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Linking southern Poland and northern Germany: Campanian cephalopods, inoceramid bivalves and echinoids

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ABSTRACT:

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The Campanian strata in the Wolbrom-Miechów area at Wierzchowisko, Jeżówka and Rzeżuśnia (i.e., the south-western part of the Miechów Trough, southern Poland) have been studied in some detail. Collections of macrofossils available to date include generally well-preserved and diverse cephalopods (ammonoids, coleoids), inoceramid bivalves and irregular echinoids of considerable stratigraphic and correlative value. For the present paper, taxa which allow a preliminary correlation with northern Germany (Lägerdorf, Lehrte West Syncline and Münsterland Basin) are singled out for brief discussion. Stratigraphically useful taxa include the ammonites *Pachydiscus (P.) haldemsis* (SCHLÜTER), *Lewyites elegans* (MOBERG), *Scaphites* (*S.*) *hippocrepis* III sensu COBBAN, *S.* (*S.*) *gibbus* SCHLÜTER and *Trachyscaphites spiniger spiniger* (SCHLÜTER), the coleoids *Belemnitella* ex gr. *mucronata* (VON SCHLOTHEIM) and *Gonioteuthis quadrata* (DE BLAINVILLE), the inoceramids *Cataceramus dariensis* (DOBROV & PAVLOVA), *'Inoceramus' azerbaydjanensis* ALIEV and *'I.' agdjakendsis* ALIEV, and the echinoids *Offaster pilula* (LAMARCK), *Galeola papillosa* (LESKE), *Echinocorys* ex gr. *subglobosa*/*turrita, E.* ex gr. *conica*, *Micraster* (*Gibbaster*) ex gr. *fastigatus*/*stolleyi* and *M.* (*M.*) ex gr. *schroederi*/*glyphus.* The ammonite fauna, which is dominated by pachydiscids and diplomoceratids, is closely comparable to that from the Busko Zdrój area (i.e., the southeastern part of the Miechów Trough), but hoplitoplacenticeratids are still unknown from the Wolbrom-Miechów area which, taken together with inoceramid data, may point to a gap in the upper Lower Campanian (equivalent of *conica*/*mucronata* Zone).

Key words: Cretaceous, Campanian, Cephalopods, Inoceramids, Echinoids, Correlation, Poland, Germany.

INTRODUCTION

Recent fieldwork in the Wolbrom-Miechów area (Text-fig. 1) by staff and students of the Department of Ecosystem Stratigraphy of the University of Silesia (Sosnowiec, Poland) has resulted in a collection of Campanian ammonites (inclusive of aptychi), belemnites, nautiloids, bivalves (including inoceramids), gastropods, echinoids, brachiopods, bryozoans and sponges. Singled out for discussion in the present paper are stratigraphically important taxa amongst cephalopods, inoceramid bivalves and echinoids, and a preliminary correlation with northern Germany (Lägerdorf [SCHÖNFELD & *al*. 1996], Lehrte West Syncline and the Münsterland

Basin) is briefly outlined. Biozonations in those areas are the most detailed currently available in Europe; moreover, they have the added advantage of good control on (supraregional) tectonic and sequence-stratigraphic events (ERNST & *al.* 1996). Here we adopt these zones, but wish to note that they are not used as chronozones proper. In the Wolbrom-Miechów area, additional logging of sections is needed, as well as detailed bed-by-bed sampling and identification of possible overlap between the various sections. Moreover, the extent of the stratigraphic gap across the hardground spanning the Lower/Upper Campanian boundary at Jeżówka (Text-fig. 2) needs to be determined. It appears that the correlation potential of this area has not been fully realised.

The main aim of the present paper is to outline briefly the great potential of this region which is likely to become a key area in correlation between southern Poland and NW Europe (Germany, Belgium, England, southern Sweden) and eastern Europe alike (Russia, the Ukraine). Faunal assemblages are not discussed in detail, but particular taxa are singled out and representative specimens illustrated. Detailed descriptions and synonymies will be supplied in future papers. Overlap in ammonite occurrences in the study area and at temporary exposures near Busko Zdrój (MACHALSKI & *al.* 2004) is indicated.

GEOLOGICAL SETTING

The studied area is situated in the southwesterly part of the Nida (= Miechów) Trough (Text-fig. 1) (belonging geographically to the Miechów Upland), which represents the southeasterly segment of the Szczecin-Łódź-Miechów Synclinorium, one of the major Alpine (Laramide) tectonic elements of extra-Carpathian Poland (POŻARYSKI 1977). The Cretaceous of the trough, represented by the Upper Albian-Lower Maastrichtian, overlies unconformably the Jurassic (Kimmeridgian) substrate and in its central and southern parts is covered by the Miocene deposits of the Fore-Carpathian Depression (= the Carpathian Foreland Basin) (POŻARYSKI 1977).

The Cretaceous succession of the Miechów Upland may roughly be divided into two parts. The lower part, comprising Albian through Santonian strata, is characterised by condensed sedimentation, with numerous hiatuses and discontinuities, analogous to those known from the Polish Jura Chain (e.g., SUJKOWSKI 1926, 1931; RÓŻYCKI 1937, 1938; KOWALSKI 1948; ALEXANDROWICZ 1954; MARCINOWSKI 1970, 1974; MARCINOWSKI & SZULCZEWSKI 1972; WALASZCZYK 1992; KRAJEWSKI & *al*. 2000). Besides the lowermost part, with terrigenous sedimentation, the rest of the succession is primarily a carbonate sequence. The upper part is represented by

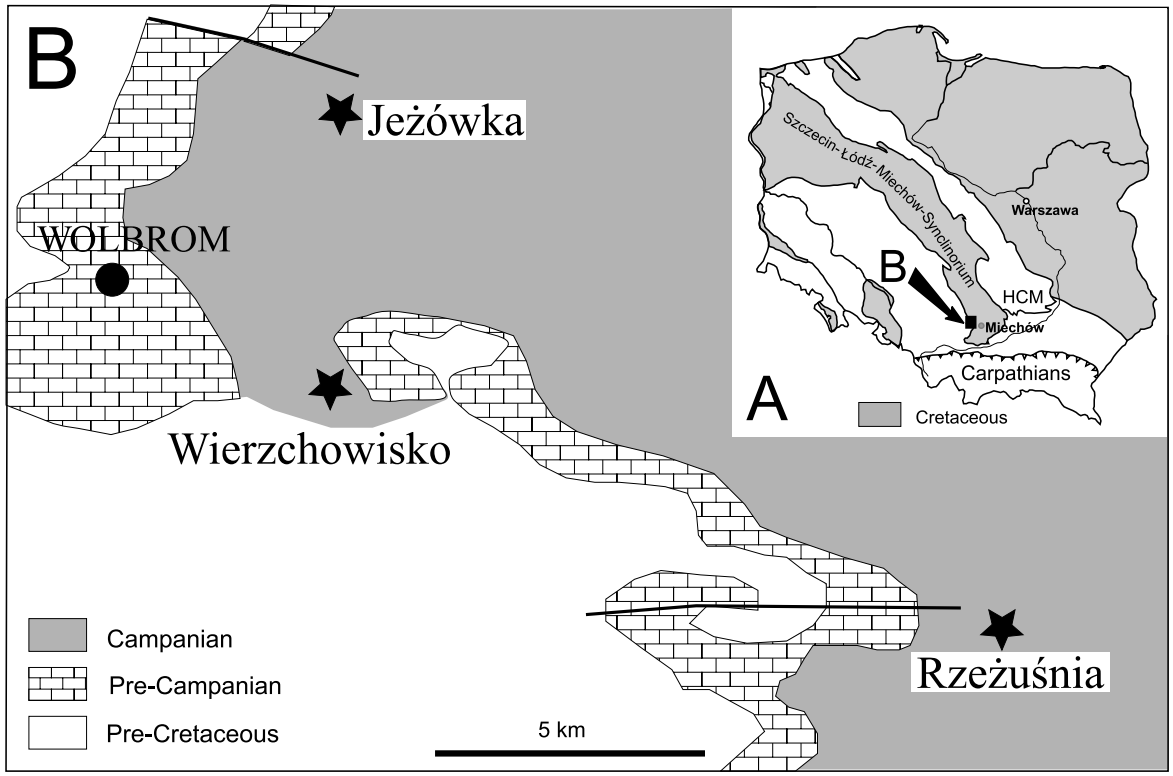

Fig. 1. Simplified geological map of the study area, showing main localities

the Campanian and Lower Maastrichtian. It is a very expanded succession, with the total thickness estimated to be about 350 m. Based on the two major discontinuities, expressed as composite hardgrounds, at the Lower/Upper Campanian boundary and within the Lower Maastrichtian, the succession was subdivided into three sedimentary cycles (RUTKOWSKI 1965): an Early Campanian, a Late Campanian – earliest Maastrichtian, and a late Early Maastrichtian one. Due to Laramide uplift, the Upper Maastrichtian is missing from the area.

