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Boreal and Subboreal ammonites in the Submediterranean uppermost Oxfordian in the Bielawy section (northern Poland) and their correlation value

BRONISŁAW ANDRZEJ MATYJA & ANDRZEJ WIERZBOWSKI

Institute of Geology, University of Warsaw, Al. Żwirki i Wigury 93, PL-02-089 Warszawa, Poland.
E-mails: *bam@geo.uw.edu.pl, awzw@geo.uw.edu.pl*

ABSTRACT:

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The youngest deposits exposed in the Bielawy Quarry (Kujawy area, northern Poland) yielded both Submediterranean ammonites, making possible recognition of the uppermost Submediterranean Oxfordian, and Subboreal-Boreal ammonites, indicative of some parts of the Subboreal/Boreal lowermost Kimmeridgian. This makes possible closer correlation of the different zonal schemes that appear to be important in discussion of the uniform Oxfordian/Kimmeridgian boundary and recognition of its GSSP. The upper part of the Submediterranean Planula Subzone yields Boreal *Amoeboceras* of the *Plasmatites* group, indicative of the Boreal Bauhini Zone. Moreover, the lowermost part of the Submediterranean Galar Subzone corresponding to the wenzeli horizon yields Boreal *Amoeboceras* of the *Amoebites* group (such as *Amoeboceras bayi* BIRKELUND & CALLOMON), indicative of the lowermost part of the Boreal Kitchini Zone, as well as late representatives of the genus *Pictonia*, described here as *Pictonia kuiaviensis* sp. nov., allowing correlation with the upper part of the Subboreal Baylei Zone.

Key-words: Jurassic, Stratigraphy, Zonal schemes, Oxfordian/Kimmeridgian boundary, Ammonites, Northern Poland.

INTRODUCTION

Exposures of Upper Jurassic deposits in northern Poland are rare because of the usually developed thick cover of Caenozoic deposits. The rare exposures include, besides the nowadays mostly abandoned quarries in the area of north-west Pomerania, the still existing outcrops of Oxfordian deposits in the Kujawy area, including the extensive Bielawy and Wapienno working quarries in the Zalesie Anticline (Text-figs 1, 2).

In contrast to the siliciclastic-dominated facies in the Oxfordian of northern Poland, the facies recognized in the Middle and Upper Oxfordian in the Bielawy and Wapienno quarries are represented by different types of carbonates – from the bioherm limestones of the microbial-sponge biohermal complex, to different flank deposits, and succeeding micritic limestones and marls (B1-B5, C – according to MATYJA & *al.* 1985). All of these deposits owe their origin to a domal structural high on the Jurassic sea-floor formed by halokinesis (MATYJA & WIERZBOWSKI 1985). The Bielawy and Wapienno quarries are located on the south-eastern limb of the Zalesie Anticline, an elongated structure of mostly halokinetic-origin which developed during the Mesozoic and even the Caenozoic. The Oxfordian deposits exposed here show a regional dip of

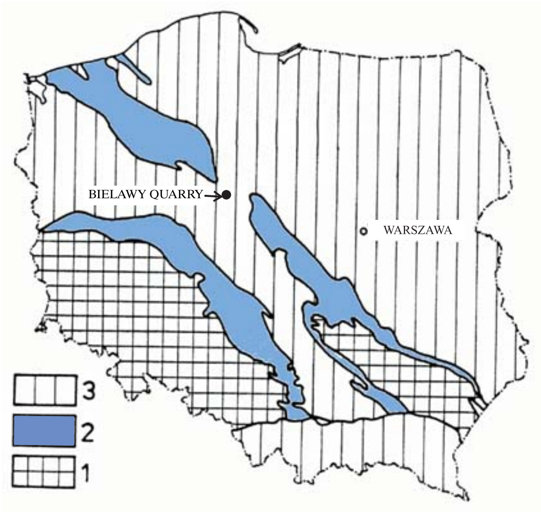

Fig. 1. Geological map of Poland without Caenozoic deposits showing location of the study area; 1 – pre-Jurassic strata, 2 – Jurassic strata; 3 – Cretaceous and Mesozoic of the Carpathians area

about 16^0 to the south-west, which results in the appearance of the youngest strata in the southernmost part of the Bielawy Quarry. Only these youngest deposits, corresponding to the transition from the biohermal flank to basinal deposits, yielded ammonites of the upper part of the Planula Zone, *i.e.* the uppermost part of the Submediterranean Upper Oxfordian, the subject of the present paper.

Although Submediterranean ammonites dominate in the Oxfordian and Lower Kimmeridgian in northern Poland, ammonites of Subboreal and Boreal affinity occur here also fairly abundantly but only in some parts of the stratigraphical interval. This makes the sections from northern Poland important for closer correlation of different zonal schemes (e.g. MATYJA & WIERZBOWSKI 1988a). The evidence from the studied section of the upper part of the Planula Zone from the Bielawy Quarry yielding ammonites of both Submediterranean type, as well as Subboreal and Boreal type, is thus of wider interest, as it provides valuable support for correlation of the zonal schemes.

It should be remembered that, beginning in the late Planula Chron, and through the Early Kimmeridgian, there existed a direct marine connection between northern Poland and southern Germany, through the area of the Bohemian Massif, at present almost completely devoid of Upper Jurassic sediments. This resulted in the appearance of similar diversified assemblage of ammonites (including deeper water Oppeliidae) in both of these areas and makes biostratigraphical comparison of the Submediterranean ammonite faunal successions (including that from the section studied) possible in remarkable detail (MATYJA & WIERZBOWSKI 1998a). On the other hand, the area of the Polish Uplands (Cracow-Wieluń Upland, Holy Cross Mts.) was occupied from the latest Submediterranean Oxfordian until the end of the Early Kimmeridgian by shallow-water carbonate-platform facies: hence, deposits occurring there are generally poorer in ammonites. Moreover, the ammonites are represented almost exclusively by shallow-water Perisphinctaceae, which are less suitable for wider biostratigraphical correlations.

