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Inoceramids and inoceramid biostratigraphy of the Upper Campanian to basal Maastrichtian of the Middle Vistula River section, central Poland

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ABSTRACT:

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The revised geological log and the biostratigraphy of the Late Campanian and earliest Maastrichtian succession of the Middle Vistula River section, central Poland, are presented. The biostratigraphy is based on inoceramid fauna, basically newly collected. Eight inoceramid zones were distinguished, corresponding, in ammonite/belemnite terms, to an interval from the upper *Bostrychoceras polyplocum* Zone up to the traditional *Belemnella occidentalis* Zone. From bottom upwards these are zones of: *Cataceramus subcompressus*, "*Inoceramus*" *tenuilineatus*, *Sphaeroceramus pertenuiformis*, "*Inoceramus*" *altus*, "*Inoceramus*" *inkermanaensis*, *Trochoceramus costaecus*, "*Inoceramus*" *redbirdensis*, and of *Endocostea typica*. The inoceramid assemblages allow a precise correlation with critical sections in Europe, as well as trans-Atlantic correlation to the US Western Interior. The traditional base of the Maastrichtian falls at the base of the *Trochoceramus costaecus* Zone, whereas the 'Tercis basal Maastrichtian boundary' may fall as high as lower *Belemnella sumensis* Zone. Based on the correlation to the US Western Interior, a subdivision of the Upper Campanian into Middle and Upper substages is suggested. The boundary between the Middle and the Upper Campanian substages may be defined by the base of the "*Inoceramus*" *tenuilineatus* Zone, which in ammonite terms, corresponds to the base of the *Didymoceras donezianum* Zone (=top of the *Bostrychoceras polyplocum* Zone).

Thirty one inoceramid species level taxa are described, of which "*Inoceramus*" *smirnovi* nom.nov. is a replacement name; 10 species are left in open nomenclature. Inoceramids of the Middle Vistula succession represent a uniform fauna characteristic of the whole Euramerican biogeographical region.

Key words: Campanian, Maastrichtian, Middle Vistula section, Central Poland, Inoceramid taxonomy, Inoceramid stratigraphy, Campanian/Maastrichtian boundary, Correlation.

INTRODUCTION

The Campanian – Maastrichtian interval of the Middle Vistula section is an expanded, fossiliferous succession, with an extremely high stratigraphical potential. It is well known for its rich ammonite record, which enabled the establishement of a zonal scheme for the Upper Campanian (BŁASZKIEWICZ 1980). It also provided a rich belemnite fauna (KONGIEL 1962). Of importance are also microfaunal groups, e.g. foraminifers (PERYT 1980, 2000) and nannofossils (GAŹDZICKA 1978, BURNETT & *al*. 1992), although detailed knowledge of these groups is still limited to selected intervals of the succession. Inoceramid faunas, although occurring in abundance in numerous levels, besides the preliminary data by

POŻARYSKI (1938), has never been studied in any detail. Also, with the exception of tegulated inoceramids, they were excluded from the general survey of the non-cephalopod molluscs from the section (ABDEL-GAWAD 1986). In the Campanian and Maastrichtian the group was regarded as characterised by extremely low evoutionary tempo and low taxonomic diversity. The recent study of inoceramid fauna from the Campanian and Maastrichtian of the US Western Interior (KAUFFMAN & *al*. 1994, WALASZCZYK & *al*. 2001) and subsequently from the Upper Campanian and lowermost Maastrichtian of the Tercis section in France (WALASZCZYK, ODIN & DHONT 2002) showed, however, that this was an incorrect view. Inoceramids remained a morphologically diverse and evolutionarily vigorous group untill the very end of their history, i.e. untill the mid-Mastrichtian (exluding tegulated inoceramids which survived till the end of the stage), keeping their high stratigraphical potential. Moreover, they also kept their high dispersal potential, with the appearance of numerous taxa with wide geographic range. In parts of the Campanian – Early Maaastrichtian succession inoceramid-based zonation appeared to be more refined than other schemes, including the ammonite-based one, and moreover, it allowed direct correlation between far distant areas. These new results both in the US and in Tercis, stimulated me to undertake the study of the inoceramids from the Vistula section. The majority of the inoceramid material used herein is represented by new collections; in the case of older collections only specimens with a precise location were used. New collections were combined with a new fundamental geological study of the Upper Campanian and of Lower Maastrichtian of the middle Vistula section, in the context of integrated stratigraphical research conducted during 2001-2003. The complete results of these studies will be published elsewhere.

The advantage of the inoceramid record in the Vistula section is an opportunity of its direct correlation with the belemnite scheme (although the latter still needs further works), enabling the correlation of the biostratigraphic scheme across the Campanian – Maastrichtian boundary as recently worked out for the boundary stratotype section in Tercis with the north European belemnite standard. Inoceramids also provide an independent tool for the correlation of the ammonite zonations between Tercis and Vistula sections. Also they provide an opportunity to correlate the succession with the US Western Interior Upper Campanian and lowermost Maastrichtian ammonite succession.

FORMER STUDIES

The first modern subdivision of the Campanian and Maastrichtian of the Vistula section was completed by POŻARYSKI (1938, see also POŻARYSKI 1948). He introduced an alphabetical scheme, units a to z, in ascending order for the beds comprising (in present terminology), the interval from the Coniacian through the Maastrichtian. The definition of most of the units was biostratigraphical, although he also included their lithological characteristics in the diagnoses. The Upper Campanian and Lower Maastrichtian correspond to his units k to w (Text-fig. 5). POŻARYSKI's (1938) scheme is a very convenient reference subdivision referred to by most of subsequent authors.

KONGIEL (1962) in his monograph on the Campanian and Maastrichtian belemnites used in general POŻARYSKI's subdivision. He introduced, however, a new subdivision of the Upper Campanian and of the Upper Maastrichtian. The Upper Campanian he subdivided into horizons α, β and γ, which were biostratigraphical zones, defined by ammonite assemblages; his zone α corresponds to POŻARYSKI's units k ad l; his zone β corresponds to POŻARYSKI's units m, n, o, p, and r; and his zone γ corresponds to POŻARYSKI's units s and t. KONGIEL (1962) shifted also the position of the Campanian/Maastrichtian boundary to the base of unit u instead of the base of unit s as suggested by POŻARYSKI (1938).

Inevitably, the benchmark paper for the stratigraphy of the studied succession is BŁASZKIEWICZ's (1980) ammonite study. He divided the interval into a sequence of ammonite and belemnite zones (Text-fig. 5), with their definitions as follows (from bottom upwards):

The *Neancyloceras phaleratum* Zone, with its base defined by the FO of *Trachyscaphites spiniger spiniger* (SCHLÜTER), and its top by the FO of *Bostrychoceras polyplocum* (ROEMER); the index taxon was noted in the upper half of the zone. This zone corresponds to the upper part of POŻARYSKI's unit j and to his unit k.

The *Bostrychoceras polyplocum* Zone, with its base defined by the FO of the index taxon and its top defined by the FO of *Menuites portlocki posterior* (BŁASZKIEWICZ); the index taxon occurs throughout the zone, with a possible extension to the basal part of the succeeding zone of *Didymoceras donezianum*. In POŻARYSKI's scheme it embraces units m, n, and o.

The *Didymoceras donezianum* Zone; its base is defined by the FO of *Menuites portlocki posterior* and its top by the FO of *Acanthoscaphites prequadrispinosus*

BŁASZKIEWICZ [= *Jelezkytes nodosus* (OWEN)]. The index taxon first appears higher in the zone and ranges only through its lower part. It corresponds to POŻARYSKI's units p and r.

Nostoceras pozaryski (=*N. hyatti*) Zone; its base is defined by the FO of *Acanthoscaphites prequadrispinosus* BŁASZKIEWICZ (=*Jelezkytes nodosus*). The index taxon first appears distinctly higher and ranges up to approximately the top of the zone.

Belemnella lanceolata lanceolata Zone. The zone, the basal Maastrichtian belemnite zone in the traditional boreal European subdivision, was defined as an interval zone, with its base defined by the FO of the index taxon and its top by the FO of the index taxon of the successive zone of *Belemnella occidentalis*. Actually the zone is also very close to the range zone of the index taxon, which disappears close to its top.

The base of the Maastrichtian in BŁASZKIEWICZ's (1980) scheme is located at the base of his *Belemnella lanceolata lanceolata* Zone.

GEOLOGICAL SETTING AND CAMPANIAN – MAASTRICHTIAN SUCCESSION

The Upper Campanian – lowermost Maastrichtian succession of the middle Vistula section is accessible in a series of natural and artificial exposures (see chapter below) between the villages of Dorotka and Kłudzie, in the western bank of the river, and between Józefów and Kamień, on its eastern side (Text-figs 1-3). Structurally the Cretaceous rocks are arranged in a homocline dipping gently to NE, with a dip not exceeding 10°. In consequence a fairly simple cartographic picture appears, with belts of successively younger strata toward the NE (Text-figs 1-2). The cartographic picture assembled during the present study corresponds to a large extent to the BŁASZKIEWICZ's (1980, fig. 1) interpretation. The difference concerns mostly the northernmost part of the area, around the town of Solec.

The basic field work for the present investigation, aimed at establishing a reliable composite section for the interval studied, were based primarily on the exposures located in the western bank of the Vistula river valley; only the huge quarry in Piotrawin and the high escarpment in Łopoczno were included from among the exposures available on the eastern side of the river (Text-figs 1-2). Because of the monotonous facies the inter-correlation of particular exposures, used to work out the presented composite section (Text-fig. 3) is based largely on fossil content; only rarely is refinement of the correlation by lithological means possible. The estimation of the total thickness of the succession studied herein, is taken as a simple product of the geographical distance perpendicular to the strike and the tangent of dip angle, based on the assumption of a more or less uniform dip, what is confirmed by measurements in all of the exposures studied, and the lack of any significant faults.

The total thickness of the studied succession, starting from the base of the Dorotka section, to the top of the Dziurków section, is estimated for about 130 m. The succession is composed of the alternation of 'pure', white opoka, usually highly fossiliferous, and of marly opokas, brownish-grey, markedly less fossiliferous. Six intervals distinguished are referred here to as Dorotka, Piotrawin, and Dziurków opoka (the intervals with pure opokas) and Opoka of Wola Pawłowicka and of Solec (for the two intervals of marly opokas) (Text-fig. 3).

The Dorotka Opoka, the lowest interval of pure opoka, starts in the Dorotka section, and continues to the top of the sections of Ciszyca Górna, what, in ammonite terms corresponds to an interval from a level in the *Bostrychoceras polyplocum* Zone to the middle part of the *Didymoceras donezianum* Zone.

The single locality, representing the *B. polyplocum* Zone, is the Dorotka quarry, an abandoned quarry in the east-facing bank of the Vistula, at the NE edge of the village of Dorotka. The quarry exposes an 8 meters thick succession of fossiliferous, thickly bedded opoka. The inoceramids are mostly single valved specimens, usually well preserved. They are dominated by *Cataceramus subcompressus* (MEEK & HAYDEN, 1860 [=*Cataceramus haldemensis* (GIERS, 1964)]. Among other species are *Cataceramus? planus* (MÜNSTER, 1836), *Platyceramus rhomboides* (SEITZ, 1961), and *Platyceramus* cf. *pierrensis* (WALASZCZYK & *al.*, 2001) (see Text-fig. 3).

The next section toward the north, that of Ciszyca Kolonia, is the locality from where the first *Menuites portlocki posteror* BŁASZKIEWICZ, 1980 comes from, indicating already the base of the *Didymoceras donezianum* Zone (BŁASZKIEWICZ 1980). The eponymous taxon is also limited to the lower part of the zone.

The inoceramids from Ciszyca Kolonia are poorly represented, but they demonstrate well the appearance of a new assemblage, referred to here as the "*Inoceramus" tenuilineatus* assemblage. Besides the name giving species the assemblage is also represented by *Cataceramus goldfussianus* (d'OBRIGNY, 1846), *Cataceramus* cf. *mortoni* (MEEK & HAYDEN, 1876), *Platyceramus* cf. *pierrensis* (Walaszczyk & *al.*, 2001),

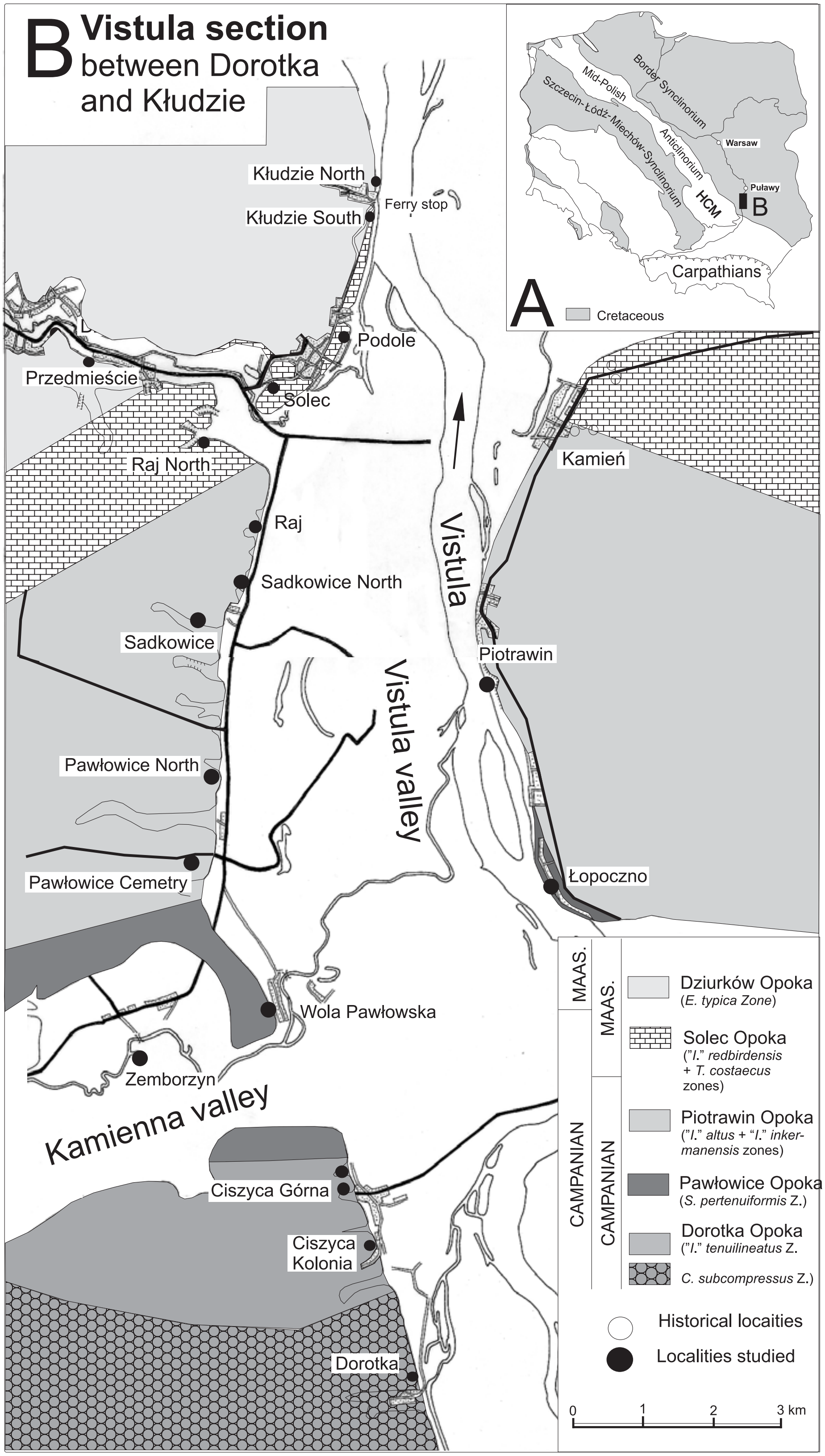

Fig. 1. Geological sketch-map with the Middle-Upper Campanian and Lower Maastrichtian of the Middle Vistula section

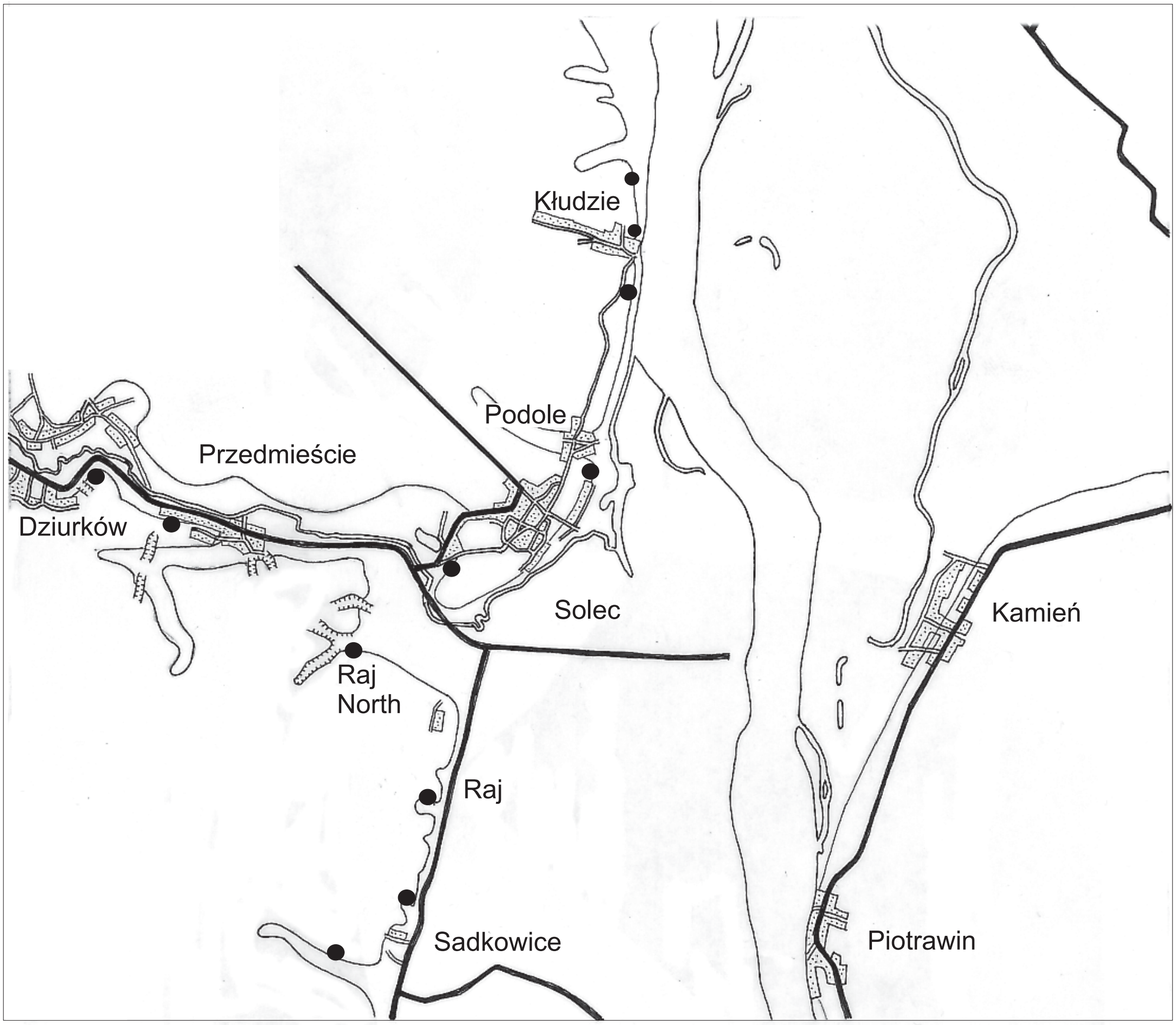

Fig. 2. Detailes of the northern part of the area

"*Inoceramus*" cf *whitfieldi* WALASZCZYK & *al*., 2001 (Text-fig. 22C), and "*Inoceramus*" sp. (Text-fig. 22D).

The precise correlation between the Ciszyca Kolonia and Ciszyca Górna sections is unknown. However, the Ciszyca Górna section represents a middle part of BŁASZKIEWICZ's (1980) *D. donezianum* Zone; most of the ammonite species characteristic of this zone come from this locality.

About one km north of Ciszyca Kolonia there are two quarries in Ciszyca Górna. The village quarry, north of the main road in the village, and a private quarry, located in the small ravine at the northern end of the village, expose an about 10 m thick succession of very fossiliferous opoka, with wavy bedding (Text-figs 1, 3). The fauna, dominated by ammonites, mainly baculite and nostoceratid fragments, bivalves and gastropods, form numerous acme horizons, with signs of redeposition. In ammonite terms this interval represents a middle part of the BŁASZKIEWICZ' (1980) *Didymoceras donezianum* Zone. Inoceramids are less common here than in Dorotka. However, the assemblage is taxonomically more diverse and distinctive. *Cordiceramus* cf. *heberti* (FALLOT, 1885), *Cataceramus goldfussianus* (D'ORBIGNY, 1847), "*Inoceramus" tenuilineatus* HALL & MEEK, 1856, *Platyceramus* cf. *pierrensis* (WALASZCZYK, COBBAN & HARRIES, 2001), "*Inoceramus*" *borilensis* JOLKICEV, 1962, and "*Inoceramus*" sp. A (Text-fig. 45) are recognised in the material studied. The number of specimens available is too low to allow any inferences about relative taxonomic abundance.

The succession represented by the sections of Dorotka, Ciszyca Kolonia and Ciszyca Górna, occurs in the steep, western escarpment of the Vistula river valley, and the relative thickness of particular section and relationships between them are relatively safe to estimate.

The higher part of the succession, in the area between Ciszyca Górna and Pawłowice, is represented by the lower interval of marly opoka, referred to here as the Pawłowice Opoka and, according to BŁASZKIEWICZ, (1980) it represents an upper part of his *D. donezianum* ammonite Zone. No characteristic ammonite assemblage was mentioned by BŁASZKIEWICZ (1980) from this interval. At present this interval is readily accessible in two small quarries, in Wola Pawłowska and Zemborzyn (Text-figs 1, 3), but in spite of intensive search only fragmentarily preserved pachydiscids and didymoceratids were found. Much better represented are the inoceramids, which dominate the paleontological record here. Belemnites are very rare. About 6 metres thick uniform succession is exposed in the Wola Pawłowska section. Inoceramids, collected in this quarry are dominated by the very characteristic *Sphaeroceramus pertenuiformis* WALASZCZYK, COBBAN & HARRIES, 2001, huge, mostly incompletely preserved "*Inoceramus*" *nebrascensis* OWEN, 1852, and fragments of huge platyceramids. Other forms are: "*I.*" *borilensis*, *C. goldfussianus* and "*Inoceramus*" sp. A (see Text-fig. 45). These opokas correspond to unit s and to lowermost part of unit t of POŻARYSKI (1939).

The succeeding interval, comprising a series of exposures from Pawłowice-cemetery up to Raj (Text-fig. 1), represents the next unit of 'pure' opoka, the Piotrawin Opoka (Text-fig. 3). In ammonites terms it is the BŁASZKIEWICZ's (1980) *N. pozaryski* (=*Nostoceras hyatti* – see Kennedy & *al.* 1992) Zone. In POŻARYSKI's scheme (1939) this part of the succession represents the middle and upper parts of his unit t. Based on lithological characteristics and, first of all, on inoceramids, this interval corresponds to the succession as exposed in the huge Piotrawin quarry, east of the river (Text-figs 1, 3). The subdivision of the sequence exposed in the Piotrawin quarry, shown in Text-fig. 3, refers to the exploitation levels, and does not refer to the stratigraphical and/or lithological changes in the succession. By chance, however, the boundary between the first and second exploitation level corresponds well to the faunal turnover in inoceramids; it is the boundary between the "*Inoceramus*" *altus* and "*Inoceramus*" *inkermanensis* Zones. When correlating with the western side of the river, the lower level correlates with the succession as exposed in Pawłowice, whereas the second and third levels are equivalents of the succession as observed in the section in Sadkowice (both Sadkowice quarry and Sadkowice North) and Raj (Text-fig. 3). This new correlation demonstrates first that, in contrast to BŁASZKIEWICZ (1980), the Piotrawin section encompasses almost the whole of his *N. pozaryski* Zone, and that the thickness of this zone is at most 35 m, and not 60 m as estimated by BŁASZKIEWICZ (1980).

BŁASZKIEWICZ (1980) defined the base of his *N. pozaryski* (=*N. hyatti*) Zone by the first appearance of his new species *Acanthoscaphites prequadrispinosus* [younger synonym of *Jeletzkytes nodosus* (OWEN) see KENNEDY & *al*. 1992], with the index taxon suggested to appear considerably higher than the base of the zone. In the Piotrawin section, the lowest specimen of *N. hyatti* (STEPHENSON) was found about 3 m above the base of the section (M. MACHALSKI personal communication). The consequence of this statement and of the new correlation presented above, is that *N. hyatti* appears presumably simultaneously with *J. nodosus*, and thus approximately at the base of the zone.

In belemnite terms the Piotrawin opoka falls in the upper part of the *Belemnitella langei* Zone (BŁASZKIEWICZ 1980, BURNETT & *al*. 1992). The sample from the upper third of the section contains *Belemnitella posterior* KONGIEL, 1962 and *Belemnitella najdini* KONGIEL (CHRISTENSEN, unpublished report 1998), the latter noted in the topmost Campanian of Donbass in Russian Platform (NAIDIN 1974) and in Norfolk (CHRISTENSEN 1995, see also CHRISTENSEN 1997). According to KONGIEL (1962) his new species ranges up to the lower Maastrichtian, however, his 'Maastrichtian' specimen from Solec (higher part of the *lanceolata* Zone) was referred by SCHULZ (1982) to his new species *Belemnitella pulchra*.

PERYT (1995; see also PERYT 2000) based on benthic foraminifera referred the upper part of the succession from Piotrawin already to the *lanceolata* Zone. She referred to the benthic foram biozonation of the North German Kronsmoor standard section (SCHÖNFELD 1990). Unless it is not a discontinuous record it may suggest a diachronous appearance of particular species of benthic foraminifera, which is not improbable in view of the difference in facies between both areas.

Already at the base of the Piotrawin opoka a considerable change is noticed in inoceramid fauna. It is well seen in Pawłowice, about 2 km north, in the road-cut near cemetery, as well as in the Vistula valley escarpment about 1 km farther to the north, as well as in the lower third of the Piotrawin quarry, where inoceramids are represented by large-sized "*Inoceramus*" *sagensis* OWEN, 1852 (Text-fig. 42), and nicely preserved "*Inoceramus*" *altus* MEEK, 1871 (Text-figs 29).

The middle and upper third of the succession in the Piotrawin quarry, as well as the succession exposed in the two quarries in Sadkowice and in Raj, all west of the Vistula river, expose the higher part of BŁASZKIEWICZ's (1980) *N. pozaryski* Zone (=*N. hyatti* Zone). This part of the Campanian contains the richest inoceramid assemblage of the whole succession studied herein. Inoceramids are rich in number and diverse taxonomically. The most common forms are (Text-fig. 4): "*Inoceramus*" *inkermanensis* DOBROV & PAVLOVA, 1959, *Cataceramus goldfussianus* (D'ORBIGNY, 1847), "*Inoceramus*" *smirnovi* nom.nov., "*Inoceramus*" *balchii* MEEK & HAYDEN, 1860, as well as the very characteristic "*Inoceramus*" *alaeformis* ZEKELI, 1852 of authors, "*Cataceramus*" aff. *gandjaeformis* WALASZCZYK, COBBAN & HARRIES, 2001, "*Inoceramus*" *maclearni* DOUGLAS, 1942. Diverse and rich in specimens are also other faunas, including ammonites, belemnites (BŁASZKIEWICZ 1980), non-inoceramid bivalves and gastropods (ABDEL-GAWAD 1986).

East of the Vistula river no younger strata than those exposed in the Piotrawin quarry are directly accessible. Numerous localities, mentioned in POŻARYSKI (1938, 1948) or BŁASZKIEWICZ (1980) e.g. old quarry in Piotrawin or the quarries in Kamień, which yielded a number of important fossils are no longer available; these are filled in and/or completely overgrown. Based on the cartographic analysis of the area, as well as on the petrographic characteristics of the material from the latter area, it seems, however, that the sections in Kamień represented a part of the succession almost immediately suceeding the highst beds exposed in the quarry of Piotrawin (see Text-fig. 3).

In contrast, the continuous succession is accessible for direct study in the western part of the area. 1.5 km NW of the Raj section there is a small quarry called herein Raj North, where one may notice a distinct change in lithological character of the opoka and its faunal content. The succession in this locality follows the sequence from the Raj quarry with a minor observational gap, most probably not exceeding 4-5 m. The succession of Raj North forms the basal part of the higher level with 'marly opoka' referred to herein as the Solec Opoka. When compared to the underlying succession from the Raj quarry the fauna occurring here is sparse and represented mostly by baculites and belemnites. Other ammonites and inoceramid bivalves, so common below, are very rare. In this part of the succession first appears *Belemnella lanceolata* [=*Belemnitella gracilis gracilis* ARKHANGELSKY in KONGIEL (1962, pl. 11, figs 1-3) synonymised with *B. lanceolata* by (SCHULZ 1979, p. 96)]. Inoceramids are represented by *Trochoceramus costaecus* (KHALAFOVA, 1966), "*Inoceramus*" *redbirdensis* WALASZCZYK, COBBAN & HARRIES, 2001, "*I.*" *balchii*, and large platyceramids. The first species is represented by very rare specimens, found loose. Nicely preserved specimen comes from old collection of Professor W. POŻARYSKI from Kamień (Text-fig. 28).

The first *Pachydiscus neubergicus* should also appear somewhere at about this level. Although no specimen was found in the Raj North section, numerous specimens of *Pachydiscus neubergicus* from equivalent strata formerly exposed in Kamień, east of the river, were reported by BŁASZKIEWICZ (1980) and referred by him to his subspecies *raricostatus* (BŁASZKIEWICZ 1980, pl. 35, figs 6-7; pl. 36, figs 3-4, 8). This material should come either from a level with first *B. lanceolata* or at most some metres higher (see Text-fig. 2).

The succession of Raj North is well exposed also in the Solec section, 1 km to NE of the Raj North section, on the right side of the entrance road to the town of Solec. It is a partly covered steep face behind the first houses in the town, with an about 12 m thick section readily accessible. The precise correlation between the two sections is uncertain, but it seems that the Raj North section corresponds to the middle and upper parts of the Solec section (Text-figs 1, 3).

In the belemnite scheme this interval belongs already to the *Belemnella lanceolata* Zone, sensu BŁASZKIEWICZ (1980) which corresponds to the *B. lanceolata*, *B. pseudobtusa* and *B. obtusa* Zones in the scheme of SCHULZ (1979).

The Solec Opoka builds the whole area of the town of Solec, and is exposed here and there in the high Vistula escarpment south, east, and north of the town, and finally it disappears below the younger strata, north of the ferry point in Kłudzie (Text-fig. 1). The top of the unit is taken here at a distinct marly horizon, 20-30 cm thick, referred to here as the 'boundary marl' (Text-fig. 3), because of its location within the Campanian/Maastichtian boundary interval. The 'boundary marl' first appears in the topmost part of the escarpment in the Podole section, where it is seen about 15 m above the Vistula river level. It then next appears 8 and 6 m above the Vistula river level in small exposures just south and north respectively of the ferry stop in Kłudzie (Text-figs 1-2). It enables a very precise correlation of all the localities in the Vistula valley escarpment between the town of Solec and Kłudzie (see Text-fig. 3).

The interval below and above the 'boundary marl' yielded numerous belemnites and large-sized baculites. Inoceramids are rare and badly preserved; they are represented by large-sized platyceramids and single specimens of "*I.*" aff. *redbirdensis*. According to

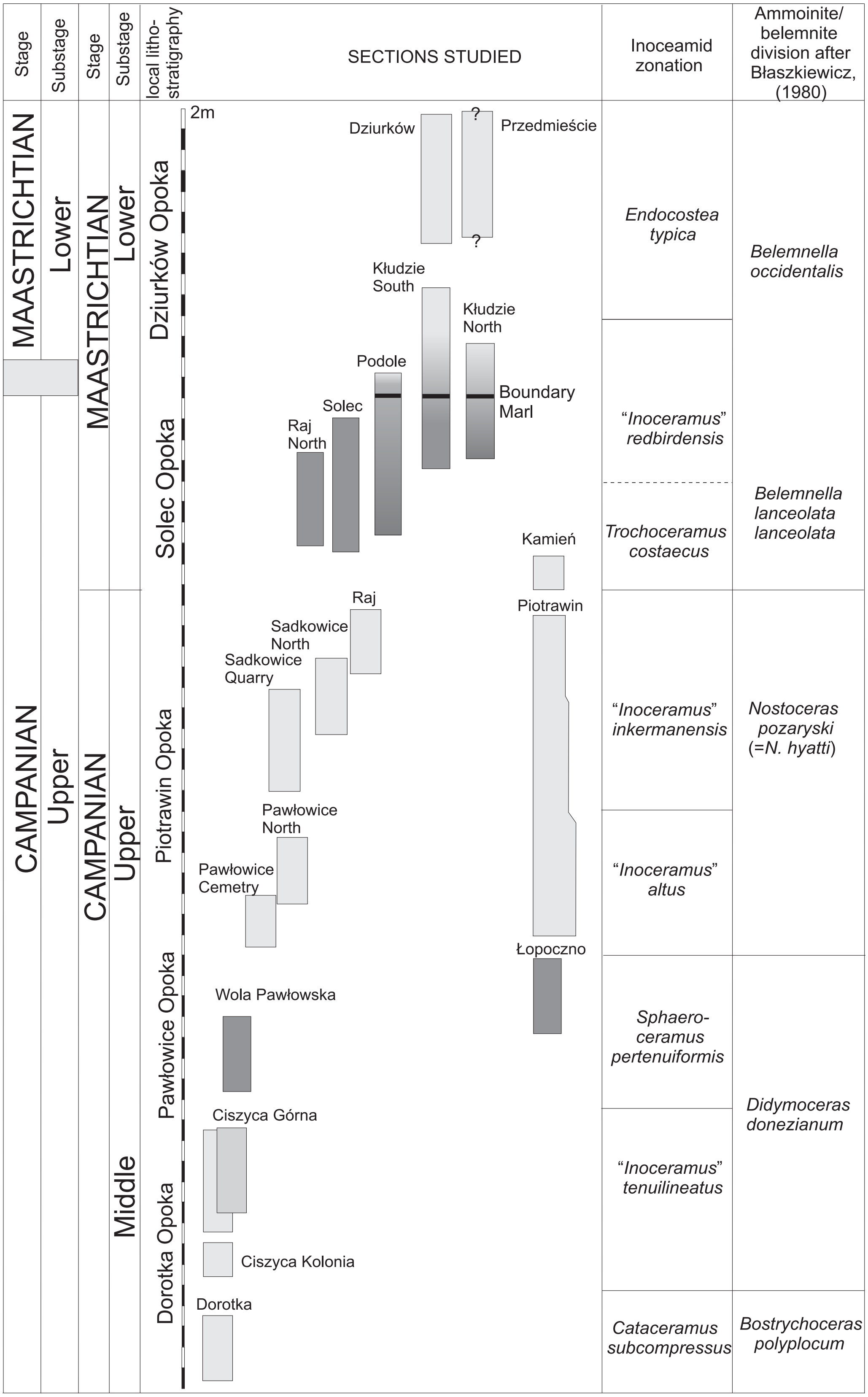

Fig. 3. Geological columns, stratigraphy and correlations of the sections studied

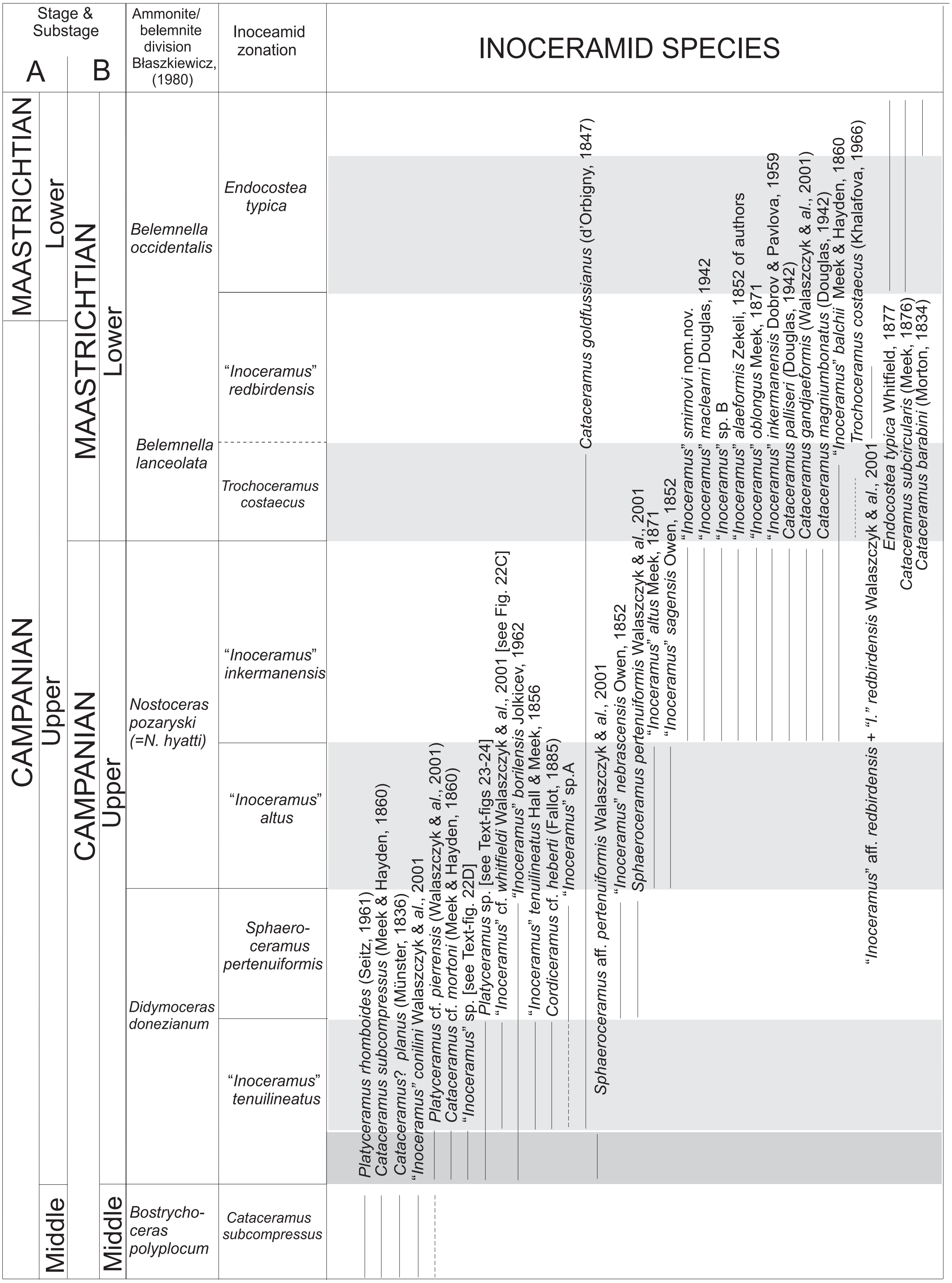

Fig. 4. Stratigraphical ranges of inoceramid species; the stage and substage subdivision according to the 'Tercis' definition (A), and according to 'Boreal' definition (B)

BŁASZKIEWICZ (1980) *Belemnella* from this level represents already *Belemnella occidentalis*, a younger synonym of *Belemnella sumensis*.

