrowniki section, bed E; Berrense Subzone (Hypselum Zone) or Bimammatum Subzone (Bimammatum Zone)

Fig. 17. *Microbiplices anglicus vieluniensis* Wierzbowski et Matyja subsp. nov., paratype, phragmocone/body chamber boundary is within missing part of the last whorl; MUZ PIG 1797.II.01; Bobrowniki section, bed C; Berrense Subzone (Hypselum Zone) or Bimammatum Subzone (Bimammatum Zone)

All ammonites in natural size; the phragmocone/body chamber boundary is arrowed

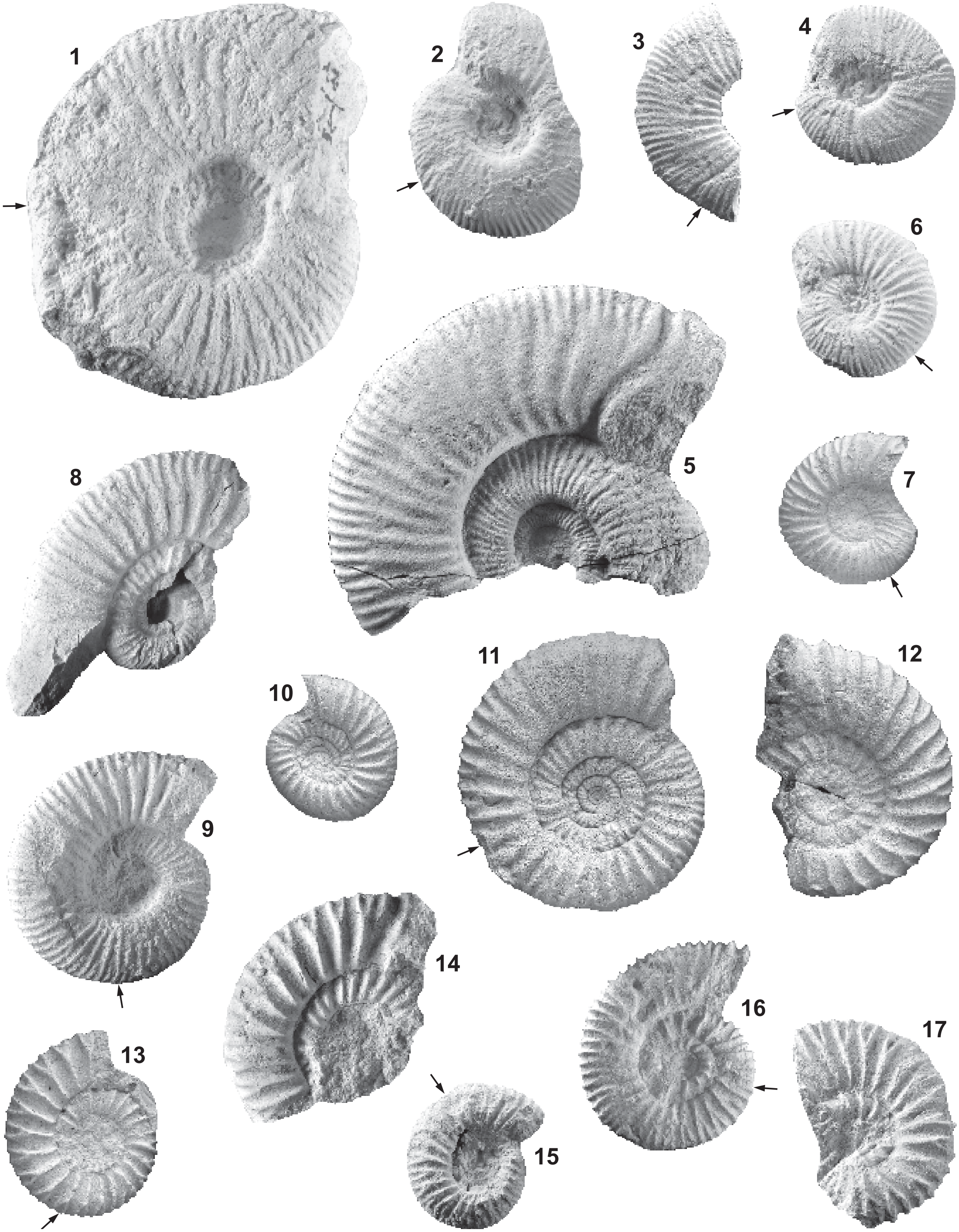
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PLATE 4