SECTION AND AMMONITES

Description of the section

The section studied is located on the highest bench of the south-eastern part of the Bielawy cement works quarry (Text-figs 2, 3). Its precise location is shown by coordinates on map at the scale 1:25000 (sheet no. 364.22 – Pakość: coordinates: x-56866, y-91448). The section exposes about 9 metres of bedded limestones with intercalations of marls, divisible into fifty-two limestone and marly beds, numbered from the base upwards (Text-fig. 4). The lithologies are fairly diversified, which enables the distinguishing of four major rock-units (I-IV on Text-figs 3 and 4) in the section, as confirmed also by a study of thin sections. The lowest unit (I) about 4.20 m in thickness (beds 1-18), consists of light grey spotted limestones with intercalations of dark grey marls: the limestones vary from the cyanobacterian biolithite type (in the lower part of the unit) to the wackestone type with common tuberoids containing fragments of siliceous sponges. A still higher unit (II), about 2.70 m in thickness (beds 19-34), shows a succession of white, thin-bedded limestones with intercalations of whitish marly limestones: the rocks are mostly mudstones with loosely placed sponge spicules of the monaxon type, small redeposited *Tubiphytes*, and other fragments of organogenic remains. In the upper part of the section the easily recognizable unit (III), about 0.6 m in thickness (beds 35-39), consists of light grey limestones with intercalations of dark grey marls: the limestones are mostly wackestones with abundant redeposited organogenic remains – mostly sponge spicules (especially of the rhax-type), small tuberoids, some of them with remains of siliceous sponge mummies, and less commonly occurring bryozoans, fragments of bivalve shells, tests of foraminifers, and echinoderm fragments. The highest unit (IV), about 1.40 m in thickness (beds 40-52), consists of white to white-yellowish micritic limestones with intercalations of dark marls: the limestones are mudstones with sparsely distributed very small bioclasts.

Fig. 2. General view of the Bielawy Quarry towards the south-east, showing position of the section studied

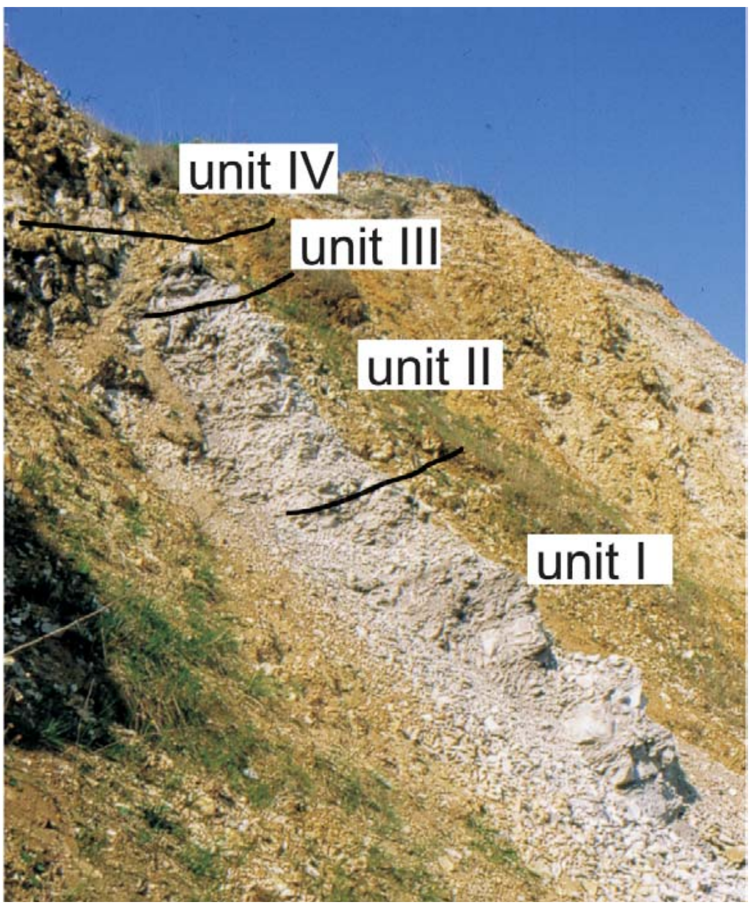

Fig. 3. Section studied in the south-eastern part of the Bielawy Quarry, lithostratigraphical units are the same as in Text-fig. 4