Inoceramids are rare in the Solec Opoka, as well seen in the quarries in Raj North, Solec, and in the lower parts of Vistula escarpment between Solec and Kłudzie (Text-figs 1-2). The decrease is also clear in other groups, as e.g. ammonites, which, besides quite common baculites, are rare.

Inoceramids were collected mostly in the Raj North and Solec sections; single specimens come from sections of Podole and of Kłudzie South. Most of the specimens are hardly determinable fragments of large platyceramids. Of importance, however, are single specimens of *Trochoceramus costaecus*, found in the lower part of the Raj North section, and of "*Inoceramus"* aff. *redbirdensis*, found in the Solec and in Kłudzie South sections.

Although I put the upper boundary of the Solec Opoka at the 'boundary marl' the actual change in the lithology takes place gradually at some distance around that level. The change of the inoceramid fauna takes place still higher, about 8 metres above the 'boundary marl'. The large-sized platyceramids noted lastly just below the 'boundary marl' give place to small-sized endocostean *Enodocostea typica* WHITFIELD, 1877, and cataceramid species, *C. subcircularis* (MEEK, 1876). This succession continuous higher in the Dziurków quarry, located west of Solec, south of the Solec – Lipsko road, and in the Przedmieście section, about 800 m east of the latter (Text-figs 1-2), which shows the younger members of the *Endocostea typica* fauna. The typical development of the Dziurków Opoka is also best seen in these quarries. Preliminary data on the belemnites from this locality (Zbyszek REMIN, personal communication) suggests that the succession of Dziurków and of Przedmieście sections belongs to the *Belemnella sumensis* Zone. This new correlation indicates that no part of the Maastrichtian younger than that exposed in the Dziurków quarry crops out in the high escarpment between Solec and Kłudzie.

LOCALITY LIST

All source localities are shortly characterised below in alphabetical order. Their stratigraphical location is shown in Text-figure 2 and their geographical position in Text-figs 1-2.

Ciszyca Górna: Two quarries, the Village quarry on the northern side of the main road leading to Tarłów, about 250 m west of the main cross-road in the village; and the Northern Quarry in a small gully in the northern end of the village, about 300 m north of the main cross-road. The two quarries expose respectively 10 and 8 m thick succession of light yellow opokas, very fossiliferous, with browny spots around the fossils. The most common fossils are ammonites, sponges, bivalves, gastropods; belemnites and inoceramid bivalves are relatively rare.

Ciszyca Kolonia: Small exposures in the bank of the Vistula River at the Leśne Chałupy – Tarłów road. Small portions of the succession composed of white opoka are exposed.

Dorotka: Small abandoned quarry in the bank of the Vistula River, 50 m north of the main road in the village. The exposed succession, with partly destroyed original structure, is composed of thick-bedded, light-grey opoka with relatively common fossils. Inoceramids and ammonites are relatively common; and sponges occur throughout the succession.

Dziurków: Working quarry of moderate size south of the Lipsko – Solec road, at the eastern end of the village of Dziurków. The 12.5 m thick succession of lower Lower Maastrichtian opokas is readily accessible in the south-eastern wall of the quarry. BŁASZKIEWICZ (1980) reported from here: *Pseudokossmaticeras galicianum* (FAVRE, 1869) and *Pachydiscus neubergicus* (HAUER, 1871). Huge baculites are very common. Additional faunal element are the belemnites and rich bivalve assemblage (see ABDEL-GAWAD 1986). Inoceramids are represented by *Endocostea typica* WHITFIELD 1880 and *Cataceramus subcircularis* (MEEK 1876).

Kamień: Although no section is currently available there this name is shortly commented herein beacuse of a number of critical mmonite and inoceramid specimens were yielded by this locality. Kamień it is a village, about 3 km north of Piotrawin. In the early 1960s a number of small quarries were active just east and north-east of the village. The locality is known for a number of specimens of *Pachydiscus neubergicus raricostatus* (see BŁASZKIEWICZ 1980) and it also yielded a specimen of *Trochoceramus costaecus* (KHALAFOVA) (see WALASZCZYK & *al.* 1996, pl. 3, fig. 3; and reillustrated herein – Text-fig. 28). The locality was regarded as being distincly higher stratigraphically than the succession in Piotrawin, and BŁASZKIEWICZ (1980) located it close to the *Belemnella lanceolata*/*B. occidentalis* boundary. Mapping shows, however, that the succession is maximally 3-4 m above, and is low within the *T. costaecus* Zone (=lower *Belemnella lanceolata* Zone).

Kłudzie North: Exposure in the bank of the Vistula, about 30 m north of the Kłudzie Ferry stop. About 9 metres of silicous chalk "opokas" with the 'boundary marl' about 6 m above the Vistula river level is visible. Numerous belemnites were found just below the 'boundary marl'. Inoceramids are rare in the lower part of the section.

Kłudzie South: Exposure in the bank of the Vistula, about 100 m south of the Kłudzie Ferry stop. It exposes 18 m thick succession of the topmost Campanian and lowermost Maastrichtian strata, with the 'boundary marl' seen in the middle part of the succession. About 8 m above the 'boundary marl' appear *Endocostea typica* and *Cataceramus subcircularis*, marking the base of the *E. typica* Zone.

Łopoczno: An exposure in the eastern bank of the Vistula river, behind the houses in the village of Łopoczno. It exposes an 8 m thick succession of the upper part of the Pawłowice Opoka.

Pawłowice North: An exposure in the western bank of the Vistula, behind a house at the northern end of the village, 1 km north of the main Pawłowice cross-road. It exposes a 6 m thick succession of white, massive opoka; fossils are relatively rare, but numerous inoceramids were found in the middle part of the succession.

Pawłowice-Cemetery: Steep clean wall at the northern end of the village cemetery with 5 m thick succession of white opokas; fossils relatively rare.

Piotrawin: Huge abandoned quarry on the eastern bank of the Vistula, about 500 m south of the village of Piotrawin. It exposes an about 30 m thick succession of light yellow brittle opokas, fossiliferous, with very common bivalves, gastropods, ammonites, belemnites, and sponges. Browny spots arounds the fossils are very characteristic feature. Three exploitation levels allow to divide the succession into three part; the lower third differs from the middle and upper thirds in its inoceramid fauna; it is characterised by "*Inoceramus*" *altus* assemblage in contrary to "*I.*" *inkermanensis* assemblage characteristic to the two higher parts.

Podole: Exposure in the Vistula bank, behind the house at the northern end of Solec; about 200 m south of the main valley in the village of Podole. It exposes a 16 m thick succession of marly opokas and opokas with the 'boundary marl' seen in the topmost part of the exposure. In the lowermost part of the succession were found *Acanthoscaphites* sp. and *Belemnella lanceolata lanceolata* (SCHLOTHEIM). Higher up in the succession, up to the 'boundary marl' belemnites (mostly *Belemnella*) and inoceramids are moderately common; the latter usually in fragments.

Przedmieście: Large, disused quarry in the eastern end of the village of Przedmieście, south of the Lipsko – Solec road. It exposes ca. 10 m thick succession of lower Maastrichtian Dziurków Opoka, roughly equivalent to the Dziurków succession.

Raj North: Small working quarry, SW of Solec, in the southern bank of the Krępianka River. It exposes a 9 m thick succession of grey relatively hard marly opokas. In the upper third the opoka is quite fossiliferous, with common bivalves, ammonites and brachiopods. Belemnites are quite common; ammonites and inoceramids (excluding the baculites), which occur in numbers throughout the succession are much rarer. It is the exposure with stratigraphically lowest record of *Belemnella lanceolata* (SCHLOTHEIM).

Raj: Abandoned small quarry wall in the northern bank of small gully, about 100 m south of the southern end of the village of Raj. The accessible succession is represented by 7 m high face of thick bedded pure opokas, light-yellow, fossiliferous, with characteristic browny spots around sponges and other fossils [the Piotrawin type opoka].

Sadkowice North: Small abandoned quarry in the western bank of the Vistula, right at the northern end of the village of Sadkowice. It exposes a 7 m thick succession of fossiliferous, light yellow Piotrawin type opokas, with brown spots around fossils.

Sadkowice Quarry: Abandoned quarry about 100 m west of the main cross-road in the village. The quarry exposes more than 10 m of very fossiliferous Piotrawin-type opoka, with belemnites particularly abundant.

Solec: Exposure in the western part of the town of Solec, 250 m east of the cross-road west of the town. The exposure is represented by a 14 m thick succession visible in the north-western bank of the escarpment of the Solec Hill. The lower and upper third of the succession represented by relatively hard, moderately fossiliferous marly opokas, is well exposed. The topmost part characterised by the common occurrence of fine (mostly bivalve) detritus. Inoceramids and ammonites are relatively rare; belemnites are more common.

Wola Pawłowska: Small working quarry in the northern bank of the Kamienna river valley, about 850 m south of the village bridge. A 7 m thick succession of massive greyish-brown marly opokas is accesible. Besides some horizons with inoceramid fragments, in the middle part of the succession, the opoka is poorly fossiliferous. Some complete inoceramids were found; ammonites and belemnites are rare.

Zemborzyn: Small working quarry in the southern bank of the Kamienna River valley, west of the road, leading south-east from the village bridge. The 4 m thick succession is represented by the same opoka as in Wola Pawłowska; no fossils were found.

INOCERAMID BIOZONATION

The inoceramid record of the Vistula section enables application of the unified zonation recognised recently in the US Western Interior and in Tercis (WALASZCZYK & *al*. 2001, WALASZCZYK, ODIN & DHONDT 2002). Small modifications in the middle part of the succession do not cause any serious difficulties in correlation with the other regions mentioned (Text-figs 3, 5).

In inoceramid terms the studied succession comprises an interval from the middle part of the *Cataceramus subcompressus* Zone up to the lower part of the *Endocostea typica* Zone. No form characteristic for the *Trochoceramus radiosus* Zone was found during recent fieldwork, neither is known from existing collections.

Cataceramus subcompressus interval Zone. As demonstrated by the US Western Interior succession and the lower Upper Campanian record in Westphalia (WALASZCZYK 1997, WALASZCZYK & *al.* 2001) the base of the zone is best defined by the last occurrence of radially sulcate inoceramids of the "*I.*" *azerbaydjanensis-vorhelmensis* group and its top by the first occurrence of

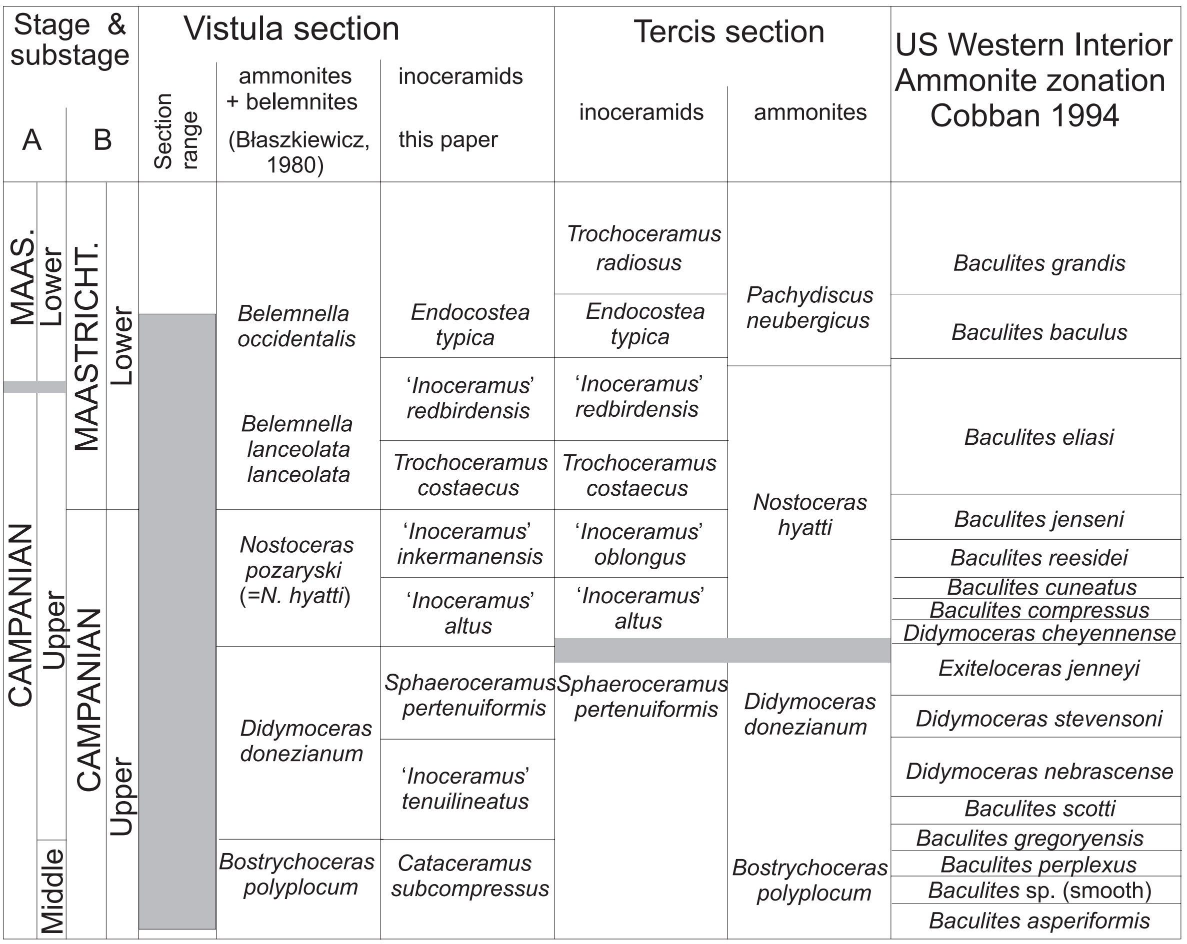

Fig. 5. Correlation of the inoceramid zonation applied with the ammonite zonation of BŁASZKIEWICZ (1980) and with the ammonite zonation for the US Western Interior (after GILL & COBBAN 1973, COBBAN 1994, and KENNEDY & al. 1999).

the distinctive group of "*Inoceramus*" *tenuilineatus*. The base and lower part of the zone are not exposed in the area studied. The Dorotka quarry is the single locality, which belongs to this zone. The upper part of the zone and the boundary to the succeeding "*I.*" *tenuilineatus* Zone were not studied in detail. However, they are not far above the top of the Dorotka succession.

This zone was first recognised in North America, where, in ammonite terms, it corresponds to the interval from the bottom of the *Baculites asperiformis* Zone up to the lower part of the *Baculites gregoryensis* Zone (see WALASZCZYK & *al*. 2001, fig. 3). In Europe its base corresponds more or less to the base of the *polyplocum* Zone, or even to a level within the top part of the upper *vulgaris* Zone (WALASZCZYK 1997).

"*Inoceramus*" *tenuilineatus* interval Zone. The base of the zone is defined by the FO of the index taxon, its top by the FO of *Sphaeroceramus pertenuiformis*. The assemblage characterising the zone differs considerably from that of the underlying zone, with the appearance of an almost completely new assemblage. This change in inoceramid assemblages is one of the most important point in the evolution of the Campanian inoceramids.

The base of the zone apparently corresponds to the base of the BŁASZKIEWICZ's (1980) *Didymoceras donezianum* Zone. In the US Western Interior ammonite scheme (e.g. COBBAN 1994 and references therein) the zone corresponds to the upper part of the *Baculites gregoryensis*, to the *Baculites scotti* and *Didymoceras nebrascense* zones. It spans thus the Middle/Upper Campanian boundary in the American tripartite subdivision of the stage.

In the studied area the zone covers the succession from the base of the Ciszyca Kolonia section up to the top of the succession exposed in Ciszyca Górna (Text-fig. 1).

Sphaeroceramus pertenuiformis interval Zone. The zone is very poorly known in the area. The middle part is exposed, both the lower and upper boundaries are not accessible. The base of the zone is defined by the FO of the index taxon, and its upper boundary by the FO of "*Inoceramus*" *altus* MEEK, 1871. The collected material comes almost exclusively from the Wola Pawłowska section; single specimens are from the upper part of the high escarpment in Łopoczno, east of the Vistula river. *S. pertenuiformis* is accompanied there by "*Inoceramus*" *nebrascensis*, "*Inoceramus*" sp. A, and *Platyceramus* cf. *pierrensis*. In the middle part of the succession occurs a horizon with fragments of huge platyceramids.

The *S. pertenuiformis* Zone corresponds to the upper part of the *Didymoceras donezianum* ammonite Zone. No more precise correlation is possible at the moment.

"Inoceramus" altus interval Zone. The base of the zone is defined by the FO of the index taxon, and its upper boundary is defined here at the FO of "*Inoceramus*" *inkermanensis*. The zone is best represented in the Piotrawin quarry, from its base to the basal part of the middle exploitation level. West of the Vistula river the zone is exposed in the Pawłowice-Cemetry and Pawłowice North section (Text-fig. 2). Inoceramids are quite common, represented by "*Inoceramus*" *altus* and "*Inoceramus*" *sagensis*. The zone corresponds to the lower part of the *Nostoceras hyatti* Zone.

"Inoceramus" inkermanensis interval Zone. The zone ranges between the FO of the index taxon and the FO of *Trochoceramus costaecus*. The zone is very well exposed and easily accessible is the Piotrawin quarry; it comprises the middle and upper exploitation levels. Moreover, it is directly accessible in the sections of Sadkowice-Quarry, Sadkowice-North and Raj. The boundary to the successive *T. costaecus* Zone is not exposed. The zone yields a very rich inoceramid assemblage, dominated by "*I.*" *inkermanensis*; also present are: *Cataceramus goldfussianus*, "*I.*" *smirnovi* nom.nov., "*I.*" *oblongus*, "*I.*" *balchii*, "*I.*" sp. B., *Cataceramus palliseri*, *Cataceramus magniumbonatus*, and "*I.*" *maclearni*. "*I.*". *inkermanensis* Zone corresponds to the middle and upper parts of the *Nostoceras hyatti* Zone.

Trochoceramus costaecus and ***"I." redbirdensis*** Zones. It is the interval between the FO of the *Trochoceramus costaecus* and the FO of *Endocostea typica*. The two index taxa are known to appear in a succession (e.g. in Tercis, see WALASZCZYK, ODIN & DHONDT 2002). Unfortunately the material to hand does not allow for the proper reading of the record here. *T. costaecus* is known from 2 incomplete specimens from the lower part of the Raj North section. A single specimen from the W. POŻARYSKI collection came from the former exposure near Kamień (see Text-figs 1, 3), which according to ammonite record (BŁASZKIEWICZ 1980) could represent an equivalent interval. "*I.*" *redbirdensis* is known from only a single specimen; some other specimens, known from the topmost part of the Solec section, and from a level 0.7 m below the 'boundary marl' in Kłudzie South, are referred herein to as "*I.*" aff. *redbirdensis* (Text-fig. 2). Other inoceramids known from that interval are *Cataceramus goldfussianus* and "*Inoceramus*" *balchii*. Numerous fragments of large sized specimens indicate, however, that the group could be markedly more diversified.

The *Trochoceramus costaecus* and *"I." redbirdensis* Zones correspond to the *Belemnella lancoelata* Zone and presumably to the basal part of *B. occidentalis* Zone of BŁASZKIEWICZ (1980).

Endocostea typica interval Zone. The base of the zone is defined by the FO of the index taxon, and its top by the FO of *Trochoceramus radiosus*. The lower boundary of the zone is best exposed in the Kłudzie South section. The boundary is located about 8 m above the 'boundary marl' (about 15 m above the river level) (Text-fig. 3), and marked by a sudden appearance of small-sized *E. typica* associated with small-sized *Cataceramus subcircularis*. It also crops out in the upper part of the Vistula escarpment, farther to the north, north of the ferry stop in Kłudzie. However, the best exposure of the zone is in the Dziurków quarry, east of Solec. It is a working quarry, about 12.5 m high. Basing on the known pattern of inoceramid change within this zone, it may be suggested that only the lower part of the zone crops out in Dziurków; *Cataceramus glendivensis*, characteristic of its upper part was not found in the quarry. The zone is also exposed in the abandoned quarry in Przedmieście, the next point to the east of Dziurków (Text-fig. 1), with approximately the same interval.

In belemnite terms the *E. typica* Zone falls most probably into the *Belemnella sumensis* Zone, as suggested by preliminary belemnite determinations from Dziurków (Z. REMIN, personal communication) and SCHULZ (1979) comments of KONGIEL's (1962) belemnites.

CORRELATIONS

The inoceramid zonation in the Vistula section is almost the same as the one worked out for the Campanian – Maastrichtian of the US Western Interior (WALASZCZYK & *al*. 2001) and as applied in the Tercis section (WALASZCZYK, ODIN & DHONDT 2002). Consequently, inoceramids allow for a direct correlation between all these areas (Text-fig. 5; see also WALASZCZYK, COBBAN & ODIN 2002, ODIN & WALASZCZYK 2003).

The Campanian/Maastrichtian boundary

The Campanian/Maastrichtian boundary defined traditionally by the FO of the belemnite species *Belemnella lanceolata* falls roughly at or slightly below the base of the Raj North section. The 'Tercis boundary', defined as an arithmetic mean of 12 bioevents (ODIN & LAMAURELLE 2001) cannot be precisely located. However, based on inoceramids it should be located in the interval between the LO of *"I." redbirdensis* and the FO of *Endocostea typica*. The stratigraphically highest *"I."* aff. *redbirdensis* was found 70 cm below, and the first *E. typica* about 8 m above the 'boundary marl'. Basing on the prediction from the correlation between Tercis and Vistula section, the boundary would lie about 2 meters below the FO of *E. typica*, and about 6 metres above the 'boundary marl'. If the belemnite dating of this interval is correct the boundary would lie in the basal part of the *Belemnella sumensis* Zone, thus much higher than the boreal '*lanceolata*'-boundary standard, and higher than suggested elsewhere. The correlation suggested herein is closest to the original view by HANCOCK & *al*. (1993) who correlated the level with FO of *Pachydiscus neubergicus* in Tercis with the middle *Belemnella obtusa* Zone, and constradicts the subsequent suggestions by CHRISTENSEN & *al*. (2000) and CHRISTENSEN (2001), that the level of the FO of *P. neubergicus* in Tercis correlates with the basal Maastrichtian *Belemnella lanceolata* Zone and that the '*Pachydiscus neubergicus* and *Belemnella lanceolata* standards for the base of the Maastrichtian are very close and not separated more than 0.2 my. A very important point arising from the inoceramid correlation between the Tercis and the Vistula section is the fact that, if the appearance of particular inoceramid assemblages is isochronous the first *Pachydiscus neubergicus* appears actually well below the level with its FO in Tercis. First representatives of this species, referred by BŁASZKIEWICZ (1980) to the subspecies *raricostatus*, were noted by this author from the basal part of his *lanceolata* Zone, and claimed to appear simultaneously with the first *Belemnella lanceolata* (see also BŁASZKIEWICZ 1969). As the base of the *B. lanceolata* Zone corresponds roughly to the base of the *T. costaecus* Zone, the equivalent level to the 'Boreal boundary' in the Tercis section could be as low as 96.7 m, i.e. at the level of the FO of *T. costaecus* there. It means that the FO of *Pachydiscus neubergicus* is not a reliable tool in the correlation to the 'Tercis boundary' of the basal Maastrichtian and that the FO of *P. neubergicus* does not obligatorily post-date the 'Tercis boundary'. Consequently the actual position of this boundary in recent correlation between the Tercis section and the North German Kronsmoor section (NIEBUHR 2003) may be higher than an interval indicated by the FOs of *P. neubergicus* and *Diplomoceras cylindraceum*.

Campanian subdivision

As it was agreed during the Brussels Symposium in 1995 the Campanian Stage should be subdivided into three substages, possibly of equal duration (HANCOCK & GALE 1996). However, no formal proposal, was made neither during the Symposium or subsequently. Recently NIEBUHR (2003) used a three-fold subdivision, dividing the European Upper Campanian into middle and upper substages. She defined the Middle/Upper Campanian boundary at the base of the *Belemnitella minor*/*Bostrychoceras polyplocum* Zone. Based on inoceramid/ammonite correlation the base of this zone is roughly equivalent to the base of the *Cataceramus subcompressus* Zone (=*Cataceramus haldemensis* Zone of WALASZCZYK 1997, fig. 4) (see also Fig. 6 and WALASZCZYK & *al*. 2001). The basal part of the *C. subcompressus* Zone correlates with the *Baculites asperiformis* ammonite Zone, dated for 79.5 m.y. (COBBAN, unpublished scheme, 2003). Consequently, the Middle Campanian defined on this basis would be very short, approximately 1.5 m.y. Undoubtedly a stratigraphically higher level should be taken as the base of the Upper Campanian to divide the stage more evenly. Based on inoceramid correlation to the US Western Interior the lower boundary of the Upper Campanian as defined therein would fall within the *Didymoceras donezianum* Zone. In inoceramid terms the most suitable level would be the appearance of the "*I.*" *tenuilineatus* fauna, which correlates roughly with the base of the *Didymoceras donezianum* ammonite Zone, i.e. at the top of the *B. polyplocum* Zone. According to recent dating (OBRADOVICH 1994 and COBBAN, unpublished scheme) this level, which correlates with the top part of the *Baculites gregoryensis* (=*Baculites reduncus* Zone) would be about 76.5 m.y. Consequently this level would divide the European Upper Campanian into a 4 m.y. long Middle Campanian and an approximately 5 m.y. long Late Campanian.

Worth of note is that according to recent ammonite correlation between Europe and the US Western Interior (Chart 5 in HARDENBOL & *al.* 1998) the base of the European donezianum Zone corresponds to the jenneyi Zone. However, at the same chart W.A. COBBAN

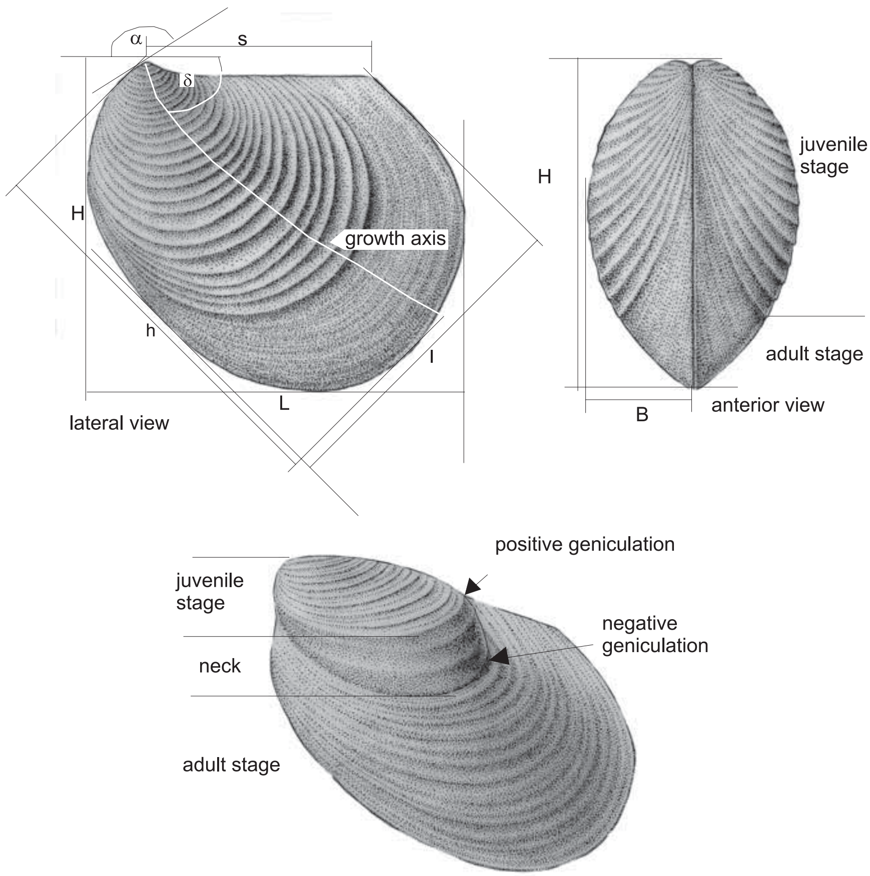

Fig. 6. Terminology and measurements of the external morphologic features of inoceramid shells as applied in this paper

indicates the occurrence of *D. donezianum* in the *gregoryensis* and *scotti* zones, what agree well with the inoceramid correlation presented herein.

CONVENTIONS

Most of the specimens are housed in the Museum of the Faculty of Geology of the University of Warsaw, abbreviated MWG. Other specimens are part of the collection of the Museum of the Earth, Warsaw, abbreviated MZ.

All dimensions are given in millimetres. The descriptive terms and measurements used are shown in Text-fig. 6; L – length; H – height; h – axial length; l – dimension perpendicular to axial length; s – hinge line; α – anterior hinge angle; δ – angle between the growth line and the hinge line; B – breadth.

SYSTEMATIC ACCOUNT

Genus: *Cordiceramus*, HEINZ, 1932

TYPE SPECIES: *Inoceramus cordiformis* SOWERBY (1823, p. 61, pl. 440) from the Santonian of Gravesand, England.

Cordiceramus cf. *heberti* (FALLOT, 1885) (Text-fig. 7)

1885. *Inoceramus heberti* FALLOT, p. 249, pl. 7, fig. 1.
1968. *Inoceramus heberti* FALLOT; SORNAY, p. 41, pl. H, fig. 3.
?non 1978. *Inoceramus* (*Cordiceramus*) sp. cf. *heberti* FALLOT; NODA & KANIE, p. 23, pl. 1, fig. 4; pl. 7, fig. 4.
non 1991. *Inoceramus* sp. aff. *heberti* FALLOT; TRÖGER & RÖHLICH, p. 1371, pl. 3, fig. 6. Text-fig. 11.
1997. *Inoceramus heberti* FALLOT; WALASZCZYK, pl. 31, fig. 1.
non 1999. *Cordiceramus*? aff. *heberti* (FALLOT); TRÖGER & *al*., p. 49, pl. 1, fig. 2; text-figs 15-16.

TYPE: The holotype is the original of FALLOT (1885, pl. 7, fig. 1) from La Madeleine, 1500 m NE of the village of Veynes in Hautes Alpes, SE France, from grey hard limestones with *Ostrea vesicularis*, *Pinna* sp., *Terebratula* sp., *Rhynchonella* sp., and ?*Hoplitoplacenticeras* sp. (SORNAY 1968, p. 41); the ammonite suggests a Middle Campanian age. The specimen is housed in the E. FALLOT collection of the Institute de Paléontologie, Muséum National d'Histoire Naturelle de Paris.

Fig. 7. *Cordiceramus* cf. *heberti* (FALLOT, 1885); MWG ZI/35/074, Ciszyca Górna, upper "*Inoceramus*" *tenuilineatus* Zone × 1.15

MATERIAL: Single specimen, MWG ZI/35/074 from Ciszyca Górna.

DESCRIPTION AND REMARKS: MWG ZI/35/074 is an internal mould of an incomplete RV; umbonal and anterior parts are missing. The subquadrate outlie, the regularly spaced rugae, distinctly oblique to grows lines, particularly in the naterior half of the valve make it very close to the FALLOT's species.

OCCURRENCE: The single specimen from Ciszyca Górna comes from the middle part of the *Didymoceras donezianum* Zone. It is known from France, from the lower Upper Campanian and from the US Western Interior, from the late Middle Campanian *Baculites gregoryensis* Zone.

Genus *Cataceramus*, HEINZ, 1932

TYPE SPECIES: *Inoceramus balticus* BÖHM (1909, pl. 11, fig. 2) from Dülmen, lower Campanian of northern Germany.

REMARKS AND OCCURRENCE: The discussion on the genus see DHONDT (1993) and WALASZCZYK & *al*. (2001). The genus appeared most probably already in the Middle Santonian and ranges to the Lower Maastrichtian. It dominates the Early and Middle Campanian inoceramid assmblages.