Fig. 1. *Microbiplices anglicus vieluniensis* Wierzbowski et Matyja subsp. nov.; MUZ PIG 1797.II.02; Bobrowniki section, bed C; Berrense Subzone (Hypselum Zone) or Bimammatum Subzone (Bimammatum Zone)

Fig. 2. *Microbiplices anglicus vieluniensis* Wierzbowski et Matyja subsp. nov.; MUZ PIG 1797.II.03; Bobrowniki section, bed C; Berrense Subzone (Hypselum Zone) or Bimammatum Subzone (Bimammatum Zone)

Fig. 3. *Prorasenia* cf. *crenata* (Quenstedt); MUZ PIG 1797.II.10; Bobrowniki section, bed B; Berrense Subzone (Hypselum Zone) or Bimammatum Subzone (Bimammatum Zone)

Fig. 4. *Perisphinctes* (*Dichotomoceras*) *bifurcatus* (Quenstedt), in density of ribbing similar to *P.* (*D.*) *crassus* Enay; MWG UW ZI/58/104; Syborowa Góra section, bed 9; Grossouvrei Subzone, Bifurcatus Zone

Fig. 5. *Perisphinctes* (*Dichotomoceras*) *bifurcatus* (Quenstedt), in density of ribbing similar to *P.* (*D.*) *crassus* Enay; MWG UW ZI/58/109; Syborowa Góra section, bed 8; Grossouvrei Subzone, Bifurcatus Zone

Fig. 6. *Perisphinctes* (*Dichotomoceras*) *bifurcatus* (Quenstedt), phragmocone; MWG UW ZI/58/110; Syborowa Góra section, bed 3; Grossouvrei Subzone, Bifurcatus Zone

Fig. 7. *Perisphinctes* (*Dichotomoceras*) *bifurcatus* (Quenstedt), phragmocone/body chamber boundary is within missing part of the last whorl; MWG UW ZI/58/112; Syborowa Góra section, bed 7; Grossouvrei Subzone, Bifurcatus Zone

Fig. 8. *Perisphinctes* (*Dichotomoceras*) *crassus* Enay, phragmocone; MWG UW ZI/58/113; Syborowa Góra section, bed 7; Grossouvrei Subzone, Bifurcatus Zone

Fig. 9. *Perisphinctes* (*Dichotomoceras*) cf. *microplicatilis* (Quenstedt); MWG UW ZI/58/114; Syborowa Góra section, bed 7; Grossouvrei Subzone, Bifurcatus Zone

Fig. 10. *Subdiscosphinctes mindowe* (Siemiradzki), phragmocone/body chamber boundary is within missing part of the last whorl; MWG UW ZI/58/120; Syborowa Góra section, bed 5; Grossouvrei Subzone, Bifurcatus Zone

Fig. 11. *Passendorferia* (*Enayites*) *rozaki* Meléndez; MWG UW ZI/58/149; Syborowa Góra section, bed 30; Semimammatum Subzone, Hypselum Zone