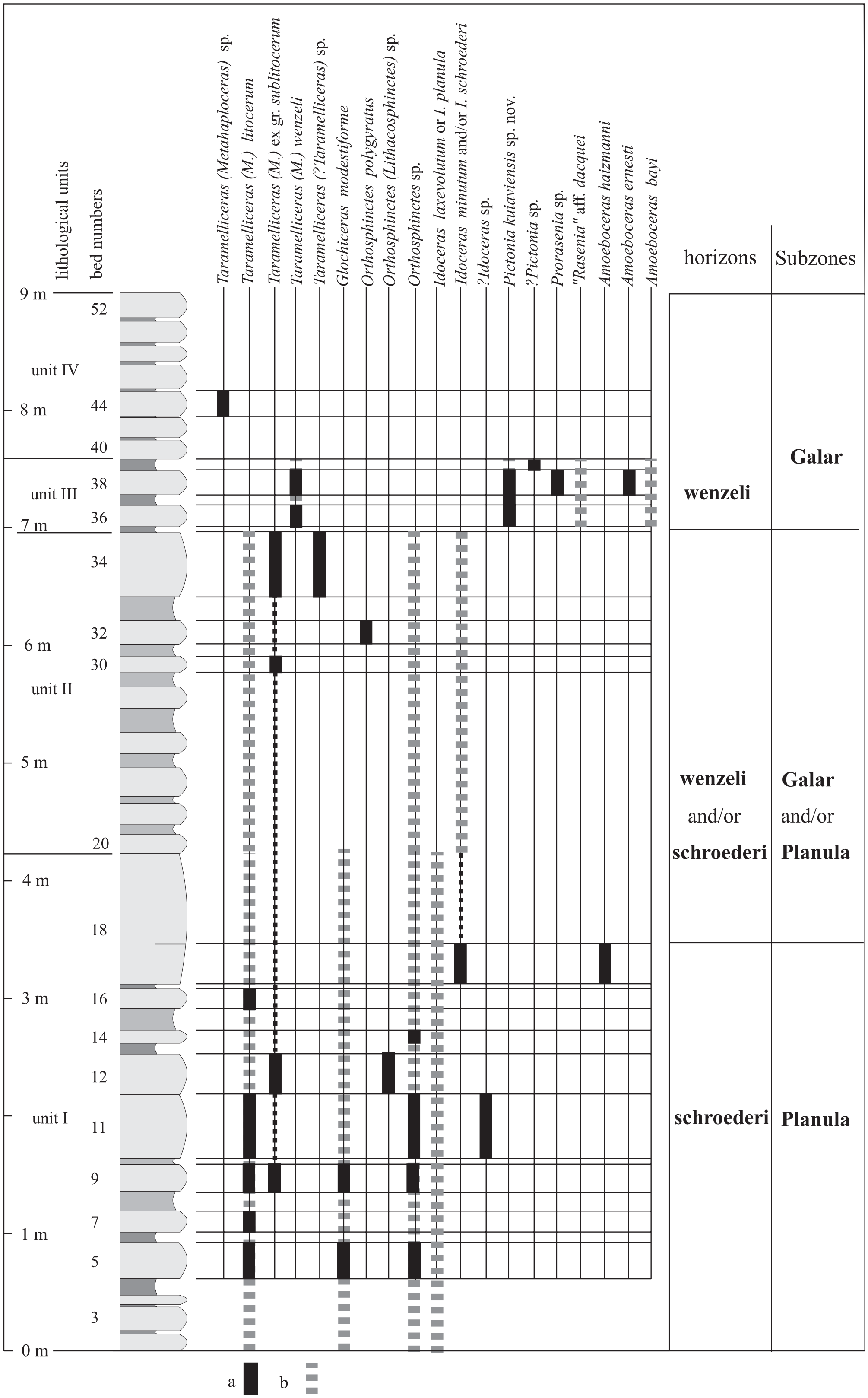

Fig. 4. Stratigraphical distribution of ammonites and biostratigraphical interpretation of studied section of the Planula Zone in the Bielawy Quarry; a – precise and b – approximate stratigraphical ranges of the ammonite taxa

The ammonites in the section are recorded bed by bed. Moreover, some more valuable specimens found loose in the talus, have been referred to particular parts of the section (rock-units I-IV) by means of the character of the matrix, as recognized also in thin sections. The ammonites from the section are listed below. Detailed palaeontological comments on some of these finds, indicated by numbers 1-8 in the list, are given in the following subchapter "Notes on the ammonites".

The ammonite succession in the studied section is as follows:

bed 5: *Taramelliceras* (*Metahaploceras*) *litocerum* (OPPEL), *Glochiceras* (*Coryceras*) *modestiforme* (OPPEL), *Orthosphinctes* sp.,

bed 7: *Taramelliceras* (*Metahaploceras*) *litocerum* (OPPEL),

bed 9: *Taramelliceras* (*Metahaploceras*) *litocerum* (OPPEL) – Pl. 2, Fig. 4, *Taramelliceras* (*Metahaploceras*) ex gr. *sublitocerum* (WEGELE)[1], *Glochiceras* (*Coryceras*) *modestiforme* (OPPEL), *Orthosphinctes* sp.,

bed 11: *Taramelliceras* (*Metahaploceras*) *litocerum* (OPPEL), *Orthosphinctes* sp., ?*Idoceras* sp.,

bed 12: *Taramelliceras* (*Metahaploceras*) ex gr. *sublitocerum* (WEGELE) – Pl. 2, Fig. 5, *Orthosphinctes* (*Lithacosphinctes*) sp. – Pl. 2, Fig. 9,

bed 14: *Orthosphinctes* sp.,

bed 16: *Taramelliceras* (*Metahaploceras*) *litocerum* (OPPEL) – Pl. 2, Fig. 2,

bed 18: (lower part): *Idoceras minutum* DIETERICH or *I. schroederi* WEGELE – Pl. 2, Fig. 10, *Amoeboceras haizmanni* (FISCHER)[2] – Pl. 1, Fig. 2,

ammonites found in the talus and inferred to come from the lower part of the section (unit I – beds 1-18) include *Taramelliceras* (*Metahaploceras*) *litocerum* (OPPEL) - Pl. 2, Fig. 3, *Glochiceras* (*Coryceras*) *modestiforme* (OPPEL) – Pl. 2, Fig. 1, *Idoceras laxevolutum* (FONTANNES) or *I. planula* (HEHL) sensu ZIEGLER 1959 – Pl. 2, Fig. 11, *Orthosphinctes* (*Orthosphinctes*) sp., *Orthosphinctes* spp.,

bed 30: *Taramelliceras* (*Metahaploceras*) ex gr. *sublitocerum* (WEGELE),

bed 32: *Orthosphinctes* (*Orthosphinctes*) *polygyratus* (REINECKE) – Pl. 2, Fig. 8,

bed 34: *Taramelliceras* (*Metahaploceras*) ex gr. *sublitocerum* (WEGELE), *Taramelliceras* (?*Taramelliceras*) sp.,

ammonites found in the talus and inferred to come from the middle part of the section (unit II – beds 19-34) include *Idoceras minutum* DIETERICH[3] – Pl. 2, Fig. 12, *Orthosphinctes* spp., *Taramelliceras* (*Metahaploceras*) spp., unidentifiable fragments of Aulacostephanidae,

bed 36: *Taramelliceras* (*Metahaploceras*) *wenzeli* (OPPEL)[4], *Pictonia kuiaviensis* sp. nov.[5] – Pl. 1, Fig. 11,

bed 37: *Pictonia* cf. *kuiaviensis* sp. nov.,

bed 38: *Taramelliceras* (*Metahaploceras*) *wenzeli* (OPPEL) – Pl. 2, Fig. 6 and 7, *Pictonia kuiaviensis* sp. nov. – Pl. 1, Figs 4, 5, 7, *Prorasenia* sp., *Amoeboceras ernesti* (FISCHER)[6] – Pl. 1, Fig. 1a,b,

bed 39: ?*Pictonia* sp.,

ammonites found in the talus and inferred to come from the upper part of the section (unit III, beds 36-39) include *Taramelliceras* (*Metahaploceras*) *wenzeli* (OPPEL), *Pictonia kuiaviensis* sp. nov. – Pl. 1, Figs 6, 8-10, "*Rasenia*" aff. *dacquei* WEGELE[7] – Pl. 1, Fig. 12, *Amoeboceras* (*Amoebites*) *bayi* BIRKELUND & CALLOMON[8] - Pl. 1, Fig. 3,

in the uppermost part of the section (unit IV – beds 40-50) ammonites are very rare: the only specimen found so far is *Taramelliceras* (*Metahaploceras*) sp. from bed 44.

Notes on the ammonites

The collection consists of 63 specimens. It is housed in the Museum of Geology, University of Warsaw (collection number IGPUW/A/38/1-63).

Detailed palaeontological comments on some of the ammonite finds indicated in the description of the section are given below.

The following abbreviations are used in palaeontological comments on ammonites: D – diameter of the specimen in mm, Wh – whorl height as percentages of D, Ud – umbilical diameter as percentage of D, PR – number of primary ribs per whorl, SR/PR – ratio of secondary to primary ribs (calculated for 5 ribs) at given diameter.