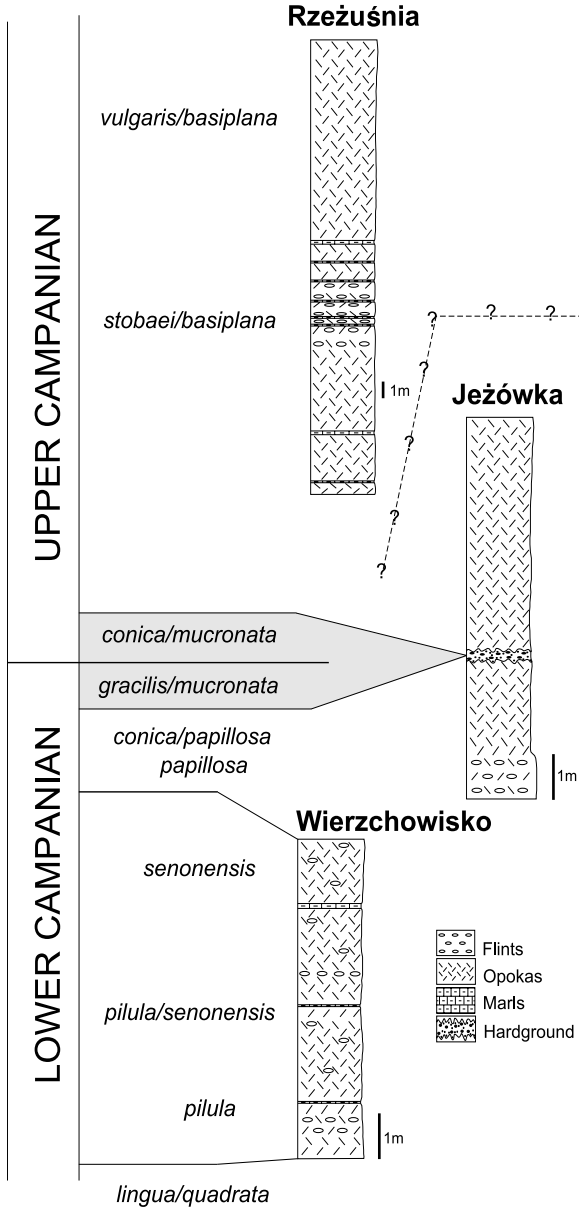

Fig. 2. Preliminary correlation of the three sections studied, with the hiatus at the hardground of Jeżówka marked

CEPHALOPODS

Two species of coleoid and at least ten ammonoid taxa have been recognised so far, the most important ones of which are here selected for brief discussion. Of note is the occurrence of numerous pachydiscids and of heteromorph taxa (in particular baculitids and the diplomoceratid *Lewyites elegans*), and the absence of species of *Hoplitoplacenticeras.*

Preliminary observations on pachydiscids in the present collections suggest that there are at least three morphotypes, one of them apparently assignable to *Menuites.* Most medium-sized phragmocones seem best referred to *P.* (*P.*) *haldemsis*, but some are closer to *P.* (*P.*) *subrobustus* as interpreted by KAPLAN & *al*. (1996). The latter species is known from the higher Vorhelmer Schichten (= *'vulgaris'/basiplana* Zone) in the Münsterland Basin, and is characterised by a change from a stage in which primary ribs with faint bullae and one or two short or long intercalatories occur, to a stage where solely long ribs remain. KENNEDY & *al*. (2004) record this taxon as the sole pachydiscid from Busko Zdrój. Here we only discuss one of these species; the others will be dealt with in detail in a forthcoming paper awaiting study of available collections.

Pachydiscus (*Pachydiscus*) *haldemsis* (SCHLÜTER, 1867)
(Pl. 1, Fig. 9)

*1867. *Ammonites haldemsis* SCHLÜTER, p. 19, pl. 3, fig. 1.
1997. *Pachydiscus (Pachydiscus) haldemsis* (SCHLÜTER, 1867); KENNEDY & KAPLAN, p. 40, pl. 4, figs 5-8; pl. 5, fig. 4; pl. 6, figs 1, 2; pl. 7, figs 2, 3; pls 8, 9; pl. 10, figs 5, 8 (with additional synonymy).

DESCRIPTION AND DISCUSSION: A dozen or two of medium-sized phragmocones, most of them distorted to varying degrees, appear to belong here. In showing moderately involute coiling, a shallow umbilicus, a compressed whorl section with the greatest breadth below mid-flank, feebly convex flanks and rounded ventrolateral shoulders and venter, the illustrated specimen (GIUS 9-2340-MT-9) corresponds well to previously recorded material. Primary ribs, arising at umbilical seam, strengthen across umbilical wall and shoulder; are straight and prorsiradiate on inner/middle flank and flex forwards, passing the venter in a feeble convexity. One (- two) intercalated ribs, arising either low or high on flanks, match primaries in strength on outermost flank, ventrolateral shoulder and venter.

OCCURRENCE: Where well dated, *P. haldemsis* is typical of the (lower) Upper Campanian; the most precise records are from NW Germany (Stemweder Berg; see KENNEDY & KAPLAN 1997) where it is known from the

Dielingen and lower Haldem Schichten (= lower Upper Campanian, *spiniger*/*basiplana* Zone) and from the correlative Coesfeld Schichten in the Münsterland Basin. A similar range has been recorded from NE Belgium, southern Sweden (KENNEDY & CHRISTENSEN 1997), northern Ireland, Norfolk (England), Austria (Gschliefgraben), the Ukraine and Turkmenia. In the Vistula River valley sections, *P. haldemsis* (as *P. koeneni*, a junior synonym) was recorded from the *Neancyloceras phaleratum* and *Bostrychoceras polyplocum* zones by BŁASZKIEWICZ (1980).

Lewyites elegans (MOBERG, 1885)
(Pl. 1, Fig. 8)

*1885. *Ancyloceras*? *elegans* MOBERG, p. 30, pl. 3, fig. 10.
1997. *Lewyites elegans* (MOBERG, 1885); KENNEDY & KAPLAN, p. 57, pl. 58, figs 1-5; pl. 59, figs 1, 2; pl. 60, figs 1-5 (with synonymy).
1997. *Lewyites elegans* (MOBERG, 1855) [sic]; NIEBUHR & *al.*, p. 220, pl. 3, fig. 3.
2004. *Lewyites elegans* (MOBERG, 1885); MACHALSKI & *al*., p. 459, pl. 5, figs 6, 7; pl. 6, figs 1-3; pl. 8, fig. 15.

DESCRIPTION AND DISCUSSION: To date, KENNEDY & KAPLAN (1997) provided the most detailed description of this taxon which was first recorded from the lower Upper Campanian of southern Sweden. The material from the Miechów area, all from the lower Upper Campanian at Jeżowka and Rzeżuśnia, comprises mostly fragmentary composite moulds, all of them distorted laterally, and none showing the sutures. In curvature and style of ribbing, they are closely comparable to specimens from the Stemweder Berg. KENNEDY & KAPLAN (1997) were of the opinion that their material could be divided into microconchs and macroconchs, and noted that there was a certain variability in rib index. The specimen illustrated here (?microconch; GIUS 9-2339-MT-8) shows on the shaft fairly strong, straight to concave, rursiradiate primary ribs, pairs of which end in rounded-clavate ventral tubercles. Across the venter these tubercles are linked by a pair of looped ribs. Intercalated between the tuberculate ribs are two to four nontuberculate ribs.

OCCURRENCE: The material from Stemweder Berg all stems from the Dielingen Schichten, which are of early Late Campanian age (low *spiniger*/*basiplana* Zone). The species is also known from correlative horizons in southern Sweden, NE Belgium, Aquitaine (France) and Poland (Waganowice, Busko Zdrój). The record from the Lehrte West Syncline by NIEBUHR & *al.* (1997), from the Ahlten opoka facies, is referred to the upper *bipunctatum*/*roemeri* Zone (equivalent of *langei* Zone), i.e. of late Late Campanian age.

Neocrioceras (*Schlueterella*) *pseudoarmatum* (SCHLÜTER, 1872)
(Pl. 1, Figs 5, 10)

1997. *Neocrioceras (Schlueterella) pseudoarmatum* (SCHLÜTER, 1872); KENNEDY & KAPLAN, p. 60, pls 64, 65.

DESCRIPTION AND DISCUSSION: Referred here are two specimens; one representing a fragment (GIUS 9-2341-MT-10) from the lower Upper Campanian at Rzeżuśnia, which is strongly laterally compressed by crushing. In style of ribbing (two nontuberculate ribs intercalated between tuberculate rib pairs; rib index) it is similar to material from the ?lower Upper Campanian of Darup (Germany), illustrated by KENNEDY & KAPLAN (1997, pl. 65, figs 1-4, holotype). The lower-lateral tubercles are not well visible, which may be a matter of preservation.

The other specimen (GIUS 9-2338-MT-7) consists of a partial straight shaft and curved adapical portion, from the lower Upper Campanian of Rzeżuśnia, with a compressed oval whorl section (laterally compressed by compaction). Paired ribs end in small ventral tubercles placed on a swelling; lower lateral tubercles are not well preserved. Intercalated are two nontuberculate ribs of varying strength, which efface slightly dorsally.

The limited material available is closer to the type of *N.* (*S.*) *pseudoarmatum* than to specimens from Dielinger Kleis, Germany (low *spiniger*/*basiplana* Zone) as recorded by KENNEDY & KAPLAN [1997, as *Neocrioceras* (*Schlueterella*) aff. *pseudoarmatum*, p. 60, pl. 59, fig. 4; pls 62-63], which have a higher rib index (10-12 *vs* 6) and usually show 4/6 to 13 nontuberculate ribs between tuberculate ones.