All ammonites in natural size; the phragmocone/body chamber boundary is arrowed

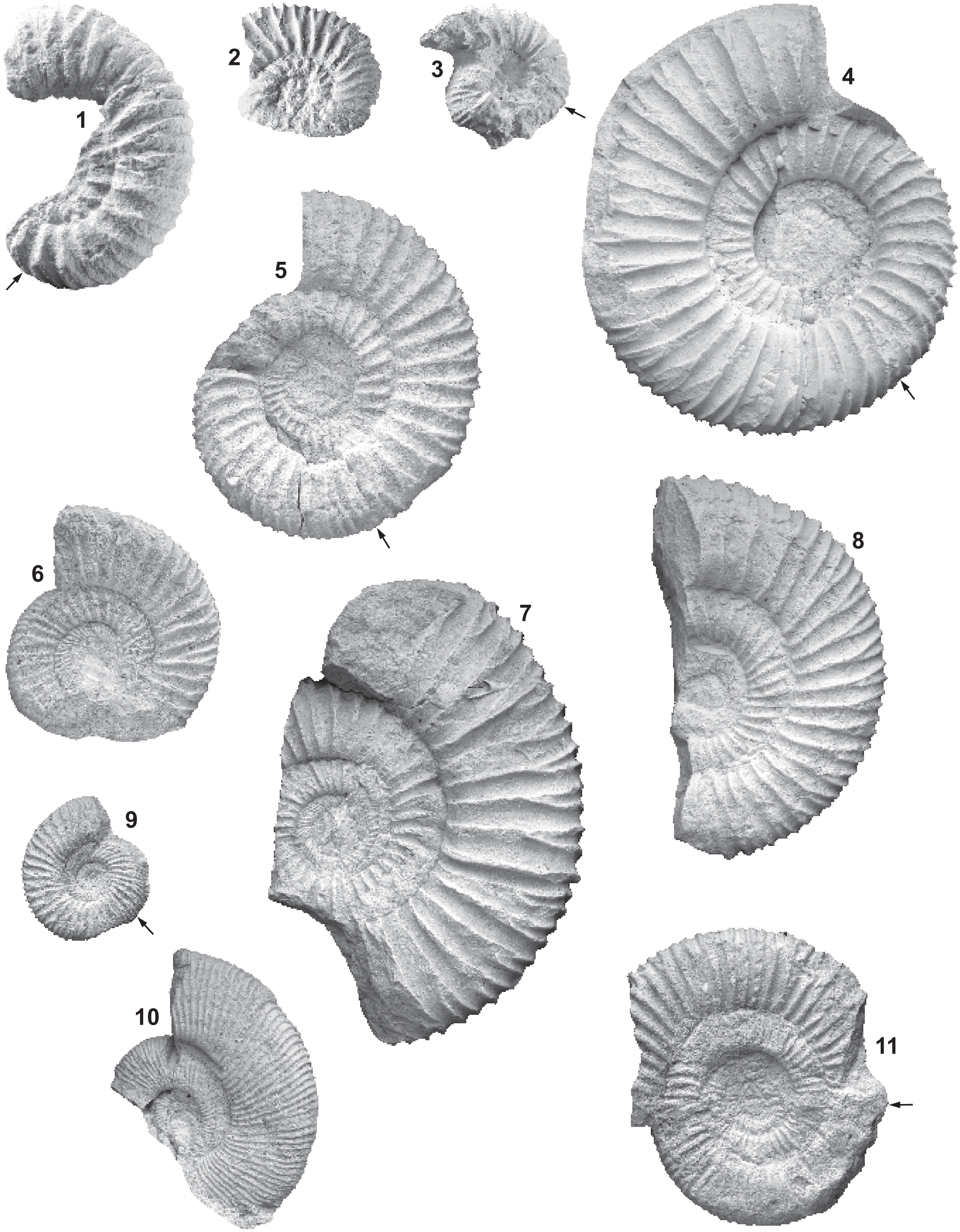

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PLATE 5

Fig. 1. *Subdiscosphinctes* („*Aureimontanites*“) *mindowe* (Siemiradzki); MWG UW ZI/58/103; Syborowa Góra section, bed 7; Grossouvrei Subzone, Bifurcatus Zone

Fig. 2. *Passendorferia uptonioides* (Enay), microconch; MWG UW ZI/58/146; Syborowa Góra section, rubble (beds 1–9); Grossouvrei Subzone, Bifurcatus Zone

All ammonites in natural size; the phragmocone/body chamber boundary is arrowed

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PLATE 6

Fig. 1. *Passendorferia*/*Presimoceras* transitional form, phragmocone/body chamber boundary is within missing part of the last whorl ; MWG UW ZI/58/163; Syborowa Góra section, bed 27; Semimammatum Subzone, Hypselum Zone

Fig. 2. *Graefenbergites arancensis* (Meléndez), a part of the last whorl preserved is body-chamber; MWG UW ZI/58/161; Syborowa Góra section, rubble (beds 1–5); Grossouvrei Subzone, Bifurcatus Zone