1. *Taramelliceras* (*Metahaploceras*) ex gr. *sublitocerum* (WEGELE)

Six mostly incomplete specimens found in beds nos. 9, 12, 30 and 34, of which two larger impressions attain about 25-28 mm in maximum diameter and show crowding and fading of the ribbing at the end of whorls, which suggests they are fully grown (Pl. 2, Fig. 5). The umbilicus is fairly wide (Ud = 20-23% at D = 17-28 mm). The ribbing is of the falcate type showing thus affinity with that of the subgenus *Metahaploceras*. The primary ribs are fairly strong, somewhat accentuated at the mid-flank; the secondary ribs are much fainter, occasionally bifurcating near the venter. The specimens show close similarity to the type specimen of *Taramelliceras* (*Metahaploceras*) *sublitocerum* (WEGELE) as illustrated by WEGELE (1929, Pl. 27, Fig. 6a, b), and to the smaller specimen of the two representing the type series of *Taramelliceras* (*Metahaploceras*) *pseudowenzeli* (WEGELE) (see WEGELE 1929, Pl. 27, Fig. 8a, b). These two specimens of WEGELE are very close to each other, differing mainly (SCHAIRER 1983) in the finer ribbing of *T. sublitocerum*, and they could represent a single species. On the other hand, the two specimens of the type series of *T.* (*M.*) *pseudowenzeli* are not unequivocally conspecific (SCHAIRER 1983, p. 43), and the larger of them seems similar to *Taramelliceras* (*Metahaploceras*) *wenzeli* (OPPEL) (see also SCHWEIGERT & CALLOMON 1997, p. 11).

2. *Amoeboceras haizmanni* (FISCHER)

Single specimen, about 28 mm in maximum diameter (Pl. 1, Fig. 2). The ribbing is clearly visible on the last half whorl: it consists initially of fairly thin ribs that are sharp and markedly accentuated at the umbilicus and at the transition to the venter, but markedly weakened at the mid-flank. The final part of the whorl shows the presence of dense weak ribblets. The specimen is very close to the holotype of *Amoeboceras haizmanni* as illustrated and described by FISCHER (1913, Pl. 5, Fig. 16, pp. 43-45), and discussed recently by SCHWEIGERT (2000, Pl. 1, Fig. 12, p. 205). The form *A. haizmanni* is one of the representatives of the *Amoeboceras bauhini* group (SALFELD, 1916, p. 182), which are usually placed in the subgenus *Plasmatites.*

3. *Idoceras minutum* DIETERICH

A single specimen (Pl. 2, Fig. 12), about 40 mm in final diameter and showing the aperture with lappets. The specimen is moderately evolute (Wh = 31%, Ud = 47.5% at D = 40 mm). The ribbing is fairly dense, consisting of about 46-48 primary ribs per whorl at 30-40 mm diameter. The ribs are biplicate, and, less commonly, single. The small final size and fairly dense, rather weak ribbing of the studied specimen suggest its affinity with the broadly conceived species *Idoceras* (*Subnebrodites*) *minutum* DIETERICH (see e.g. DIETERICH 1940, Pl. 2, Figs 3-7; SCHAIRER 1989, Pl. 8, Figs 1-14). The specimen in question differs, however, from the most typical representatives of the species in its more evolute coiling.

4. *Taramelliceras* (*Metahaploceras*) *wenzeli* (OPPEL)

The species *Taramelliceras* (*Metahaploceras*) *wenzeli* (OPPEL) is restricted nowadays to the specimens coming from the upper part of the Planula Zone (Pl. 2, Fig. 6 and 7), which is the type level of the holotype. Similar specimens from the Hauffianum Subzone, for a long time attributed to that species, differ in having elongated ventrolateral tubercles, and have been placed by SCHWEIGERT & CALLOMON (1997, Pl. 2, Figs 7-8, pp. 10-11) in the newly established species, *Taramelliceras* (*Metahaploceras*) *muehlheimense* (SCHWEIGERT & CALLOMON).

5. *Pictonia kuiaviensis* sp. nov. (Pl. 1, Figs 4-11)

1998a. *Pictonia* sp., MATYJA & WIERZBOWSKI, p. 46, Pl. II, fig. 2.

TYPE MATERIAL: holotype figured in Pl. 1, Fig. 9, and paratype in Pl. 1, Fig. 11, distinguished from a type series comprising eight specimens.

TYPE LOCALITY: Bielawy Quarry in the Zalesie Anticline.

TYPE HORIZON: wenzeli horizon of the Galar Subzone of the Planula Zone (uppermost Oxfordian of the Submediterranean subdivision) – beds 36-39 of the Bielawy Quarry section (Text-fig. 4).

ETYMOLOGY: after the name of the region – Kujawy (Latin – *Kuiavia*).

DESCRIPTION: Specimens of the type series are generally small, from about 30 to 50 mm in diameter. Coiling is from weakly involute (more commonly), to weakly evolute (Ud oscillates between 28-36%). Ribbing is moderately dense (at D = 25-50 mm, PR = 20 - 29), with a rather high number of secondary ribs (at D = 25-50 mm, SR/PR = 2.8-4.5). The primary ribs are rather fine up to about 20-30 mm diameter, then they become much more stronger, sometimes even somewhat swollen. The secondary ribs appear about mid-flank and have a more or less irregular appearance – some of them (mostly 2-3) are joined to the primaries, others become loose. Whereas the primary ribs are weakly prorsiradiate, the secondary ribs are rectiradiate. At about 40 mm diameter, the secondary ribs become slightly weaker at their bases, which results in the appearance of a poorly marked smooth spiral band (Pl. 1, Figs 6,10 and 11). Collared constrictions are well developed in some specimens, especially at smaller diameters.

DISCUSSION: The discussed specimens (as well as a few fragments referred to this species with reservation) show some variability, expressed mostly in the strength of ribbing. It covers the range from specimens showing more delicate and dense ribbing, to those that are more coarsely ribbed (see e.g. Pl. 1, Fig. 6 and Fig. 7 respectively).

The species *P. kuiaviensis* sp. nov. is closest to *Pictonia perisphinctoides* (WEGELE). The holotype of *Pictonia perisphinctoides* (WEGELE) is a fairly large specimen about 75 mm in diameter (see WEGELE 1929, Pl. 10, Fig. 2a, b, pp. 81-82), but other illustrated specimens of this species (e.g. SCHWEIGERT & CALLOMON 1997, Pl. 7, Figs 13-14) show final sizes and type of ornamentation similar to those of the bulk of the studied specimens. When compared with German specimens of *P. perisphinctoides*, the Polish specimens of *P. kuiaviensis* described herein differ in the appearance of secondary ribs slightly lower on the flank, in the often stronger development of primary ribs, and in the appearance of an incipient smooth spiral band developed at the bases of the secondary ribs already at about 40 mm diameter. These features result in a somewhat more raseniid-like appearance of specimens of *Pictonia kuiaviensis* which, as a whole, constitute an assemblage evolutionarily more advanced (and mostly younger) than that of *P. perisphinctoides*, thus being phylogenetically closer to the earliest members of the genus *Rasenia* – such as *Rasenia inconstans* SPATH.