OCCURRENCE: The type material of *N.* (*S.*) *pseudoarmatum* is of early Late Campanian age, as is the material recorded here.

Baculites sp.
(Pl. 1, Fig. 3)

DESCRIPTION AND DISCUSSION: From directly above the hardground at Jeżówka and at certain levels in the lower portion of the section exposed at Rzeżuśnia, there are numerous, generally poorly preserved baculitids. Since all of these are strongly laterally compressed by compaction, mostly show a thin green veneer and invariably do not show sutures, it will prove virtually impossible

to identify them to species. Of note is the flood occurrence at the latter locality – similar concentrations of baculitids are known from the lower Upper Campanian of the Lehrte West Syncline, and also at Stemweder Berg baculitids are the commonest ammonites represented. The suite illustrated by KENNEDY & KAPLAN (1997, pl. 66, figs 1-14) includes noded forms such as the one here figured. Those authors compare their material with members of the *Baculites aquilaensis* group, which co-occurs with *Trachyscaphites spiniger spiniger* in the Western Interior and Gulf Coast of the United States.

OCCURRENCE: Not until more material has been collected will it prove possible to determine the relationships of this form in more detail. Accordingly, comparisons with occurrences elsewhere (and with the US Western Interior, in particular) cannot be made at present, which is unfortunate as baculitids in the North American zonation have turned out to be of high stratigraphic value, and zones based on these ammonites are well dated.

Scaphites (*Scaphites*) *hippocrepis* III sensu COBBAN, 1969
(Pl. 1, Fig. 4)

*1969. *Scaphites hippocrepis* (DeKay) III; COBBAN, p. 21, pl. 3, figs 1-25; pl. 4, figs 35-49; pl. 5, figs 36-40; text-figs 2, 4, 10, 11 (with additional synonymy).

1997b. *Scaphites* (*Scaphites*) *hippocrepis* (DEKAY, 1828) III COBBAN, 1969; KENNEDY & *al*., p. 15, fig. 11.

DESCRIPTION AND DISCUSSION: A single body chamber (GIUS 9-2335-MT-4) from the Lower Campanian (below hardground) at Jeżówka is available. Although rather poorly preserved and fragmentary, style of ribbing and tuberculation show this to be a small macroconch, comparable to material from Wyoming and New Jersey illustrated by COBBAN (1969, pl. 3, figs 19, 20) and KENNEDY & *al*. (1997b, fig. 11f), respectively. The base of the body chamber is narrow, the hook broader; ventral ribbing and structure of ventrolateral nodes are typical; of umbilical nodes just a single one is visible; the specimen appears to lack mid-flank bullate nodes or ribs, but this may be a matter of preservation.

OCCURRENCE: This is the first Polish record of this species important for trans-Atlantic correlations. Three successive subspecies (I-III) are recognised in the Western Interior of the United States and these have subsequently been recorded from other parts of the world (western Europe). In the Lehrte West Syncline as well as in the Münsterland Basin, *S. hippocrepis* is known to range through the entire Lower Campanian (WIPPICH 1995), although NIEBUHR (1996, fig. 2) documented it only from the *conica*/*papillosa* and lowermost *gracilis*/*mucronata* zones in the former area.

Scaphites (*Scaphites*) *gibbus* SCHLÜTER, 1872
(Pl. 1, Fig. 6)

*1872. *Scaphites gibbus* SCHLÜTER, p. 87, pl. 26, figs 6-9.

1996. *Scaphites* (*Scaphites*) *gibbus* SCHLÜTER, 1872a; KAPLAN & *al.*, p. 44, pl. 34, figs 1-3; pl. 35, figs 1, 2; pl. 36, figs 1-5; pl. 37, figs 1-4; pl. 38, figs 1-3, 5-11; pl. 39, figs 1-7; pl. 40, figs 1-6 (with full synonymy).

1997. *Scaphites* (*Scaphites*) *gibbus* SCHLÜTER, 1872; KENNEDY & KAPLAN, p. 62, pl. 67, figs 1-13.

2004. *Scaphites gibbus* SCHLÜTER, 1872; MACHALSKI & *al*., p. 462, pl. 7, figs 1-3, 6, 7, 9, 10.

DESCRIPTION AND DISCUSSION: A single fragmentary macroconch (GIUS 9-2336-MT-5) is available from the lower Upper Campanian at Rzeżuśnia, consisting of part of the spire and the lower portion of the shaft. Style of ribbing (well-developed primaries, occasionally branching, and intercalatories), which effaces on the early part of the shaft, and the prominent ventrolateral tubercles are so typical as to preclude confusion with any other scaphitid.

OCCURRENCE: In the Lehrte West Syncline, this species makes its first appearance in the upper Lower Campanian (upper *conica*/*papillosa* Zone), shows an acme in the next zones (*gracilis*/*mucronata* and *conica*/*mucronata* zones) and ranges upwards into the middle *stobaei*/*basiplana* Zone (lower Upper Campanian; see NIEBUHR 1996). In the Münsterland Basin, *S. gibbus* ranges from the lower *conica*/*mucronata* Zone to well into the *'vulgaris'*/*basiplana* Zone (= Beckumer and Vorhelmer Schichten) (see WIPPICH 1995; KAPLAN & *al.* 1996). In Poland, the species is also known from the Vistula River valley sections, where it occurs in the *Neancyloceras phaleratum* and *Bostrychoceras polyplocum* zones (see BŁASZKIEWICZ 1980; as *Trachyscaphites* (?) *gibbus*) as well as from Busko Zdrój (MACHALSKI & *al.* 2004).

Trachyscaphites spiniger spiniger (SCHLÜTER, 1872)
(Pl. 1, Fig. 7)

*1872. *Scaphites spiniger* SCHLÜTER, p. 82, pl. 25, figs 1-7.

1997. *Trachyscaphites spiniger spiniger* (SCHLÜTER, 1872); KENNEDY & KAPLAN, p. 63, pl. 10, fig. 3; pl. 59, fig. 2; pl. 68, figs 1-6; pl. 69, figs 2-5; pl. 70, figs 1-9; pl. 71, figs 1-10; pl. 72, figs 1-7; pl. 73, figs 1-9; pl. 74, figs 4-6, 8; pl. 75, figs. 1-5; pl. 77, fig. 6 (with synonymy).

2004. *Trachyscaphites spiniger spiniger* (SCHLÜTER, 1872); MACHALSKI & *al*., p. 464, pl. 8, figs 1-12, 14, 16, 17.

DESCRIPTION AND DISCUSSION: One well-preserved specimen (a microconch; GIUS 9-2337-MT-6), a fragmentary ?macroconch and some spire fragments are known from the lower Upper Campanian of Rzeżuśnia, all absolutely typical in style of ribbing and tuberculation and closely comparable to material from elsewhere in Europe and North America. For the Stemweder Berg, KENNEDY & KAPLAN (1997, fig. 7) noted an acme for the lower part of the *spiniger*/*basiplana* Zone (= Dielingen Schichten), and, from float material, were able to determine that the species ranged into their *roemeri* Zone (= lower Haldem Schichten, equivalent of *vulgaris*/*basiplana* and *vulgaris*/*stolleyi* zone of NIEBUHR & *al.* 1997). The same range is reported for the NW Münsterland Basin and the Lehrte West Syncline – the species is missing from the SE Münsterland Basin. NIEBUHR (1996) showed *T. s. spiniger* to range from the *stobaei*/*basiplana* to the upper *vulgaris*/*stolleyi* zones.

OCCURRENCE: All current records show *T. s. spiniger* to be typical of the lower/middle Upper Campanian, with records from Germany, the Netherlands, Belgium, southern Sweden, the Ukraine, Armenia, Turkmenia and the United States (Texas). In Poland, it is known from the Vistula River valley sections, the Lublin Trough and Busko Zdrój.

Belemnitella ex gr. *mucronata* (VON SCHLOTHEIM, 1813)
(Pl. 1, Fig. 1)

DESCRIPTION AND DISCUSSION: A handful of medium- to large-sized guards from the lower Upper Campanian of Rzeżuśnia are available; unfortunately, a larger population is needed to allow the species to be identified on internal features and by univariate/bivariate biometric analyses. On external features (ventral and lateral profile, character of vascular markings), these specimens are undoubtedly members of the *mucronata* group. Given the dating based on inoceramids, ammonites and echinoids, it does not appear likely that *B. woodi* or other species of *Belemnitella* restricted to the middle/upper Upper Campanian (CHRISTENSEN 1995, 1997a, b, 1999) are represented in this material, but at present, we cannot be sure about this.

OCCURRENCE: In the Central European Subprovince, typical *B. mucronata* first occurs in the upper Lower Campanian and ranges throughout the lower half of the Upper Campanian, with an acme in the *spiniger*/*basiplana* Zone and its lateral equivalents (CHRISTENSEN 1997b). In the Lehrte West Syncline, CHRISTENSEN (2000) showed the species to range from the base of the *gracilis*/*mucronata* Zone to the lower *vulgaris* (or *'vulgaris'*/*stolleyi*) Zone (see Table 1). In Poland, material generally assigned to *B. mucronata*, but in need of revision, is known from the Vistula River valley sections and from the Lublin Trough.