All ammonites in natural size

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PLATE 7

Fig. 1. *Graefenbergites idoceroides* (Dorn); MWG UW ZI/58/151; Biała Dolna section, bed 1; Semimammatum Subzone, Hypselum Zone

Fig. 2. *Graefenbergites idoceroides* (Dorn), phragmocone/body chamber boundary is within missing part of the last whorl ; MWG UW ZI/58/153; Syborowa Góra section, bed 19; Semimammatum Subzone, Hypselum Zone

Fig. 3. *Graefenbergites idoceroides* (Dorn); MWG UW ZI/58/154; Biała Dolna section, bed 1; Semimammatum Subzone, Hypselum Zone

Fig. 4. *Graefenbergites idoceroides* (Dorn); MUZ PIG 1797.II.54; Katarowa Góra section, bed 9; Semimammatum Subzone, Hypselum Zone

Fig. 5. *Praeataxioceras* sp. nov. ; MUZ PIG 1797.II.55; Katarowa Góra section, bed 20; Semiarmatum Subzone, Hypselum Zone

Fig. 6. *Praeataxioceras virgulatus* (Quenstedt); MUZ PIG 1797.II.56; Katarowa Góra section, bed 22 (B2/B3); Semiarmatum Subzone or Berrense Subzone, Hypselum Zone

Fig. 7. *Epipeltoceras semimammatum* (Quenstedt); MWG UW ZI/58/144; Jaroszów-Zawada section, rubble; Semimammatum Subzone, Hypselum Zone

Fig. 8. *Epipeltoceras semimammatum* (Quenstedt); MWG UW ZI/58/143; Syborowa Góra section, bed 30; Semimammatum Subzone, Hypselum Zone

Fig. 9. *Epipeltoceras semimammatum* (Quenstedt); MWG UW ZI/58/140; Syborowa Góra section, bed 27; Semimammatum Subzone, Hypselum Zone

Fig. 10. *Epipeltoceras semimammatum* (Quenstedt); MWG UW ZI/58/135; Syborowa Góra section, bed 30; Semimammatum Subzone, Hypselum Zone

Fig. 11. *Epipeltoceras* cf. *semiarmatum* (Quenstedt); MUZ PIG 1797.II.49; Katarowa Góra section – rubble (beds 18, 20 or 22); Semiarmatum Subzone, Hypselum Zone