6. *Amoeboceras ernesti* (FISCHER)

Two specimens, about 22 mm and 28 mm in their diameters, weakly evolute to weakly involute (Ud oscillates between 36 and 38.6%), very densely ribbed (at D = 20-25 mm, number of primary ribs per half whorl equals about 50); the ribs are clearly visible on the last half whorl, where they are mostly single, but a few bifurcating at about 2/3 of the whorl height, rectiradiate or slightly prorsiradiate on the flank, and markedly prorsiradiate on the venter; the whorl section is suboval with a serrated keel; the keel is bordered by poorly marked ventral sulci across which some outer ribs continue with slight weakening up to the keel's serrations (Pl. 1, Fig. 1ab). The specimens are similar to some densely ribbed forms such as *Amoeboceras ernesti* (FISCHER) – see FISCHER (1913, Pl. 5, Fig. 17a, b), and possibly also to *Amoeboceras subtilicaelatum* (FONTANNES). They appear close to densely ribbed specimens recorded recently from the lowermost part of the Platynota Zone from southern France and northern Switzerland referred to *A. ernesti* (FISCHER) by ATROPS & *al.* (1993, Pl. 2, Figs 11-16, p. 221), as well as to those from the uppermost part of the Planula Zone, and lowermost part of the Platynota Zone from southern Germany referred to as *A. subtilicaelatum* (FONTANNES) by SCHWEIGERT (2000, Pl. 1, Figs 13-14, pp. 205-206). All these specimens represent possibly the extremely densely ribbed variant of the same species as more loosely and strongly ribbed *Amoeboceras bayi* – see ATROPS & *al.* (1993).

7. "*Rasenia*" aff. *dacquei* WEGELE

Single specimen, about 80 mm in diameter, represented by an outer whorl (Pl. 1, Fig. 12). Ribbing is very coarse, consisting of slightly curved primaries, and nearly straight prorsiradiate secondaries (at D = 70 mm, PR is about 20, SR/PR = 3.2). Coiling is involute (at D = 70 mm, Wh = 35%, Ud = 30 %), whorl section – high oval. The coarse development of ribbing at a diameter comparable to that of the studied specimen is recognized in specimens of *Rasenia dacquei* of WEGELE (1929, Pl. 10, Figs 1a-b) from the Planula Zone of southern Germany, whose affinity with *Pictonia perisphinctoides* seems highly probable (SCHWEIGERT & CALLOMON 1997, p. 44-45). Although the studied specimen is similar to *Rasenia dacquei,* it differs in the more involute coiling of the whorls, and hence, it is tentatively referred to as "*Rasenia*" aff. *dacquei* WEGELE. As the specimen in question has been found in the same beds as *Pictonia kuiaviensis* it could, however, represent a later ontogenetic stage of that species.

8. *Amoeboceras* (*Amoebites*) *bayi* BIRKELUND & CALLOMON

Single specimen, about 23 mm in maximum diameter, with partly damaged part of outer whorl (Pl. 1, Fig. 3), mentioned previously by MATYJA & WIERZBOWSKI (1998b, p. 58). The coiling is weakly evolute (Ud = 43%, Wh = 40.5% at D = 21 mm). Ribbing is fairly dense (PR = 39 at D = 20 mm); ribs are straight, differentiated into simple primaries, and short secondaries, separated by a smooth spiral band (as stated on the preserved outer part of the last whorl). The looped outer ribs are developed at the end of the last whorl, already at about 20 mm diameter. The venter is tabulate, with a coarsely crenulated keel bordered by shallow ventral sulci. The specimen in almost all of its features compares well with representatives of the type-series of *Amoeboceras* (*Amoebites*) *bayi* as described and illustrated by BIRKELUND & CALLOMON (1985, Pl. 1, Figs 1-12, pp. 13-18), differing only in its smaller final size, and in the earlier appearance of looped ribs. This phenomenon may be treated as an adaptive reaction of the invasive Boreal ammonite to the new environmental conditions of the Submediterranean Province (see MATYJA & WIERZBOWSKI 2000).

SUBMEDITERRANEAN AMMONITE SUCCESSION IN THE BIELAWY SECTION AND CORRELATION WITH OTHER SECTIONS OF THE SUBMEDITERRANEAN PROVINCE

Although the ammonites of Submediterranean affinity predominate markedly in number over the Subboreal/Boreal ammonites, they represent a not very diversified assemblage consisting mostly of various forms of *Taramelliceras* (*Metahaploceras*) and *Orthosphinctes* (comprising about 50% and 20% of the total number of collected specimens respectively), accompanied by rare *Glochiceras* and *Idoceras.* Nevertheless, the Submediterranean ammonites permit the recognition of the upper part of the Planula Zone (Text-fig. 4), and the distinguishing of some ammonite subzones and horizons known so far from other areas of Europe, especially of southern Germany.

The lower and middle parts of the section, including unit I (beds 1-18) and at least a part, if not all of unit II (beds 19-34), yielded *Idoceras* (*Subnebrodites*) species indicating the presence of the Planula Subzone. The occurrence of *Idoceras minutum* DIETERICH or *I. schroederi* WEGELE in bed 18, as well as *I. minutum* in unit II (precise level unknown – beds 19-34), suggests the schroederi horizon at the top of the Planula Subzone, which is defined by the incoming of small-sized *Idoceras* species (SCHWEIGERT & CALLOMON 1997). What is possibly the same level has been distinguished as the minutum horizon – after *Idoceras* (*Subnebrodites*) *minutum* DIETERICH – in the Iberian Chain and SE France (see MELENDEZ & *al.* 1983; ATROPS & MELENDEZ 1994; CARIOU & *al.* 1997), but it was erroneously located at the base of the Planula Subzone, as shown by SCHWEIGERT & CALLOMON (1997, p. 38) and MATYJA & WIERZBOWSKI (1997, p. 92). It should be remembered that the minutum horizon under discussion does not correspond to the minutum horizon of MATYJA & WIERZBOWSKI (1997), which lies at the base of the Planula Subzone and yields densely-ribbed, small-sized ammonites similar to *I. minutum* (see MATYJA & WIERZBOWSKI 1997, Pl. 9, Fig. 4). Thus, for distinction, the latter horizon is named herein (Text-fig. 5) the aff. minutum horizon. As the type-level of *Idoceras minutum* DIETERICH lies within the upper part of the Planula Subzone in southern Germany, some other ammonites co-occurring therein have given support for the recognition of additional ammonite horizons that are generally close in their stratigraphical position to that of the schroederi horizon. These are: the tenuinodosum horizon (DIETERICH 1940, and earlier papers cited therein) from southern Germany, named after small-sized *Taramelliceras tenuinodosum* (WEGELE); and the praecursor horizon (ATROPS 1982; see also NITZOPOULOS 1974) from SE France and southern Germany, named after *Sutneria praecursor* DIETERICH. The stratigraphical positions of these two horizons seem to be approximately the same but unfortunately neither horizon can be distinguished in the Bielawy section as it has not yielded any specimens of *Taramelliceras tenuinodosum* (WEGELE) or of *Sutneria praecursor* DIETERICH. On the other hand, the section has yielded several specimens referred to *Taramelliceras*