Cataceramus barabini (MORTON, 1834)
(Text-figs 16D, I)

1834. *Inoceramus Barabini* MORTON, p. 62, pl. 13, fig. 11; pl. 17, fig. 3.
? 1860. *Inoceramus cuneatus* MEEK & HAYDEN, p. 181.
1876. *Inoceramus Cripsii*? var. *Barabini* MORTON; MEEK, p. 49, pl. 12, fig. 3 [?pl. 13, fig. 1], text-figs 1-4.
?pars 1880. *Inoceramus barabini* MORTON; WHITFIELD, p. 398, pl. 9, fig. 8 [?non pl. 7, fig. 7].
1898. *Inoceramus barabini* MORTON; LOGAN, p. 504, pl. 109, fig. 2.
pars 1913. *Inoceramus Barabini*; BÖSE, pl. 4, fig. 1 [non pl. 3, figs 1, 7; pl. 3, fig. 1 = *Endocostea typica*].
1942. *Inoceramus barabini* var. *inflatiformis* DOUGLAS, p. 63, pl. 2, fig. 3.
?non 1959. *Inoceramus barabini* MORTON; DOBROV & PAVLOVA, p. 140, pl. 22, fig. 2 [=? *Cataceramus* aff. *barabini*].
pars 1970. *Inoceramus barabini* MORTON; KAUFFMAN, p. 217, pl. 1, fig. 8 [non pl. 1, fig. 3].
?pars 1974. *Inoceramus barabini* MORTON; KOCIUBYNSKIJ, p. 83, ?pl. 23, fig. 2 [non pl. 20, fig. 1 = ?*Cataceramus subundatus*]. *Cataceramus? barabini* (MORTON); WALASZCZYK & *al*., p. 156, pl. 33, figs 1, 3; pl. 35, fig. 1; pl. 36, figs 2, 4, 6-7; pl. 39, figs 4-5; ?pl. 40, fig. 5.*Cataceramus? barabini* (MORTON); WALASZCZYK, ODIN & DHONDT, p. 280, pl. 14, figs 4, 11, 14.

TYPE: The lectotype, by subsequent designation of MEEK (1876, p. 55) is ANSP 15469, the original of MORTON (1834, pl. 17, fig. 3) from the Upper Cretaceous of Greene County, Alabama, USA.

MATERIAL: Three specimens, MWG ZI/35/116 through MWG ZI/35/118; all from the upper part of the Dziurków quarry, upper *Endocostea typica* Zone.

DESCRIPTION: All three specimens are internal moulds of single valves; all are deformed to various degrees. MWG ZI/35/116 is compressed laterally, whereas ZI/35/117 and ZI/35/118 are comporessed in the ventral-dorsal plane. The specimens are of modetate size for the species. The valves are subrectangular in outline posteriorly elongated and strongly oblique. The beak is small, pointed, terminal, projecting very slightly above the hinge line. The hinge line is long and straight. The anterior margin is short and straight, passing into the very long, broadly convex antero-ventral margin. The posterior margin is convex. The valve inflation is influenced by the secondary deformation to such an extent, that the original one can only be geussed. The posterior auricle is weakly separated from the disc.

The valve ornamention changes during ontogeny from quite regular rugation in the juvenile, to irregular rugae or to an almost smooth valve in the adult. Traces of the growth lines are not observed.

REMARKS: The *balticus*-like outline and the gradual ontogenetic change in the ornament, not associated with the geniculation, are feauters characterising *C. barabini*. The very shallow radial sulcus, characterising MEEK's original (1876, pl. 13, fig. 1a; and WALASZCZYK & *al*. 2001, pl, 36, fig. 2) is not observed, but this may partly be due to deformation.

OCCURRENCE: The species is known from the Lower Maastrichtian of the US Western Interior and in Europe. In the sections precisely dated, as e.g. in the Tercis section, SW France, and in Vistula section, it appears higher within the *Endocostea typica* Zone of the basal Maastrichtian.

Cataceramus gandjaeformis
WALASZCZYK, COBBAN & HARRIES, 2001
(Text-figs 8, 9A-B, 12D, 31A, ?44C, F)

1974. *Inoceramus wegneri* BOEHM; KOCIUBYNSKIJ, p. 84, pl. 20, fig. 2.
? 1993. *Platyceramus* cf. *artigesi* SORNAY; DHONDT, p. 231, pl. 5, fig. 5.
?pars 2001. *Cataceramus*? *gandjaeformis* sp. nov.; WALASZCZYK, COBBAN & HARRIES, p. 168, pl. 25, fig. 3; ?pl. 26, fig. 1; pl. 41, fig. 5.

TYPE: The holotype, by original designation, is the orignal of WALASZCZYK & *al*. (2001, pl. 25, fig. 3) from the *Baculites reesidei* ammonite Zone of the US Western Interior of the United States Geological Survey Mesozoic locality D2849.

MATERIAL: MWG ZI/35/084, MWG ZI/35/085, MZ ML 1500/1, and PIG 11.V.2 from Ciszyca.

Dimensions:

Specimen	h	l	H	L	s	VR	α	δ	hmax
ZI/35/084	55	53	50	54.5	32.5	–	135	58	77
ML1500/1	67	76	64	66	43	–	138	54	106
PIG 11.V.2	157	165	134	154	100.5	*65	133	45	205

DESCRIPTION: The valves are of moderate size, subquadrate to trapezoid in outline, weakly oblique, very weakly inflated. The maximum inflation is in the dorsal

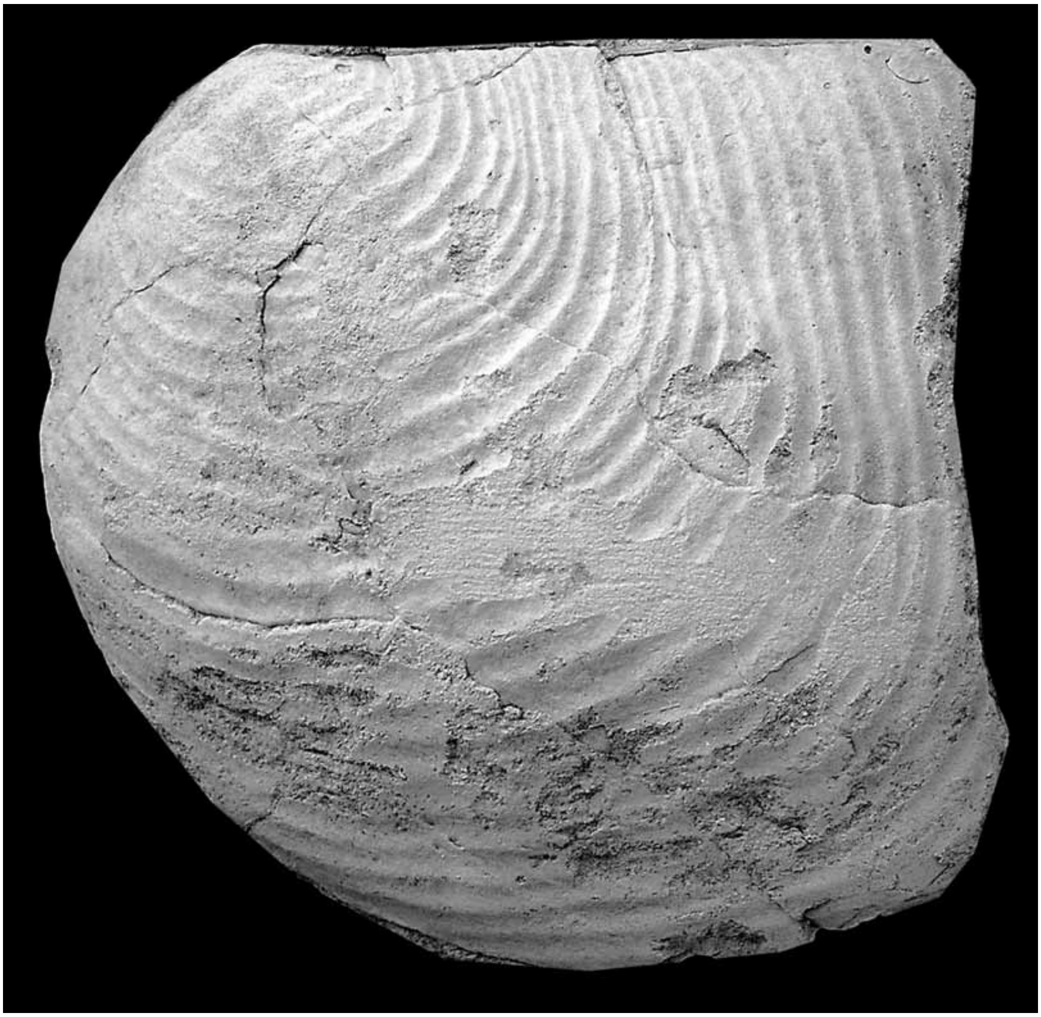

Fig. 8. *Cataceramus gandjaeformis* WALASZCZYK, COBBAN & HARRIES, 2001; PIG II.V.2; Zapusta near Solec; × 0.7

part along the growth axis. The flat posterior auricle is weakly separated from the disc. The umbo is subterminal, small, projecting slightly above the hinge line. It is curved antero-dorsally. The hinge line is straight, relativley long, The anterior margin is convexly rounded, passing into broadly rounded ventral margin. The very characetristic posterior margin is almost straight, curved distincly anteriorward just close to the hinge line.

The huge PIG 11.V.2 is subquadrate in outline and clearly shows the presence of the posterior, auricular sulcus, which starts already about 40 mm from the beak and becomes gradually more distinct. The anterior curvature of the rugae approaching the hinge line also become more distinct with age.

The valves are ornamented with regularly spaced commarginal rugae, which are almost symmetrical in the cross section. They are the strongest in the axial part of the disc, weakening slightly toward the anterior and posterior ends of the valve.

REMARKS: The species resembles *Cataceramus goldfussianus*, from which it differs in the outline of the posterior auricle, the presence of the auricular sulcus and the ornament; whereas in *C. goldussianus* (D'ORBIGNY) the interspaces grow gradually ventralward, in *C. gandjaeformis* the interspaces of the adult rugae are more or less constant.

Two specimens, and particularly the one large fragment, are characterised by rugae that are strongly oblique to the growths lines (Text-figs 10D-E). They closely resemble some French specimens from Tercis, illustrated recently by WALASZCZYK, ODIN & DHONDT (2002, pl. 8, figs 3, 6), and referred to as *C.* aff. *gandjaeformis*. More material is needed to clear up the relationships of this taxon and of *C. gandjaeformis*.

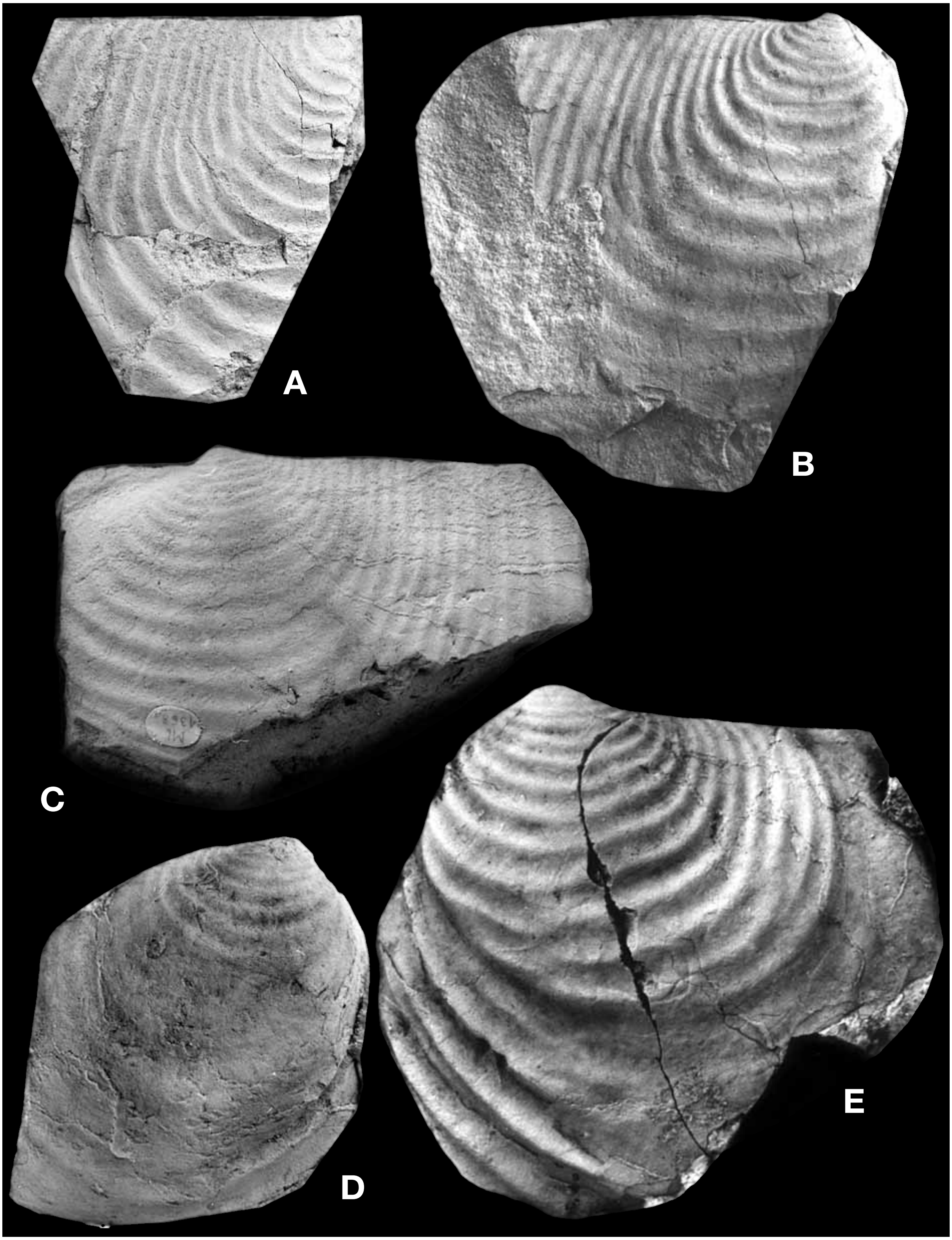

Fig. 9. A-B – *Cataceramus gandjaeformis* WALASZCZYK, COBBAN & HARRIES, 2001; A – MWG ZI/35/085, B – MWG ZI/35/084; Piotrawin, "*Inoceramus*" *inkermanensis* Zone; × 1. C – "*Inoceramus*" *alaeformis* ZEKELI, 1852 of authors; MZ ML1368, Kamień, × 1. D-E – *Cataceramus goldfussianus* (D'ORBIGNY, 1847); D – MWG ZI/35/081, × 1; E – MWG ZI/35/078, × 0.9; both from the Piotrawin quarry

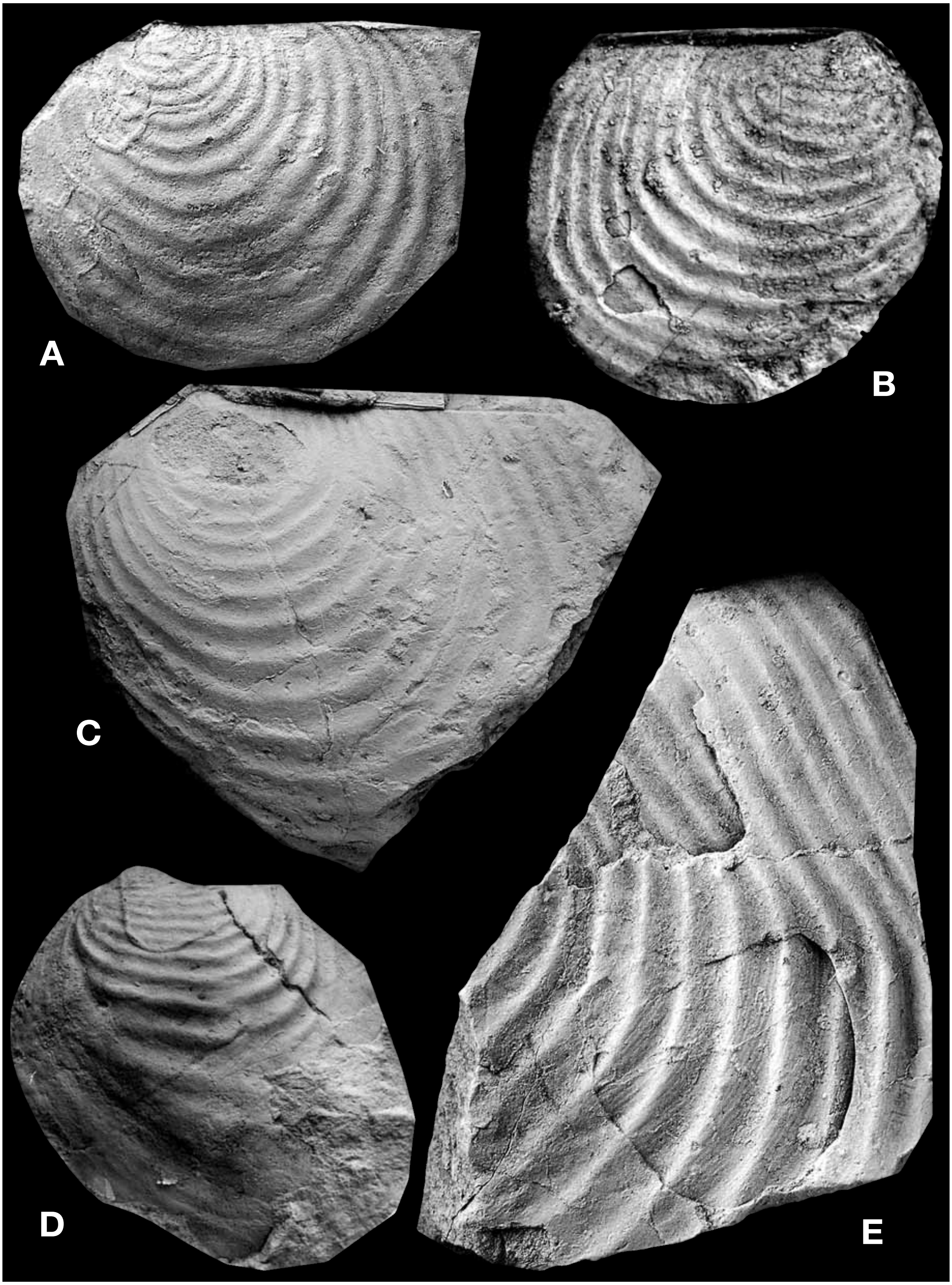

Fig. 10. A-C – *Cataceramus goldfussianus* (D'ORBIGNY, 1847); A – MWG ZI/35/075, Piotrawin, "*Inoceramus*" *inkermanensis* Zone, × 1; B – MWG ZI/35/091, Wola Pawłowska, *Sphaeroceramus pertenuiformis* Zone, × 0.94; C – PIG 146, Piotrawin, "*Inoceramus*" *inkermanensis* Zone, × 0.95. D-E – *Cataceramus* aff. *gandjaeformis* WALASZCZYK, COBBAN & HARRIES, 2001; D – MWG ZI/35/088 and E – MWG ZI/35/089, both from the Piotrawin quarry and × 1.

OCCURRENCE: In the Vistula section the species is limited to the "*Inoceramus*" *inkermanensis* Zone (=upper part of the *Nostoceras hyatti* ammonite Zone). It is known from the Upper Campanian (no further details) of the Ukraine, and from the *Baculites reesidei* and *Baculites jenseni* ammonite Zones of the US Western Interior.

Cataceramus goldfussianus (d'Orbigny, 1847)
(Text-figs 9D-E, 10A-C, ?11A, 11B, 12A-C, E-F)

1847\. *Inoceramus Goldfussianus* d'Orbigny, p. 517, pl. 411, figs 1-2.
1939\. *Inoceramus* aff. *regularis* d'Orbigny; Aliev, p. 224, pl. 3, fig. 2.
1956\. *Inoceramus gandjaensis* Aliev, p. 463, pl. 1, fig. 1; pl. 2, fig. 1.
1957a. *Inoceramus goldfussi* d'Orbigny; Sornay, no. 57.
non 1969. *Inoceramus* (*Cataceramus*) *goldfussianus* d'Orbigny; Cox, p. N315, fig C46.4. [=*Cataceramus marcki* (Giers, 1964)].
1976\. *Inoceramus goldfussi* d'Orbigny, Sornay, p. 9, text-fig. 9; pl. 4, figs 4-5, pl. 5.
1993\. "*Cataceramus*" *goldfussianus* d'Orbigny; Dhondt, p. 218, pl. 2, figs 1-3.
1997\. *Inoceramus gandjensis* Aliev; Niebuhr, p. 220, pl. 6, fig. 4
2001\. *Cataceramus gandjaensis* (Aliev); Walaszczyk & *al*., pl. 13, figs 2-3; pl. 19, fig. 1.
2002\. *Cataceramus goldfussianus* (d'Orbigny); Walaszczyk, Odin & Dhondt, p. 282, pl. 1, fig. 1; pl. 2, fig. 3; pl. 3, fig. 10; pl. 4, fig. 6; pl. 5, figs 2-3; pl. 7, fig. 3; pl. 8, fig. 5.

TYPE: The lectotype, by subsequent designation of Sornay (1957) is MNHP 7593, the original to d'Orbigny (1847, pl. 411, figs 1-2; photographic illustration in Sorany 1957, fig. 3 and 1976, text-fig. 5) from the ?Upper Campanian of Royan (Charante-Maritime), SW France.

MATERIAL: MWG ZI/35/075-ZI/35/083 and MWG ZI/35/091; additionally, MZ ML1402 and ML1500/2; PIG 146 from Piotrawin (coll. Z. Modliński); possibly also MWG ZI/35/004.

Dimensions:

Specimen	h	l	H	L	s	VR	α	δ	hmax
ZI/35/083	88.2	85.6	76.9	90.0	43.7	40.4	130	57	109.6
ZI/35/075	62.4	65.5	59.0	65.8	35.6	31.2*	135	65	68.0
ZI/35/77	60	61.7	52	63	38	23	130	50	87
ZI/35/78	68.0	72.5	58.7	77.0	43,7	23	138	52	82.0
IZ/35/091	68.4	66.0	58.9	70.4	43.0	–	130*	48	77.0
ML1402	65.0	66	59	62	36	–	128	56	80
PIG 146	103.7	98	97.5	105.6	59.6	46*	140	52	105

DESCRIPTION: All specimens are represented exclusively by internal moulds of single valves. The species is of moderate size for the genus. The valves are moderately to markedly oblique, with δ ranging between 48 and 65°, and are weakly inflated. The valve outline is subquadrate to suboval. The anterior marign is short to very short, passing into the long rounded antero-ventral margin, and then into the rounded ventral margin. The posterior margin is convex or almost straight. Besides the most juvenile part the posterior auricle weakly separated from the disc.

The ornament is composed of regular to subregular commarginal rugae, with interspaces increasing gradually ventralward. The number of rugae in 20-60 mm interval of the growth axis varies between 5 and 8. Traces of growth lines rarely visible; where seen they are parallel to the rugae.

REMARKS: The species varies particularly in the outline, in the obliquity and the rugation. The outline varies between subquadrate through subrounded and subovate to subrectangular. This feature is closely tied to changes in the obliquity. The variation in ornament concerns mainly the density of the rugae, which is controllod by the width of the interspaces. Coarsely rugate forms, similar to those illustrated by Sornay (1976, pl. 4, fig. 1) or Kociubynskij (1968, pl. 27, fig. 2) occur rarely. Here belongs the large specimen PIG 146 and, possibly also MWG ZI/35/004, both from the Piotrawin quarry, although the latter may represent weakly inflated *Cataceramus magniumbonatus* (Douglas, 1942).

One specimen (MWG ZI/35/78) shows irregular rugae in the adult stage.

As mentioned in Walaszczyk, Odin & Dhondt (2002) *Cataceramus gandjaensis* is a junior synonym of *Catacerami goldfussianus* (d'Orbigny).

OCCURRENCE: In the Vistula section the species appears in the "*Inoceramus*" *tenuilineatus* Zone (=lower part of the *Didymoceras donezianum* ammonite Zone) and ranges to the top of the "*Inoceramus*" *inkermanensis* Zone (=top of the *Nostoceras hyatti* ammonite Zone) and possibly even higher, to the *Trochoceramus costaecus* Zone. It apparently spans the same interval it spans in the Tercis section and in the US Western Interior. The species is widely recorded in SE Europe (the Crimea, Caucusus and Kopet-Dagh) (as *Inoceramus gandjaensis*), dated roughly as the Campanian (e.g. Aliev 1956, 1978).

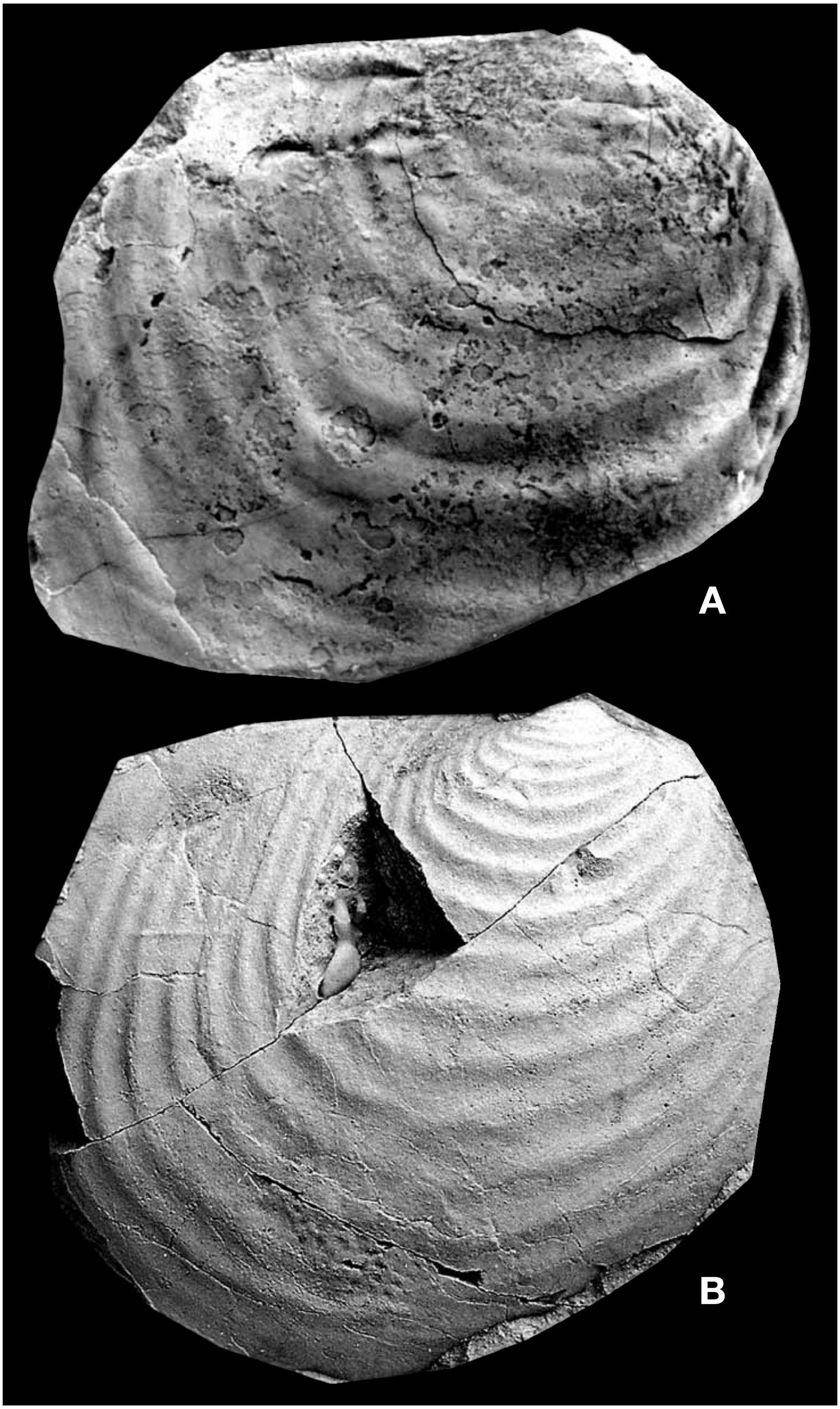

Fig. 11. A – *Cataceramus goldfussianus* (D'ORBIGNY, 1847) or *Cataceramus magniumbonatus* (DOUGLAS, 1942); MWG ZI/35/004, Piotrawin, "*Inoceramus*" *inkermanensis* Zone, × 1. B – *Cataceramus goldfussianus* (D'ORBIGNY, 1847), MWG ZI/35/083, Sadkowice Quarry, "*Inoceramus*" *inkermanensis* Zone, × 1.1

Cataceramus magniumbonatus (DOUGLAS, 1942)
(Text-figs ?11A, 13)

1942. *Inoceramus barabini* var. *magniumbonatus* DOUGLAS, p. 63, pl. 1, fig. 1.
?non 1962. *Inoceramus barabini* aff. var. *magniumbonatus* DOUGLAS; JOLKICEV, p. 142, pl. 5, fig. 1.
? 1981. *Inoceramus borilensis* JOLKICEV; TZANKOV, p. 91, pl. 40, fig. 1.
2001. "*Inoceramus*" *magniumbonatus* DOUGLAS; WALASZCZYK, COBBAN & HARRIES, p. 225, pl. 19; pl. 31, fig. 2; pl. 32, figs 1, 4-5.
2002. "*Inoceramus*" *magniumbonatus* DOUGLAS; WALASZCZYK, ODIN & DHONDT, p. 297, text-fig. 8.

TYPE: The holotype, by original designation, is GSC 8930, illustrated by DOUGLAS (1942, pl. 1, fig. 1) from the uppermost Campanian of the Boxelder Creek, c. 190 m above the base of the Bearpaw Formation, Saskatchewan, Canada.

MATERIAL: MWG ZI/35/005 and possibly also MWG ZI/35/004.

DESCRIPTION: MWG ZI/35/005 is an internal mould of the RV; adult fragment of the LV attached to it belongs possibly to the same specimen. It is a large specimen (an estimated length L must have been at least 200 mm), with teminal and massive umbo, projecting strongly above the hinge line, and subrectangular, length-elongated outline. The valve is moderately inflated, with the maximum inflation in the central part of the disc. The posterior auricle is well separated from the disc at least in the juvenile and early adult stage. The anterior margin is relatively short, with a steep, moderatey high anterior face. It passes into the broadly rounded antero-ventral margin; the posterior margin is not preserved. The hinge line is also poorly preserved, but it must have been long and straight. The umbo is curved antero-dorsally.

The valve is coarsely ornamented with sharp-edged sub- to irregular rugae, with broad interpsaces, which very quickly are between 20 and 20 mm wide. The rugae are the strongest in the antero-ventral part. They become gradually weaker when passing onto the axial and the dorsal part of the valve.

REMARKS: From *Cataceramus goldfussianus* it differs in its greater inflation, in more massive beak, which moreover projects highly above the hinge line, and finally in its more vigorous ornament. However, the transitional form occur, as e.g. MWG ZI/35/004, that are characterised by a more distinctive ornament and seemingly more massive umbo, than in typical representatives of *C. goldfussianus*.

OCCURRENCE: The specimen studied comes from the "*Inoceramus*" *inkermanensis* Zone (=upper part of the *Nostoceras hyatti* ammonite Zone) of the Piotrawin quarry. The species is also known from the equivalent interval of the Tercis section and from the *Inoceramus oblongus* Zone (*Baculites reesidei* ammonite Zone) of the US Western Interior. It was also reported from the 'Upper Campanian' of Bulgaria.

Cataceramus cf. *mortoni* (MEEK & HAYDEN, 1876)
(Text-fig. 22B)

non 1856. *Inoceramus proximus* TOUMEY, p. 171 [nomen nudum].
1876. *Inoceramus proximus* TOUMEY?; MEEK, p. 53, pl. 12, fig. 7a, b.
? 1983. *Inoceramus* (*Endocostea*) sp. aff. *I.* (*E.*) *proximus* TOUMEY; NODA, p. 106, fig. 4; pl. 1, figs 1-8.
non 1984. *Inoceramus proximus* TOUMEY; BALANOS & BUITRON, p. 411, pl. 1, fig. 5.
1991. *Inoceramus* (*Platyceramus*) sp. aff. *heberti* FALLOT; TRÖGER & RÖHLICH, p. 1371, pl. 3, fig. 6.
2001. *Cataceramus mortoni* (MEEK & HAYEN); WALASZCZYK & *al.*, pl. 7, figs 2-3; pl. 11, figs 6-8, 10, 12.
2002. *Cataceramus mortoni* (MEEK); WALASZCZYK, ODIN & DHONDT, p. 282, pl. 1, fig. 4.

TYPE: The holotype is MEEK's (1876, pl. 12, fig. 7) original, reillustrated by WALASZCZYK & *al.* (2001, pl. 11, fig. 12) from the *Baculites gregoryensis* and *Baculites scotti* ammonite zones of the Middle/Upper Campanian (in the North American Campanian subdivision) of the Great Bend of the Missouri river, below Pierre, South Dakota, USA, Gregory Member of the Pierre Shale.

MATERIAL: Single specimen, MZ ML1269, from Ciszyca Kolonia.

Dimensions:

Specimen	h	l	H	L	s	α	δ	VR	hmax
ML1269	52	39	41.4	45.3	28	112	47	16.5	54.7

DESCRIPTION: MZ ML1269 is an internal mould of a single RV. The valve is moderately oblique, subquadrate, moderately inflated, with the maximum inflation dorcocentral. The growth axis is straight. Th eumbo is terminal, small projecting slightly above the hinge line. The latter is straight and moderately long. The anterior margin is rather short; its outline has been changed most probably due to deformation. The posterior auricle well separated from the disc.