All ammonites in natural size; the phragmocone/body chamber boundary is arrowed

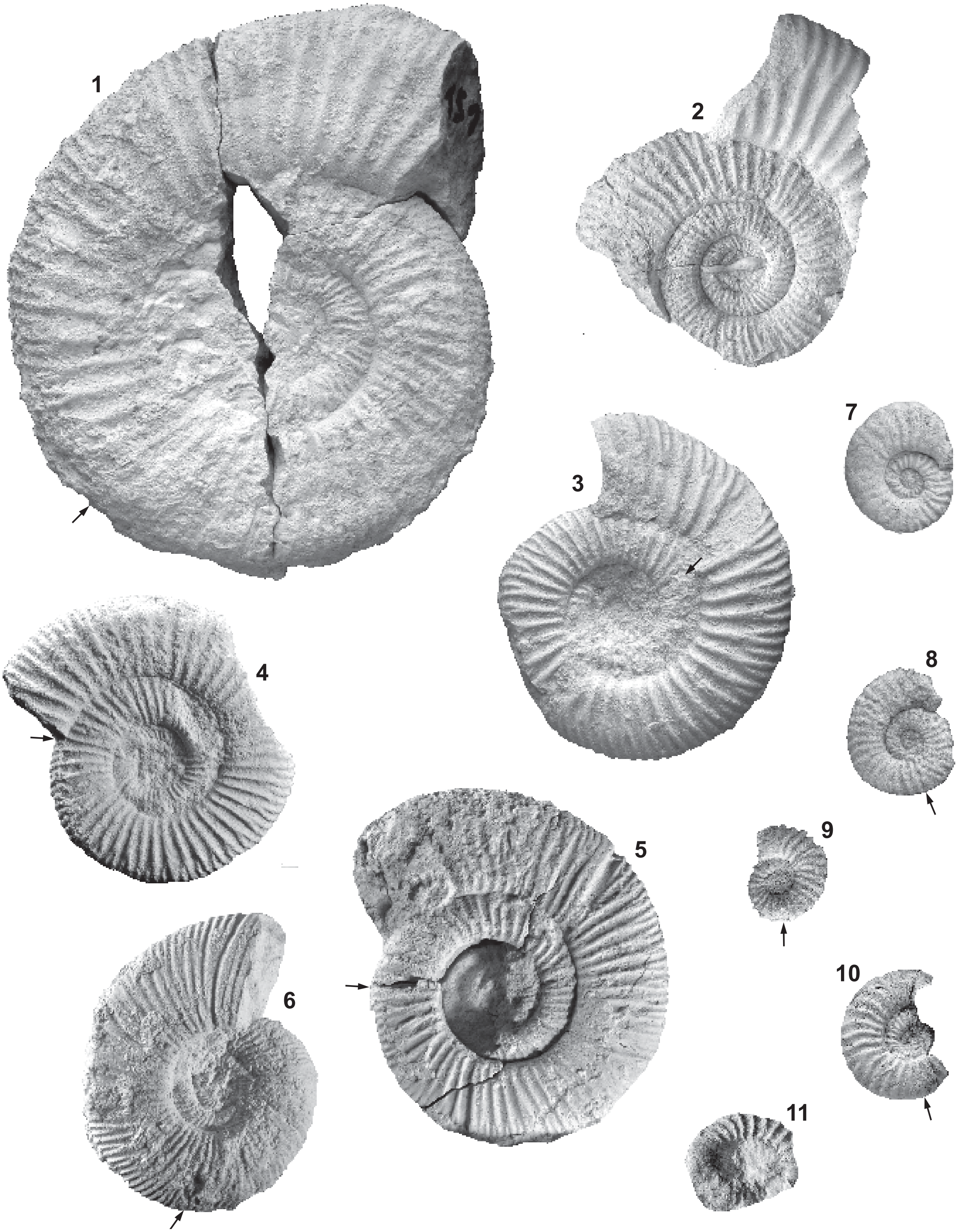

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PLATE 8

Fig. 1. *Neaspidoceras radisense* (d'Orbigny); MWG UW ZI/58/144; Jaroszów-Zawada section, bed 2; Semimammatum Subzone, Hypselum Zone

Fig. 2. *Neaspidoceras radisense* (d'Orbigny), phragmocone; MWG UW ZI/58/132; Syborowa Góra section, bed 32; Semimammatum Subzone, Hypselum Zone

Fig. 3. *Euaspidoceras striatocostatum* (Dorn); MWG UW ZI/58/127; Syborowa Góra section, bed 11; Semimammatum Subzone, Hypselum Zone