Boreal Province	Submediterranean Province			Subboreal Province	
Zones	Zones	Subzones	horizons	horizons	Zones
Kitchini (pars)	Platynota (pars)	Polygyratus		inconstans	Cymodoce (pars)
			Amoeboceras		Baylei (pars)
	Planula	Galar	falcula		
			wenzeli		
Bauhini (pars)		Planula	schroederi	normandiana	
			planula		
			proteron	baylei	
			aff. minutum		
	Bimammatum (pars)	Hauffianum	broilii	densicostata (? pars)	
			litocerum		

Fig. 5. Correlation of the Subboreal and Boreal zonal schemes in relation to the Submediterranean uppermost Oxfordian zonal scheme discussed herein; grey blocks indicate the interval of uncertain correlation

(*Metahaploceras*) ex gr. *T. sublitocerum* (WEGELE) from beds 9-12, indicating a stratigraphical position not lower than the top part of the Planula Subzone, or the top part of the "Malm Mittel-Beta" of southern Germany (DIETERICH 1940; SCHMIDT-KALER 1962; SCHULER 1965; NITZOPOULOS 1974; SCHAIRER 1989). Hence, the stratigraphical interval from bed 9 up to an unprecisely recognized level between beds 19 and 34 of the section is assigned to the highest part of the Planula Subzone (Text-fig. 5), and tentatively correlated with the schroederi horizon from southern Germany.

A still younger Submediterranean fauna in the Bielawy section, consisting of *Taramelliceras* (*Metahaploceras*) *wenzeli* (OPPEL), is abundantly represented in unit III (beds 36 and 38). This species is the index form of a wenzeli horizon recognized in southern Germany as the lowermost horizon of the Galar Subzone of the Planula Zone (SCHWEIGERT & CALLOMON 1997; see also DIETERICH 1940). This occurrence indicates that the base of the Galar Subzone lies not higher than the base of bed 36, and not lower than the unidentifiable level within unit II (beds 19-34) marking the top of the Planula Subzone (see stratigraphical comments above).

CORRELATION BETWEEN SUBMEDITERRANEAN AND BOREAL/SUBBOREAL ZONAL SCHEMES

The oldest ammonite of the genus *Amoeboceras* in the Bielawy section is *Amoeboceras haizmanni* (FISCHER), found in bed 18. This form belongs to the *A. bauhini* group and thus it is indicative of the Bauhini Zone of the Boreal zonal scheme (see WIERZBOWSKI & SMELROR 1993; see also BIRKELUND & CALLOMON 1985). The ammonite comes from the part of the section that is correlated with the highest part of the Planula Subzone. The same species was reported also from southern Germany (SCHWEIGERT 2000, Pl. 1, Fig. 12) from the Planula Subzone, possibly from its highest part, *i.e.* the schroederi horizon.

A still younger assemblage of *Amoeboceras* is recognized in beds 36-39 in the Bielawy section, corresponding to the lower part of the Submediterranean Galar Subzone. It consists of *Amoeboceras* (*Amoebites*) *bayi* BIRKELUND & CALLOMON and *Amoeboceras ernesti* (FISCHER) – representing closely allied forms characteristic of the lowermost part of the Kitchini Zone of the Boreal subdivision (ATROPS & *al*. 1993; WIERZBOWSKI & SMELROR 1993). Similar forms, including densely ribbed *Amoeboceras subtilicaelatum* (FONTANNES), were reported from southern Germany from the upper part of the Galar Subzone (SCHWEIGERT 2000, Pl. 1, Fig. 13).

From the aforegoing, it becomes evident that the boundary between the Bauhini Zone and the Kitchini Zone of the Boreal Succession can be fairly well localized in the Bielawy section – and that it corresponds approximately to the boundary of the Planula Subzone and the Galar Subzone of the Submediterranean zonal scheme (Text-fig. 5; see also SCHWEIGERT & CALLOMON 1997, Text-fig. 10). The boundary between the Bauhini Zone and the Kitchini Zone lies thus somewhat lower in the Submediterranean Succession than previously assumed by the authors (MATYJA & WIERZBOWSKI 1997, Text-fig. 4; MATYJA & WIERZBOWSKI 1998a, Tab. 2).