Gonioteuthis quadrata (DE BLAINVILLE, 1827)
(Pl. 1, Fig. 2)

DESCRIPTION AND DISCUSSION: Two guards are available from the Lower Campanian of Wierzchowisko. Judging from their association with the echinoid *Offaster pilula*, it appears advisable to assign them to *quadrata* s. str., but more material is needed for a careful analysis and detailed comparison with populations from elsewhere in northern Europe.

OCCURRENCE: *Gonioteuthis quadrata* is widely distributed in the Central European Subprovince (CHRISTENSEN 1991, 1997b), with records from England, France, Belgium, the Netherlands, southern Sweden, Germany, Poland and European Russia. The extinction of *G. quadrata* has traditionally been equated with the Lower/Upper Campanian in the boreal sense, with the exception of the United Kingdom, where the first appearance of *B. mucronata* defines the Lower/Upper Campanian boundary.

INOCERAMID BIVALVES

In the material studied, inoceramids are well represented from Jeżówka and Rzeżuśnia. However, their distribution is very uneven, and in addition to a handful of specimens from the lower portion of the section exposed at Jeżówka, most of the material collected recently actually stems from a relatively thin interval at Rzeżuśnia. The remainder of the combined WJR section is rather poorly documented as far as inoceramids are concerned. Although inoceramids appear to be comparatively common at Jeżówka as well, more or less complete specimens are rare at that locality.

Inoceramids represent two distinct assemblages. The lower one, as documented by material from below the hardground at Jeżówka, and an upper one, represented by material from Rzeżuśnia.

The lower assemblage comprises just four specimens, only three of which are complete enough to be identified. Two taxa are recognised: *Cataceramus dariensis* (DOBROV & PAVLOVA, 1959) (Pl. 2, Fig. 8) and *C.* juv. specimen ex gr. *dariensis-beckumensis*. Both are members of the *Cataceramus dariensis-C. beckumensis* lineage (see WALASZCZYK 1997). At Jeżówka, no inoceramids were found above the hardground.

The upper assemblage is very rich in specimens and represents a taxonomically diverse fauna, which allows precise stratigraphic allocations. However, it must be borne in mind that specimens at hand were either collected ex situ or come from a narrow, inoceramid-rich interval somewhere in the median portion of the section exposed. Amongst the taxa identified are: *Cataceramus ellipticus* (GIERS, 1964) (Pl. 2, Fig. 2), '*Inoceramus*' *agdjakendsis* ALIEV, 1952 (Pl. 2, Fig. 7), *Cataceramus pteroides* (GIERS, 1964), '*Inoceramus*' *vorhelmensis* WALASZCZYK, 1997 (Pl. 2, Figs 4, 5), *'I.' azerbaydjanensis* ALIEV, 1939 (Pl. 2, Fig. 1), '*Inoceramus*' *bosenbergensis* WALASZCZYK, 1997, and *C. balticus* (BÖHM, 1907) (Pl. 2, Figs 3, 6).

Both assemblages are widely distributed in the entire Euramerican biogeographical region. Their precise stratigraphic succession has recently been recognised mainly on the basis of material collected from Germany (Münsterland Basin; WALASZCZYK 1997), and in part on the US Western Interior record (COBBAN & KENNEDY 1993; KAUFFMAN & *al.* 1994; WALASZCZYK & *al.* 2001).

The fauna from Jeżówka documents the late Early Campanian *Cataceramus dariensis* fauna (DOBROV & PAVLOVA 1959; ARZUMANOVA 1965), which, stratigraphically, documents the *Sphaeroceramus sarumensis-Cataceramus dariensis* Zone (WALASZCZYK 1997). In terms of the echinoid/ammonoid zonation used for the Münsterland Basin, this zone characterises the interval between the middle *pilula* Zone (middle Lower Campanian) up to the *gracilis/mucronata* Zone (upper Lower Campanian) (see WALASZCZYK 1997, figs 2, 3; see also Table 1 here).

The younger assemblage from Rzeżuśnia documents a fauna which characterises the lower, but not lowermost, Upper Campanian, in the European sense. In terms of the zonation used for the Münsterland, this assemblage would correspond to the *stobaei/basiplana* (= *spiniger/basiplana*) and *vulgaris/basiplana* zones (lower /middle Upper Campanian; see WALASZCZYK 1997, fig. 3). The oldest Upper Campanian zone, the *conica/mucronata* Zone, cannot be documented to date on the basis of inoceramids. This zone, characterised in the Münsterland by a *Cataceramus beckumensis* fauna, is either missing here (a gap confined to the hardground at Jeżówka?), or is represented by an interval not documented with inoceramids (= part of the succession above the hardground at Jeżówka, or the lowermost portion of the section exposed at Rzeżuśnia).

Cataceramus dariensis, '*I.*' *azerbaydjanensis* and '*I*'. *agdjakendsis* allow for precise correlation within the entire Euramerican biogeographical region. All three species are common in eastern Europe, from where they were originally described (ALIEV 1939, 1952 1978, 1979; see also DOBROV & PAVLOVA 1959; PERGAMENT & SMIRNOV 1972; ALIEV & KHARITONOV 1981). The two last-named are also common in the US Western Interior, where they are confined to the Middle Campanian *Baculites obtusus* and *B. maclearni* ammonite zones (KAUFFMAN & *al.* 1994; WALASZCZYK & *al.* 2001), yielding a very precise tie between the European and Western Interior successions.

ECHINOIDS

With the exception of a single, well-preserved specimen of *Salenocidaris obnupta* (SCHLÜTER, 1892) from Wierzchowisko (lower Lower Campanian) and a few dissociated cidarid primary spines from Rzeżuśnia (lower Upper Campanian), the present collections comprise irregular echinoids only. Amongst these, medium- to large-sized holasteroids of the genus *Echinocorys* predominate; this, at least in part, is certainly due to collection bias.

All taxa represented compare well with faunas known from the echinoid-rich marl-limestone rhythmites as exposed in the Lehrte West Syncline, east of Hannover, Germany (see ERNST 1975; NIEBUHR 1995; ERNST & *al.* 1997). Rigid collecting in that area over several decades has allowed the stratigraphic ranges of the various echinoid species to be determined in great detail. This has also led to the recognition of several lineages (e.g., *Offaster-Galeola*, *Micraster schroederi-M. glyphus*), useful in biostratigraphy and correlation. Here we adopt the names of the various taxa as used by ERNST (1971, 1972, 1975), with the exception of a single micrasterid (*M. fastigatus*), for which we follow STOKES (1975). In a recent paper on holasteroid phylogeny, SMITH (2004, p. 140, table 3) considered the genus *Galeola* to be basal to the crown group Urechinina, in showing meridosternous plating in all interambulacra, in lacking a frontal groove and in having a an inframarginal periproct. According to that author, *Offaster* may also be a member of the urechinine stem group, but it lacks convincing synapomorphies (compare his table 3). There appears to be a general consensus that *Offaster* and *Galeola* are sister groups, and SMITH & WRIGHT (2003) may well be right in synonymising *Holaster senonensis* D'ORBIGNY, 1855, index of the *pilula/senonensis* and *senonensis* zones in the German scheme for the Lower Campanian (see Table 1), with *Offaster pilula.*

Offaster pilula (LAMARCK, 1816)
(Pl. 3, Fig. 1)

DESCRIPTION AND DISCUSSION: The present lot includes a handful of specimens from the Lower Campanian of Wierzchowisko; some are well preserved, others abraded (e.g., not showing tuberculation/fascioles)

and laterally compressed by compaction. In size, L/H ratio, anal angle and position of the periproct, most specimens correspond closely to material described by ERNST (1971) from the Lower Campanian of the Lehrte West Syncline. One specimen is larger (L = 23.4 mm), thus approaching material assigned to *Galeola senonensis* by German authors (see note above), but with a comparatively high position of the periproct and a smaller anal angle. There is also a certain resemblance to *O. pilula planatus* from the upper Lower Campanian of southern England, as illustrated by ERNST (1971, figs 18/8, 19c; 1972, fig. 21). For the time being, all material is here assigned to *O. pilula.*

Although SMITH & WRIGHT (2003, p. 550) have recently noted that the spelling of the species name should in fact be *pillula*, and not *pilula*, ICZN rules stipulate that a name in use for more than 50 years need not be changed (E. SEIBERTZ, pers. comm., June 2004).

OCCURRENCE: As indicated by ERNST (1971, 1975), *O. pilula* in northern Germany is restricted to the lower Lower Campanian (*pilula*, *pilula*/*senonensis* and *senonensis* zones; see FRERICHS 1995), giving rise in the latter zone to *G. senonensis*, which higher up section leads to *G. papillosa.* As noted above, SMITH & WRIGHT (2003) have recently suggested that *Galeola senonensis* of authors is best synonymised with *O. pilula*; we concur. Members of this lineage have also been illustrated by MĄCZYŃSKA (1989, pl. 198, fig. 2; pl. 199, figs 1, 2), based on material from the Campanian of the Miechów Trough. However, the specimen illustrated under the name of *G. senonensis* (MĄCZYŃSKA, 1989, pl. 199, fig. 1) is perhaps better referred to *G. papillosa*, as based on anal angle and position of the periproct (compare FRERICHS 1995, fig. 5).