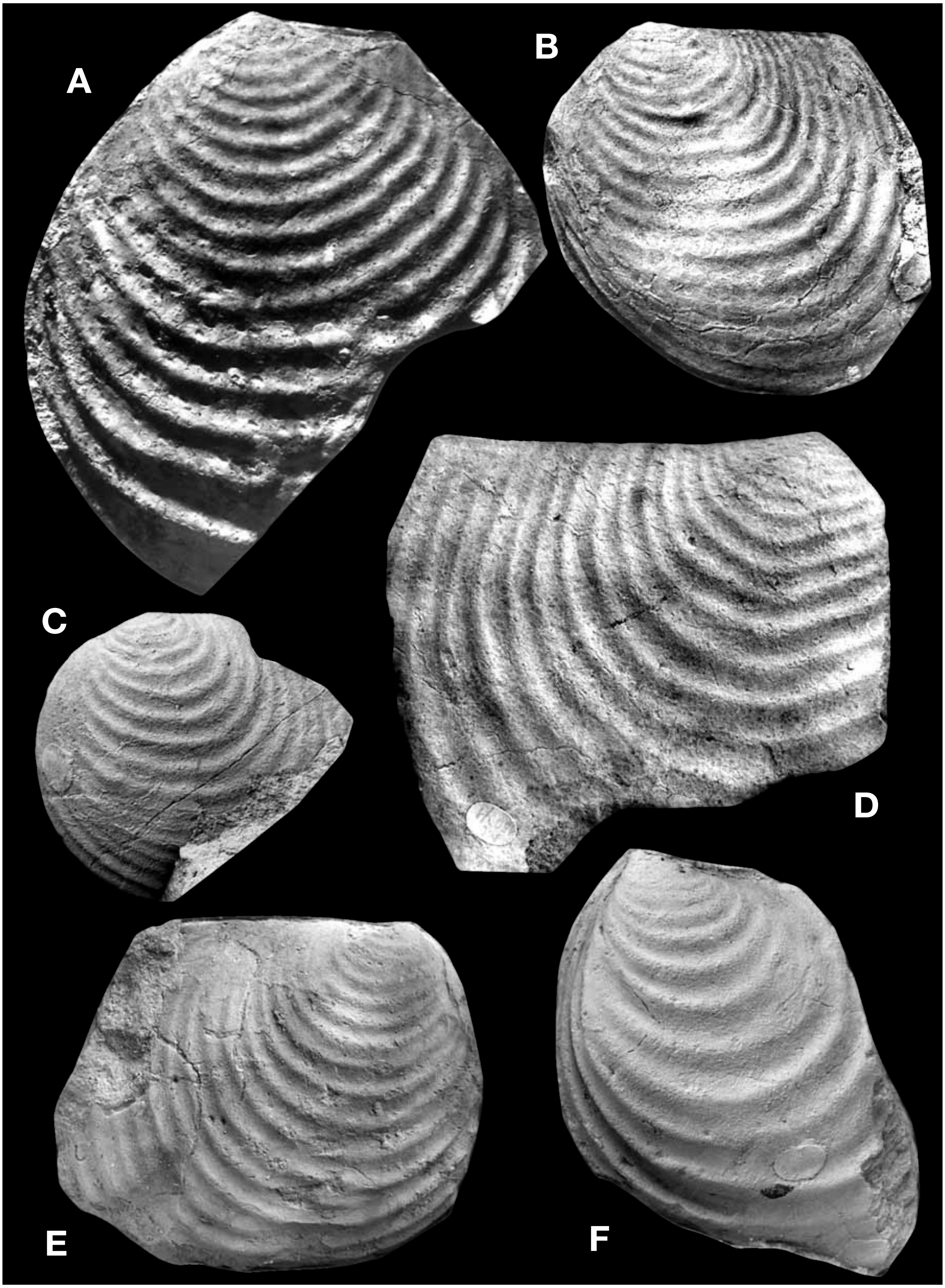

Fig. 12. A-C, E-F – *Cataceramus goldfussianus* (D'ORBIGNY, 1847); A – MWG ZI/35/082, Piotrawin, × 0.9; B – MWG ZI/35/079, Piotrawin, × 0.9; C – MZ ML1500/2 Piotrawin, × 0.95; E – MZ ML 1402, Ciszyca, × 0.95; F – MZ ML 1438, Ciszyca Górna, × 0.95. D – *Cataceramus gandjaeformis* WALASZCZYK COBBAN & HARRIES, 2001; MZ ML 1500/1, Piotrawin, × 0.9

The valve is ornamented with regularly, closely spaced, sharp-edged commarginal rugae. They weaken slighly when passing onto the posterior auricle.

REMARKS: The general outline and the type of ornament make this specimen close to the type of the species (MEEK 1876, pl. 12, fig. 7 and illustration in WALASZCZYK & *al*. 2001, pl . 11, fig. 12).

OCCURRENCE: A single specimen comes from the lower part of the *Didymoceras donezianum* ammonite Zone of the Ciszyca Górna section. It is known from the upper *Baculites gregoryensis* through *Didymoceras nebrascense* ammonite Zones in the US Western Interior. Similar material has been described from Japan and referred questionably to MEEK's species.

Cataceramus palliseri (DOUGLAS, 1942)
(Text-fig. 14)

1847. *Inoceramus regularis* D'ORBIGNY, p. 516, pl. 410, figs 1-2.

pars 1880. *Inoceramus vanuxemi* MEEK & HAYDEN; WHITFIELD, p. 396, pl. 7, figs 8-?9 [non pl. 7, fig. 10 = ?*Inoceramus vanuxemi* MEEK & HAYDEN]. *Inoceramus palliseri* DOUGLAS, p. 62, pl. 1, fig. 2.

pars 1958. *Inoceramus balticus* BÖHM; KOCIUBYNSKIJ, p. 18, pl. 8, fig. 33.

1962. *Inoceramus regularis* D'ORBIGNY; SORNAY, p. 120, fig. 1C; pl. 7(sic), fig. 3.

1964. *Inoceramus* cf. *regularis* D'ORBIGNY; GIERS, p. 247, pl. 3, fgis 3-4.

pars 1968. *Inoceramus impressus* D'ORBIGNY; KOCIUBYNSKIJ, p. 144, pl. 28, fig. 1.

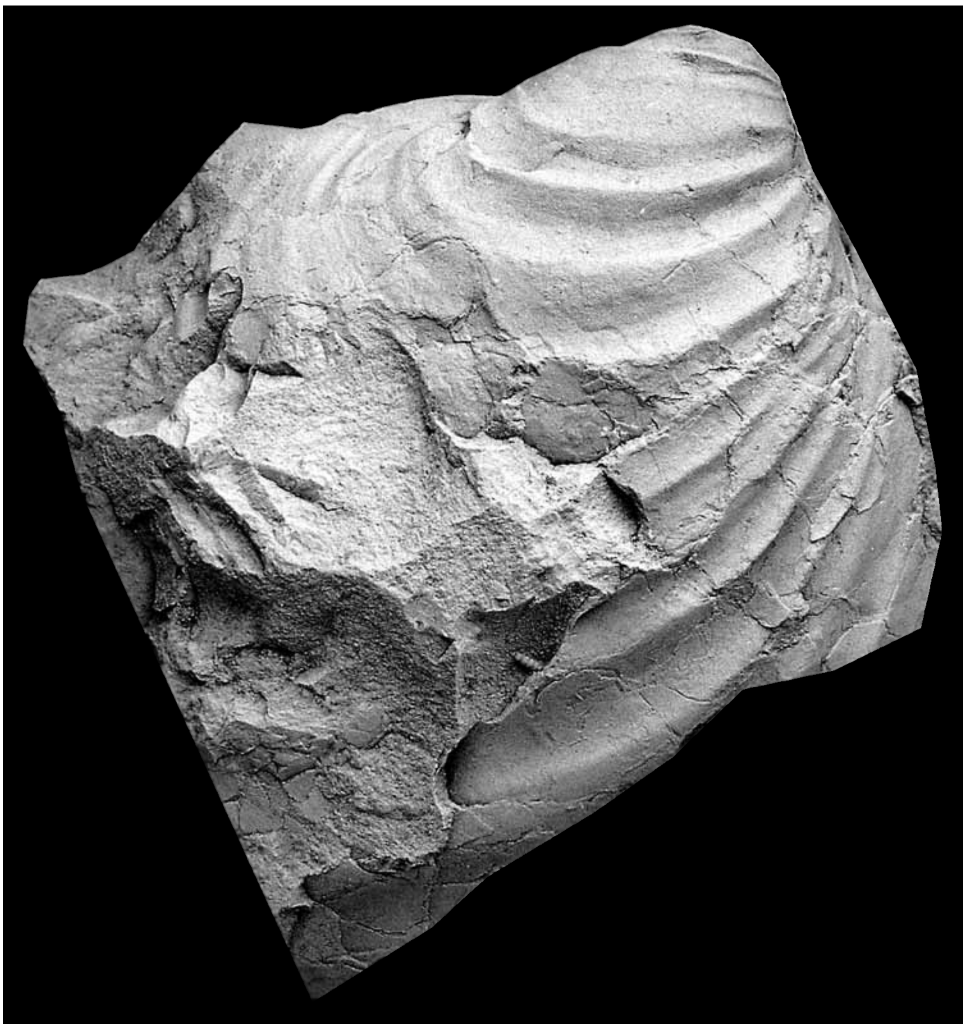

Fig. 13. *Cataceramus magniumbonatus* (DOUGLAS, 1942); MWG ZI/35/005, Piotrawin, × 0.9

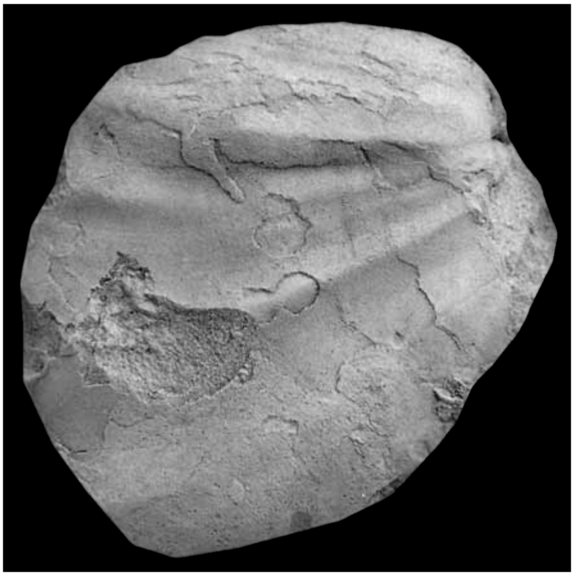

Fig. 14. *Cataceramus palliseri* (DOUGLAS, 1942); MWG ZI/35/039, Piotrawin, × 1

1974. *Inoceramus impressus* ORBIGNY; KOCIUBYNSKIJ, p. 84, pl. 21, fig. 1.
1976. *Inoceramus regularis* D'ORBIGNY; SORNAY, p. 7, pl. 2, fig. 3; pl. 3 figs 3-4.
pars 1976. *Inoceramus artigesi* SORNAY, p. 3, pl. 1, fig. 2 [*non* pl. 1, fig. 1]
1993. *Selenoceramus sornayi* DHONDT, p. 236, pl. 6, fig. 3; pl. 7, fig. 5.
1997. *Cataceramus sornayi* (DHONDT); WALASZCZYK, p. 26, pl. 32, figs 1-3.
1997. *Inoceramus artigesi* SORNAY; WALASZCZYK, pl. 32, figs 4-5.
2001. *Cataceramus*? *palliseri* (DOUGLAS); WALASZCZYK & *al*., p. 162, pl. 27, fig. 2; pl. 33, fig. 2; pl. 27, fig. 1.
2002. *Cataceramus*? palliseri (DOUGLAS); WALASZCZYK, ODIN & DHONDT, p. 283, pl. 8, figs 1-2; pl. 10, fig. 4.

TYPE: The holotype, by original designation, is GSC 8928, the original of DOUGLAS (1942, pl. 1, fig. 2) from Boxelder Creek, Canada, about 180 m below the top of the Bearpaw Formation.

MATERIAL: 4 registered specimens MWG ZI/35/038 through ZI/35/040 and ZI/35/101, all from the "*Inoceramus*" *inkermanensis* Zone of the Piotrawin quarry; numerous unregistered fragments.

DESCRIPTION: All specimens studied are represented by internal moulds of single valves. The species possesses two distinct growth stages; the juvenile one, is weakly inflated, posteriorly elongated and suboval to subrectangular in outline; the adult stage grows more ventralward and contacts the juvenile stage along a distinct positive geniculation. The juvenile stage is regularly ornamented, with fine, closely spaced rugae. The adult stage is sub- to irregularly ornmaneted, with widely spaced, low rugae.

REMARKS: *Cataceramus palliseri* (DOUGLAS), the correct name for *C. sornayi* (DHONDT)(=*Inoceramus regularis* D'ORBIGNY) [see comments in WALASZCZYK & *al*. (2001), and WALASZCZYK, ODIN & DHONDT (2002)] is a very poorly known species. Its relationships to other morphologically very close species, i.e. to the mainly Early Campanian *Cataceramus balticus* (BÖHM) and to the mainly Early Maastrichtian *Cataceramus barabini* (MORTON) are still unknown.

OCCURRENCE: In the studied material it is known exlusively from the "*Inoceramus*" *inkermanensis* Zone (=upper *Nostoceras hyatti* ammonite Zone) of the Piotrawin quarry. It is also known from Tercis, where it appears in the *Sphaeroceramus pertenuiformis* Zone and ranges to the top of the "*Inoceramus*" *oblongus* Zone. Known from the upper Upper Campanian of the US Western Interior.

Cataceramus? *planus* (MÜNSTER, 1836)
(Text-fig. 15A, B)

pars 1834-40. *Inoceramus planus* MÜNSTER; GOLDFUSS, p. 117, pl. 113, fig. 1b [non pl. 113, fig. 1a]
non 1958. *Inoceramus planus* MÜNSTER; KOCIUBYNSKIJ, p. 22, pl. 7, fig. 30 [=*Cataceramus subcircularis*]
1964. *Inoceramus planus* MÜNSTER; GIERS, p. 246, pl. 3, fig. 2.
non 1968. *Inoceramus planus* MÜNSTER; KOCIUBYNSKIJ, p. 147, pl. 29, fig. 7 [=*Cataceramus subcircularis*].
?pars 1968. *Inoceramus regularis* D'ORBIGNY; KOCIUBYNSKIJ, p. 143, pl. 29, figs ?1, 2. *Inoceramus regularis* D'ORBIGNY; KOCIUBYNSKIJ, p. 85, pl. 21, fig. 2; pl. 23, fig. 1.
? 1978. *Inoceramus* cf. *planus* MÜNSTER; SORNAY & BILOTTE, p. 5, pl. 3, fig. 1.
? 1979. *Inoceramus planus* MÜNSTER; IVANNIKOV, p. 71, pl. 22, fig. 1.
non 1993. *Inoceramus* aff. *planus* MÜNSTER; DHONDT, p. 217, pl. 3, fig. 1.
1997. *Inoceramus planus* MÜNSTER; WALASZCZYK, p. 41, pl. 30, figs 2, 4.

TYPE: The lectotype, by subsequent designation of GIERS (1964, p. 246) is the original of GOLDFUSS (1834-

40, pl. 113, fig. 1b), from the *Bostrychoceras polypocum* ammonite Zone of Haldem, Germany.

MATERIAL: Three specimens, MWG ZI/35/062 through MWG ZI/35/064; all from the Dorotka section.

Dimensions:

Specimen	h	l	H	L	s	VR	α	δ	hmax
ZI/35/062	64	66	57	70	–	25	130	53	113
ZI/35/063	64	68	57	73	–	23	130	54	103

DESCRIPTION: The species is of moderate size, inequilateral, ?equivalve and weakly inflated. The moderately oblique valve, with δ=50-55° is subrounded to oval in outline. The beak is small, and projects only slightly above the straight, moderately long hinge line. The anterior margin is weakly convex, relatively short, passing into long, broadly convex antero-ventral margin. The posterior maring is straight to weakly convex. The posterior auricle is weakly separated from the disc in the juvenile stage, but thereafter not separated at all.

The valves are ornamented with, regularly to subreguarly spaced comarginal rugae. In cross section the rugae are much narrower than the interspaces. Growth line traces are poorly visibe; they invariably parallel the rugae.

REMARKS: From *Cataceramus subcompressus* the species differs in its smaller obliquity (higher δ values). All other parameters, such as the longer anterior magin, the relatively shorter hinge line and different outline are the result of this. Early Maastrichtian reports of the species should be be referred to *Cataceramus subcircularis* (MEEK, 1876).

OCCURRENCE: The species is known from the lower to upper Upper Campanian (the *stobaei/basiplana* Zone up to the *Bostrychoceras polyplocum* Zone) of Europe.

Cataceramus subcircularis (MEEK, 1876)
(Text-fig. 16A-C, E-H)

?1834. *Inoceramus Barabini* MORTON, p. 62 (pars), pl. 13, fig. 11.
1876. *Inoceramus proximus*? var. *subcircularis* MEEK, p. 55, pl. 12, fig. 2.
1959. *Inoceramus buguntaensis* DOBROV & PAVLOVA, p. 140, pl. 22, fig. 1.

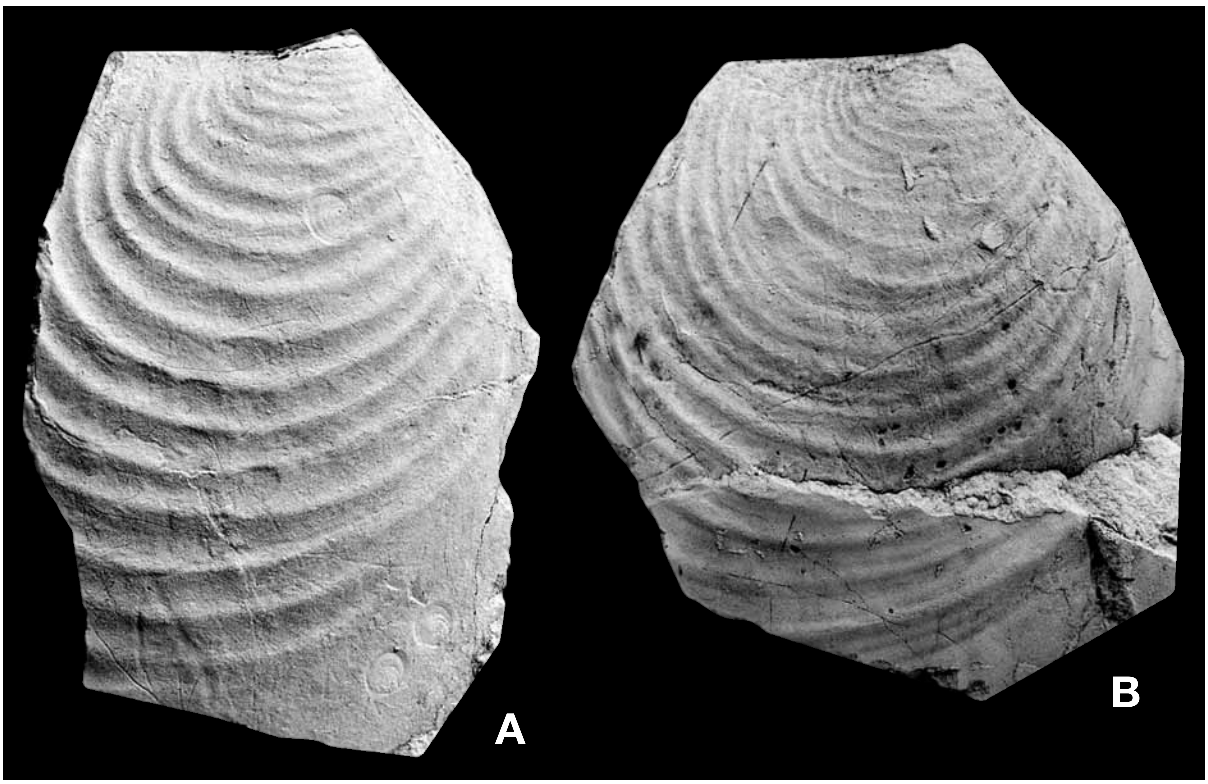

Fig. 15. *Cataceramus*? *planus* (MÜNSTER, 1836); A – MWG ZI/35/062, B – MWG ZI/35/063; both from Dorotka and × 0.8

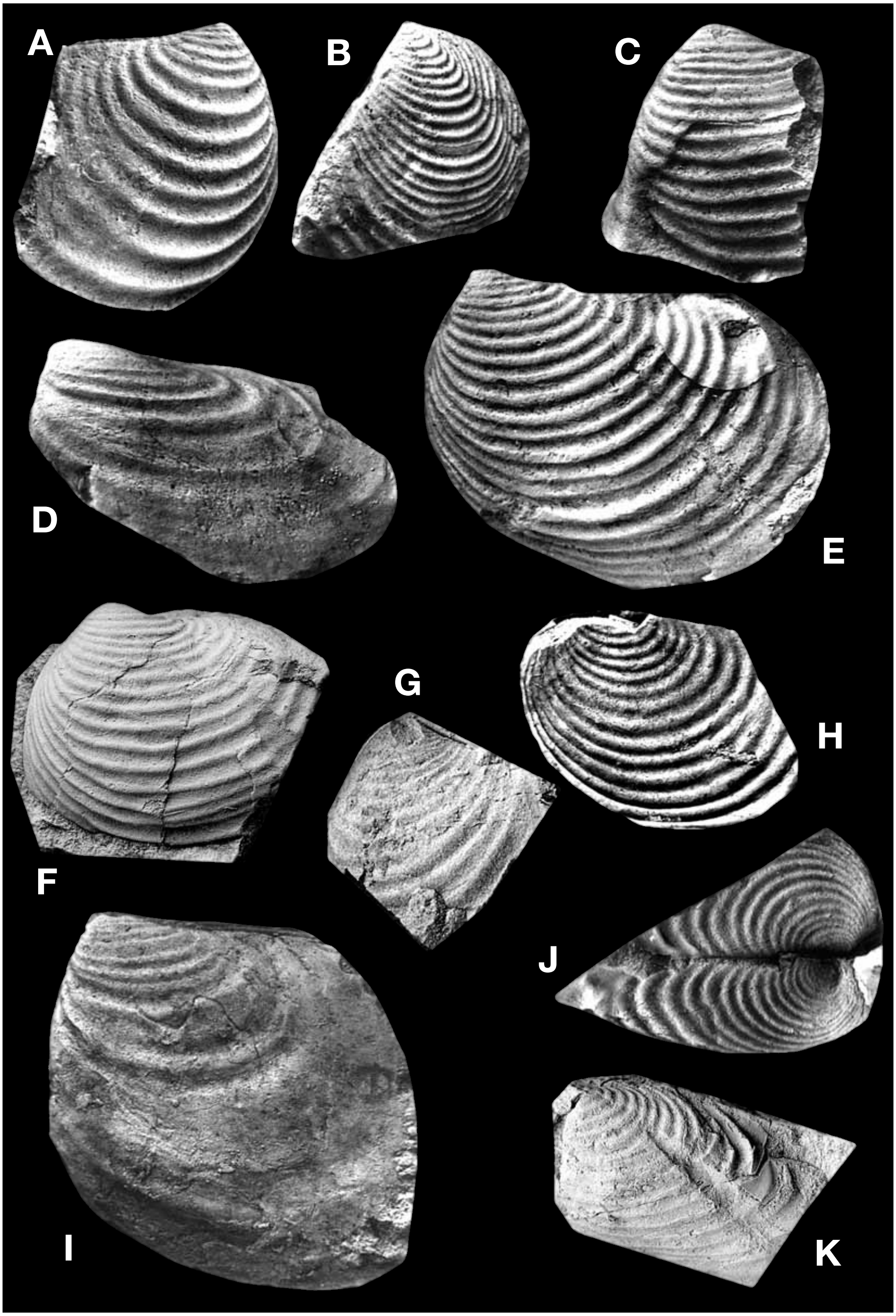

Fig. 16. A-C, E-H – *Cataceramus subcircularis* (MEEK, 1876); A – MWG ZI/35/134, B – MWG ZI/35/137, C – MWG ZI/35/133, E – MWG ZI/35/143, F – MWG ZI/35/132, G – MWG ZI/35/143, H – MWG ZI/35/145; besides H, which is from Kłudzie all other specimens are from Dziurków; all × 1. D, I – *Cataceramus barabini* (MORTON, 1834); D – MWG ZI/35/117, I – MWG ZI/35/116; both from Dziurków × 1. J, K – *Endocostea typica* WHITFIELD, 1877; J – MWG ZI/35/115, K – MWG ZI/35/113; Dziurków; both × 0.95

1969. *Inoceramus balticus rotatilis* KHALAFOVA, p. 231, pl. 28, figs 2-4.

pars 1991. *Inoceramus regularis* D'ORBIGNY; COBBAN & KENNEDY, pl. 1, figs 16-17 [non pl. 1, figs 18, 22 = *Trochoceramus* sp.].

pars 1993. *Trochoceramus nahorianensis* (KOCIUBYNSKIJ) DHONDT, p. 238, pl. 7, fig. 4.

1996. "*Incoeramus*" sp. cf. *planus* (of authors) MÜNSTER; WALASZCZYK & *al*., pl. 5, fig. 4.

1995. *Endocostea* (*Selenoceramus*) *semaili* MORRIS, p. 260, pl. 1, figs 5-6.

1997. *Inoceramus buguntaensis* DORBOV & PAVLOVA; ATABEKIAN, p. 68, pl. 27, fig. 1.

pars 2001. *Cataceramus subcircularis* (MEEK); WALASZCZYK & *al*., p. 160, [non pl. 31, fig. 3 = *Cataceramus palliseri*]; pl. 36, fig. 8; pl. 37, figs 1-2; pl. 39, figs 3, 6; pl. 41, figs 1-?2; pl. 42, fig. 1; pl. 43, fig. 6; pl. 44, fig. 5.

2001. *Trochoceramus* (?) sp. aff. *dobrovi* (PAVLOVA); TRÖGER & *al*., p. 155, pl. 2, figs 3-4; pl. 3, figs 3-4.

2002. *Cataceramus subcircularis* (MEEK); WALASZCZYK, ODIN & DHONDT, p. 285, pl. 13, figs 6, 10; pl. 14, figs 1-3, 6, 8-9).

TYPE: The holotype by original designation is USNM 479, the specimen illustrated by MEEK (1876, p. 12, fig. 2) reillustrated by WALASZCZYK & *al*. (2001, pl. 36, fig. 8) from Yellowstone River, about 150 miles above its mouth, from most probably Lower Maastrichtian (upper part of the Pierre Shale near Glendive, Montata, USA).

MATERIAL: MWG ZI/35/132 through MWG ZI/35/146, and numerous unregistered specimens from Dziurków and Kłudzie; all from the *Endocostea typica* Zone.

Dimensions:

Specimen	h	l	H	L	s	VR	α	δ	hmax
ZI/35/132	33	42	33	43	–	–	130	65	45
ZI/35/134	40	36	38	37	27	–	118	70	50
ZI/35/137	41	39	36	–	–	–	–	65	41
ZI/35/143	51	52	42	53	35	–	115	50	68

DESCRIPTION: The material studied is composed almost entirely of small-sized specimens, represented by internal moulds of single valves. All are deformed to some extent. The valves are of subrounded outline, larger specimens are sometimes more subrectangular, elongated postero-ventrally. The beak is small, subterminal, projecting slighly above the hinge line. The anterior, ventral and posterior margins are convex. The dorso-anterior part, just below the umbo, may be slightly concave. The hinge line is straight, moderately long to long. The posterior auricle is either very weakly separated from the disc or, apart from the most juvenile stage, not separated at all.

The valves are ornamented with regular, closely spaced commarginal rugae. They are characterised by quite even strength throughout, except for the dorso-posterior part. Traces of growth lines were not observed.

REMARKS AND OCCURRENCE: The species has a very simple architecture: subrounded outline with regular, commarginal rugae. It is probably indistinguishable from juvenile specimens of *Cataceramus balticus*, *C. palliseri*, or *C. planus*. When well developed *C. subcircularis* possesses rounder-topped rugae, however, this feature is quite variable.

The Early Maastrichtian record of the species is characterised by a distinct phyletic size increase from very small forms at the base of the *Endocostea typica* Zone to moderately large in the overlying *Trochoceramus radiosus* Zone (see WALASZCZYK & *al*. 2001 and WALASZCZYK, ODIN & DHONDT 2002). Consequently, it seems probable, that this species appears first in the *E. typica* Zone (=base of the *Baculites baculus* ammonite Zone). The report of this species from the topmost Campanian strata (e.g. WALASZCZYK & *al*. 2001) should therefore be excluded from the synonymy of the species.

Cataceramus subcompressus (MEEK & HAYDEN, 1860)
(Text-figs 17-19)

1835. *Inoceramus Cripsii* MANT.; GOLDFUSS, p. 116, pl. 12, fig. 4c.

1860. *Inoceramus subcompressus* MEEK & HAYDEN, p. 181.

1876. *Inoceramus Cripsii*? var. *subcompressus* MEEK & HAYDEN; MEEK, p. 48, pl. 38, fig. 2bis.

1909. *Haenleinia cymba* BÖHM, p. 56, pl. 12, fig. 2; pl. 13, fig. 2.

1964. *Inoceramus balticus haldemensis* GIERS, p. 243, pl. 2, fig. 2.

1997. *Inoceramus haldemensis* GIERS; NIEBUHR, p. 220, pl. 6, figs 1, 3.

pars 1967. *Inoceramus* (*Endocostea*) *cymba* BÖHM; SEITZ, p. 66, pl. 7, fig. 3.

pars 1982. *Inoceramus balticus haldemensis* GIERS; TRÖGER & RÖHLICH, p. 104, pl. 1, figs 1-2, 4, 6.

1997. *Inoceramus haldemensis* GIERS; WALASZCZYK, p. 40, pl. 30, figs 1, 3, 5.

pars 1991. *Inoceramus* (*Endocostea*) *balticus haldemensis* GIERS; TRÖGER & RÖHLICH, p. 1361, pl. 1, figs 1-2, 4.

pars 1991. *Inoceramus* (*Endocostea*) *balticus* cf. *haldemensis* GIERS; TRÖGER & RÖHLICH, p. 1361, pl. 1, fig. 8.

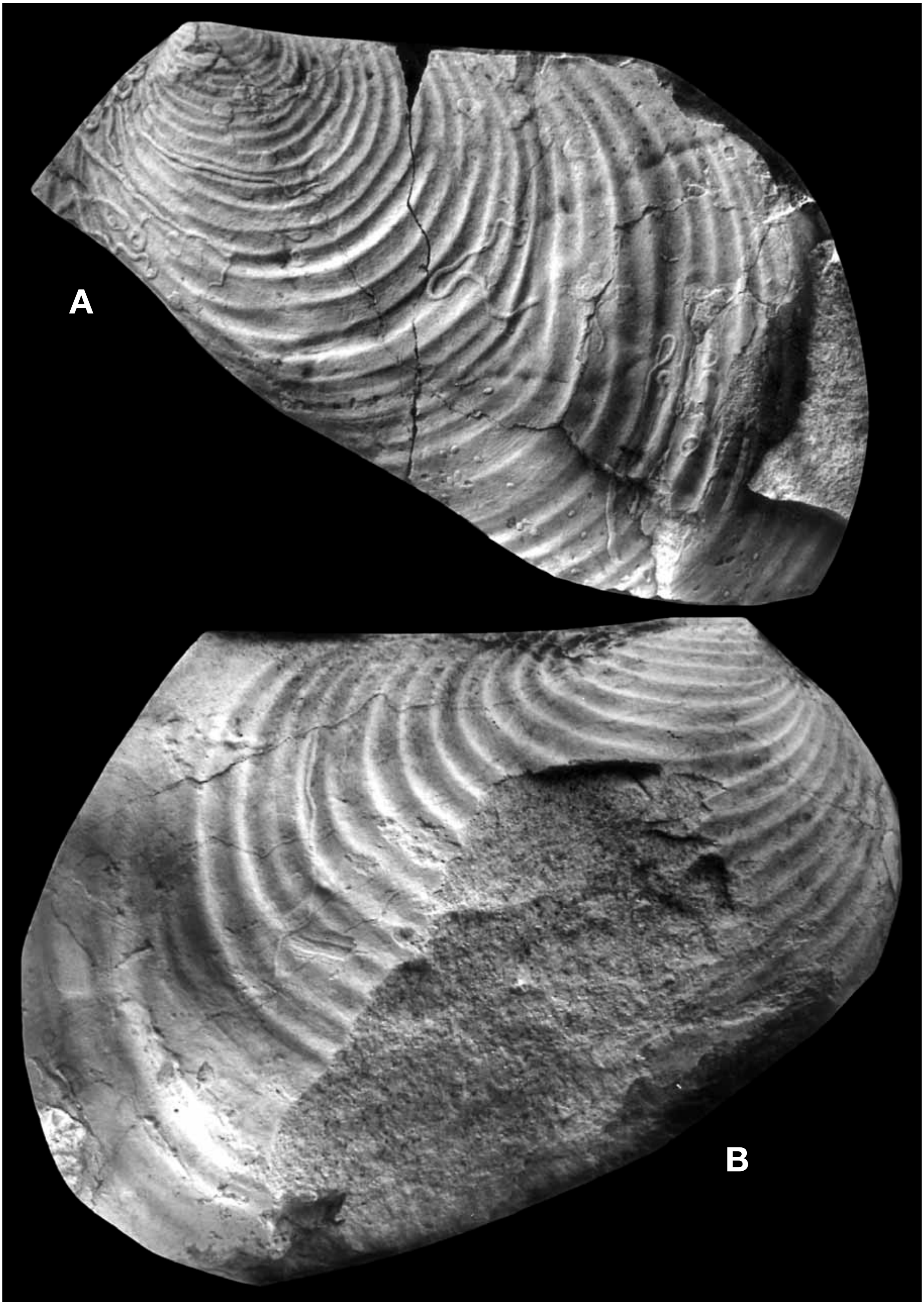

Fig. 17. *Cataceramus subcompressus* (MEEK & HAYDEN 1860); A – MWG ZI/35/061, × 0.70; B – MWG ZI/35/055, × 0.75; both from Dorotka

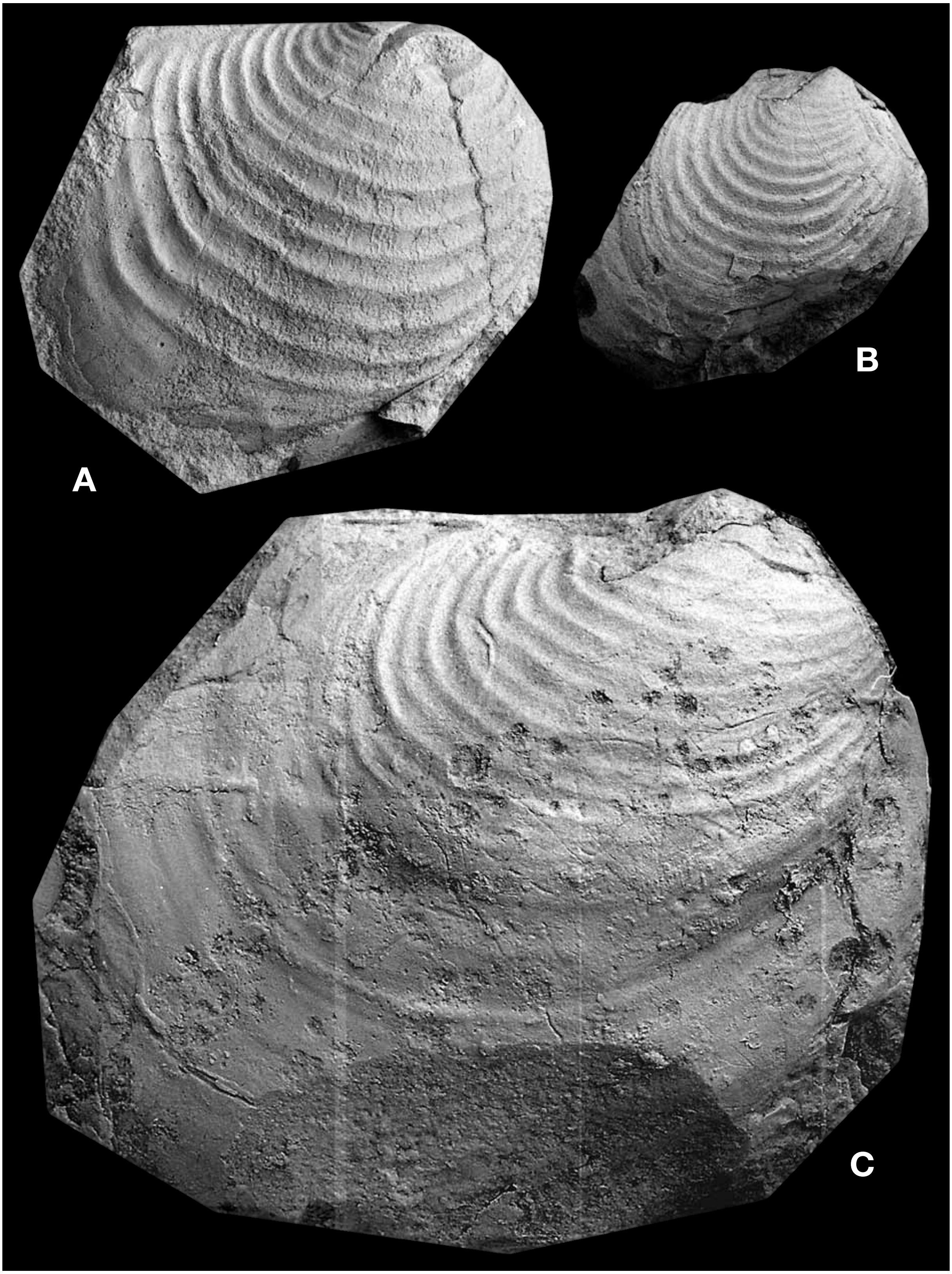

Fig. 18. *Cataceramus subcompressus* (MEEK & HAYDEN 1860); A – MWG ZI/35/068, × 1; B – MWG ZI/35/054, × 0.9; C – MWG ZI/35/049, × 1; all from Dorotka

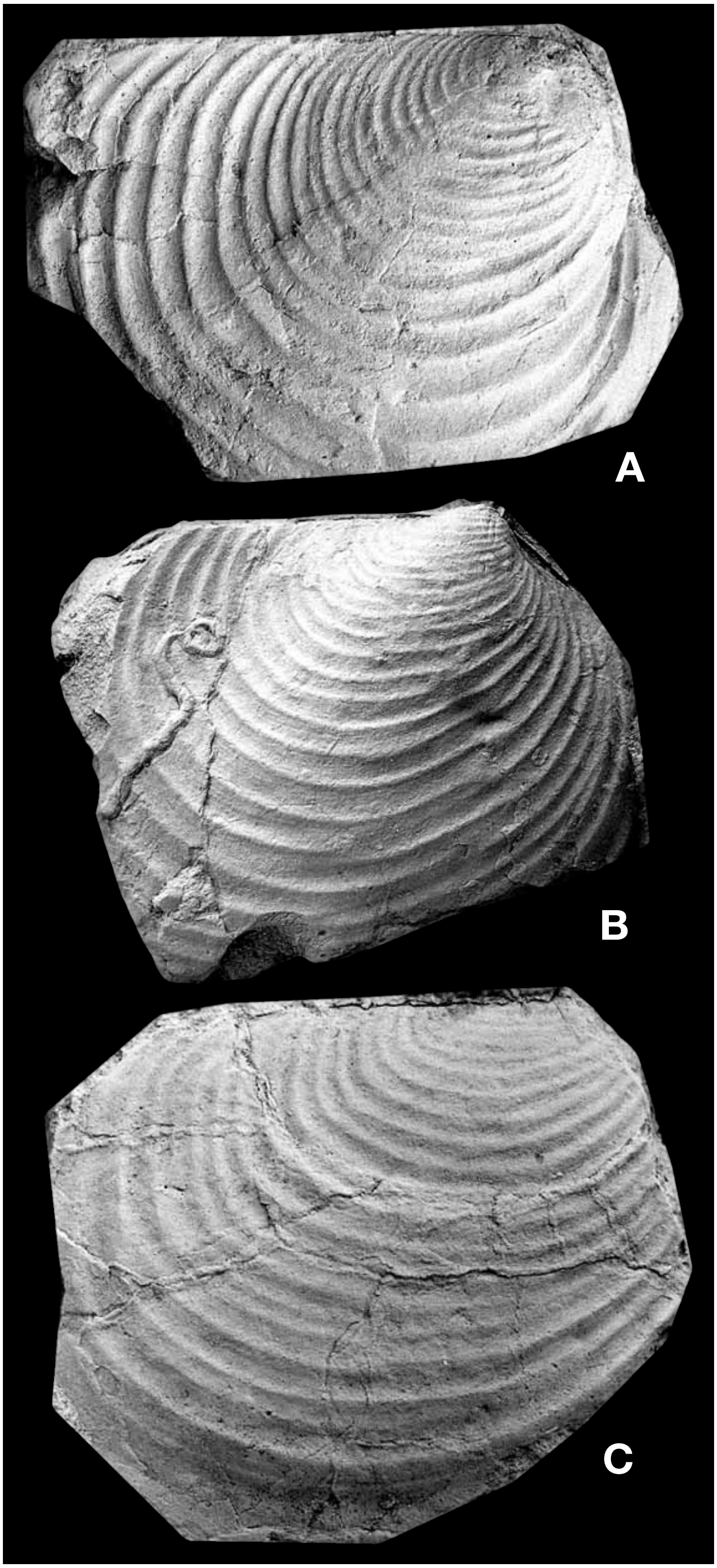

Fig. 19. *Cataceramus subcompressus* (MEEK & HAYDEN 1860); A – MWG ZI/35/059, × 0.95; B – MWG ZI/35/060, × 0.80; C – MWG ZI/35/051, × 1; all from Dorotka

2001. *Cataceramus subcompressus* (MEEK & HAYDEN); WALASZCZYK, COBBAN & HARRIES, p. 144, pl. 6, figs 1-4, 6-7; pl. 7, figs 5, 9; pl. 11, figs 5, 9; pl. 36, fig. 3.