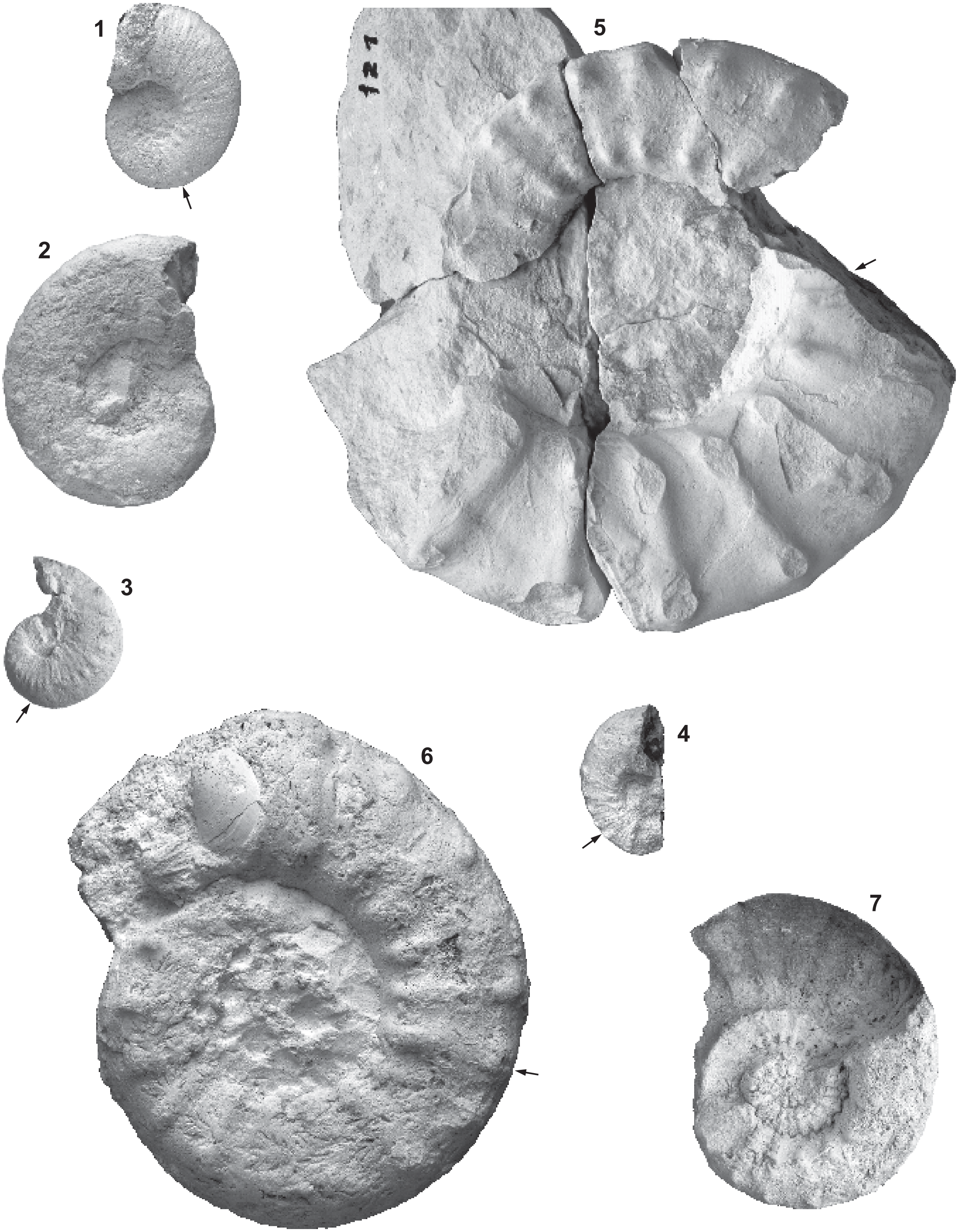
Fig. 4. *Euaspidoceras striatocostatum* (Dorn); MWG UW ZI/58/130; Syborowa Góra section, bed 30; Semimammatum Subzone, Hypselum Zone

Fig. 5. *Euaspidoceras* cf. *eucyphum* (Oppel); MWG UW ZI/58/121; Syborowa Góra section, bed 27; Semimammatum Subzone, Hypselum Zone

Fig. 6. *Euaspidoceras hypselum* (Oppel); MWG UW ZI/58/122; Morgi section, bed 1; Semimammatum Subzone, Hypselum Zone

Fig. 7. *Euaspidoceras hypselum* (Oppel), phragmocone; MWG UW ZI/58/123; Biskupice section, bed 4; Semimammatum Subzone, Hypselum Zone

All ammonites in natural size; the phragmocone/body chamber boundary is arrowed



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Appendix

COMMENTS ON BIVALVES *BUCHIA* FROM THE KATAROWA GÓRA SECTION

by Victor ZAKHAROV[1]