Galeola papillosa (LESKE, 1778)
(Pl. 3, Fig. 2)

*1778. *Echinocorys minor* var. *papillosa* LESKE, p. 183, pl. 16, figs c, d.

2003. *Galeola papillosa* (LESKE, 1778); SMITH & WRIGHT, p. 554, pl. 176, figs 5-16; text-figs 230, 231 (with additional synonymy).

DESCRIPTION AND DISCUSSION: Available are several specimens from Jeżówka and a single, deformed test from Rzeżuśnia (A. KIN collection). A single specimen from the Lower Campanian of Jeżówka is remarkable in view of its size, lateral profile and inframarginal position of the periproct. It is closely comparable to material illustrated by ERNST (1971, figs 20c, 23/9, as *Galeola* m.f. *papillosa*/*basiplana*) from the lower Upper Campanian Craie d'Obourg of Harmignies (Mons Basin, southern Belgium). JAGT (2000) recorded similar tests from the lower Upper Campanian of Liège (NE Belgium), as did SMITH & WRIGHT (2003, pl. 176, figs 9-12, as form *basiplana*) from the Upper Campanian (*Belemnitella mucronata* Zone) of Norfolk (England). However, it should be noted that 'populations' from the middle Lower Campanian (*papillosa* Zone) of Höver (Lehrte West Syncline) include comparable, even larger, specimens (see FRERICHS 1995, fig. 6).

OCCURRENCE: In northern Germany, *G. papillosa* (= *G. p. papillosa* in ERNST's terminology) ranges from the *papillosa* to the *?gracilis*/*mucronata* zones (Lower Campanian); the lineage continues into the Upper Campanian with *G. papillosa basiplana*. With records from the upper Lower and lower upper Campanian of Jeżówka and Rzeżuśnia, respectively, the range of this species in southern Poland is thus closely comparable.

Echinocorys ex gr. *subglobosa*/*turrita*
(Pl. 3, Figs 5-6)

DESCRIPTION AND DISCUSSION: Collections before us include numerous specimens, in varying states of preservation, in particular from the Upper Campanian of Rzeżuśnia. Test size (length, height) ranges from 71 to 93 mm and from 59 to 79 mm, respectively. Grouped here are tests that in profile as well as in structure of apical disc and plastron, compare most closely to what German authors refer to as *E. subglobosa.* JAGT (2000), upon a re-examination of the type specimen of that form, noted that it could well have come from the lower Upper Campanian Zeven Wegen Member (Gulpen Formation) of the Haccourt-Lixhe area (NE Belgium), where comparable test morphologies are common.

Most specimens in the present collection match JAGT's (2000, p. 274, pl. 21, fig. 9) concept of *E.* gr. *subglobosa*; a few are closer to what MĄCZYŃSKA (1989, pls 201, 202) termed *E. turrita*. This explains why these two morphologies, which appear to constitute a gradational series, are referred to as a 'group'. Typical *E. ovata* (sensu LAMBERT, 1903) are not represented in the present lot (although a few specimens come close). On the other hand, *E.* gr. *pyramidata*, which comprises tests that typically are almost symmetrically conical, does occur, albeit rarely (Pl. 3, Fig. 4a, b). In NW Europe, the latter group characterises the upper Upper Campanian and Lower (?lowest) Maastrichtian (see also SMITH & WRIGHT 2003, pl. 169, figs 6-8, as form *pyramidalis* [sic]). MĄCZYŃSKA's (1989) concept of *E. pyramidata* differs from that of western European authors.

It should be noted that SMITH & WRIGHT's (2003, pl. 170, figs 2, 7, 9) concept of *E. scutata* form *subglobosa* dif-

fers considerably from the one adopted here, which is based on the type specimen as well as on rich, coeval material from the Lehrte West Syncline.

The present collection also contains a number of tests from Rzeżuśnia which are close in lateral profile to those of the *E. marginata* group (sensu germanico). ERNST (1975, fig. 11) recorded this (as *E.* gr. *"gibba/marginata"*) from the Lower Campanian of the Lehrte West Syncline, with an acme in the basal *pilula/senonensis* Zone (see also ERNST 1972, pl. 6, fig. 3). MĄCZYŃSKA (1989, pl. 200) recorded *E. marginata* from the Campanian of the Miechów Trough.

OCCURRENCE: ERNST (1975, fig. 11) showed *E. subglobosa* in the Lehrte West Syncline to range from the middle Lower (*papillosa* Zone) to the middle Upper Campanian with a distinct acme in the *stobaei/basiplana* (= *spiniger/basiplana)* Zone.

Echinocorys ex gr. *conica*
(Pl. 3, Fig. 3)

DESCRIPTION AND DISCUSSION: A handful of specimens, most of them poorly to moderately preserved, from the Lower Campanian of Jeżówka are available, with test length and height ranging from 41 to 44 mm, and from 33 to 37 mm, respectively.

Grouped here are comparatively small, (sub)conical tests, with a near-circular, flat base, and either a truncated or raised apex. Various names have been introduced for extreme morphologies within this group. MĄCZYŃSKA's *E. zejszneri* (1989, pl. 207, fig. 1; pl. 208, fig. 1), from the Campanian of the Miechów Trough and the Polish Outer Carpathians, is here considered to fall within the range of variation of the *conica* group.

OCCURRENCE: In NW Europe, this morphology characterises the upper Lower and lower Upper Campanian. ERNST (1972, 1975) documented distinct acmes in the *conica/papillosa* and *gracilis/mucronata* zones (upper Lower Campanian) for the Lehrte West Syncline. The overlap in range between *E.* ex gr. *subglobosa* and *E.* ex gr. *conica* in the upper Lower and lower Upper Campanian appears to be useful in stratigraphic correlation across large parts of Europe.

Echinocorys ex gr. *gibba*
(Pl. 3, Fig. 7)

DESCRIPTION AND DISCUSSION: A single, partially abraded, specimen is known from the Lower Campanian at Wierzchowisko. As noted by JAGT (2000, p. 271), typical representatives of and intermediates between *gibba* and *marginata* have been recorded from the middle Lower Campanian of northern Germany, France and southern England. Records from Belgium (Mons and Liège-Limburg basins) show this form to range into the Upper Campanian, where it is a rare component in an assemblage dominated by *Echinocorys* of the *conica*, *subglobosa* and *pyramidata* groups.

OCCURRENCE: Comparable test morphologies are known from Höver (Lehrte West Syncline). KÜCHLER's (2000, pl. 5, figs 1-3) *E. scutata cincta* from the middle Lower Campanian of the Barranca (Navarra, northern Spain) seems more closely related to the *gibba* group than to genuine *cincta* which characterises a narrow interval within the Lower Campanian in southern England (see SMITH & WRIGHT 2003, pl. 168, figs 5-8, but compare also p. 533).

Micraster (*Gibbaster*) ex gr. *fastigatus/stolleyi*
(Pl. 4, Figs 1-2)

DESCRIPTION AND DISCUSSION: From Wierzchowisko (Lower Campanian) and Rzeżuśnia (Upper Campanian), there are in the present collection a few small- to medium-sized tests which have a subconical profile and a frontal ambulacrum which is similar in structure to the paired ones. Some have a diffuse subanal fasciole; others show patches of miliaries only, close to the periproct. In the literature, such morphologies have been attributed to *Isomicraster* and *Gibbaster*, but, following STOKES (1975), these are best synonymised with *Micraster*. According to STOKES (1975, 1977), test morphology of these representatives reflect a mode of life different from that of the main lineage of *Micraster* (shallow ploughing *vs* deep burrowing). It is here preferred to synonymise *Isomicraster* with *Gibbaster* and afford the latter subgeneric status.

Previous authors have indicated that, at times, the distinction between *M. fastigatus* and *M. stolleyi* may be difficult, which holds true for the present assemblage as well. Typical specimens (from Wierzchowisko) of the former have a subanal fasciole, which, however, is often diffuse or poorly developed, and differ from the latter in having a more convex ('gibbous') upper side and periproct situated at 35-55% of total test height. Typical *M. stolleyi* (from Rzeżuśnia) have more or less straight sides, are more subconical, lack a subanal fasciole and have the periproct situated at 25-45% of total test height. In addition, the labral plates differ in both species; that of *M. fastigatus* is posteriorly narrow and then widens towards the peristome, the widest point being close to the peristome rim, that of *M. stolleyi* is much wider along its entire length, with the widest point at c. 50% of its length.

In absence/presence of subanal fasciole, test profile, anal angle and position of periproct, the present specimens combine features of both *M. fastigatus* and *M. stolleyi*. STOKES (1975) noted that, because it is occasionally difficult to distinguish late forms of *M. fastigatus* and early ones of *M. stolleyi*, the former is considered to be restricted to strata of Early Campanian age and the latter to those of Late Campanian date. This arbitrary decision is not followed here; instead, the material is referred to the group of *fastigatus*/*stolleyi*, well characterised by their (sub)conical profile and development of the frontal ambulacrum and easily distinguished from the main *M. (Micraster)* lineage (see below).