TYPE: The holotype, by original designation, is USNM 4301, illustrated by MEEK (1876, pl. 38, fig. 2bis) and reillustrated by WALASZCZYK & *al*. (2001, pl. 36, fig. 3), from either the upper Lower Campanian *Scaphites hippocrepis* ammonite Zone or the lower Middle Campanian *Baculties asperiformis* ammonite Zone at the mouth of the Judith River, central Montana, US Western Interior.

MATERIAL: 13 well preserved specimens and a number of fragments; all specimens are from the Dorotka section; ZI/35/048 through ZI/35/058 and ZI/35/067.

Dimensions:

Specimen	hmax	hjuv	ljuv	Hjuv	Ljuv	δjuv	δ108	sjuv	VRjuv
ZI/35/049	166	85	75.5	67.3	93.4	30	38	56	31.5
ZI/35/050	150	78	69.0	61	90.5	30	40	–	25
ZI/35/051	97	93	79	74.4	99	34	–	53	–
ZI/35/055	192	122.5	108	96	137	36	–	82	42
ZI/35/052	205	83	81	67	90	30	35	63	–
ZI/35/054	87.6	63.7	46.8	46	53	33	–	–	17

DESCRIPTION: The species is large to very large, strongly inequilateral, ?equivalve. The valves show two distinct growth stages (juvenile and adult), differring in ornament and obliquity. The two growth stages contact along a more or less distinctly developed positive geniculation. The juvenile stage is of moderate to large size, moderately inflated, with the maximum h meausered in ZI/35/055 (Text-fig. 17B) equal 122.5 mm. The umbo is terminal to subterminal, small, projecting very slightly above the hinge line. The hinge line is long and straight. The anterior margin is straight or slightly convex, very short, with VR/h ratio varying between 0.32 and 0.34. Ventralward it passes into the very long, broadly convex antero-ventral margin. The ventral marign is rounded. The valves are strongly oblique; the maximum juvenile δ is invariably around 30° and then increases sligtly to about 40°. As demonstrated by more complete specimens (e.g. ZI/35/052) the adult stage dominated.

The juvenile ornament is *balticus*-like, composed of regularly and relatively closely spaced, commarginal rugae, with the interspaces increasing slowely ventralward. Rarely some rugae split into two or are discontinuous. The number of rugae in 20 and 50 mm interval of the axial length is 7 to 8. The growth lines are parallel to the rugae. They are usually very weakly seen on internal moulds. The adult stage is irregularly ornamented with low, widely spaced rugae, with the interspaces up to 30 mm wide.

REMARKS: The materal studied herein confirmes the suggestion of WALASZCZYK & *al*. (2001, p. 146) that *Cataceramus haldemensis* (GIERS, 1964), to which it would normally be referred in Europe, should be synonymised with the American species *C. subcompressus* (MEEK & HAYDEN). The apparent differences result mostly from differences in preservation. The American material is three-dimenionally preserved, and represented mostly by small-sized specimens. The European material is composed normally of moderate to large-sized internal moulds, usually strongly laterally compressed.

Inoceramus algeriensis HEINZ, 1932 (VOUTE 1951, pl. 5, fig. 2)(newly illustrated in WALASZCZYK 1997, pl. 31, figs 3, 5) differs in finer juvenile ornament and more rounded outline of commarginal juvenile rugae.

Very similar to *C. subcompressus* is a latest Campanian – Early Maastrichtian species *Cataceramus palliseri* (DOUGLAS, 1942)(=*Inoceramus regularis* D'ORBIGNY)(=*Selenoceramus sornayi* DHONDT 1993). Although *C. palliseri* is more finely rugate and more triangular instead subquadrate in shape, both species are very similar.

OCCURRENCE: *C. subcompressus* is a common taxon in the *Bostrychoceras polyplocum* ammonite Zone in Europe and in an interval starting from the *Baculites asperiformis* ammonite Zone and ranging up to the lower *Baculites gregoryensis* ammonite Zone of the US Western Interior.

Genus *Endocostea* WHITFIELD, 1877

TYPE SPECIES: *Endocostea typica* WHITFIELD 1877, p. 32, from the *Baculites baculus* ammonite Zone of the Lower Maastrichtian, of the Old Woman Form of the Cheyenne River, Blak Hills area in easternmost Wyoming, USA.

REMARKS AND OCCURRENCE: For discussion of the genus see MORRIS (1995) and WALASZCZYK & *al*. (2001). The genus first appeared most probably in the latest Campanian, with the species *Endocostea* aff. *typica*, from the *Baculites reesidei* ammonite Zone (WALASZCZYK & *al*. 2001) and also reported from Europe, from the middle part of the *Nostoceras hyatti* Zone of the Tercis section (WALASZCZYK, ODIN & DHONDT 2002). It occurs regularly starting from the base of the *E. typica* Zone (=base of the *Baculites baculus* ammonite Zone).

Endocostea typica WHITFIELD, 1877
(Text-fig. 16 J, K, L)

1877. *Endocostea typica* WHITFIELD, p. 32.
pars 1880. *Endocostea typica* WHITFIELD; WHITFIELD, p. 403, pl. 9, figs 1-3, 7 [non pl. 9, figs 4-6 = *Cataceramus barabini* (MORTON)].
1913. *Inoceramus Barabini* MORTON; BÖSE, p. 35, pl. 3, fig. 1.
non 1931. *Endocostea typica* WHITFIELD; RIEDEL, p. 664, pl. 75, figs 2-4; pl. 76, fig. 1.
non 1964. ?*Endocostea impressa* (D'ORBIGNY); GIERS, p. 248.
non 1999. *Endocostea typica* (D'ORBIGNY); TRÖGER & *al*., p. 45, pl. 2, figs 1, 3, 5-6; text-figs 7-8.
non 1999. *Endocostea* aff. *impressa* (D'ORBINGY); SUMMESBERGER & *al*., p. 165, pl. 8, figs 1-2.
2002. *Endocostea typica* WHITFIELD; WALASZCZYK, ODIN & DHONDT, p. 287, pl. 13, figs 1-5, 7-8, 11.

TYPE: The lectotype, by subsequent designation of SEITZ (1967, p. 55) is USNM 12261, the original of WHITFIELD (1880, pl. 9, fig. 3), from the lower Maastrichtian *Baculites baculus* ammonite Zone of the Old Women Fork of the Cheyenne River in the Black Hills, Wyoming, USA.

MATERIAL: Five specimens, MWG ZI/35/112 through MWG ZI/35/115 from the Dziurkow section, and MZ ML1360/1, from Kłudzie.

DESCRIPTION: The species is poorly represented in the material studied. Besides numerous fragments five more complete specimens are in the collection. The species is small-sized, inequilateral, ?equivalve. The valves are subquadrate in outline, moderately to strongly inflated and markedly oblique. The umbo is small, subterminal, projecting slightly to markedly above the hinge line. The anterior margin is very short and convex. It passes into vey long, broadly convex antero-ventral margin. The posterior margin is short and convex. The hinge line is long and straight. The posterior auricle either indistinct, not separated from the disc or it is strongly separated along a distinct step. A distinct 'Hohlkehle' is developed in MWG ZI/35/113.

The valves are ornamented with regularly spaced commarginal rugae, with interspaces increasing gradually ventralward.

REMARKS: *Endocostea* aff. *typica* (see WALASZCZYK & *al*. 2001, pl. 26, fig. 3; and WALASZCZYK, ODIN & DHONDT 2002, text-fig. 7) is very similar in general outline and architecture. It differs, however, in surface ornament; the ornament in this form is less regular and composed of sharply edged very closely spaced rugae/?growth lines. *E.* aff. *typica* occurs stratigraphically distintly lower, in the upper part of the *Nostoceras hyatti* Zone (="*Inoceramus*" *inkermanensis* Zone); then it disappears from the record.

The late Early Maastrichtian *Endocostea impressa* (D'ORBIGNY) differs in surface ornament and possesses strongly projecting umbo. Moreover, its posterior auricle is separated from the disc along well-developed auricular sulcus.

Endocostea jolkicevi WALASZCZYK, ODIN & DHONDT, 2002, differs from the American species in possessing a distinct radial sulcus and in smaller obliquity.

OCCURRENCE: The species is limited to the basal Lower Maastrichtian, with its FO marking the base of the eponymous zone. It is known from Europe, North America, and from South America.

Genus *Sphaeroceramus*, HEINZ, 1932

TYPE SPECIES: *Inoceramus subsarumensis* RENNGARTEN, 1926 (=*Inoceramus pila* HEINZ, 1932), based on a specimen of *Inoceramus inconstans* WOODS (1912, text-fig. 48) from the ?Lower Campanian of England (locality unknown).

REMARKS AND OCCURRENCE: The discussion on the genus see WALASZCZYK (1997) and WALASZCZYK & *al*. (2001). It is known from the late Early and early Late Campanian of Europe and of USA.

Sphaeroceramus pertenuiformis
WALASZCZYK, COBBAN & HARRIES, 2001
(Text-figs 20A-C, E, G, 21)

pars 1976. *Inoceramus borilensis dauensis* SORNAY, p. 5, pl. 1, fig. 3; pl. 2, fig. 2 [non pl. 2, fig. 1].
2001. *Sphaeroceramus pertenuiformis* WALASZCZYK, COBBAN & HARRIES, p. 176, pl. 13, figs 1, 5-6; pl. 14, figs 2, 4; pls 17-18; pl. 19, figs 2-3; pl. 20, fig. 3; pl. 21, figs 1, 3-4.
2002. *Sphaeroceramus pertenuiformis* WALASZCZYK, COBBAN & HARRIES; WALASZCZYK, ODIN & DHONDT, p. 287, pl. 2, figs 1-2, 4-5; pl. 3, figs 1-3, 5-6.

TYPE: The holotype, by original designation, is USNM 507552, the original of WALASZCZYK & *al*. (2001, pl. 14, fig. 2) from the *Didymoceras stevensoni* – *Exiteloceras jenneyi* ammonite zones of the Pierre Shale near Red Bird, Niobrara County, Wyoming, USA.

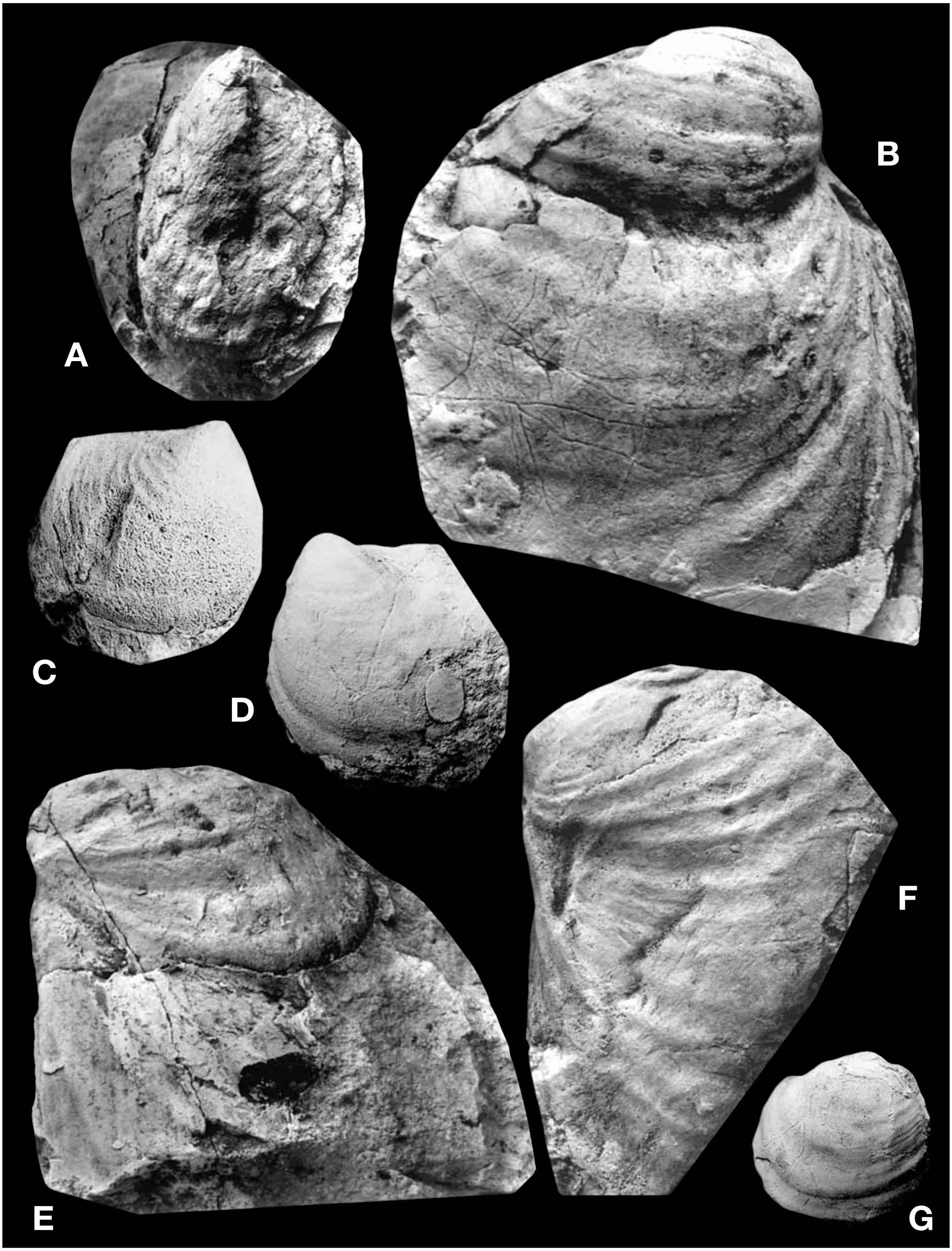

Fig. 20. A-C, E, G – *Sphaeroceramus pertenuiformis* WALASZCZYK, COBBAN & HARRIES, 2001; A, E – MWG ZI/35/098, B – MWG ZI/35/099, C – GIUSG-2170US-40, G – MWG ZI/35/096; A-B, E, G are from Wola Pawłowska and C is from Ciszyca; all are natural size. D – "*Inoceramus*" *tenuilineatus* HALL & MEEK, 1856; MZ ML1416, Ciszyca Kolonia, × 1; F – "*Inoceramus*" *borilensis* JOLKICEV, 1962, MWG ZI/35/092 × 1

MATERIAL: Eight specimens; MWG ZI/35/094 through MWG ZI/35/-ZI/35/099, all from the Wola Pawłowska section; MZ ML1404 from Kolonia Ciszyca.

DESCRIPTION: In the studied material the species is represented exclusively by single valves; one specimen preserved with a shelly counterpart. All are deformed to a variable extent.

The species is of moderate size, inequilateral, ?equivalve. It is composed of two distinct growth stages: the small juvenile one, followed by an adult stage with the neck part in between. Usually two distinct geniculations are developed; the positive one at the ventral edge of the juvenile stage and the negative one at the dosral edge of the adult stage. The juvenile stage is subrounded to subrectangulat in outline, prosocline to orthocline. Its surface is very weakly ornamented to almost smooth. The adult stage, growing perpendicularly to the juvenile one, is markedly larger. It possesses a long and straight anterior margin, passing into long and convex ventral and posterior margins. Its surface is covered with irregular, low, widely spaced rugae.

REMARKS: The species resembles closely "*Inoceramus*" *borilensis* JOLKICEV and "*Inoceramus*" sp. A, which may possibly represent a new species (see its description at the end of the taxonomic part). From both of these species *S. pertenuiformis* differs in the juvenile stage only. The *balticus*-like juvenile stage of "*I.*" *borilensis*, the generic affiliation of which is unclear, may possibly represent a *Cataceramus* species, whereas that of "*Inoceramus*" sp. A resembles more *C. goldfussianus*.

OCCURRENCE: The species occurs in the *Didymoceras stevensoni* and *Exiteloceras jenneyi* zones (early Late Campanian in the American subdivision) of the US Western Interior. In Europe, besides the Vistula section it was reported from the Tercis section, from the upper part of the *Bostrychoceras polyplocum* Zone.

Genus *Platyceramus*, HEINZ, 1932
(Text-figs 23-27)

TYPE SPECIES: *Inoceramus mantelli* (DE MERCEY) BARROIS, 1879, p. 454, pl. 4, fig. 1.

OCCURENCE: The genus appeared in the Middle (?late Early) Coniacian and ranged till the Early Maastrichtian; apparently world-wide.

Platyceramus rhomboides (SEITZ, 1961)
(Text-figs 25-26)

1961. *Inoceramus* (*Platyceramus*) *rhomboides rhomboids*, SEITZ, p. 82, pl. 3, fig. 2; pl. 4, figs 1-2, 7.

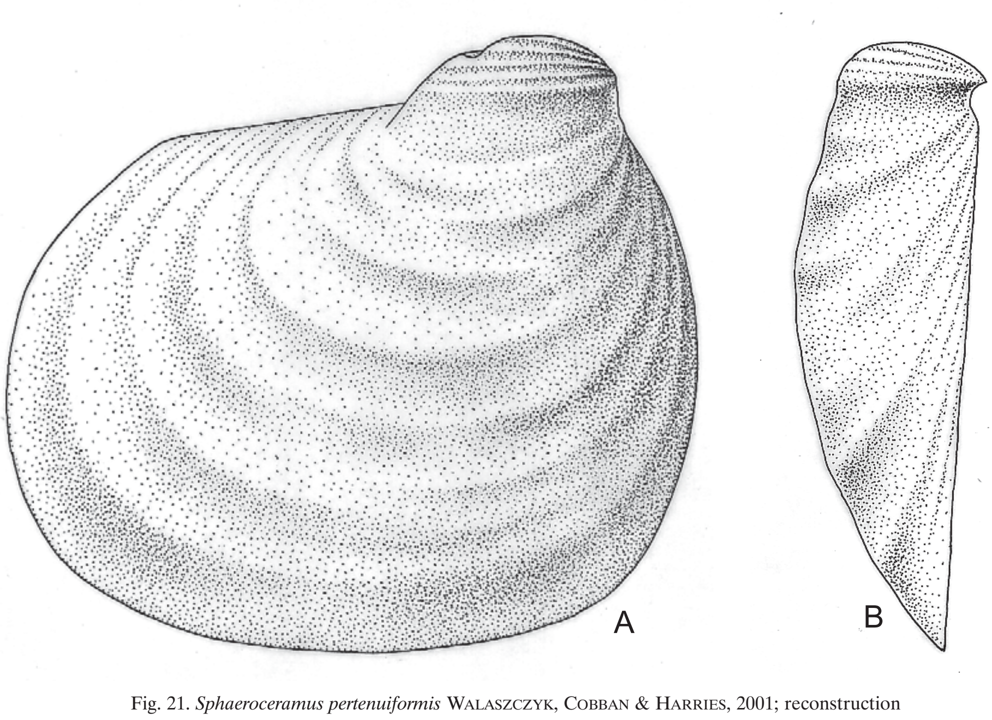

Fig. 21. *Sphaeroceramus pertenuiformis* WALASZCZYK, COBBAN & HARRIES, 2001; reconstruction

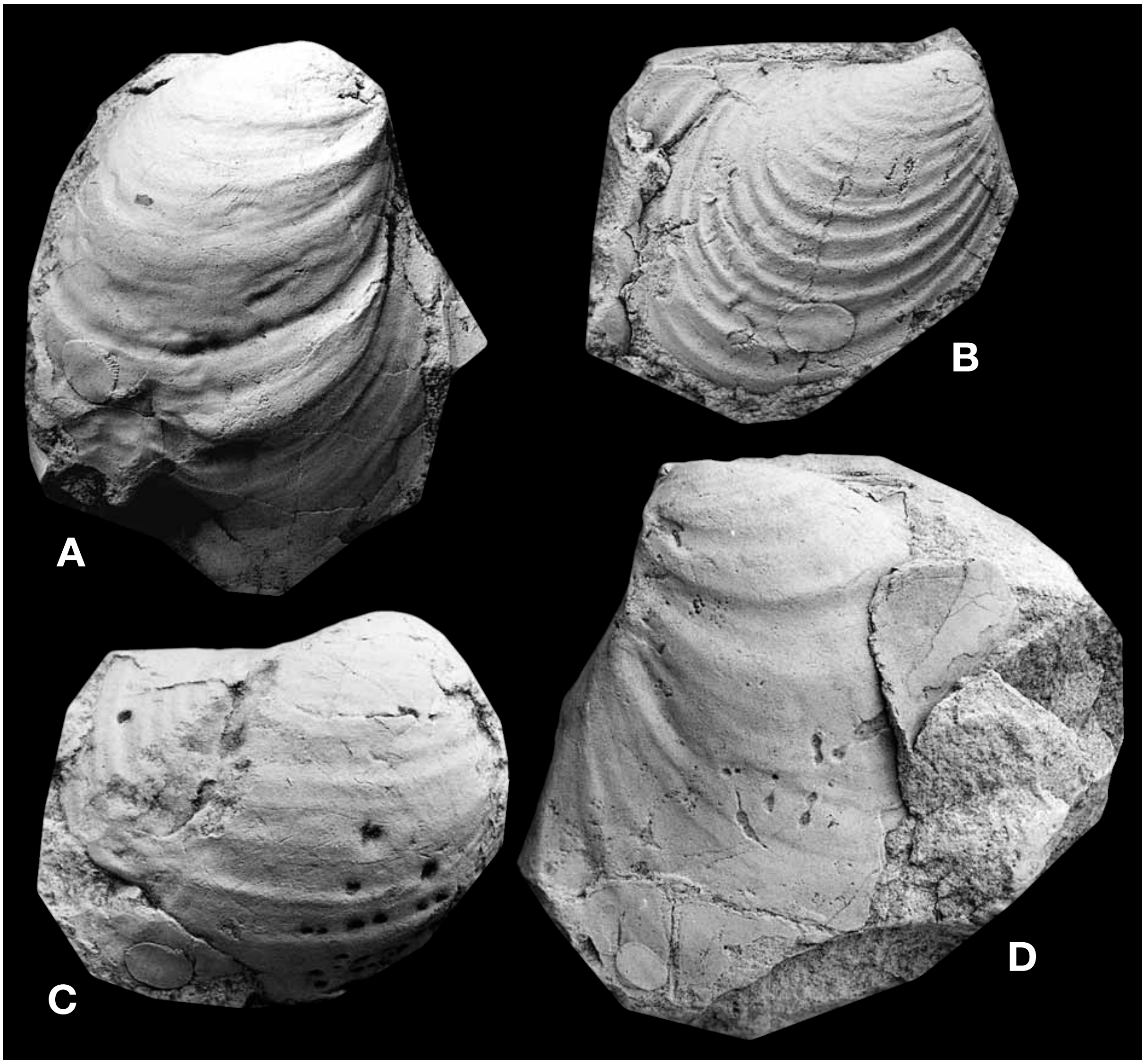

Fig. 22. A – *Sphaeroceramus* aff. *pertenuiformis* WALASZCZYK, COBBAN & HARRIES, 2001; MZ ML1404, Ciszyca Kolonia, × 1; B – *Cataceramus* cf. *mortoni* (MEEK & HAYDEN , 1860); MZ ML1269, Ciszyca Kolonia, × 1; C – *Inoceramus* sp. cf. "*Inoceramus*" *whitfieldi* WALASZCZYK, COBBAN & HARRIES, 2001, MZ ML1412, Ciszyca Kolonia, × 1. D – "*Inoceramus*" sp., MZ ML1434, Ciszyca Kolonia, × 1

MATERIAL: 8 specimens, MWG ZI/35/041 through MWG ZI/35/47, and MWG ZI/35/075, all from the Dorotka section; *Cataceramus subcompressus* Zone (= *Bostrychoceras polyplocum* ammonite Zone).

Dimensions:

Specimen	h	l	H	L	s	VR	α	δ	hmax
ZI/35/041	95	80	76	96	56	–	116	50	154
ZI/35/045	92	82	77	88	83	–	120	50	146

DESCRIPTION AND REMARKS: All specimens are represented by internal moulds of single valves; only few shell fragments are attached. The specimens are usually deformed to a varying extent. Some are simply compressed laterally (ZI/35/043, ZI/35/045, and Zi/35/075), whereas the others are compressed in other planes, what resulted in the change of their outline.

The species is of medium to large size, inequilateral, equivalve. The umbo is small, terminal and projects only slightly above the hinge line. The valves are composed of two stages that differ in their surface ornament. Both stages grow in the same plane; a weak geniculation is visible only in deformed specimens and is probably enhanced due to it. The anterior margin is short, straight to slightly convex and passesses into the long, broadly convex, and partly straight, antero-ventral margin, and thence into the regularly rounded ventral margin. The posterior margin is almost straight. The hinge line is straight and moderately long. Apart from the umbonal region, the posterior auricle is not separated from the disc.

The valve ornament varies between the juvenile and the adult stages. The juvenile stage is covered with regular to subregular commarginal rugae with superimposed growth lines, the traces of which are well preserved, and with interspaces increasing gradually ventralward. The adult stage bears irregular, low, widely spaced rugae; sometimes is almost smooth.

The general outline, the type of ornament and the general architecture of the specimens studied are very close to the type material of the species (SEITZ 1961, pl. 3, fig. 2; pl. 4, figs 1-2, 7) from northern Germany. The apparently stronger rugae in the German material may be due to the deformation of the studied specimens.

OCCURRENCE: The species ranges from the topmost Lower Santonian to Lower Campanian in northern Germany. The studied specimens form the Vistula section seem to be the stratigraphically youngest specimens.

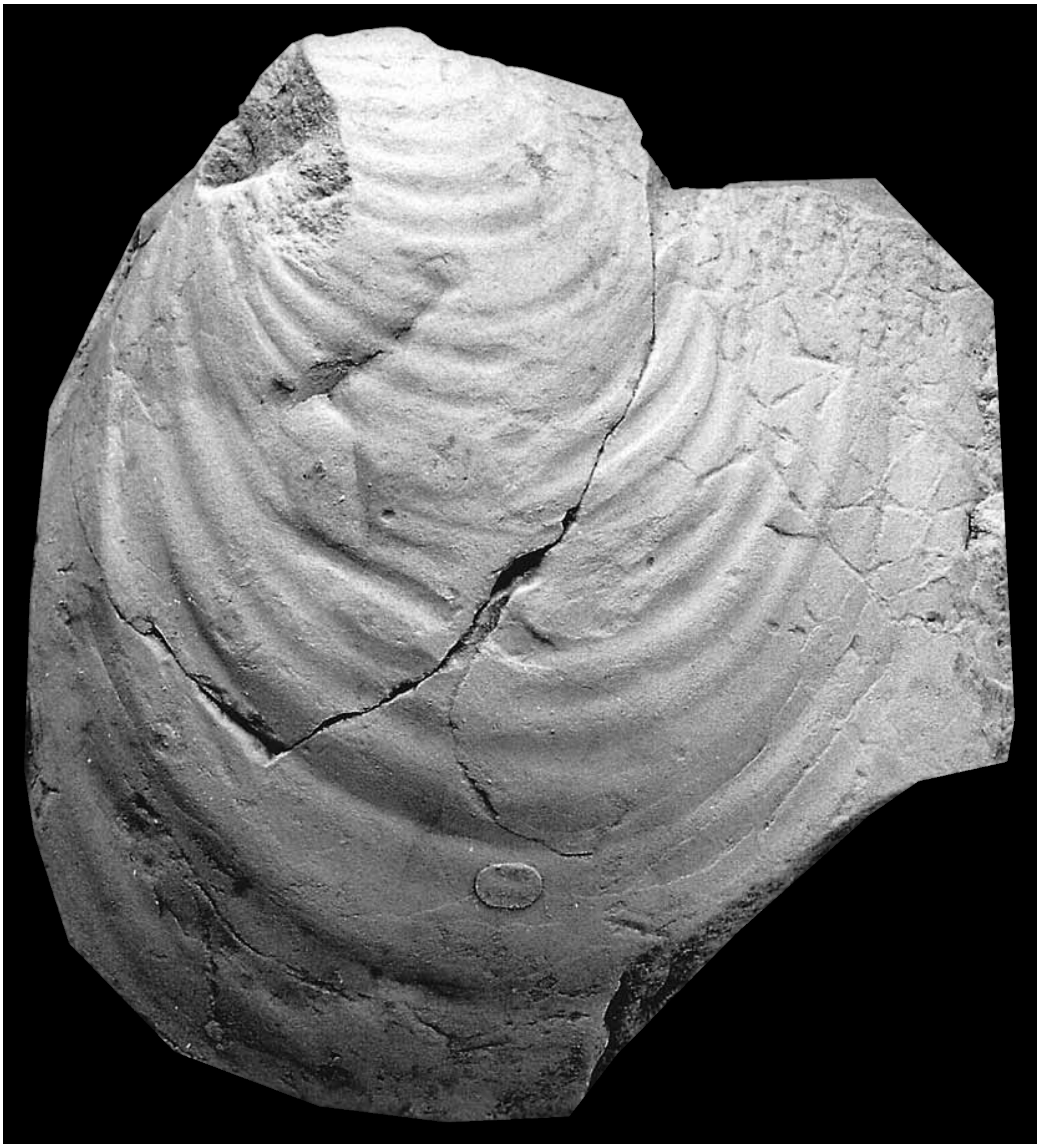

Fig. 23. *Platyceramus* sp.; MZ ML1226, Ciszyca Kolonia, × 1

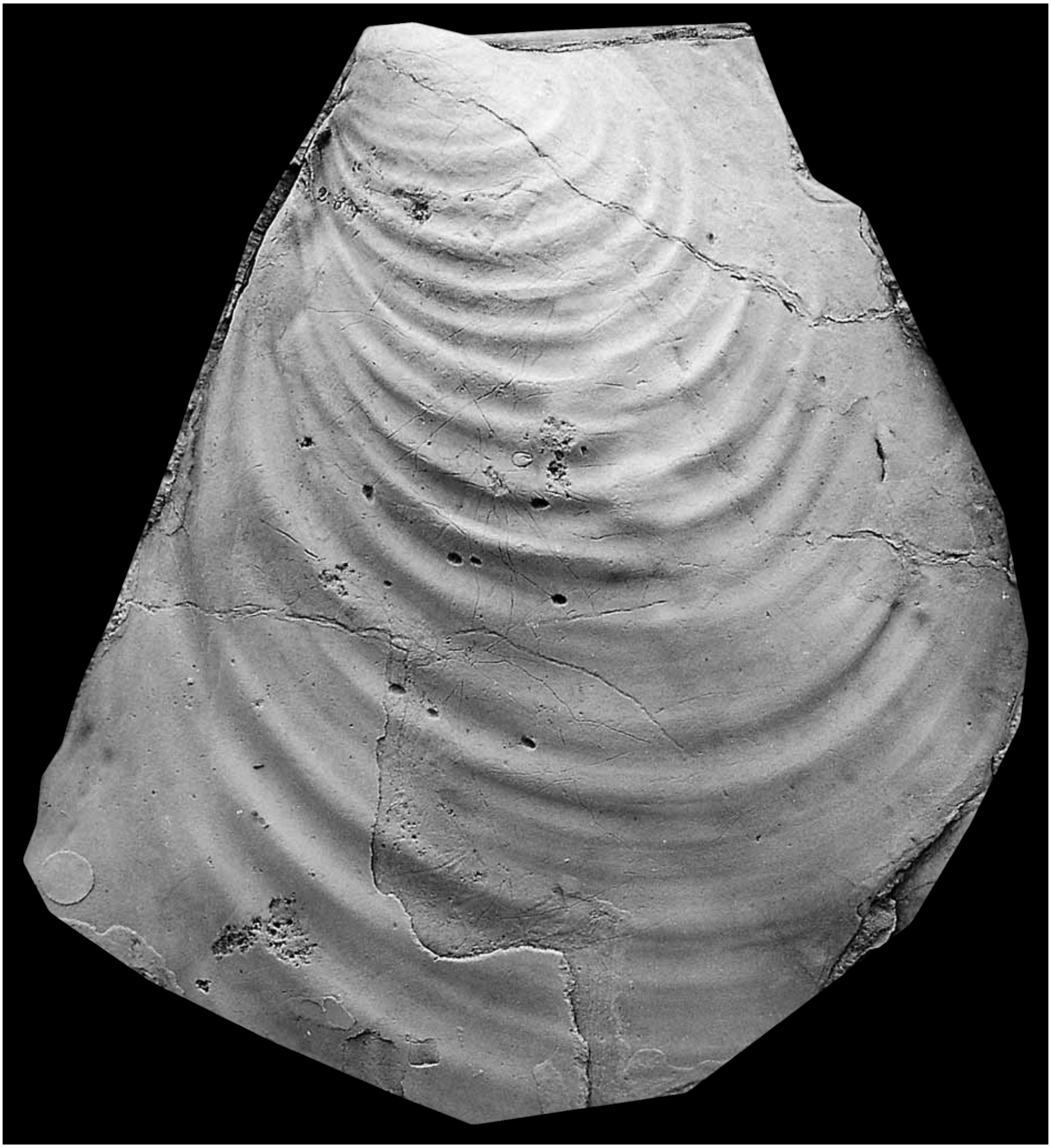

Fig. 24. *Platyceramus* sp.; PIG 234 II 45, Ciszyca, × 1

Platyceramus cf. *pierrensis*
(WALASZCZYK, COBBAN & HARRIES, 2001)
(Text-fig. 27)

1896. *Inoceramus sagensis* OWEN; GILBERT, p. 56, fig. 2.
2001. "*Inoceramus*" *pierrensis* sp. nov.; WALASZCZYK, COBBAN & HARRIES, p. 206, pl. 12, pl. 14, figs 1, 3, 5; pl. 15, fig. 4; pl. 16, fig. 1.