The twelve specimens studied come from the Katarowa Góra section: bed 17 (two specimens represented by separated left and right valves), bed 18 (one specimen – left valve, Fig. 7: 1), bed 20 (of four specimens three represented by left valves, Fig. 7: 2–4; one by right valve, Fig. 7: 5), bed 22 (three specimens – left valves, Fig. 7: 6, 9, 10), bed 23 (one specimen – left valve, Fig. 7: 7), and bed 24 (right valve, Fig. 7: 8). The morphology of the bulk of the specimens coincides precisely with that of *Buchia concentrica* (J. Sowerby). Only some specimens from bed 20 referred to as *Buchia* cf. *concentrica* (J.Sowerby) (Fig. 7: 2, 3) differ from the type specimen of the species in a more tapering shell outline, more convex left valve and a weaker sculpture. There are also some shells in the collection studied (*e.g.* from beds 18, 20, and 22), which resemble *Buchia tenuistriata* (Lahusen, 1888) in some characters (presence of radial ribs and the shape of left valves). Similar forms, however, are reported from Northern Siberia (*e.g.* in the Kimmeridgian Borealis Zone – see Zakharov, 1981, pl. 3: 6) where they constitute but a part of a uniform population of *B. concentrica*, and thus are considered as representing the intraspecific variations.

As it can be judged by the taphonomy of the material studied (valves are found isolated and poorly sorted by size, completely preserved valves are absent, no valve aggregations are present, meaning no sorting), it can be suggested that the sediment, which includes the shells, was formed in a relatively quiet environment, below the level of regular waves, and possibly below the depth of storm wave penetration.

Among Jurassic and Cretaceous bivalves, the geographic ranges of buchiid genera and species are restricted mostly to the Panboreal Realm. Most buchiid-bearing deposits are siliciclastic rocks: clays (or argillites), silts (or alevrolites), sands (or sandstones). In the territories which were close to the North Pole (Southeastern Asia, islands of modern Arctic Ocean, North Alaska, Northern Canada and Greenland) buchiids dominated in the bivalve communities of the Callovian, Late Jurassic and Neocomian. During the Late Jurassic and Early Cretaceous buchiids penetrated to the south several times, into Peri-Tethys areas, but did not domicile anywhere there for a longer time except for the Circum-Pacific region (North America, Primorye in Russia). Buchiids penetrated to Central European seas only sporadically (Zakharov, 1981; Kelly, 1990), *e.g. Buchia concentrica* is encountered commonly in central Poland, but also in southern Germany in limestones of the thin, but widely distributed, *Amoeboceras* layer in the Semimammatum Subzone of the Hypselum Zone of the Upper Oxfordian (Matyja, Wierzbowski, 1988, pl. 2). Thus, it may be concluded that these mollusks preferred cold and moderate environments, and were able to penetrate to the south (south of 45º north latitude) only during cooling events. This assumption is confirmed by the fact that around the Peri-Tethys margins buchiids are often associated with Boreal ammonites of the family Cardioceratidae.

Buchia concentrica (J. Sowerby) ranges from the Middle Oxfordian to the Lower Kimmeridgian of the Boreal succession – it occurs commonly in the Upper Oxfordian and Lower Kimmeridgian of North-East Greenland, Western and Arctic Canada, Alaska, Siberia, Eastern and Western Europe (Zakharov, 1981; Kelly, 1990). In the section of the Polish Jura studied it is encountered at some levels of the Hypselum Zone of the Upper Oxfordian – from the Semimammatum Subzone (Matyja, Wierzbowski, 1988), through the Semiarmatum Subzone up to the Berrense Subzone (see materials described herein).