OCCURRENCE: ERNST (1972, 1975), who referred to *M. fastigatus* as *M. (Gibbaster) gibbus*, showed this morphotype to range from the *pilula*/*senonensis* to the top of the *gracilis*/*mucronata* Zone, with a distinct acme in the *senonensis* Zone. *Micraster stolleyi*, on the other hand, was considered by him to be restricted to the lower/middle Upper Campanian, with acmes in the uppermost *stobaei*/*basiplana* (= *spiniger*/*basiplana*) and *'vulgaris'*/*stolleyi* Zone (see also FRERICHS 1989; ERNST & *al.* 1997).

MĄCZYŃSKA (1968) recorded *M. gibbus* from Jeżówka and Wierzchowisko, and *M. stolleyi* from Jeżówka, amongst other localities. She did mention *M. fastigatus* as well, but not from the localities under consideration here. As STOKES (1975) pointed out, *M. gibbus* is a Coniacian-Santonian species which is confined to the Anglo-Paris Basin. A comparison of her illustrations (text-figures and plates) with those presented here, shows that MĄCZYŃSKA too had specimens which combined features of both species. Consider, for instance, the structure of the labral plate and the absence/presence of a subanal fasciole. For that reason, a record in open nomenclature is favoured here. In future, it may be possible, by analysis of bed-by-bed collections of 'populations', to separate these morphotypes, but for now they are lumped.

Micraster (*Micraster*) ex gr. *schroederi*/*glyphus*
(Pl. 4, Figs 3-5)

DESCRIPTION AND DISCUSSION: The present lot contains a number of medium- to large-sized micrasterids of poor preservation (crushed, fragmentary) as well as a handful of smaller-sized individuals which are much better preserved. The specimens here illustrated are from Wierzchowisko (Lower Campanian) and Rzeżuśnia (Upper Campanian), and are easily distinguished from the subconical morphotype (see above) by the general presence of a well-developed subanal fasciole, an elongated, narrow labral plate, a deep frontal notch and nonconjugate isopores in the frontal ambulacrum. In addition, large specimens have a distinctly angular test outline in plan view.

Analyses of 'populations' have shown that *M. schroederi* and *M. glyphus* are members of the same lineage, and that occasionally it is difficult to separate them. The typical angular test morphology of *M. glyphus* represents just one extreme of a continuum. In the Lehrte West Syncline in particular, where *M. schroederi* is amongst the commoner echinoids found, this is well illustrated (see ERNST 1975, fig. 11). Differences are subtle, but mention may be made of anal angle, L/W ratio of tests and position of the highest point of the test, which is in the posterior third in *M. schroederi* and in the anterior third (near-apically) in *M. glyphus.*

We follow STOKES (1975) in considering *M. coranguinum*, *M. brongniarti*, *M. bibicensis*, *M.* (*Paramicraster*) *cracoviensis*, *M.* (*P.*) *latior* and *M.* (*P.*) sp. of MĄCZYŃSKA (1968) to be conspecific with *M. glyphus.*

OCCURRENCE: In the Lehrte West Syncline, *M. schroederi* ranges throughout most of the Lower Campanian, with acmes in the *pilula*, *conica*/*papillosa* and *gracilis*/*mucronata* zones, while *M. glyphus* is comparatively rare and occurs in the lower Upper Campanian (*conica*/*mucronata* and *stobaei*/*basiplana* zones, in particular), but ranges into the lower *minor*/*polyplocum* Zone (upper Upper Campanian; see ERNST & *al.* 1997, fig. 60). This lineage is well known from the white chalk and 'mergelkalk' facies of northern Europe, broadly corresponding to the 'Province Nord' of STOKES (1975).

DISCUSSION

From the ammonite, belemnite, inoceramid bivalve and echinoid evidence presented above it is clear that the exposures in the Wolbrom-Miechów area have a lot of potential, not hitherto realised. Detailed logging of the three main sections (Wierzchowisko, Jeżówka and Rzeżuśnia) in the area (as well as some others noted during a first visit late in 2003) is needed to determine the intercorrelation between these. Bed-by-bed collecting of macrofossils and sampling for micromorphic brachiopods, calcareous nannofossils and dinoflagellates is called for as well, to augment existing collections.

Of special note is the absence in the record of species of *Hoplitoplacenticeras*, which is well represented in Busko Zdrój area, in the northern margin of the Nida Trough. MACHALSKI & *al*. (2004) record from the latter area *H.* (*H.*) *dolbergense* (SCHLÜTER, 1876) and *H.* (*Lemfoerdiceras*) *lemfoerdense* (SCHLÜTER, 1872). The former is well known from the Münsterland Basin (KAPLAN & *al*. 1996) where it is restricted to the upper Beckumer Schichten (= *conica*/*mucronata* Zone), and other finds have been made

	LEHRTE WEST SYNCLINE	STEMWEDER BERG	MÜNSTERLAND
	bipunctatum/roemeri	*langei*	
	minor/polyplocum	*polyplocum*	
	vulgaris/stolleyi		
Upper Campanian	*vulgaris/basiplana*	*roemeri*	*vulgaris/basiplana*[5]
	stobaei/basiplana	*spiniger/basiplana*	*basiplana/stobaei*[4]
	conica/mucronata	*conica/mucronata*	*conica/mucronata*[3]
	gracilis/mucronata	*gracilis/mucronata*	*gracilis/mucronata*[2]
	conica/papillosa		
	papillosa		
Lower Campanian	*senonensis*		*quadrata*[1]
	pilula/senonensis		
	pilula		
	lingua/quadrata		*lingua/quadrata*
	granulataquadrata		*granulataquadrata*

[1] upper portion of Stromberger Schichten; [2] uppermost Stromberger Schichten; [3] Beckumer Schichten; [4] lower portion of Vorhelmer Schichten; [5] remainder of Vorhelmer Schichten (see KAPLAN & *al.* 1996).

Table 1. Comparison of stratigraphic nomenclature for the Campanian of the Lehrte West Syncline (NIEBUHR & *al*. 1997), the Stemweder Berg (KENNEDY & KAPLAN 1997) and the Münsterland Basin (KAPLAN & *al.* 1996; HAUSCHKE & *al.* 1999).

from the lower Upper Campanian in the Coesfeld-Darup area. In the Lehrte West Syncline where the species is rare, its range is comparable (low *conica/mucronata* Zone). According to KENNEDY & KAPLAN (1997), *Hoplitoplacenticeras lemfoerdense* at Stemweder Berg occurs in the upper Haldem Schichten, and judging from float specimens, might first apper in the higher portion of their '*roemeri*' Zone; certain is its occurrence in the lower *polyplocum* Zone. It should be noted that those authors also recorded *H.* aff. *lemfoerdense*, which they considered transitional between *H. dolbergense* and *H. lemfoerdense*, from the lower portion of their *spiniger/basiplana* Zone (= *stobaei/basiplana* Zone). The fact that the sections in the Wolbrom-Miechów area have not (yet) yielded hoplitoplacenticeratids and the observation on inoceramids (see above) that the lowermost Upper Campanian (or: *conica/mucronata* Zone) cannot be documented, suggests a gap in that part of the sequence. To document this more fully, the overlap, if any, between the sections exposed at Jeżówka and Rzeżuśnia, as well as the hiatus represented by the hardground at the former locality need to be determined.

Of the zones employed in northern Germany (Lägerdorf, Lehrte West Syncline and Münsterland Basin; see Table 1), the following have now been recognised in the study area:

Wierzchowisko — *pilula* and *pilula/senonensis* zones (possibly including *senonensis* Zone as well).

Jeżówka — *papillosa* and *conica/papillosa* zones (possibly also higher)

Hardground possibly represents equivalents of (portions of) *gracilis/mucronata* and *conica/mucronata* zones, which thus suggests its formation was largely controlled by the latest Early Campanian 'Peine Phase', introduced by RIEDEL (1940) for the Hannover-Braunschweig area, and resulted from sediment winnowing around the sequence boundary and during the following transgressive systems tract of the *mucronata* Transgression (B. NIEBUHR, pers. comm., June 2004).

Rzeżuśnia — *spiniger/basiplana* Zone (and perhaps higher).

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PLATES 1-4

PLATE 1

1 – *Belemnitella* ex gr. *mucronata* (VON SCHLOTHEIM, 1813), GIUS 9-2332-MT-1; lower Upper Campanian, Rzeżuśnia, x 1.

2 – *Gonioteuthis quadrata* (DE BLAINVILLE, 1827), GIUS 9-2333-MT-2; lower Lower Campanian, Wierzchowisko, x 1.

3 – *Baculites* sp., GIUS 9-2334-MT-3; lower Upper Campanian, Rzeżuśnia.

4 –*Scaphites* (*S.*) *hippocrepis* III sensu COBBAN, 1969, GIUS 9-2335-MT-4; upper Lower Campanian, Jeżówka.

5, 10 – *Neocrioceras* (*Schlueterella*) *pseudoarmatum* (SCHLÜTER, 1872), 5 - GIUS 9-2338-MT-7, 10a, b - GIUS 9-2341-MT-10; lower Upper Campanian, Rzeżuśnia.

6 – *Scaphites* (*S.*) *gibbus* SCHLÜTER, 1872, GIUS 9-2336-MT-5; lower Upper Campanian, Rzeżuśnia.

7 – *Trachyscaphites s. spiniger* (SCHLÜTER, 1872), GIUS 9-2337-MT-6; lower Upper Campanian, Rzeżuśnia.