TYPE: The holotype, by original designation, is USNM 507740 (WALASZCZYK & *al*. 2001, pl. 14, fig. 1) from the *Baculites scotti* ammonite Zone of the Red Bird section, Wyoming US Western Interior (USGS locality D1923)(see GILL & COBBAN 1966). USNM 507560, USNM 507562, USNM 507563, USNM 507566, USNM 507568, USNM 507569, USNM 507576 and USNM 507578 (WALASZCZYK & *al*. 2001) are paratypes.

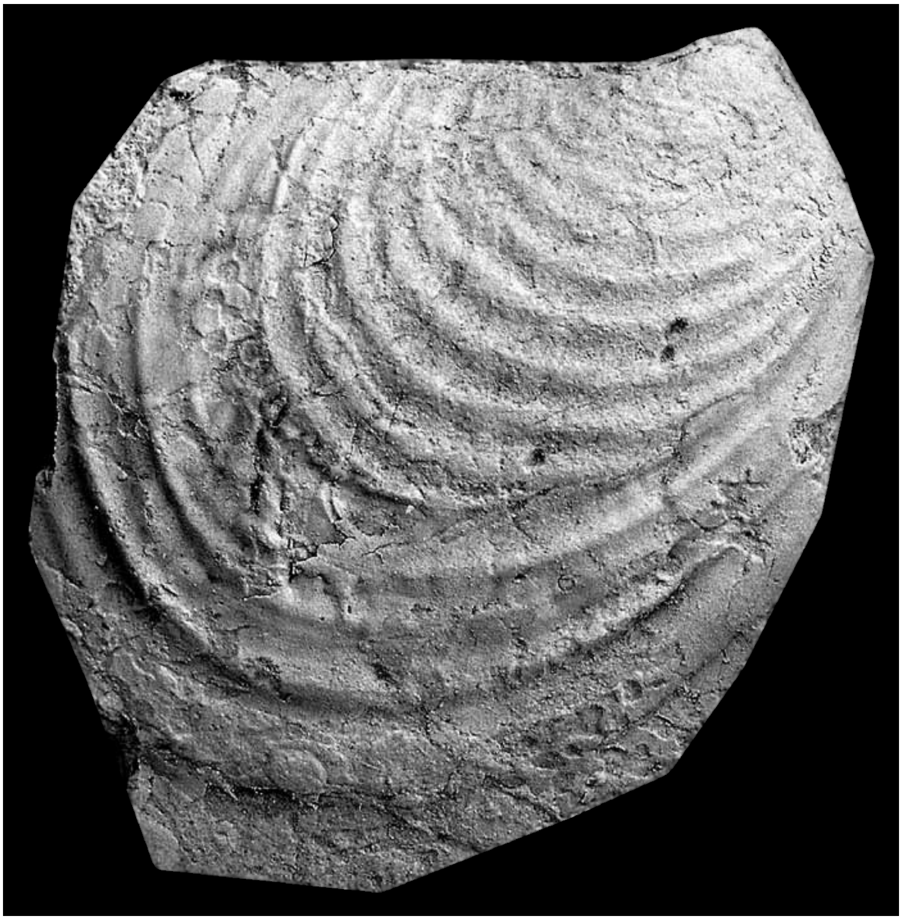

Fig. 25. *Platyceramus rhomboides* (SEITZ, 1961); MWG ZI/35/043, Dorotka, × 1

MATERIAL: MZ ML 1261/1 from Ciszyca Kolonia, and probably also MWG ZI/35/065 from Dorotka.

Dimensions:

Specimen	h	l	H	L	s	VR	α	δ	hmax
ZI/35/041	61	56	55	57	32	–	115	60	77

DESCRIPTION AND REMARKS: MZ ML1261/1 is a fragmentarily preserved RV: its ventral and posterio-ventral parts are missing. It is a weakly developed, moderately oblique valve, with a straight, moderately long anterior margin, rounded ventral margin, and a straight and long hinge line. The inflation is greatest in the umbonal part. The umbo is small, terminal, projecting very slightly above the hinge line. The posterior auricle is not separated from the disc.

The valve is ornamented with commarginal rugae and superimposed, parallel growth lines, the traces of which are relatively well preserved. The juvenile ornament is poorly visible, but the early adult rugae are widely spaced, with flat-floored interspaces, and with second-order rugae visible in some cases. The rugae are apparently symmetrical in crossection.

To this species also belongs, most probably, MWG ZI/35/065, represented by internal mould of a RV, with missing postero-ventral part. The specimen is deformed in the umbonal region.

OCCURRENCE: ML 1261/1 comes from the lower part of the "*Inoceramus*" *tenuilinetus* Zone (=lower part of the *Didymoceras donezianum* Zone) of Ciszyca Kolonia. The other specimen, referred to here with a question mark, is from Dorotka. The species is described from the US Western Interior, where it occurs in the "*I.*" *tenuilineatus* and in the *Sphaeroceramus pertenuiformis* Zone, an interval which coresponds to the late Middle Campanian *Didymoceras scotti* ammonite Zone through the early Late Campanian *Exiteloceras jenneyi* ammonite Zone.

Platyceramus sp.
(Text-figs 23-24)

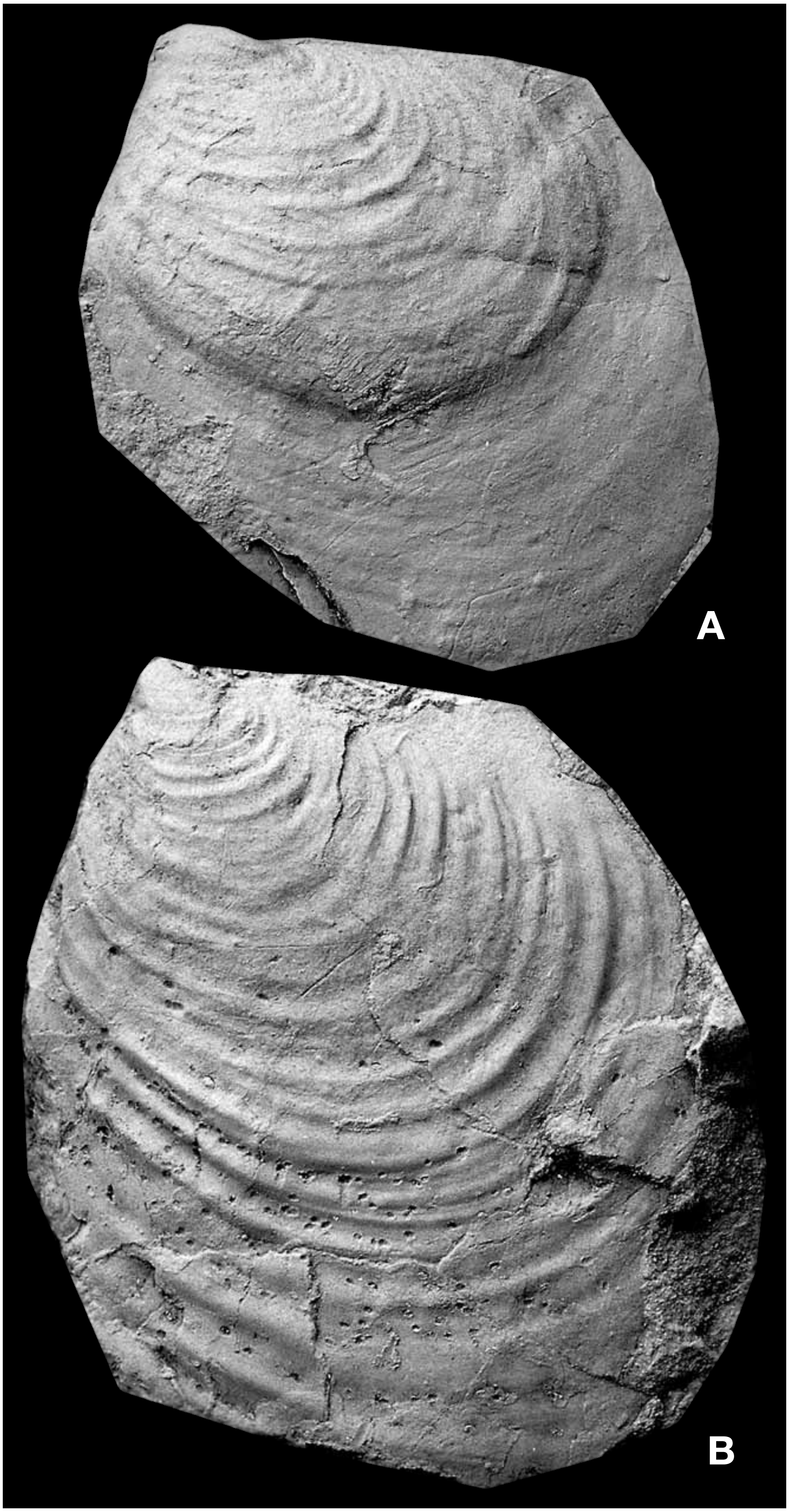

Fig. 26. *Platyceramus rhomboides* (SEITZ, 1961); A – MWG ZI/35/041, × 0.7; B – MWG ZI/35/045, × 0.9; both from Dorotka

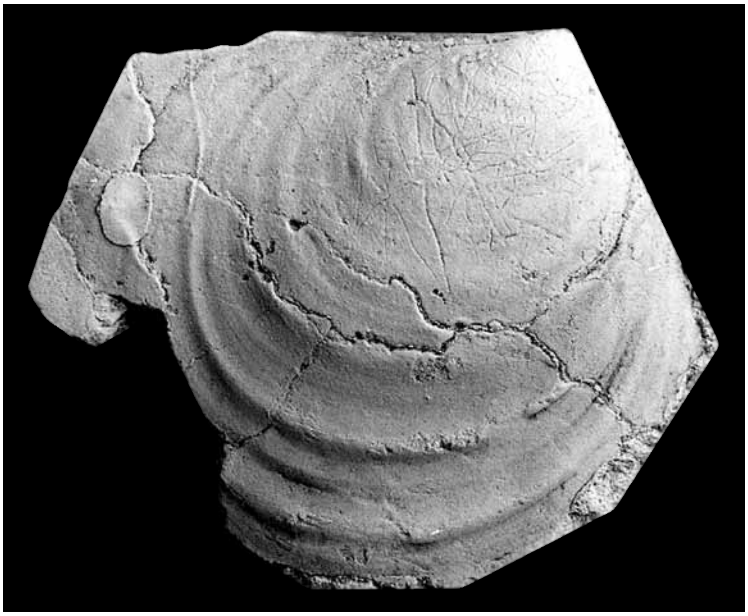

Fig. 27. *Platyceramus* cf. *pierrensis* (WALASZCZYK, COBBAN & HARRIES, 2001); MZ ML1261/1, Ciszyca Kolonia, × 1

MATERIAL: Two specimens, MZ ML 1226, from Ciszyca Kolonia, and PIG 234.II.45 from Ciszyca (coll. W. POŻARYSKI).

Dimensions:

Specimen	h	l	H	L	s	VR	α	δ	hmax
ML1226	112	94	98	100	68	40	110	56	160
234.II.45	91.7	79	79.6	81.6	53.6	25.4	120	55	163

DESCRIPTION: PIG 234.II.45 is a huge single LV (its estimated maximum axial length hust have been well above 250 mm), slightly deformed in the dorso-anterior part, and most probably also a little bit compressed laterally as demonstrated by the shape of the umbonal regional. The umbo is small and curved distinctly dorso-anteriorly. The hinge line and anterior margin are straight, moderately long. Up to 90 mm of the axial length the valve is subregularly ornamented, with the interspaces of the adult ruage between 6 and 8 mm. The rugae are best developed in the axial part, weakening on the anterior margin and on the posterior auricle. Ventralward the ornament becomes weaker and less regular and is composed of low, widely spaced rugae. Growth lines traces visible in parts only; they are parallel to the rugae.

MZ ML1226 is also a large specimen (although less completely preserved than the other specimen). It is an internal mould of the LV, with the dorso-posterior and postero-ventral parts missing. It clearly shows two growth stages, with different ornament. The rugae are poorly preserved.

REMARKS: Both specimens differ from representatives of *Platyceramus rhomboides* in their more robust ornament, and in the fact that the rugae in the regularly rugate part weaken distinctly when passing onto anterior and posterior parts. *Platyceramus pierrensis* possesses quite distinct rugae, which are narrow in cross section, relatively steep, widely spaced and with flat-floored interspaces. *Platyceramus* sp. probably represents a new species but more material is needed to see the actual variability range of the species and to exclude the possibility that these are simply specimens from a margin of the range of variability of any other species.

OCCURRENCE: The studied specimens are from the "*Inoceramus*" *tenuilineatus* Zone (=lower part of the *Didymoceras donezianum* ammonite Zone) of Ciszyca Kolonia and Ciszyca.

Genus *Trochoceramus*, HEINZ, 1932.

TYPE SPECIES: *Trochoceramus helveticus* HEINZ (1932, p. 19)(see discussion in SEITZ 1970).

Trochoceramus costaecus (KHALAFOVA, 1966)
(Text-figs 28, 31C, E)

1959. *Inoceramus alaeformis* ZEKELI; DOBROV & PAVLOVA, p. 154, pl. 18, fig. 1.

1966. *Inoceramus costaecus* KHALAFOVA, p. 52, pl. 1, fig. 1.
1969. *Inoceramus zitteli* KOCIUBYNSKIJ non PETRASCHECK, SORNAY in ANTUNES & SORNAY, p. 89, pl. 7, fig. 1.
1988. *Inoceramus alaeformis* ZEKELI; ALIEV & KHARITONOV in ALI-ZADE & *al*., p. 262, pl. 16, figs 1-3.
1996. *Trochoceramus costaecus* (KHALAFOVA); WALASZCZYK & *al*., p. 157, pl. 1, figs 1-5; pl. 3, fig. 3; pl. 6, fig. 2.
1996. *Trochoceramus morgani* (SORNAY); WALASZCZYK & *al*., p. 156, pl .2, figs 1-8, pl. 3, fig. 2.
2001. *Trochoceramus* sp.; WALASZCZYK & *al*., p. 184, pl. 42, fig. 10; pl. 43, figs 7-9.
2001. *Trochoceramus* sp.; ODIN, pl. 3, fig. 23.
2002. *Trochoceramus costaecus* (KHALAFOVA); WALASZCZYK, ODIN & DHONDT, p. 289, pl. 11, figs 1-7; pl. 12, figs 2-3, ?7.

TYPE: The holotype, by original designation, is the specimen illustrated by KHALAFOVA (1966, pl. 1, fig. 1) from the ?uppermost Campanian of the Gerga section, Daghestan, NE Caucasus, Russia.

MATERIAL: Three specimens; MWG ZI/35/119 (see WALASZCZYK & *al*. 1996, pl. 3, fig. 3) from Kamień, and ZI/35/120 and ZI/35/121 from the Raj North section.

DESCRIPTION AND REMARKS: The large, complete specimen from Kamień was described in WALASZCZYK & *al*. (1996, p. 158, pl. 3, fig. 3). The two other specimens are small, fragmentary internal moulds of single valves. They well demonstrate the characteristic outline and ornament of the species.

OCCURRENCE: The type species was cited from the Early Maastrichtian of Daghestan, what corresponds well to the traditional location of the Campanian/Maastrichtian boundary, i.e. defined with the FO of the belemnite species *Belemnella lanceolata*. It is late Late Campanian in reference to the Tercis boundary. It occurs in the eponymous zone of the Vistula section and of the Tercis section. The forms illustrated by

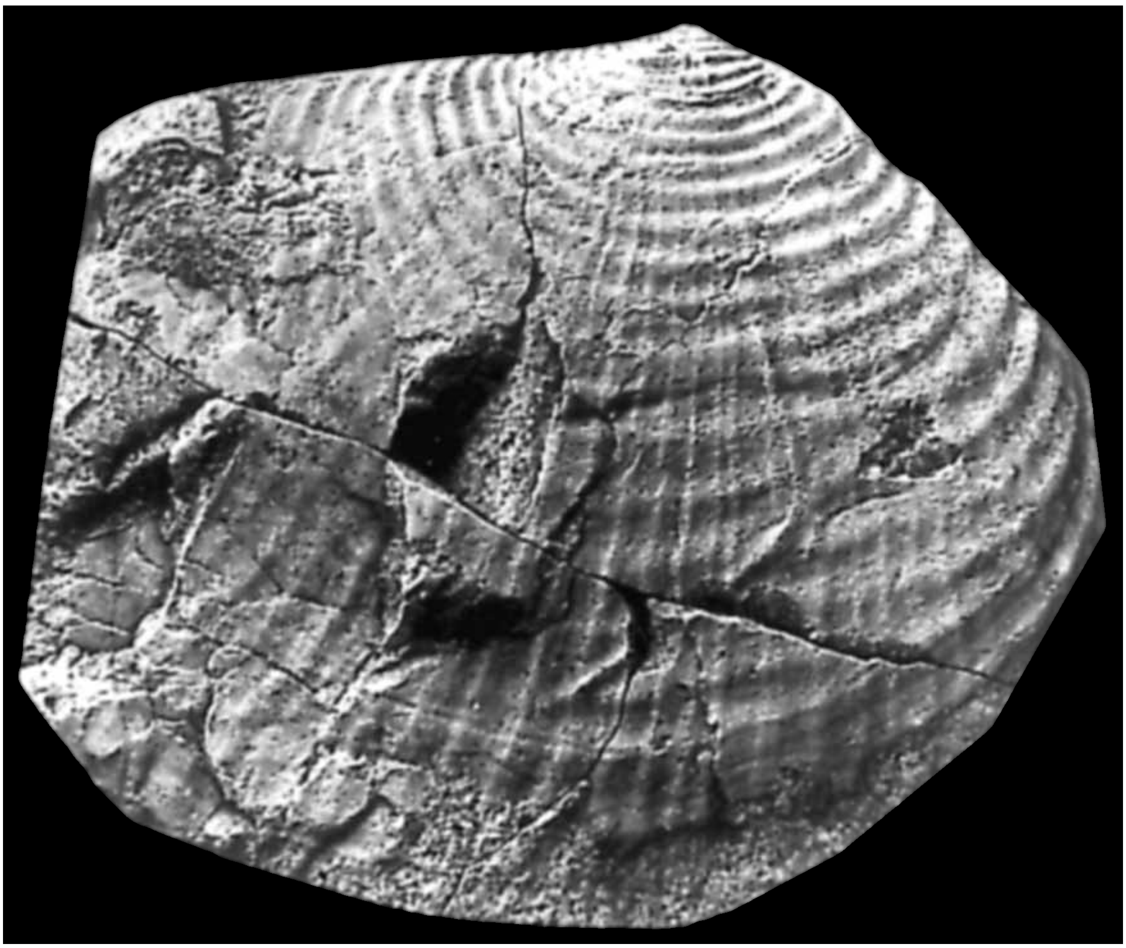

Fig. 28. *Trochoceramus costaecus* (KHALAFOVA, 1966) [=WALASZCZYK & *al*. 1996, pl. 3, fig. 3]; MWG Zi/35/119, Kamień, *Trochoceramus costaecus* Zone, × 1

WALASZCZYK & *al*. (2001) from the North American Gulf Coast should most probably be referred to this species.

Forms left in open nomenclature

There is a number of forms which, at the genereric level, are referred here in open nomenclature and referred to "*Inoceramus*" sensu lato. Firstly, they are known so far almost entirely from internal moulds, with even such basic characteristics as their ligamental plates or outer surface ornament not known in detail. Secondly, the knowledge of the Campanian and Maastrichtian inoceramid record is insufficient to allow for the interpretation or even suggestion of the phylogenetic links of numerous taxa, although thanks to recent studies in the Western Interior, Tercis, and the present one in the Vistula section, more and more data are available.

The taxa are described here in alphabetic order. The informal grouping, as used formerly in WALASZCZYK & *al*. (2001) or in WALASZCZYK, ODIN & DHONDT (2002) is not followed.

"*Inoceramus*" *altus* MEEK, 1871
(Text-figs 29)

1871. *Inoceramus altus* MEEK, p. 302.
1876. *Inoceramus altus* MEEK; MEEK, p. 43, pl. 14, fig. 1.
non 1880. *Inoceramus altus* MEEK; WHITFIELD, p. 391, pl. 9, fig. 11 [=*Mytiloides* sp.].
1898. *Inoceramus altus* MEEK; LOGAN, p. 506, pl. 107, fig. 1.
1978, *Inoceramus lapparenti* SORNAY in SORNAY & BILOTTE, p. 36, pl. 6, figs 1-2.
1978. *Inoceramus launartensis* SORNAY in SORNAY & BILOTTE, p. 34, pl. 5, fig. 1.
pars 1993. *Endocostea balticus beckumensis* (GIERS); DHONDT, p. 221, pl. 3, fig. 3.
2001. "*Inoceramus*" *altus* MEEK; WALASZCZYK & *al*., p. 214, pl. 22, figs 1-8; pl. 23, figs 1, 3-5; pl. 24, fig. 1.
2002. "*Inoceramus*" *altus* MEEK; WALASZCZYK, ODIN & DHONDT, p. 294, pl. 4, figs 4-5; pl. 5, fig. 1; pl. 6, figs 2, 6.

TYPE: The holotype, by original designation, is USNM 12462, the specimen illustrated by MEEK (1876, pl. 14, fig. 1)(reillustrated by WALASZCZYK & *al*. (2001, pl. 24, fig. 1) from near Medicine Bow Station, Wyoming, from the *Baculites compressus* ammonite Zone of the middle Upper Campanian (in the tripartite North American subdivision).

MATERIAL: 2 complete specimens, MWG ZI/35/102 and MWG ZI/35/103, and numerous small fragments; all specimens are from the lowermost (lowest meter of the succession) part of the Piotrawin section.

Dimensions:

Specimen	h	l	H	L	s	VR	α	δ	hmax
ZI/35/102	52	48	44.5	48.4	28	21.4	112	60	78
ZI/35/103	66.4	61.4	56.4	61.3	31	–	115*	63	100

DESCRIPTION: Both specimens studied are internal moulds of single RVs; the ventral and posterior parts of the valves are missing. No fragments of the shell are preserved. The valve is moderately oblique with δ above 60°, subrectangular in outline. The beak is terminal, projecting distinctly above the hinge line, curved antero-dorsally. The valves are weakly inlfated, with the maximum inflation dorso-central. The posterior auricle is small, triangular in outline, well separated from the disc in the juvenile stage, thereafter only weakly. The anterior margin is moderately long, straight, slightly concave below the umbo. It passes into the long and convex antero-ventral margin. The ventral margin is rounded, and passes into the almost straight, rather short posterior margin.

The valves are ornamented with very regular rugae, which are lamallete in appearance; they are closely spaced, and are very asymmetrical in cross section, with the leading edge very steep. The interspaces increase gradually ventralward. The rugae weaken and become much closely spaced on the posterior auricle. The growth lines traces are not seen on the mould surfaces.

REMARKS: The weak obliquity, height-elongated subrectangular outline, and the closely and regularly spaced'lamellate' rugae are the main features of this very characteristic species. It resembles "*Inoceramus*" *vanuxemi*, which, however, possesses symmetrical rugae and is less oblique.

OCCURRENCE: The studied material comes from the "*Inoceramus*" *altus* Zone of the Piotrawin section (lower part of the *Nostoceras hyatti* ammonite Zone). It is known from the *Baculites compressus* ammonite Zone of the US Western Interior, and from the lower part of the *Nostoceras hyatti* Zone of the Tercis section. Also known from the late Late Campanian of the Pyrenees.

"*Inoceramus*" *balchii* MEEK & HAYDEN, 1860
(Text-figs 30A-B, 31B, D)

1860. *Inoceramus Balchii* MEEK & HAYDEN, p. 180.

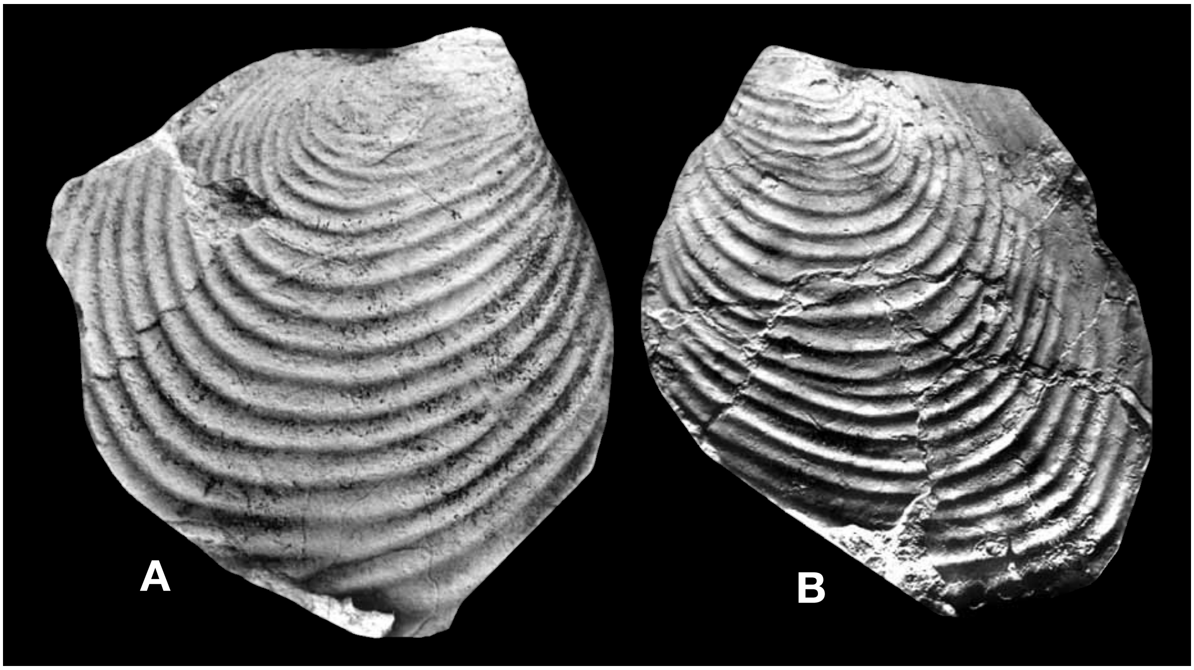

Fig. 29. "*Inoceramus*" *altus* Meek, 1871; A – MWG ZI/35/102, × 1; B – MWG ZI/35/103 × 0.8; both from basal part of the succession in the Piotrawin quarry

1876. *Inoceramus Balchii* MEEK & HAYDEN; MEEK, p. 56, pl. 15, fig. 1.
1880. *Inoceramus sagensis* OWEN; WHITFIELD, p. 393, pl. 7, fig. 12; pl. 8, fig. 2.
non 1903. *Inoceramus balchii* MEEK & HAYDEN; JOHNSON, p. 117, pl. 2, fig. 16. [=?*Inoceramus vanuxemi* MEEK & HAYDEN 1860]
non 1963. *Inoceramus balchi* MEEK & HAYDEN; TSAGARELI, p. 99, pl. 2, fig. 1.
2001. "*Inoceramus*" *balchii* MEEK & HAYDEN; WALASZCZYK, COBBAN & HARRIES, p. 212, pl. 35, fig. 5; pl. 37, fig. 7; pl. 44, fig. 1.

TYPE: The holotype, by monotypy, is USNM 484, the original to MEEK (1876, pl. 15, fig. 1) (illustrated photographically in WALASZCZYK & *al*. 2001, pl. 35, fig. 5), from the Yellowstone River, 150 miles above its mouth, from the Early Maastrichtian *Baculites grandis* ammonite Zone.

MATERIAL: Three specimens, MWG ZI/35/025 and MWG ZI/35/026 from the Piotrawin section, and MWG ZI/35/027, from the Raj North section.

Dimensions:

Specimen	h	l	H	L	s	VR	α	δ	hmax
ZI/35/025	101.6	100	84	102	69	45	107	36	120
ZI/35/026	102	89	85	95	47	34	110	38	130
ZI/35/027	106	92	91	102	58	46*	120	40	121

DESCRIPTION: All three specimens are represented by internal moulds of single valves; no shell fragments are preserved. The valve is weakly inflated, with maximum inflation in the anterior-dorsal part, its outline is subrectangular. The beak is relatively small, terminal, projecting a little bit above the hinge line. The hinge is long and straight. The anterior margin is also straight, moderately long, forming a half or less of the respective axial length. The anterior margin passes into the broadly rounded anteror-ventral margin. The posterior margin is rounded. The growth axis is slightly conex anteriorly; much more in the juvenile stage, then it becomes almost straight. Besides in the juvenile, near umbonal part, the posterior auricle is weakly separated from the disc.

The valves are ornamented with semiregular, widely spaced rugae, in the 15-85 mm interval of the axial lenght, the interspaces vary between 8 and 15 mm. The rugae are most distinct in the anterior part, and become gradually less distinct toward the axial and toward the hinge line. Also they weaken markedly in the ventral part.

REMARKS: MW ZI/35/025 and ZI/35/027 agree very well with the American type. Less typical is MWG ZI/35/026, which differs from the two other in its smaller h/l ratio, what causes its more slender appearance.

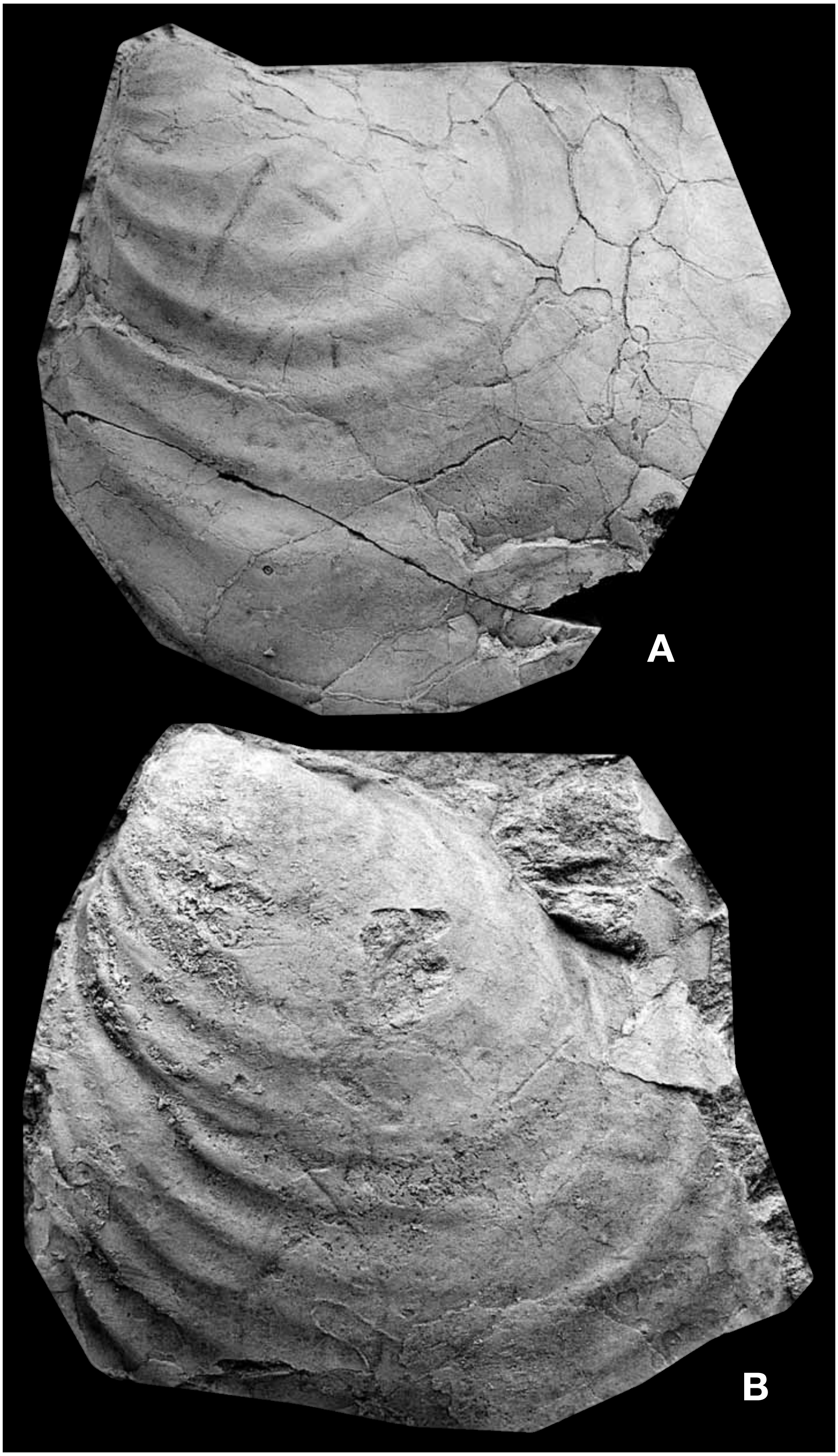

Fig. 30. "*Inoceramus*" *balchii* MEEK & HAYDEN, 1860; A – MWG ZI/35/025, B – MWG ZI/35/026; both from upper third of the Piotrawin succession; both are × 0.9

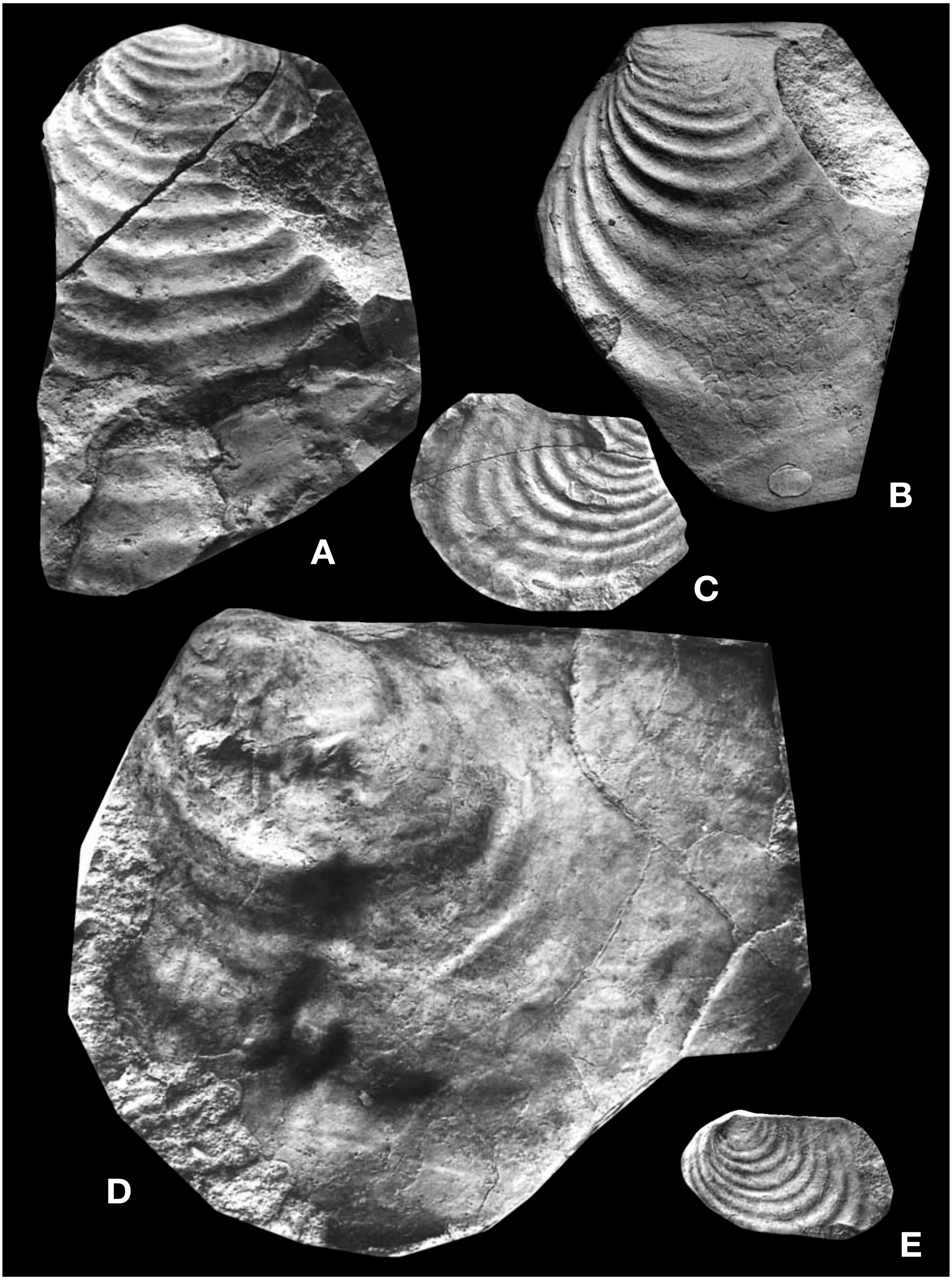

Fig. 31. A – *Cataceramus gandjaeformis* WALASZCZYK, COBBAN & HARRIES, 2001; MWG ZI/35/147, × 0.65; B, D – "*Inoceramus*" *balchii* MEEK & HAYDEN, 1860, B – MZ ML1369, Kłudzie, × 0.65; D – MWG ZI/35/027, Raj North, × 0.85; C, E – *Trochoceramus costaecus* (KHALAFOVA, 1966), C – MWG ZI/35/120, D – MWG ZI/35/121, both are natural size

"*I.*" *balchii* resembles weakly inflated "*I.*" *inkermanensis*, from which it differs in the subrectangular outline, smaller beak projection, and more regular rugation. MWG ZI/35/128 (see Text-fig. 36) referred questionably to the DOBROV & PAVLOVA's (1959) species may possibly be "*I.*" *balchii*.