The Bielawy section yielded also fairly numerous ammonites of Subboreal affinity belonging to the Aulacostephanidae, and coming almost exclusively from beds 36-39, where they comprise nearly 43% of the specimens collected. The most common of them are referred to *Pictonia kuiaviensis* sp. nov. This new species resembles *Pictonia perisphinctoides* (WEGELE) from the Planula Zone of southern Germany (occurring mostly in the Planula Subzone; see SCHWEIGERT & CALLOMON 1997), differing mainly in its more advanced, raseniid-like appearance (see description of the new species p. 418). It should be remembered that the "Submediterranean" species of the genus *Pictonia* have been sometimes referred to the subgenus *Pictonites*, which was founded by MESEZHNIKOV (1969, pp. 103-104) for *Pictonia perisphinctoides* and its allies from southern Germany; when compared with typical representatives of the genus *Pictonia* from the Subboreal Province, these "Submediterranean" species differ in their somewhat more regular ribbing. However, all "Submediterranean" species of the genus *Pictonia* – such as *Pictonia praeperisphinctoides* SCHWEIGERT & CALLOMON, *P. perisphinctoides* (WEGELE), and possibly also *P. kuiaviensis* sp. nov., are end-members of the laterally varied assemblages within the main stock of the genus *Pictonia*, rather than members of the independent Submediterranean lineage (see SCHWEIGERT & CALLOMON 1997, p. 45). *Pictonia perisphinctoides* seems to be closely related to the Subboreal species *P. thurmanni* (CONTEJEAN) = *P. normandiana* TORNQUIST (see HANTZPERGUE 1989), indicative of the upper part of the Subboreal Baylei Zone (BIRKELUND & CALLOMON 1985). On the other hand, *P. kuiaviensis*-like forms have not been recognized so far in the Subboreal Province. The most similar seem to be some weakly-ribbed specimens that are morphologically close to *Pictonia* but represent an extreme morphotype of the oldest *Rasenia inconstans* assemblage – e.g. *Rasenia inconstans* SPATH illustrated by BIRKELUND & CALLOMON (1985, p. 34; Pl. 14, Fig. 1) from East Greenland. Thus, according to the horizontal approach to species classification, it seems probable that the *P. kuiaviensis*-like assemblage should directly precede that of the first *Rasenia inconstans*, dominated by specimens with heavy bullate ribs, in the Subboreal aulacostephanid lineage. Hence, the occurrence of *P. kuiaviensis* sp. nov. in beds attributed to the lower part of the Galar Subzone in the Bielawy section may indicate that this stratigraphical interval still correlates with the upper part of the Subboreal Baylei Zone. This correlation agrees well with the occurrence of ammonites of the genus *Amoeboceras* related to the Boreal species *Amoeboceras bayi* in an even younger part of the Submediterranean Succession – in the lowermost part of the Platynota Zone of SE France and northern Switzerland (ATROPS & *al*. 1993), as it has been shown that *A. bayi* usually co-occurs with ammonites of the genus *Pictonia* in the upper part of the Baylei Zone in the Boreal/Subboreal Succession (BIRKELUND & CALLOMON 1985; WRIGHT 1989). Hence, it may be assumed that both the Galar Subzone of the Planula Zone, and the lowermost part of the Platynota Zone of the Submediterranean Succession correlate with the upper part of the Subboreal Baylei Zone, as previously suggested (MATYJA & WIERZBOWSKI 1997).

On the other hand, the species *Pictonia perisphinctoides*, as based on specimens known so far from southern Germany mostly from the middle part of the Planula Subzone, has been interpreted by SCHWEIGERT & CALLOMON (1997, p. 45) as staying morphologically between the species *Pictonia thurmanni* and the earliest species of the Subboreal genus *Rasenia* – *Rasenia inconstans* SPATH. Consequently, the upper boundary of the Subboreal Baylei Zone (and thus, the base of the overlying Cymodoce Zone) was correlated approximately (SCHWEIGERT & CALLOMON 1997, Text-fig. 10) with the base of the Submediterranean Galar Subzone. The occurrence of *P. kuiaviensis* sp. nov. in the lower part of the Galar Subzone in the Bielawy section, as well as of some closely related forms attributed to the genus *Pictonia* in the stratigraphical interval corresponding to the uppermost part of the Planula Zone in the Kcynia IG-IV Borehole in northern Poland (MATYJA & WIERZBOWSKI 1998a, p. 52; Pl. 2, Fig. 2), supports, however, correlation of the upper part of the Planula Zone with the Subboreal Baylei Zone (Text-fig. 5).

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PLATE 1

1 – *Amoeboceras ernesti* (FISCHER); IGPUW/A/38/41, two sides of the same specimen, bed 38

2 – *Amoeboceras haizmanni* (FISCHER); IGPUW/A/38/43, bed 18 (lower part)

3 – *Amoeboceras* (*Amoebites*) *bayi* BIRKELUND & CALLOMON; IGPUW/A/38/40, x 2, talus, unit III

4-11 – *Pictonia kuiaviensis* sp. nov.; 4 – IGPUW/A/38/8, bed 38; 5 – sp. nov.; IGPUW/A/38/3, bed 38; 6 – IGPUW/A/38/61, talus, unit III; 7 – IGPUW/A/38/14, bed 38; 8 – IGPUW/A/38/13, talus, unit III; 9 – holotype; IGPUW/A/38/4, talus, unit III; 10 – IGPUW/A/38/2, talus, unit III; 11 – paratype; IGPUW/A/38/1, bed 36;

12 – "*Rasenia*" aff. *dacquei* WEGELE; IGPUW/A/38/45, talus, unit III

All specimens are natural size, except Fig. 3

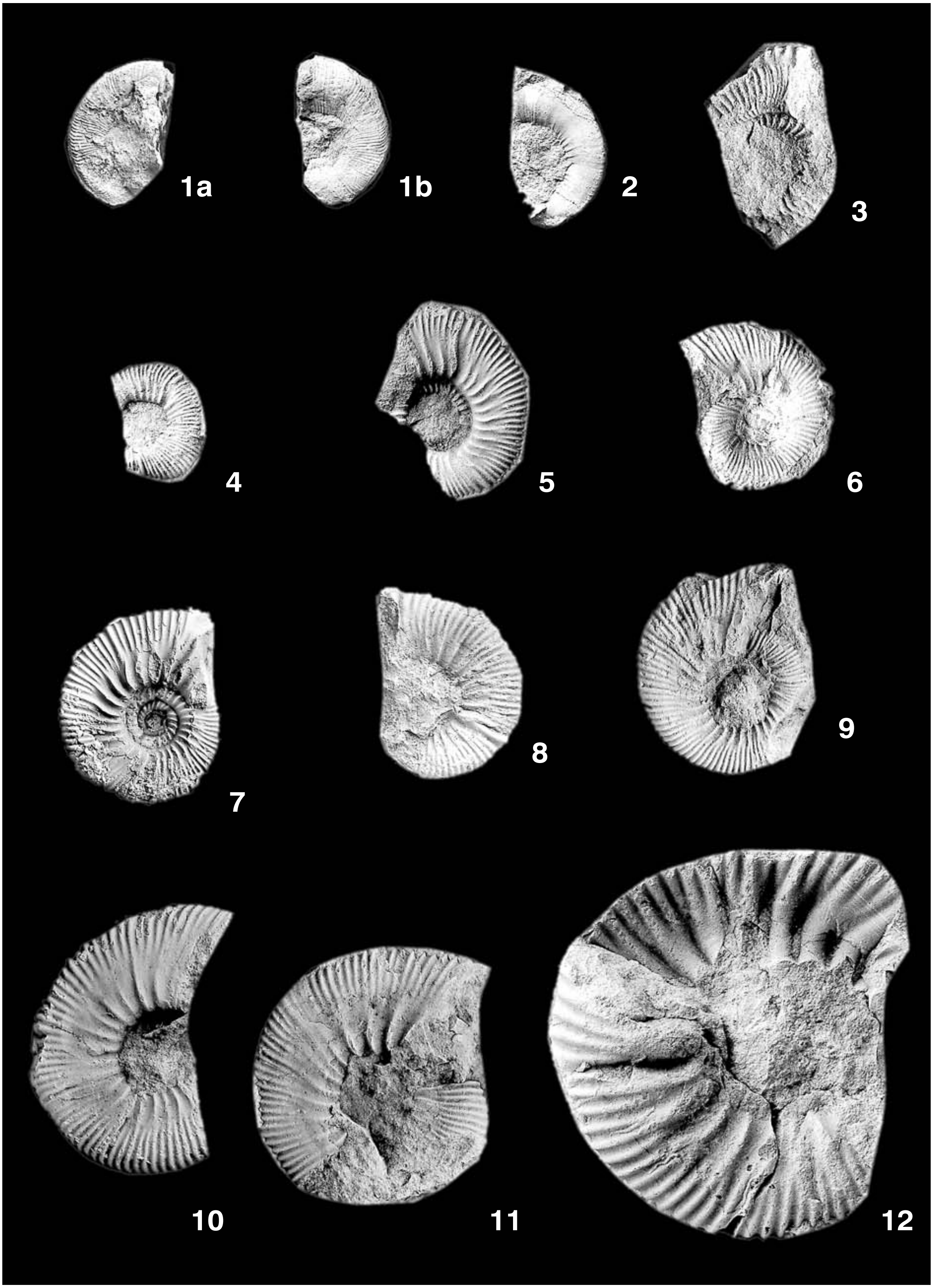
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PLATE 2