8 – *Lewyites elegans* (MOBERG, 1885), GIUS 9-2339-MT-8; ?microconch; lower Upper Campanian, Rzeżuśnia.

9 – *Pachydiscus* (*P.*) *haldemsis* SCHLÜTER, 1867, GIUS 9-2340-MT-9; lower Upper Campanian, Rzeżuśnia.

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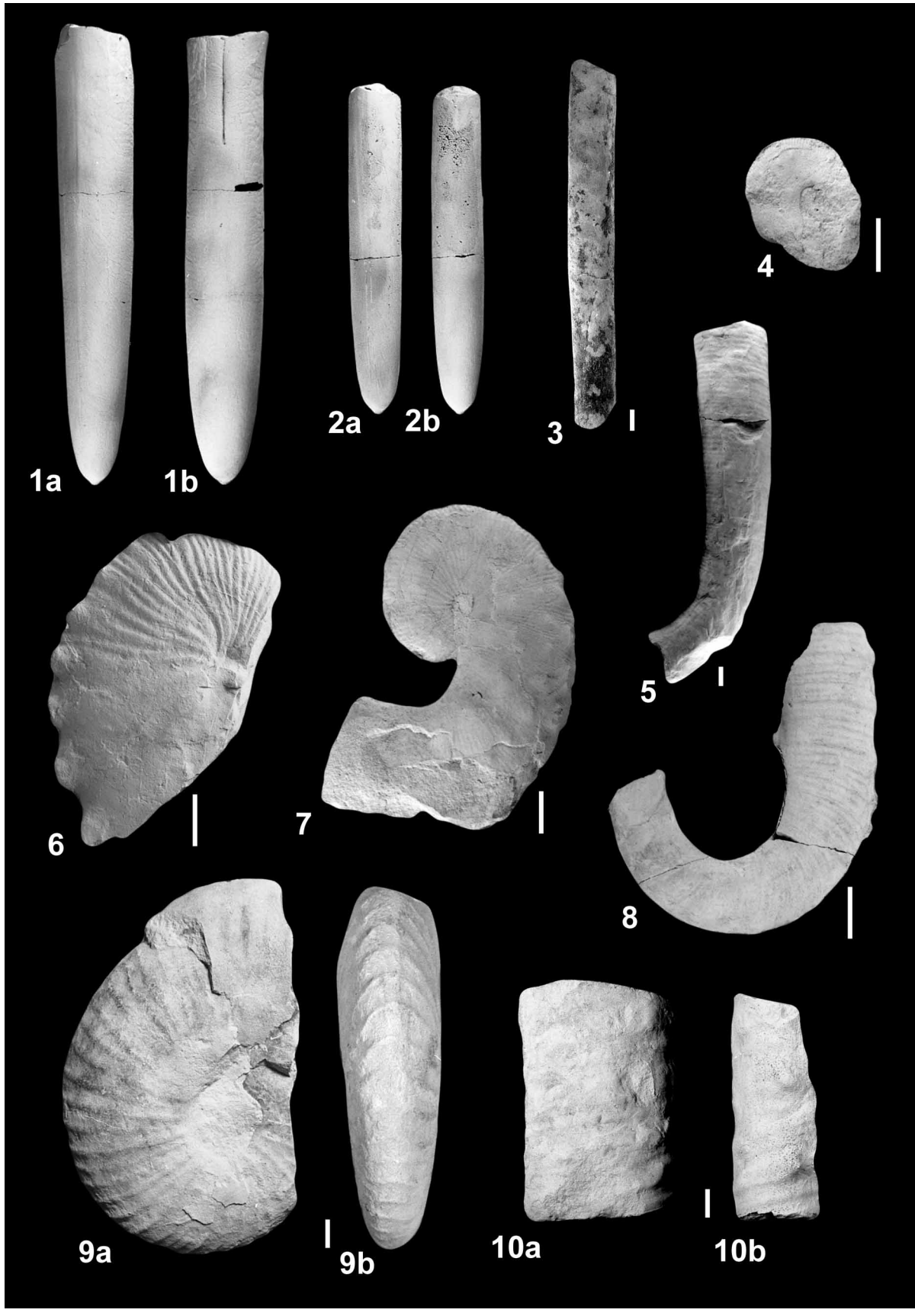
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PLATE 2

1 – *'Inoceramus' azerbaydjanensis* ALIEV, 1939, MWG ZI/35/200; lower Upper Campanian, Rzeżuśnia.

2 – *Cataceramus ellipticus* (GIERS, 1964), MWG ZI/35/201; lower Upper Campanian, Rzeżuśnia.

3, 6 – *Cataceramus balticus* (BÖHM, 1907); lower Upper Campanian, Rzeżuśnia; 3 – MWG ZI/35/202; 6 – MWG ZI/35/203.

4-5 – *'Inoceramus' vorhelmensis* WALASZCZYK, 1997; lower Upper Campanian, Rzeżuśnia; 4 – MWG ZI/35/204, 5 – MWG ZI/35/205.

7 – *'Inoceramus' agdjakendsis* ALIEV, 1952, MWG ZI/35/206; lower Upper Campanian, Rzeżuśnia.

8 – *Cataceramus dariensis* (DOBROV & PAVLOVA, 1959), MWG ZI/35/207; upper Lower Campanian, Jeżówka.

All figures are natural size

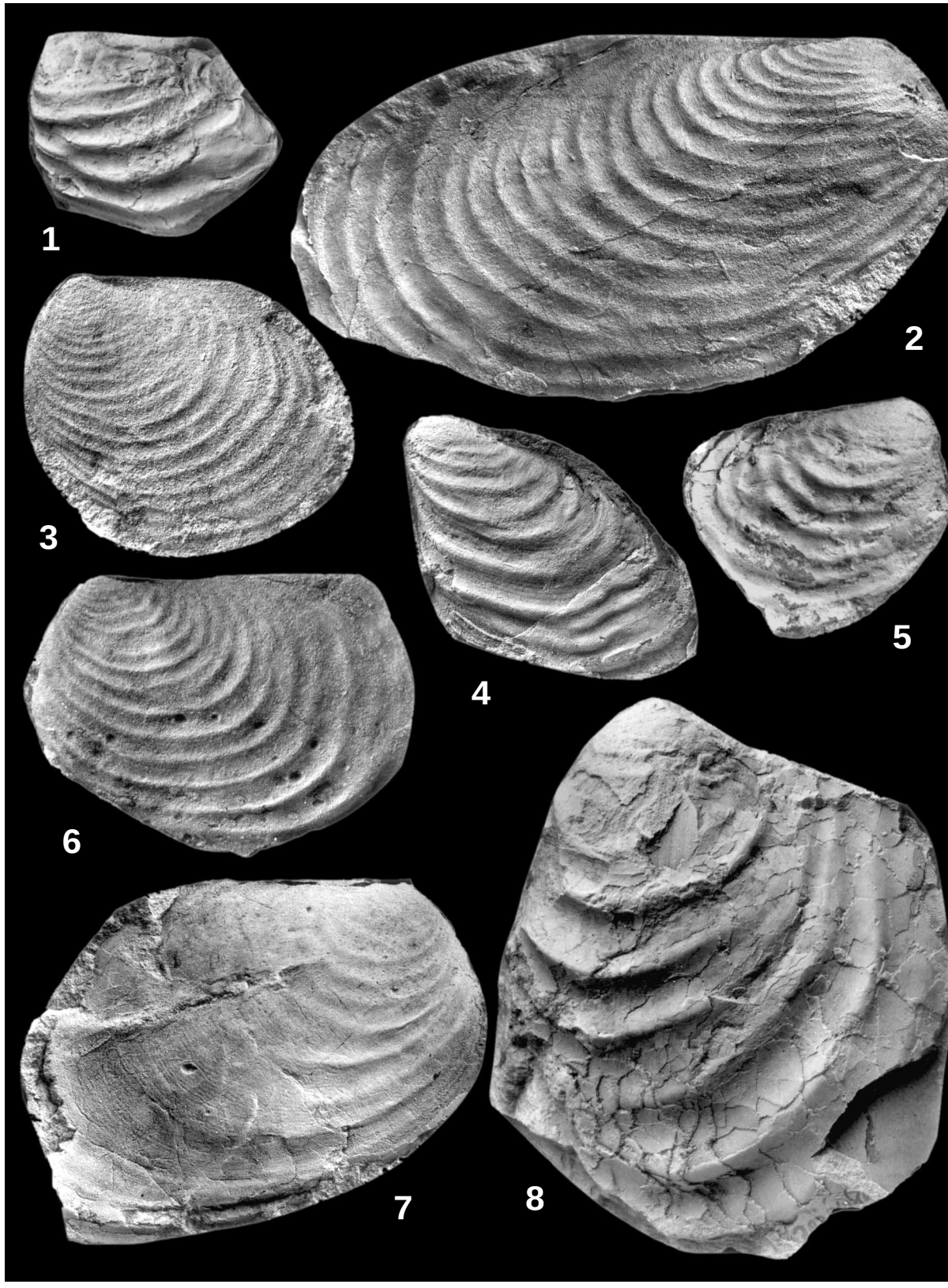
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PLATE 3

1 – *Offaster pilula* (LAMARCK, 1816), GIUS 9-2342-MT-11; lower Lower Campanian, Wierzchowisko.