OCCURRENCE: The species occurs in the Early Maastrichtian *Baculites grandis* and *Baculites clinolobatus* ammonite Zones of the US Western Interior and is known also from the Lower Maastrichtian of the Gulf Coast. The report from the Vistula section is thus stratigraphically the oldest. Other previous reports from Europe are not confirmed.

"*Inoceramus*" *borilensis* JOLKICEV, 1962
(Text-figs 20F, 32)

1962. *Inoceramus borilensis* nov.sp.; JOLKICEV, p. 145, pl. 7, fig. 1.
non 1976. *Inoceramus borilensis dauensis*; SORNAY p. 5, pl. 1, fig. 3; pl. 2, figs 1-2.
non 1978. *Inoceramus* aff. *borilensis*; SORNAY & BILOTTE, p. 33, fig. 4.
1982. *Inoceramus borilensis* JOLKICEV; SORNAY, p. 7, pl. 2, fig. 1; pl. 3, fig. 3.
pars 1982. *Inoceramus* cf. *borilensis* JOLKICEV; SORNAY, p. 9, pl. 3, fig. 2 [non pl. 3, fig. 1].
non 1993. "*Inoceramus*" *borilensis* JOLKICEV; DHONDT, p. 215, pl. 1, fig. 1; pl. 3, fig. 2.
non 1993. "*Inoceramus*" cf. *borilensis* JOLKICEV; DHONDT, p. 216, pl. 4, fig. 1.
1997. *Inoceramus* aff. *borilensis* JOLKICEV; WALASZCZYK, p. 37, pl. 28, figs 1-5.
non 1999. *Inoceramus* cf. *borilensis* JOLKICEV; TRÖGER & *al.*, p. 46, text-fig. 10.
non 2001. *Inoceramus borilensis* JOLKICEV; ODIN, pl. 1, figs 8-9 [=*Inoceramus redbirdensis*]
2002. "*Inoceramus*" *borilensis* JOLKICEV; WALASZCZYK, ODIN & DHODNT, p. 202, pl. 3, fig. 7.

TYPE: The holotype, by original designation, is the original of JOLKICEV (1962, pl. 7, fig. 1) from the Campanian of Medven, Bulgaria.

MATERIAL: PIG N432 from Wałowice (coll. W. POŻARYSKI); MWG ZI/35/092, MWG ZI/35/093, and MWG ZI/35/100, from Wola Pawłowska.

Dimensions:

Specimen	hjuv	h	l	H	L	s	VR	a	d	hmax
N432	50	115	–	74	125	–	19	135*	35*	152
ZI/35/092	73*	70	43	45	67	43	12	90	30	81

DESCRIPTION: All specimens studied are represented by internal moulds of single valves. PIG N432 and MWGZI/35/093 are more complete, with a part of the adult stage preserved; MWG ZI/35/092 is represented by the juvenile stage only.

The species is of moderate to large size, with two distinct growth stages bordering along a single positive geniculation or with two geniculations, the positive followed by the negative one. The juvenile stage is small, weakly to moderately inflated, strongly oblique, with the beak small, terminal to subterminal. It possesses a long and straight hinge line, a very short anterior margin, and very long, broadly convex anterro-ventral margin. The juvenile stage is ornamented with regularly and closely spaced ruage of the *balticus*-type.

The growth of the adult stage almost perpendicularly to the juvenile one; usually there is a low neck stage between these two stages. The adult valve is usually weakly ornamented, with irregular, low, widely spaced rugae. Growth lines traces are rarely observed on the specimes studied.

The most completely preserved is PIG N432, which is distinctly geniculated. Its juvenile stage is 50 mm in axial length, and its measured adult stage is 152 mm (its estimated maixmum size must have been at least 230 mm). The juvenile stage shows an anteriorly curved growth axis, with δ decreasing from about 35 to about 28°. The juvenile stage with a distinct, *balticus*-like ornament; the neck and the adult stages have weak rugae. Growth lines traces are visible in parts; they are parallel to the rugae.

REMARKS: The juveniles of "*I.*" *borilensis* are indistinguishable from forms like *Cataceramus palliseri* (DOUGLAS), more oblique *Cataceramus subcompressus* (MEEK & HAYDEN), or *Cataceramus* aff. *barabini* (MORTON). A very characteristic feature of the species is that it passes very quickly in the ontogeny to the adult stage. In general architecture it clearly resembles *Sphaeroceramus pertenuiformis*, from which it differs in its juvenile stage; the juvenile stage in the latter species is subrounded to suboval with weakly developed ornament.

For discussion on the relationships between "*I.*" *borilensis* and "*I.*" *borilensis dauensis* and "*I.*" aff. *borilensis* in WALASZCZYK (1997) see WALASZCZYK, ODIN & DHONDT (2002).

OCCURRENCE: The studied material comes from the *Sphaeroceramus pertenuiformis* Zone (=upper part of the *Didymocera donezianum* ammonite Zone) of the Wola Pawłowska section; PIG N432 may possibly by older (lower part of the *Didymoceras donezianum*/?*Bostrychoceras polyplocum* ammonite Zones).

The species is known from the equivalent stratigraphical interval in the Tercis section (WALASZCZYK, ODIN & DHONDT 2002) and from the Houthalen mine shaft section, in SE Belgium (SORNAY 1982, WALASZCZYK & DHONDT, in prep.).

"*Inoceramus*" *conlini*
WALASZCZYK, COBBAN & HARRIES, 2001
(Text-fig. 33)

pars 1967. *Inoceramus* (*Endocostea*) *cymba* BÖHM; SEITZ, p. 66, pl. 3, fig. 2 [non pl. 2, fig. 2 = *Endocostea typica*, and non pl. 7, fig. 3 – *Cataceramus subcompressus*].

2001. "*Inoceramus*" *conlini* sp. nov.; WALASZCZYK, COBBAN & HARRIES, p. 188, pl. 3, figs 1-2.

2002. "*Inoceramus*" *conlini* WALASZCZYK & *al*.; WALASZCZYK, ODIN & DHONDT, p. 293, pl. 1, fig. 3.

TYPE: The holotype, by original designation, is USNM 507476, the original of WALASZCZYK & *al*.

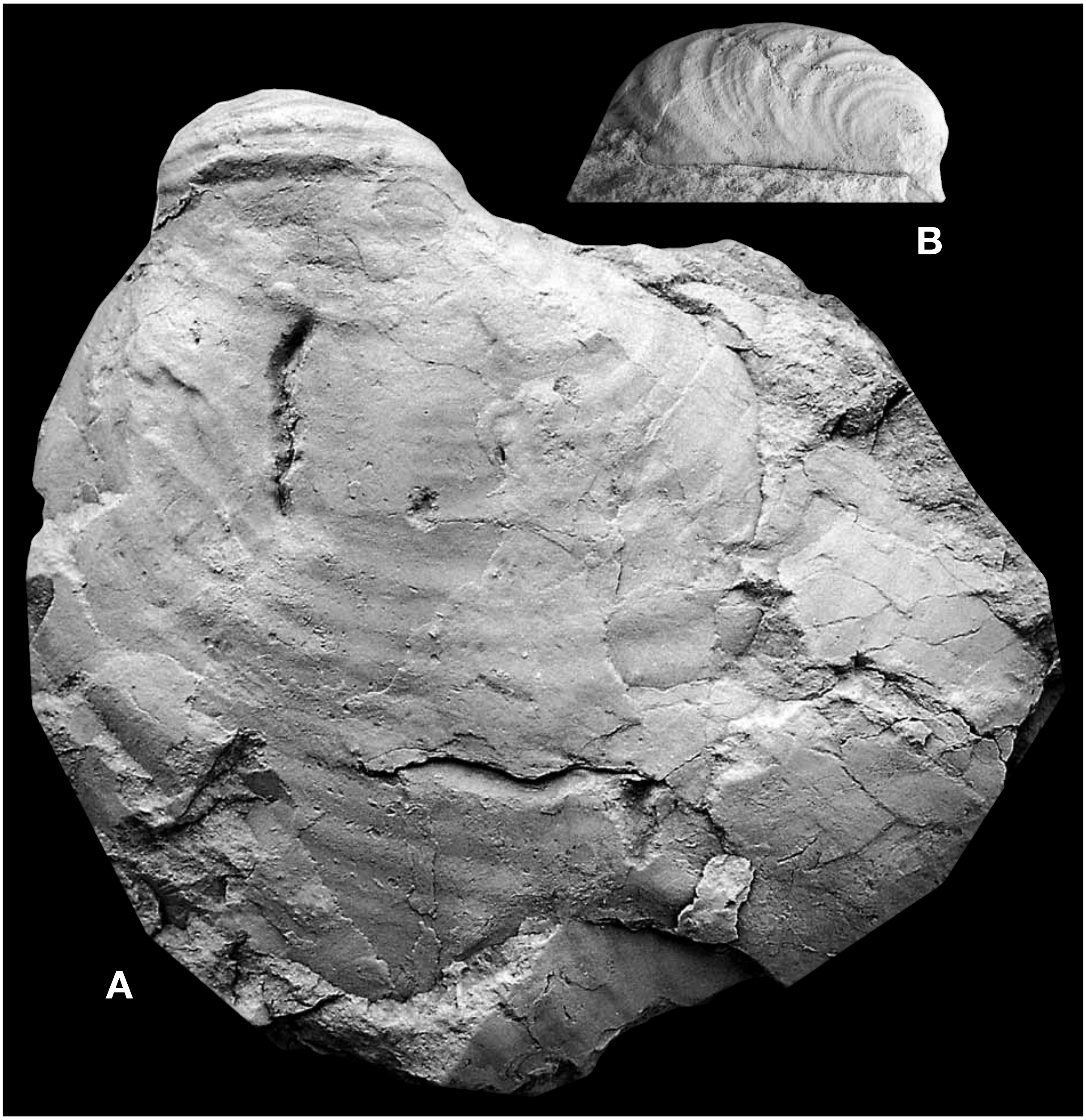

Fig. 32. "*Inoceramus*" *borilensis* JOLKICEV, 1962; PIG N432, Wałowice, A – lateral view of the adult stage, B – lateral view of the juvenile stage; "*Inoceramus*" *tenuilineatus* Zone, × 1

(2001, pl. 3, fig. 2) from the Early Campanian *Haresiceras placentiforme* ammonite Zone, from near the top of the Telegraph Creek Formation, in the NW part of Fergus County, Montana (USGS Mesozoic locality 21568), US Western Interior.

MATERIAL: Single specimen, MWG ZI/35/073 from Dorotka.

DESCRIPTION: MWG ZI/35/073 is an internal mould of a single, incomplete RV; the antero-ventral and ventral parts are missing. No shell fragments are preserved. The valve is of moderate size with hmax = 118 mm; its L = 116.5.

The valve shows two distinct gowth stages separated by two successive geniculations, the positive and the negative one. The juvenile stage is small, oblique, with δ = 30°, and with L_{max}=52 mm. The beak is small and does not project above the hinge line. It is markedly deformed in the studied specimen. The ventral part is folded against the dorsal part and shifted dorsally, giving the impression of a distinctly inflated form. In fact the inflation had to be only moderate at most. This stage is regularly ornamented with fine, closely spaced rugae, with the interspaces increasing gradually ventralward.

Ventrally of the juvenile stage follows the low neck stage, which then passes into the adult stage. The negative geniculation is poorly developed, and in the most anterior part is almost invisible. The adult stage is elongated posteriorly, with the outline *Cataceramus*-like. The valve surface bears irregular, indistinct rugae.

REMARKS: Unless the presence of the raised juvenile stage is an ecophenotypic feature, the general architecture, *Cataceramus*-like outline of the adult stage, and the presence of the two growth stages with different ornament, allow the studied specimen to be referred to “*Inoceramus*” *conlini*. Although the ecophentotypic interpretation cannot be excluded the occurrence of this morphotype in distinct stratigraphical intervals suggest an their evolutionary appearance. To the same morphotype belongs the late Late Campanian “*Inoceramus*” *maclearni* DOUGLAS and possibly “*Inoceramus*” *furnivali* DOUGLAS (the latter is very poorly known and may actually be a synonym of “*I.*” *maclearni*) (see WALASZCZYK & *al*. 2001).

OCCURRENCE: The studied specimen comes from the *Bostrychoceras polyplocum* ammonite Zone of the Dorotka section. The species is known from the late Early Campanian of the US Western Interior and

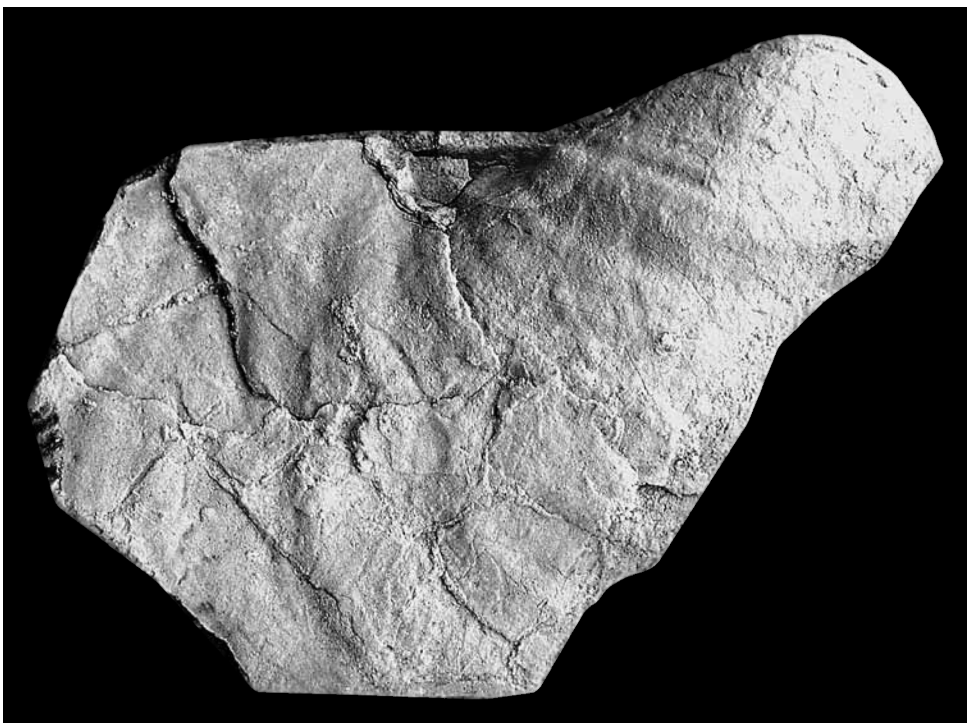

Fig. 33. “*Inoceramus*” *conlini* WALASZCZYK, COBBAN & HARRIES, 2001; MWG ZI/35/073, Dorotka, *Cataceramus subcompressus* Zone, × 1

Germany. A single specimen was described from the earliest Late Campanian of the Tercis section.

"*Inoceramus*" *inkermanensis* DOBROV & PAVLOVA, 1959 (Text-figs 34, 35B, D-F, ?36, 37B, F, 44B, E)

1959. *Inoceramus inkermanensis* sp. nov.; DOBROV & PAVLOVA, p. 157, pl. 19, fig. 3.

TYPE: Holotype, by original designation, is K/73w, from the 'Lower Maastrichtian' [a level which may actually represent a Late Campanian interval] near Bachtchisaray, the Crimea. The specimen is housed in the Paleontological Collections of the Moscow State University.

MATERIAL: Thirteen specimens MWG ZI/35/006 through MWG ZI/35/018; all from the middle and upper third of the Piotrawin quarry.

Dimensions:

Specimen	h	l	H	L	s	VR	α	δ	hmax
ZI/35/006	81	70	69	80	–	–	115	50	137
ZI/35/008	62	48	46	58	38	–	–	40	62
ZI/35/009	73	70	68	75	–	–	120	55	73

DESCRIPTION: The species is of moderate size for the genus, equivalve, inequilateral. The umbo is moderately large, extending markedly above the hinge line. The latter is straight and moderately long. The valve is obliquely ovate in outline, distinctly higher than long. The posterior auricle is relatively small; in the dorsal part well separated from the disc, whereas in the adult it passes gradually into the disc. The anterior margin is distinctly concave below the beak, and then straight to slightly convex. It passes into the broadly rounded ventral margin, The complete posterior margin is not preserved in any of the specimens studied but seems to be evenly convex.

The valves covered with moderately regular to irregular commarginal rugae; they are most regular in the medium part of the shell in the umbonal and in most ventral parts the ornament becomes irregular and sometimes disappears completely.

The species possesses a very characteristic ligament plate, which is almost entirely devoid of the division into ressilifers and ridges but instead form a narrow tube (see Text-fig. 35D).

DISCUSSION: The general valve outline, inflation of the juvenile part, and the type of ornament makes the sample from Piotrawin conspecific with the Russian species. All specimens studied herein are deformed to a variable extent, mostly due to simple lateral compression. As a result the valves are much less inflated than the original specimens were, and moreover, their most inflated juvenile part are deformed.

Very similar to "*I.*" *inkermanensis* is "*Inoceramus*" *convexiformis* WALASZCZYK, COBBAN & HARRIES, 2001, known from a single specimen, from the *Baculites reesidei* Zone of the US Western Interior. In contrary to "*I.*" *inkermanensis*, the American form possesses a distinctly and regularly ornamented juvenile part. Further material from there is needed to decide whether both species should be regarded as conspecific, two separate species, or as two geographic subspecies of a single species.

The ligamental plate of "*I.*" *inkermanensis* belongs to the plate type recognised by ZONOVA (1980), based on the Campanian species *Inoceramus djusaliensis* described from Kyzyl-Kum in Central Asia by SOBOLEVA (1970). ZONOVA (1980) referred this type to a new, tube-type ligamental plate. "*I.*" *inkermanensis* resembles "*I.*" *djusaliensis* in its general outline but differs in its more inflated umbonal region, and its projection distinctly above the hinge line. WALASZCZYK & *al*. (2001) regarded SOBOLEVA's (1970) species as a junior synonym of "*Inoceramus*" *sagensis* OWEN.

OCCURRENCE: In the Vistula section "*I.*" *inkermanensis* is limited to the upper part of the *Nostoceras hyatti* ammonite Zone, and in inoceramid terms it seems to occur exclusively within the "*I.*" *inkermanensis* Zone. DOBROV & PAVLOVA (1959) reported their new species from the Upper Campanian and Lower Maastrichtian of the Crimea and Caucasus, however, their definition of these chronostratigraphic units was different. PERGAMENT & SMIRNOV (1972) reported true "*I.*" *inkermanensis* from the *Inoceramus alaeformis* Zone, what means from the topmost Campanian of the Daghestan, NE Caucasus.

"*Inoceramus*" *maclearni* DOUGLAS, 1942 (Text-fig. 35A, C)

1942. *Inoceramus mclearni* DOUGLAS, p. 60, pl. 2, fig. 1.
1942. *Inoceramus mcshaniensis* DOUGLAS, p. 61, pl. 2, fig. 2.
2001. "*Inoceramus*" *maclearni* DOUGLAS; WALASZCZYK, COBBAN & HARRIES, p. 226, pl. 38, figs 1, 3, 5.

TYPE: The holotype, by original designation, is GSC 8925 illustrated by DOUGLAS (1942, pl. 2, fig. 1 and reillustrated by WALASZCZYK & al. 2001, pl. 38, fig. 5) from the uppermost Campanian exposed along McShane Creek, Saskatchewan, Canada, about 140 m below the top of the Bearpaw Formation.

MATERIAL: MWG ZI/35/001, MWG ZI/35/002 and MWG ZI/35/003; all from the upper third of the Piotrawin quarry.

DESCRIPTION: All three specimens are represented by internal moulds of single valves. MWG ZI/35/001 is a fragment of the RV, with the juvenile and adult part almost completely preserved; only small dorsal and anterior parts of the gerontic stage attached. This specimen well displays the basic characteristic of the species: the three ontogenetic stages with various growth direction,

Fig. 34. "*Inoceramus*" *inkermanensis* DOBROV & PAVLOVA, 1959; reillustration in natural size of the original photo from DOBROV & PAVLOVA, 1959, pl. 19, fig. 3

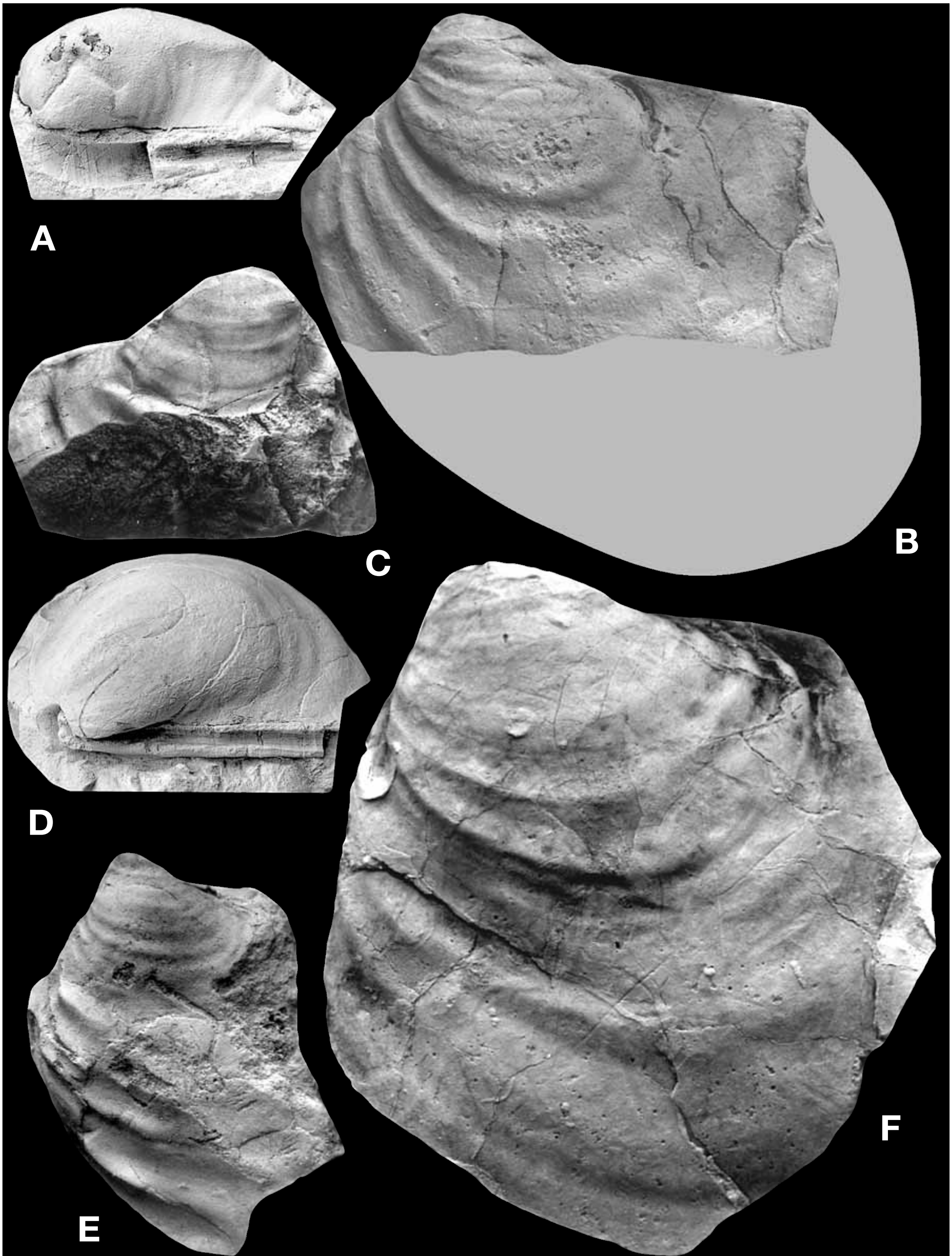

Fig. 35. A, C – "*Inoceramus*" *maclearni* DOUGLAS, 1942, MWG ZI/35/002, A – view of the umbonal region with the ligamental plate, × 1.8, C – lateral view, × 0.85; B, D-F – "*Inoceramus*" *inkermanensis* DOBROV & PAVLOVA, 1959; B – MWG Zi/35/008, × 1; D – MWG ZI/35/009, umbonal region with the view of the ligamental plate [the lateral view of this specimen see Text-fig. 37B], × 0.7; E – MWG ZI/35/149, × 0.9; F – MWG ZI/35/006, × 0.85; all specimens are from the "*Inoceramus*" *inkermanensis* Zone of the Piotrawin quarry

and with clear geniculations between them. The juvenile stage is small-sized, with L = 24 mm, moderately oblique, with the beak terminal, curved anteriorly, not projectin above the hinge line. Its ornament is not preserved, but it was seemingly smooth, or very weakly ornamented. The adult stage (neck part) is seemingly almost perpendicular to the juvenile stage. Its h=15.5 mm. Its growth is moderately oblique. The gerontic stage is strongly elongated postero-ventrally (*balticus*-like outline). Although the specimen appears to have had annother (negative) geniculation, the sharp boundary between the adult and gerontic stages may be due to secondary deformation, as is suggested by other specimens. The adult stage weakly ornamented, the gerontic stage bears irregular, moderately strong rugae. A small part of the ligamental plate preserved shows is of the tube type.

MWG ZI/35/002 is a deformed internal mould of the LV, with poorly preserved juvenile, adult and anterior part of the gerontic stages. It shows relativley strong ornament in the gerontic stage, which, however, may to a large extent be a result of deformation. The maximum h measured is 82 mm.

MWG ZI/35/003 is a RV, with a strongly deformed juvenile stage. The completely smooth adult and gerontic stage may result from the lateral compression.

REMARKS: "*Inoceramus*" *maclearni* belongs to the same architectural type as "*Inoceramus*" *conlini*, from the Lower and basal Upper Campanian, or "*Inoceramus*" *furnivali* DOUGLAS, 1942, from the *Baculites reesidei* ammonite Zone (late Late Campanian) of the US Western Interior. Very close is also *Inoceramus incurvus* MEEK & HAYDEN, 1856, from the upper *Endocostea typica* Zone of the US Western Interior. To the same type also belongs "*Inoceramus*" *cymbaeformis* PERGAMENT (1974) from the ?upper Upper Campanian

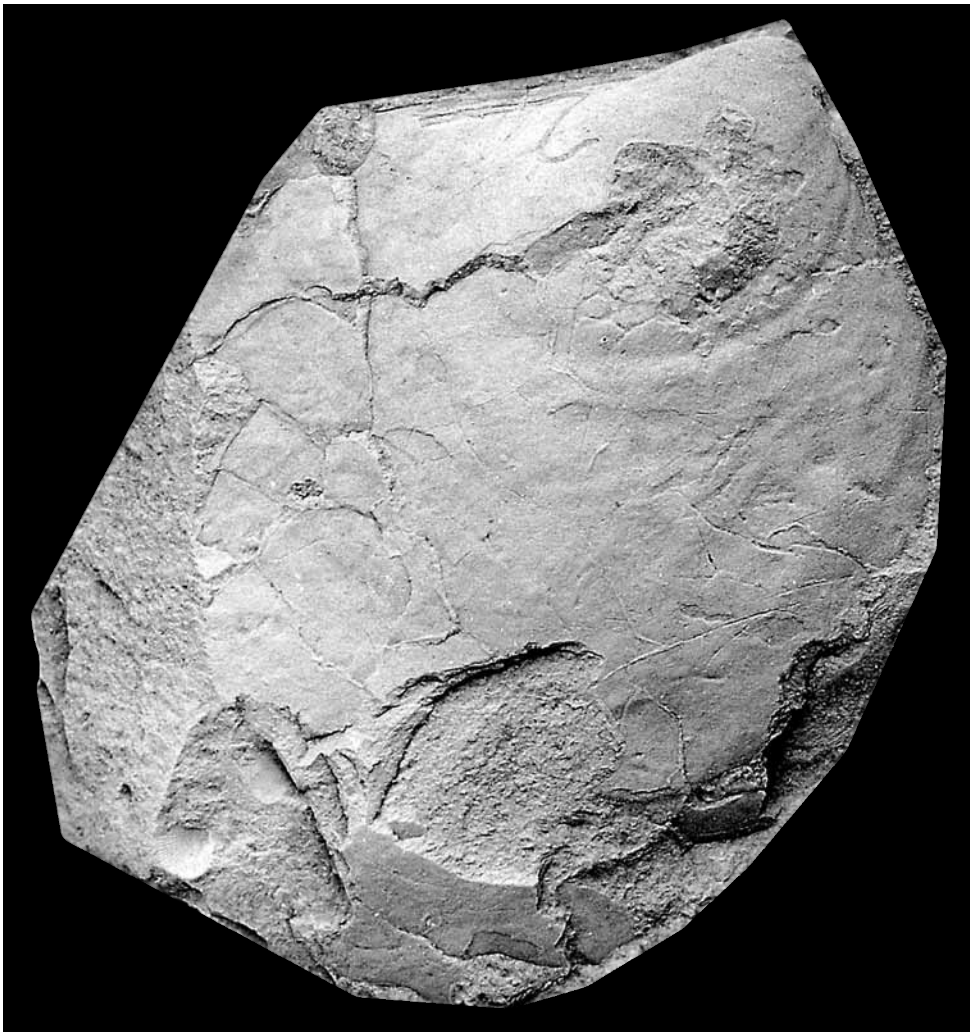

Fig. 36. "*Inoceramus*" *inkermanensis* DOBROV & PAVLOVA, 1959 or "*Inoceramus*" *balchii* MEEK & HAYDEN, 1860; MWG ZI/35/128, × 1

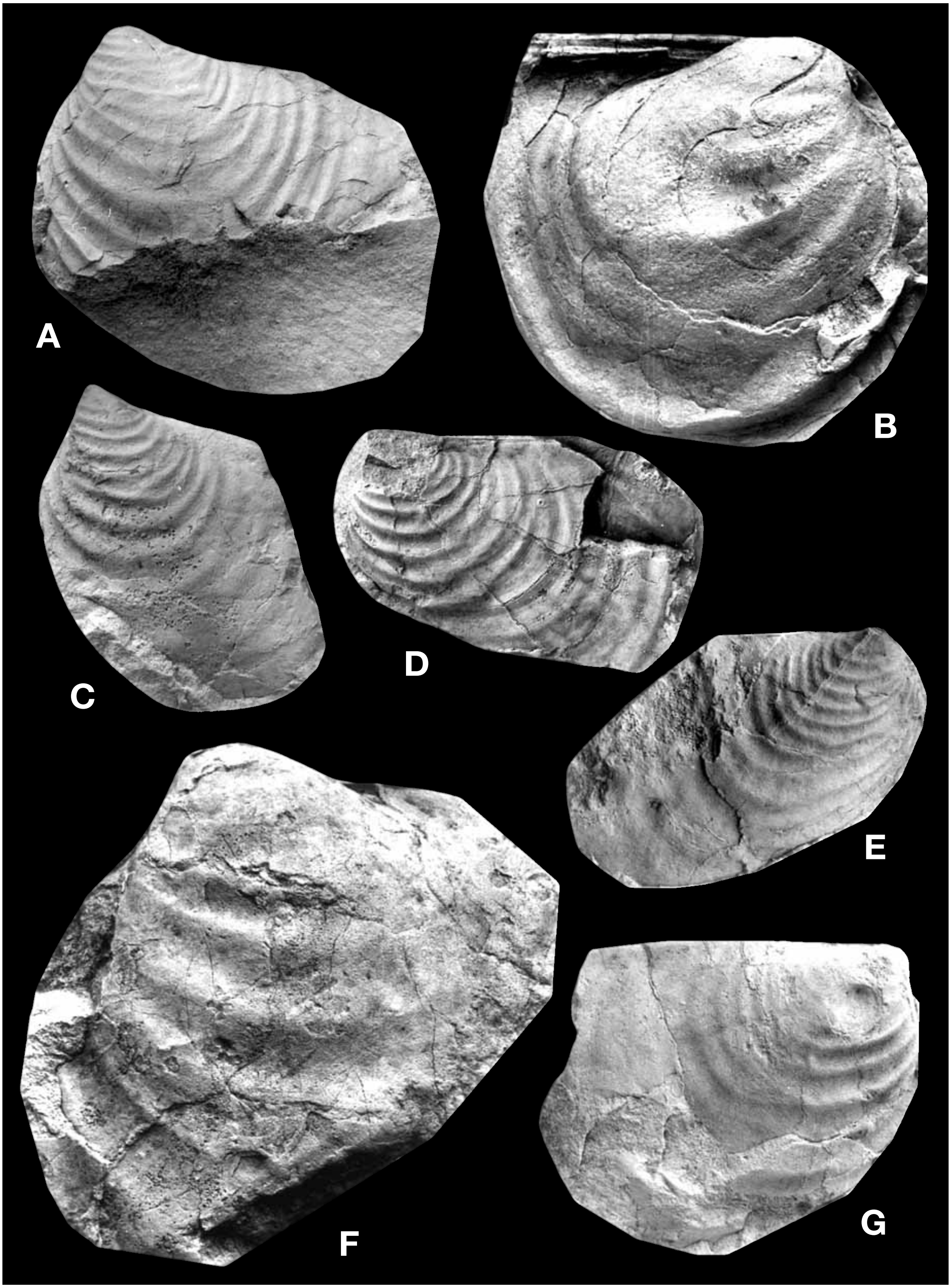

Fig. 37. A, C-E, G – "*Inoceramus*" sp. B; A – MWG ZI/35/021, C – MWG ZI/35/020, D – MWG ZI/35/024, E – MWG ZI/35/019, G – MWG ZI/35/122; besides C and E which are × 0.9 the others are × 0.95; all from Piotrawin B, F – "*Inoceramus*" *inkermanensis* DOBROV & PAVLOVA, 1959; B – MWG ZI/35/009 [its umbonal region see fig. 35D]; F – MWG ZI/35/011; both are from Piotrawin and are × 0.95