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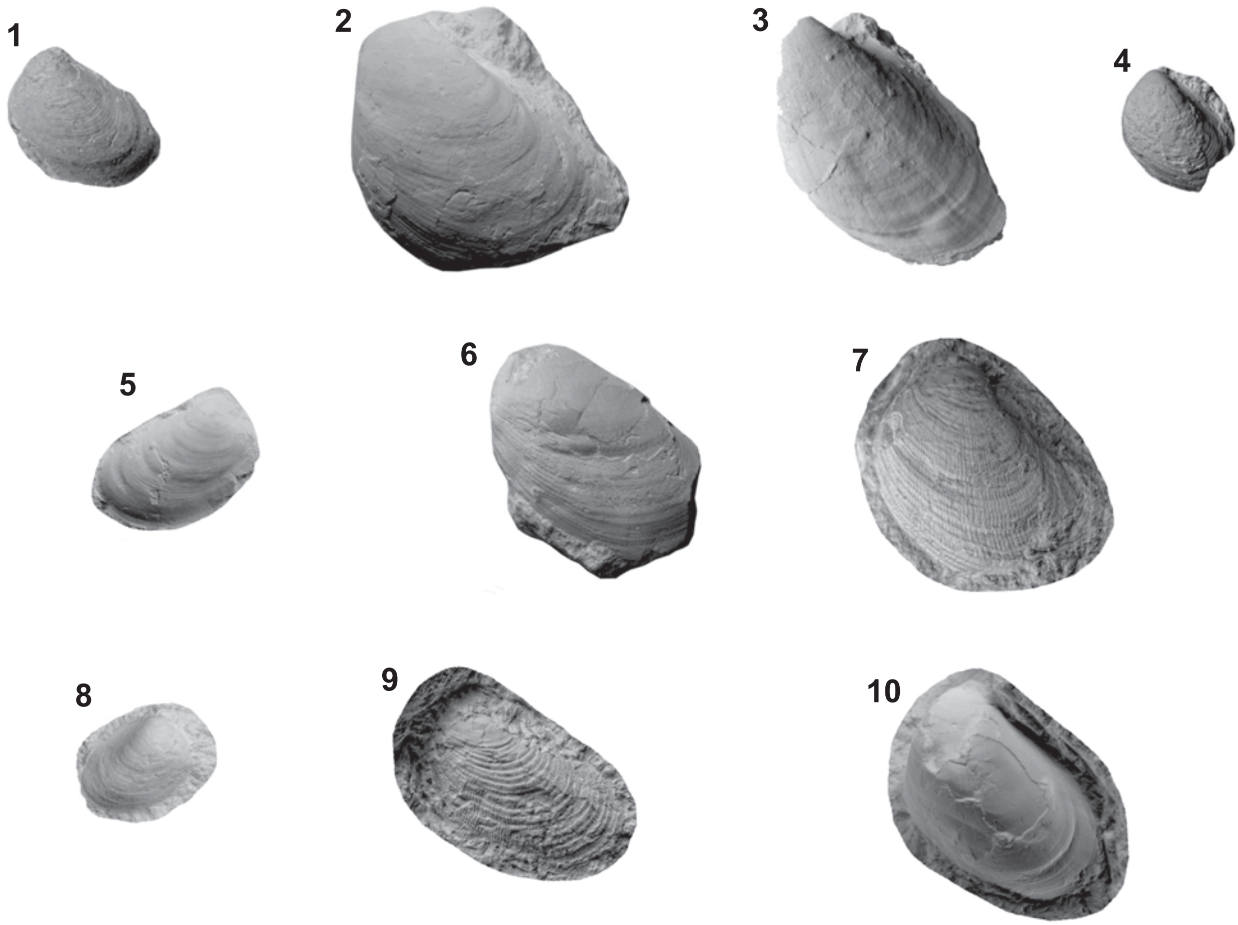

Fig. 7. Bivalves *Buchia* from the Katarowa Góra section from the Hypselum Zone

1 – *Buchia concentrica* (J. Sowerby), left valve; as the shell is absent the ornamentation of concentric and radial ribs is poorly visible; bed 18
2 – *Buchia* cf. *concentrica* (J. Sowerby), left valve; bed 20
3 – *Buchia* cf.*concentrica* (J. Sowerby), left valve; differs from type specimen by more prominent tapering, more convex valve and less developed sculpture; bed 20
4 – *Buchia concentrica* (J. Sowerby), left valve; bed 20
5 – *Buchia concentrica* (J. Sowerby), right valve, as the shell is absent the ornamentation is poorly visible; bed 20
6 – *Buchia concentrica* (J. Sowerby), left valve; bed 22
7 – *Buchia concentrica* (J. Sowerby), left valve; bed 23
8 – *Buchia concentrica* (J. Sowerby), right valve; as the shell is absent the ornamentation is poorly visible; bed 24
9 – *Buchia concentrica* (J. Sowerby), left valve; bed 22 (B2/B3)
10 – *Buchia* cf. *concentrica* (J. Sowerby), left valve; note weakly developed concentric sculpture; bed 22 (B2/B3); all specimens of collection MUZ PIG 1797.II.

All bivalves in natural size