2 – *Galeola papillosa* (LESKE, 1778), GIUS 9-2343-MT-12; upper Lower Campanian, Jeżówka.

3 – *Echinocorys* ex gr. *conica* (AGASSIZ, 1847), GIUS 9-2344-MT-13; upper Lower Campanian, Wierzchowisko.

4 – *Echinocorys* ex gr. *pyramidata* (PORTLOCK, 1843); GIUS 9-2439-MT-22; lower Upper Campanian, Rzeżuśnia.

5-6 – *Echinocorys* ex gr. *subglobosa*/*turrita*; lower Upper Campanian, Rzeżuśnia; 5a, b – GIUS 9-2345-MT-14; 6a, b — GIUS 9-2346-MT-15.

7 – *Echinocorys* ex gr. *gibba*, GIUS 9-2347-MT-16; lower Lower Campanian, Wierzchowisko.

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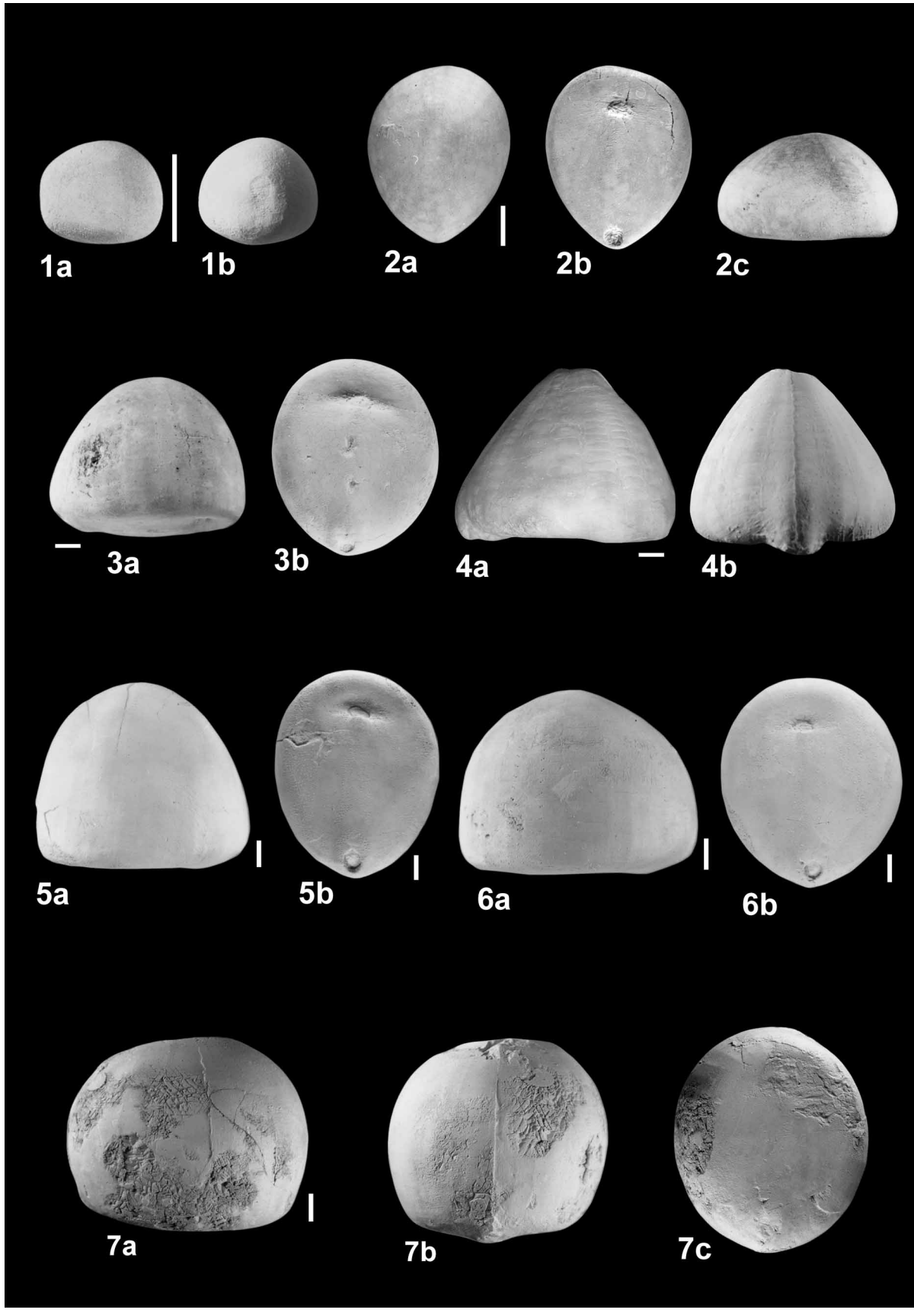
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PLATE 4

1-2 – *Micraster* (*Gibbaster*) ex gr. *fastigatus*/*stolleyi*; 1a, b – GIUS 9-2348-MT-17, lower Lower Campanian, Wierzchowisko; 2a-d – GIUS 9-2349-MT-18, lower Upper Campanian, Rzeżuśnia.

3-5 – *Micraster* (*Micraster*) ex gr. *schroederi*/*glyphus*; 3a-c – GIUS 9-2350-MT-19, lower Upper Campanian, Rzeżuśnia; 4a, b – GIUS 9-2351-MT-20, lower Lower Campanian, Wierzchowisko, 5a, b – GIUS 9-2352-MT-21, lower Lower Campanian, Wierzchowisko.

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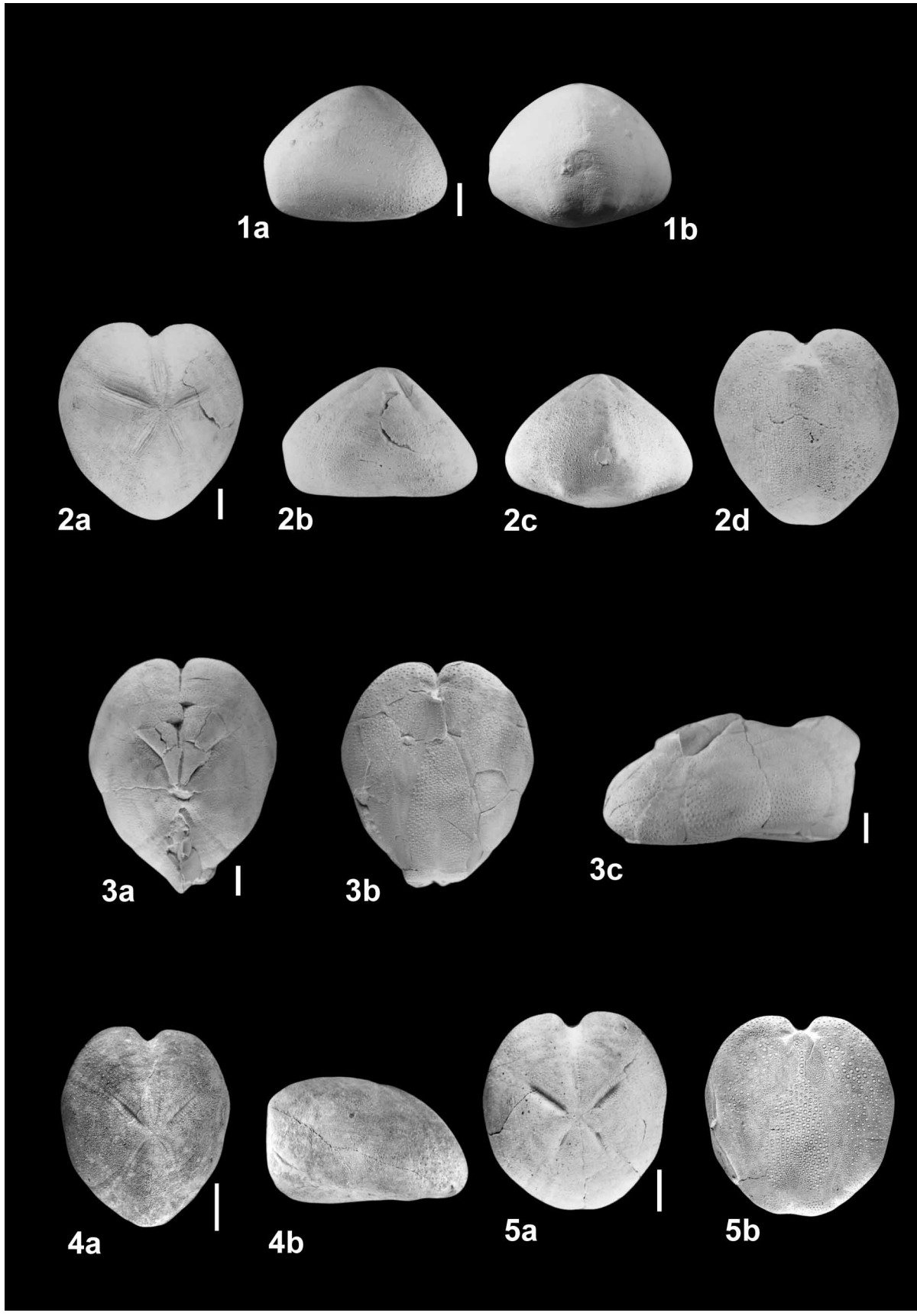
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