1 – *Glochiceras* (*Coryceras*) *modestiforme* (OPPEL); IGPUW/A/38/31, talus, unit I

2-4 – *Taramelliceras* (*Metahaploceras*) *litocerum* (OPPEL); 2 – IGPUW/A/38/21, bed 16; 3 – IGPUW/A/38/30, talus, unit I; 4 – IGPUW/A/38/19, bed 9

5 – *Taramelliceras* (*Metahaploceras*) ex gr. s*ublitocerum* (WEGELE); IGPUW/A/38/10, bed 12

6-7 – *Taramelliceras* (*Metahaploceras*) *wenzeli* (OPPEL); 6 – IGPUW/A/38/7, bed 38; 7 – IGPUW/A/38/9, bed 38

8 – *Orthosphinctes* (*Orthosphinctes*) *polygyratus* (REINECKE); IGPUW/A/38/38, bed 32

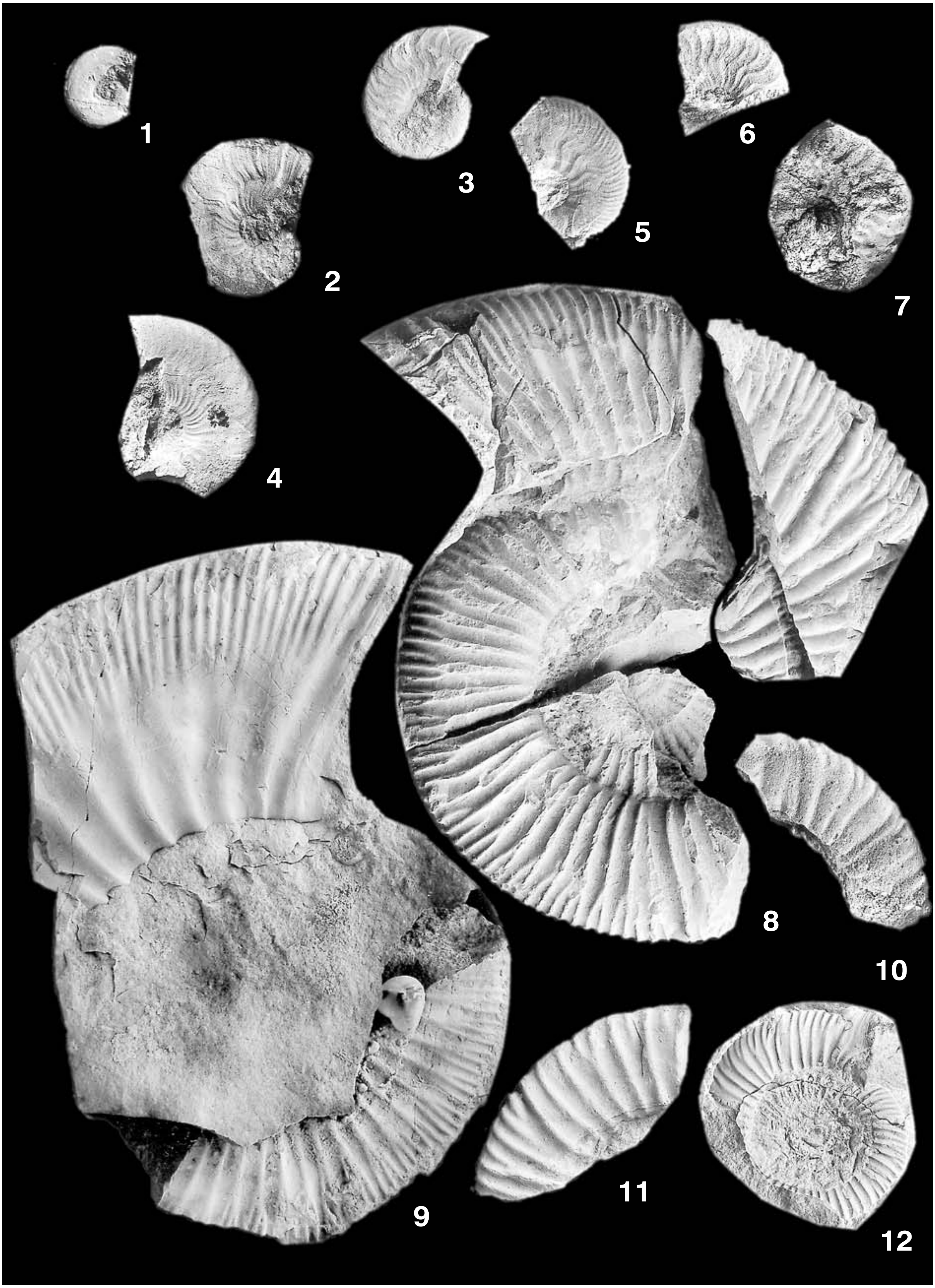
9 – *Orthosphinctes* (*Lithacosphinctes*) sp.; IGPUW/A/38/39, bed 12

10 – *Idoceras minutum* DIETERICH or *I. schroederi* WEGELE; IGPUW/A/38/17, bed 18 (lower part)

11 – *Idoceras laxevolutum* or *I. planula*; IGPUW/A/38/34, talus, unit I

12 – *Idoceras minutum* DIETERICH; IGPUW/A/38/33, talus, unit II

All specimens natural size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