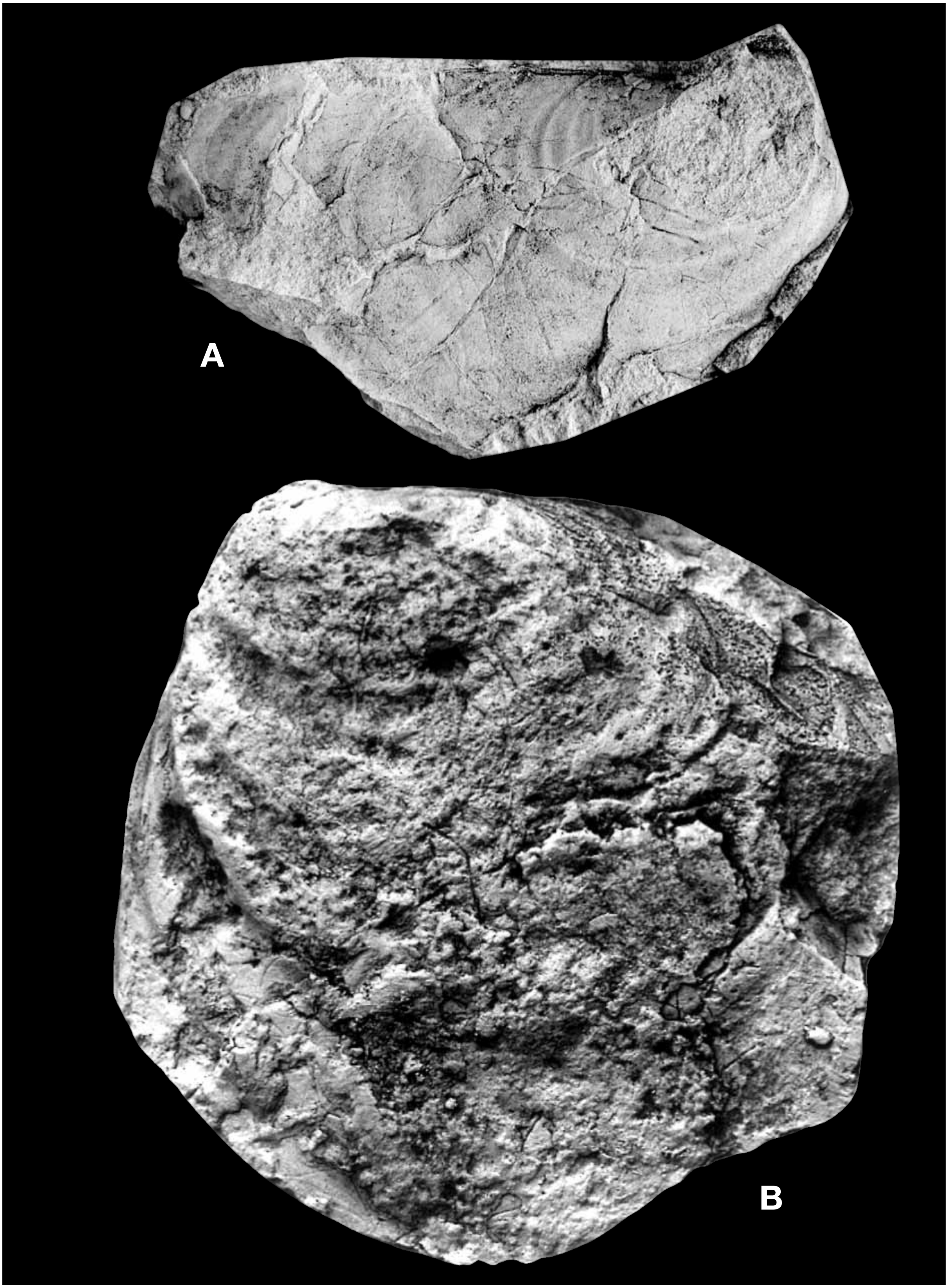

Fig. 38. "*Inoceramus*" *nebrascensis* OWEN, 1852; A – MWG ZI/35/129, Ciszyca Górna, × 1; B – MWG ZI/35/130, Wola Pawłowska, × 0.95

of Kamchatka, North Pacific Province. To what extent this morphological resemblance is the effect of their close evolutionary history, and to what extent it is due to homeomorphy remains unclear.

OCCURRENCE: All three specimens studied herein are from the Piotrawin quarry, from the upper part of the "*I.*" *inkermanensis* Zone, which corresponds to the upper part of the *Nostoceras hyatti* ammonite Zone. The American type material comes from the upper part of the *Baculites reesidei* ammonte Zone, which corresponds to the upper part of the "*Inoceramus*" *oblongus* Zone. One specimen comes from the *Baculites baculus* Zone.

"*Inoceramus*" *nebrascensis* OWEN, 1852
(Text-fig. 38, 39)

1852. *Inoceramus Nebrascensis* (N.S.); OWEN, p. 582, pl. 8A, fig. 1.
non 1876. *Inoceramus Sagensis* var. *Nebrascensis* OWEN; MEEK, p. 52, pl. 13, fig. 2.
non 1963. *Inoceramus nebrascensis* OWEN; TSAGARELI, p. 98, pl. 4, fig. 4 [=?*Inoceramus sagensis* OWEN, 1852].
?part 1978. *Inoceramus pteroides pyrenaicus* SORNAY in SORNAY & BILOTTE, p. 32, pl. 4, fig. 1 [?non pl. 2, fig. 1]
non 1982. *Inoceramus* aff. *pteroides pyrenaicus* SORNAY; SORNAY, p 10, pl. 3, fig. 4.
2001. "*Inoceramus*" *nebrascensis* OWEN; WALASZCZYK, COBBAN & HARRIES, p. 208, pl. 15, fig. 1; pl. 16, fig. 2; pl. 20, fig. 1; pl. 38, fig. 4.

TYPE: The holotype, by monotypy, is USNM 20247, OWEN's original (1852, pl. 8A, fig. 1; re-illustrated in WALASZCZYK & *al*. 2001, pl. 38, fig. 4) from the Campanian of Sage Creek, Pennington County, South Dakota, USA.

MATERIAL: Four specimens represented by single valve internal moulds; all from the *Didymoceras donezianum* ammonite Zone; MWG ZI/35/127, ZI/35/128 and ZI/35/130 from the Wola Pawłowska section and MWG ZI/35/129 from Ciszyca Górna.

DESCRIPTION: The larger specimen MWG ZI/35/130 (Text-fig. 38B) is an incomplete LV, with poorly preserved ornament. The preserved part is 142 mm in h and the actual specimen had to be at least 200 mm. The hinge line and umbo are not preserved. The juvenile part, markedly oblique and elongated posteriorly, was regularly ornamented with closely spaced rugae. The adult stage becomes gradually less oblique. Its ornament is composed of subregular, widely spaced rugae, which are best developed in the anterior part of the valve. The anterior margin is broadly convex; the ventral and posterior margins are not preserved.

The other specimen, MWG ZI/35/127, is an incomplete RV, with the postero-ventral part missing. Its maximum H value measured is about 140 mm. The juvenile and adult parts are preserved.

Two other specimens, MWG ZI/35/125 and MWG ZI/35/128 (Text-figs 38A and 39B) correspond well to the characteristics of the species.

The species becomes gradually less oblique with ontogeny; with δ value increasing from 30° in the juvenile to 40° in the adult.

REMARKS: The largest specimen closely resembles the holotype, whereas the smaller one resembles more the weakly geniculated specimens from Colorado (see WALASZCZYK & *al*. 2001, pl. 16, fig. 2; and pl. 20, fig. 1). All show well the main characteristics of the species: strong juvenile obliquity decreasing in the adult; relatively weak ornament, regular in the juvenile and subregular to irregular in the adult, and the presence of weak to moderate geniculation. "*Inoceramus*" *sagensis*, regarded as conspecific by MEEK (1876), differs from "*I.*" *nebrascensis* in its more vigorous and regular ornament, distinctly lower and constant obliquity, and the lack of geniculation.

OCCURRENCE: Known from the lower Upper Campanian (*Exiteloceras jenneyi* ammonite Zone up to the ?*Baculites compressus* ammonite Zone) of the US Western Interior; also known from the Upper Campanian of northern Spain. From the Vistula section it is known exclusively from the upper part of the *Didymoceras donezianum* ammonite Zone of the Wola Pawłowska section.

"*Inoceramus*" *oblongus* MEEK, 1871
(Text-figs 40B-D)

1871. *Inoceramus oblongus* MEEK, p. 297.
1879. *Inoceramus oblongus* MEEK; WHITE, p. 285, pl. 2, fig. 1.
2001. "*Inoceramus*" *oblongus* MEEK; WALASZCZYK, COBBAN & HARRIES, p. 224, pl. 26, figs 2, 5; pl. 27, figs 1, 3; pl. 28, fig. 5.
2002. "*Inoceramus*" *oblongus* MEEK; WALASZCZYK, ODIN & DHONDT, p. 297, pl. 9, figs 1-2; pl. 10, fig. 5.

TYPE: The holotype, by original designation is USNM 774, illustrated by WHITE (1879, pl. 2, fig. 1; reillustrat-

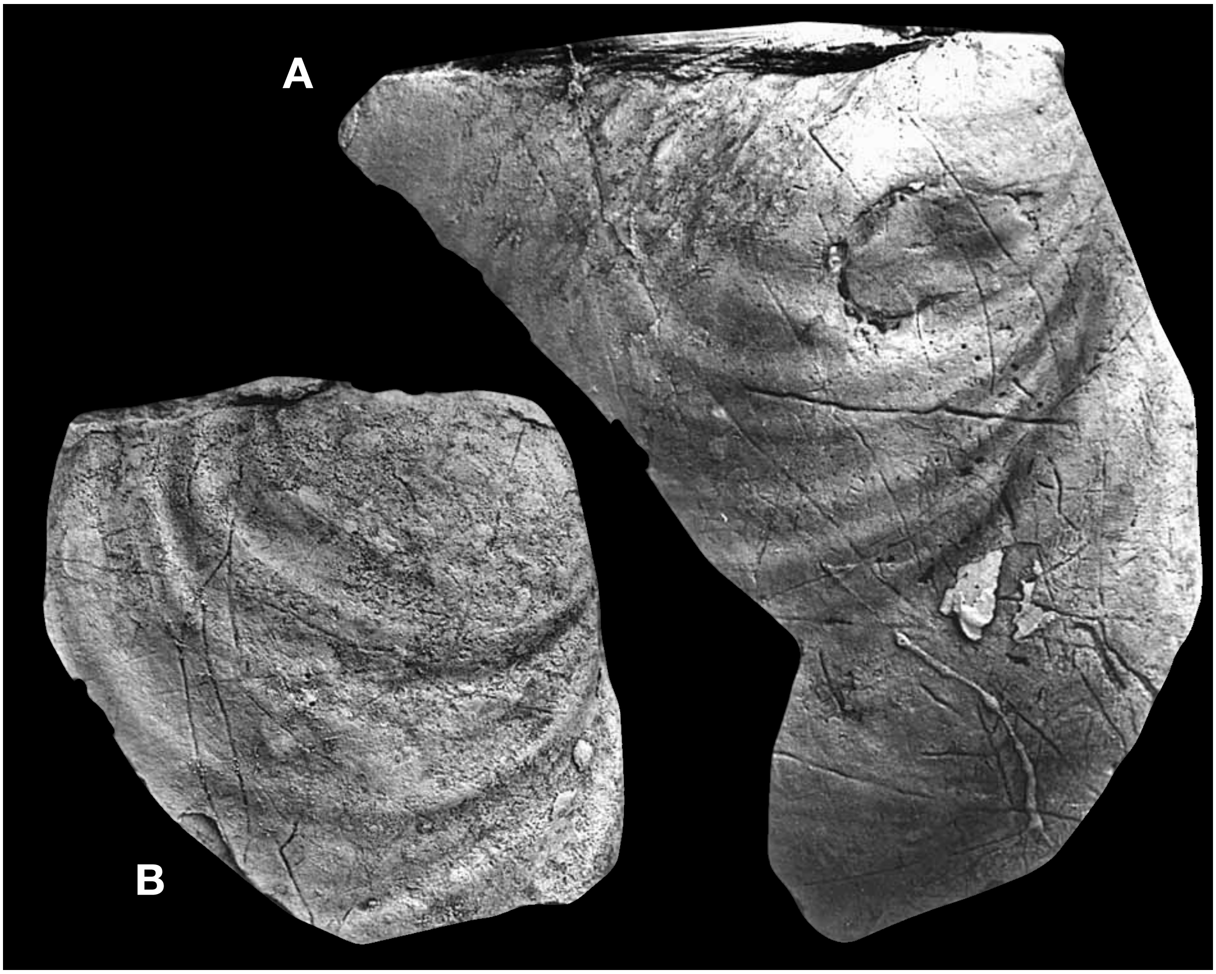

Fig. 39. "*Inoceramus*" *nebrascensis* OWEN, 1852; A – MWG ZI/35/127, B – MWG ZI/35/128; both from Wola Pawłowska, × 1

ed by WALASZCZYK & *al*. (2001, pl. 31, fig. 5), from the uppermost Campanian, south of Fort Collins, Colorado, USA.

MATERIAL: Four specimens ZI/35/035-ZI/35/037, and ZI/35/122, all from the Piotrawin quarry, from the mddle and upper third of the succession.

Dimensions:

Specimen	h	l	H	L	s	VR	α	δ	hmax
ZI/35/035	71	52	43	63	45	–	–	35	85
ZI/35/036	67	54	50	67	46	–	–	30	95

DESCRIPTION: All four specimens are represented by internal moulds of single valves; all are slightly deformed, incomplete. The species is of moderate size. The valves are subtrinagular, elongated posteriorly, resembling the *balticus*-outline. The umbo is terminal to subterminal, projecting above the hinge line. The anterior margin is very short, straight to convex, passing into the very long antero-ventral margin. The ventral margin is rounded, and passes into the slightly convex posterior margin. The hinge line is long and straight.

The juvenile ornament is composed of regularly and closely spaced rugae. The adult ornament irregular, or the surface is almost smooth, bearing weak traces of the growth lines.

REMARKS: The subtriangular, postero-ventrally elongated outline and the type of ornament are the basic features of MEEK's species.

OCCURRENCE: All studied specimens come from the "*Inoceramus*" *inkermanensis* Zone, represented by the middle and upper third of the Piotrawin quarry. The species is known from the equivalent interval of the Tercis section, and is known from the "*Inoceramus*" *oblongus* Zone (=*Baculites reesides* ammonite Zone) of the US Western Interior.

"*Inoceramus*" *redbirdensis*
WALASZCZYK, COBBAN & HARRIES, 2001
(Text-figs 41A, D-E)

2001. "*Inoceramus*" *redbirdensis* sp.nov., WALASZCZYK, COBBAN & HARRIES, p. 194, pl. 31, figs 1, 4; pl. 32, figs 2-3; pl. 34, fig. 1.
2001. *Endocostea baltica elliptica* GIERS; ODIN, pl. 1, fig. 4.
2001. *Inoceramus borilensis* JOLKICEV; ODIN, pl. 1, figs 8-9.
2002. "*Inoceramus*" *redbirdensis* WALASZCZYK, COBBAN & HARRIES; WALASZCZYK, ODIN & DHONDT, p. 294, pl. 13, figs 12-16.

TYPE: The holotype, by original designation, is USNM 507655, the original of WALASZCZYK & *al*. (2001, pl. 32, fig. 2) from the *Baculites eliasi* ammonite Zone of the Red Bird section, Wyoming, USA.

MATERIAL: 6 specimens: MWG ZI/35/104 and MWG ZI/35/105 from the Raj North section; MWG ZI/35/106 and MWG IZ/35/107 from the Solec section, and MWG ZI/35/108 from the Kłudzie South section. One specimen MWG ZI/31/79 from the *Baculites eliasi* ammonite Zone of the Rod Cheak Ranch, Wyoming, USA, as a comparative specimen.

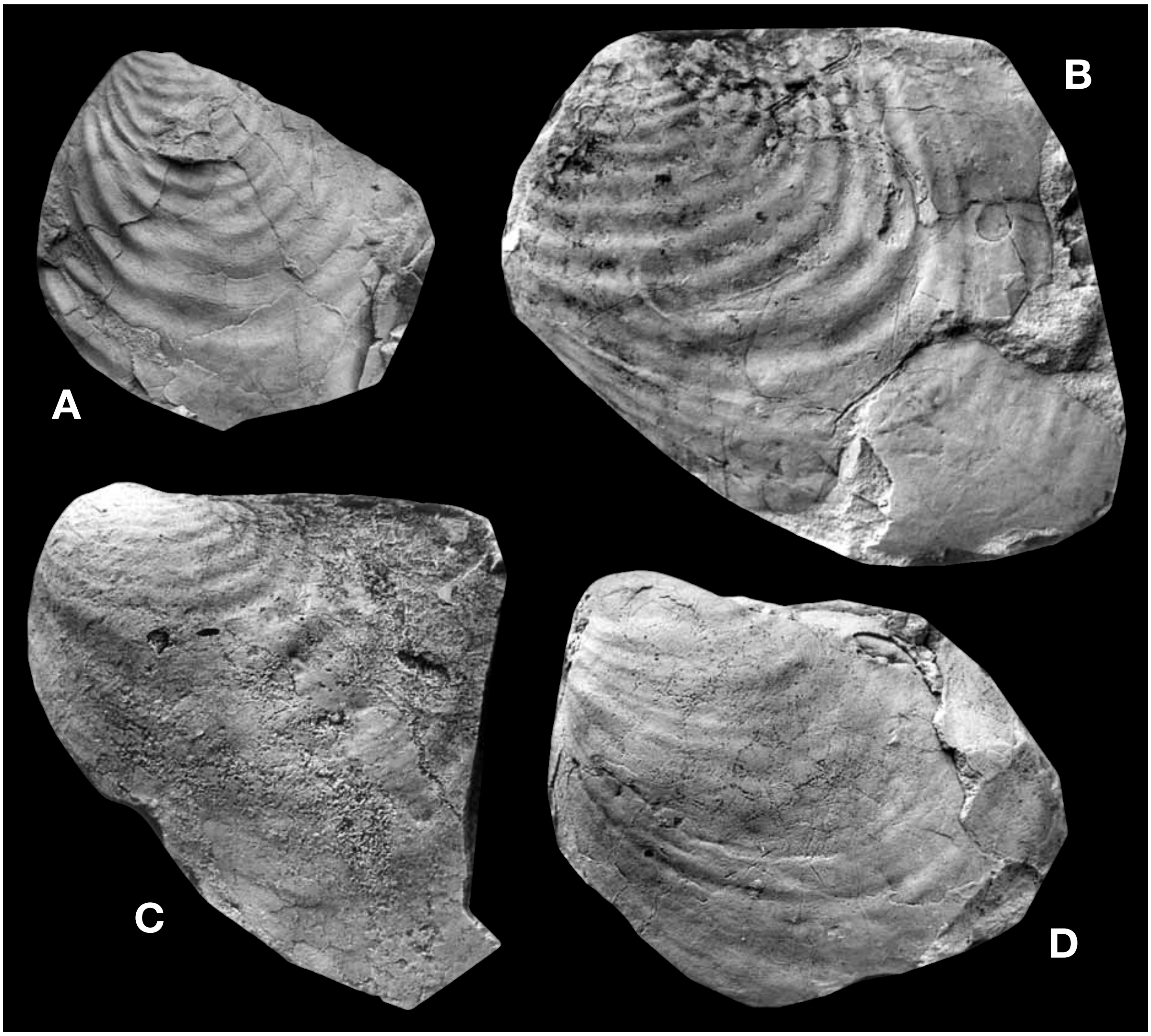

Fig. 40. A. "*Inoceramus*" sp.; MWG ZI/35/023, Piotrawin, × 1; B-D – "*Inoceramus*" *oblongus* MEEK, 1871; B – MWG ZI/35/122, × 0.80; C – MWG ZI/35/036, × 1; D – MWG ZI/35/035; all from the Piotrawin quarry

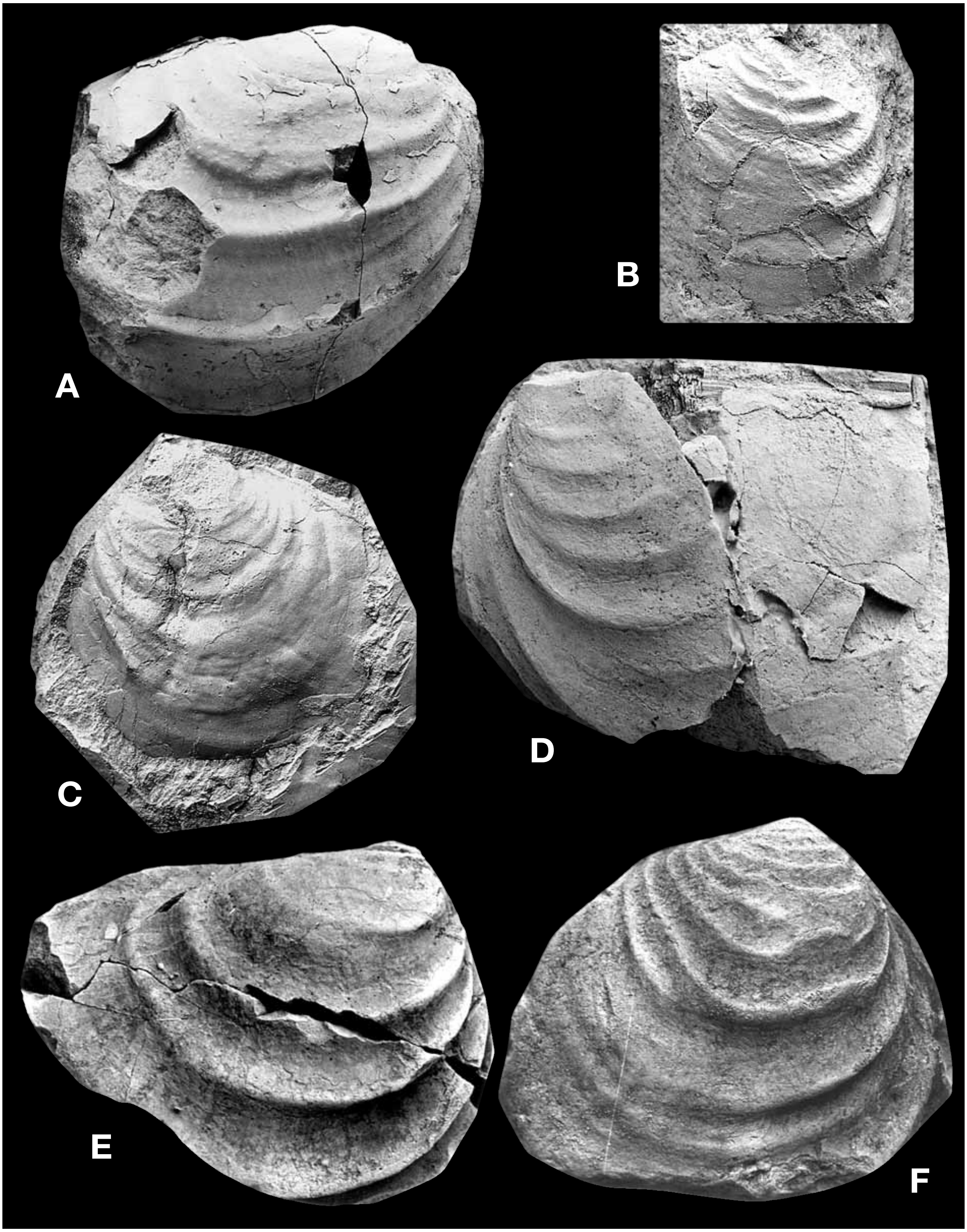

Fig. 41. A, D, E – "*Inoceramus*" *redbirdensis* Walaszczyk, Cobban & Harries, 2001; A – MWG ZI/31/79, the specimen from the Rod Cheak Ranch, Wyoming, USA, *Baculites eliasi* ammonite Zone, of the latest Late Campanian, × 0.8; D – MWG ZI/35/105, Raj North, × 1; E – MWG ZI/35/104, Raj North, × 0.9; B – "*Inoceramus*" aff. *redbirdensis* Walaszczyk, Cobban & Harries, 2001, MWG ZI/35/107, Solec, × 1; C – "*Inoceramus*" sp. cf. "*Inoceramus*" *balchii* Meek & Hayden, 1860, MWG ZI/35/131, Solec, × 0.7; F – *Cremnoceramus goldfussianus* (d'Orbigny, 1847), MWG ZI/35/148, Raj North, × 0.8

Dimensions:

Specimen	h	l	H	L	s	VR	α	δ	hmax
ZI/35/079	58	52	44	67	36	–	–	40	90
ZI/35/104	58	57	48	54	41	–	–	38	75

DESCRIPTION: All specimens are represented by internal moulds of single valves. The species is of moderate size, with maximum h measured 78 mm. MWG ZI/35/104 and ZI/35/105 (Text-fig. 41D, E) are very similar. They are composed of two growth stages, characterised by a small juvenile stage and a much larger adult stage. The juvenile stage is strongly oblique, with δ=30°, then in the early adult stage the oliquity decreases with δ=40°. The adult stage posesses very shallow but distinct axial sulcus. The beak is small, projecting slightly above the hinge line. The hinge line itself is straight relatively long. The anterior margin is slightly convex, relatively short, passing into the long, broadly convex antero-ventral marign. The ventral margin posesses small sulcus. The posterior margin is short and straight. The posterior auricle is very narrow, well separated from the disc. The ornament of both specimens is composed of closely spaced commarginal rugae in the juvenile stage, and then changing suddenly to widey to very widely spaced regular rugae, with sharp edges, and flat, wide interspaces. The incomplete MWG ZI/35/106 and MWG ZI/35/108 belong to the same type.

MWG ZI/35/107 is an incomplete RV (Text-fig. 41B), with the antero-dorsal part missing. It differs from the other specimens in being less oblique and with the adult rugae round-topped and less widely spaced.

REMARKS: With the exception of ZI/35/107, the material studied herein corresponds well to the American material. Some differences result from lateral compression, as demonstrated herein by comparison with ZI/31/079, the specimen from the *Baculites eliasi* Zone from Rod Cheak Ranch, Wyoming (Text-fig. 41A). The lateral compression causes a more rounded outline of early adult rugae. Both the American specimen and the studied specimens show the very shallow axial sulcus.

Although the specimens collected are usually of moderate size, some unregistered adult fragments suggest that the species could attain considerable size.

MWG ZI/35/107 (Text-fig. 41B) resembles specimens from Tercis (WALASZCZYK, ODIN & DHONDT, 2001, pl. 12, figs 4, 8) and is similarly referred herein to as "*Inoceramus*" aff. *redbirdensis*.

OCCURRENCE: The species is known from the "*Inoceramus" redbirdensis* Zone of SW France and in US Western Interior. In the former area it corresponds to the upper part of the *Nostoceras hyatti* ammonite Zone, whereas in the latter to the middle *Baculites eliasi* ammonite Zone.

"*Inoceramus*" *sagensis* OWEN, 1852
(Text-figs 42)

1852. *Inoceramus Sagensis* (N.S.) OWEN, p. 582, pl. 7, fig. 3.
1876. *Inoceramus Sagensis* var. *Nebrascensis* OWEN; MEEK, p. 52, pl. 13, fig. 2.
non 1880. *Inoceramus sagensis* OWEN; WHITFIELD, p. 393, pl. 7, fig. 12.
non 1885. *Inoceramus sagensis* OWEN; WHITFIELD, p. 76, pl. 14, fig. 15; pl. 15, fig. 2.
non 1896. *Inoceramus sagensis* OWEN; GILBERT, pl. 66, fig. 3 [=*Platyceramus pierrensis* WALASZCZYK, COBBAN & HARRIES, 2001].
1898. *Inoceramus sagensis* var. *nebrascensis* OWEN; LOGAN, p. 506, pl. 109, fig. 2.
non 1913. *Inoceramus* cf. *Sagensis* OWEN; BÖSE, pl. 3, fig. 6.
pars 1959. *Inoceramus sagensis* OWEN; DOBROV & PAVLOVA, p. 155, pl. 22, fig. 3.
2001. "*Inoceramus*" *sagensis* OWEN; WALASZCZYK, COBBAN & HARRIES, p. 218, pl. 24, figs 2-4; pl. 36, figs 9-10 [and literature cited therein].
2002. "*Inoceramus*" *sagensis* OWEN; WALASZCZYK, ODIN & DHONDT, p. 295, pl. 4, fig 3; pl. 5, figs 4, 6; pl. 6, fig. 4.

TYPE: The holotype, by monotypy, is USNM 20246, the original of OWEN's (1852, p. 582, pl. 7, fig. 3) specimen, from the Late Campanian *Baculites compressus* ammonite Zone of Fox Hills, Sage Creek, South Dakota, USA.

MATERIAL: Four specimens, MWG ZI/35/123 through ZI/35/126, and numerous uncatalouged fragments. ZI/35/123 and ZI/35/124 are from the Piotrawin section; ZI/35/125 and ZI/35/126 are from Pawłowice North section.

DESCRIPTION AND REMARKS: The specimens studied are all internal moulds of single valves; deformed to a variable extent and incomplete. They show well, however, the main features of the species: moderate to large size, subrectangular outline, moderate obliquity, and regular commarginal rugae in the juvenile and early adult stages. Apart from ZI/35126, with the partially preserved adult stage, all the other specimens are represented by the juvenile, regularly ornamented stage. Judging from the size of the preserved part the species must have attained a considerable size.

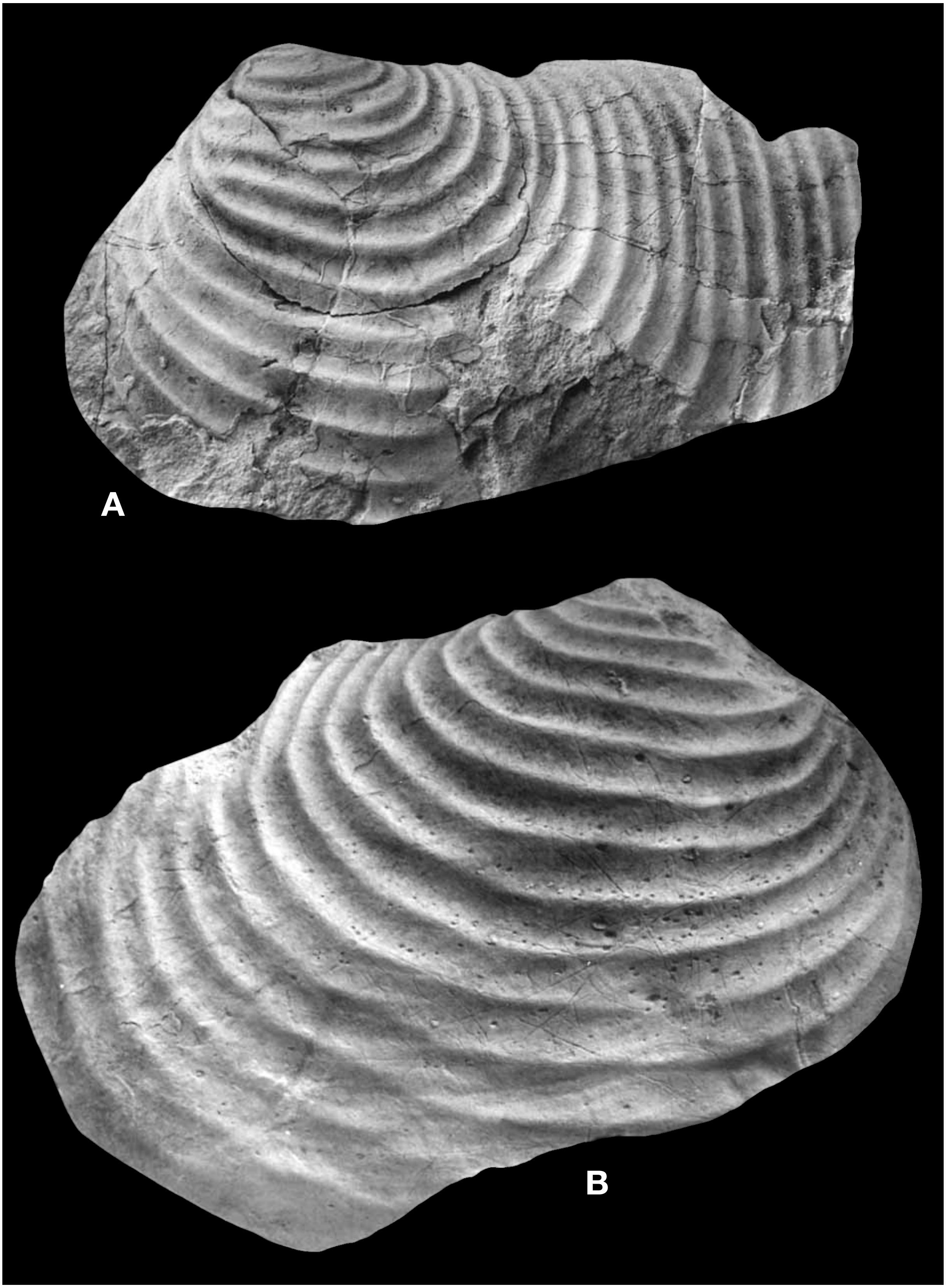

Fig. 42. "*Inoceramus*" *sagensis* OWEN, 1852; A – MWG ZI/35/124, Piotrawin, basal part, × 0.9; B – MWG ZI/35/126, Pawłowice North, × 0.9

OCCURRENCE: The species is known from the "*Inoceramus*" *altus* Zone of the Pawłowice North section and the Piotrawin quarry [lower third of the succession]. It is also known from the equivalent levels in the Tercis section (SW France) and from the US Western Interior. Known from the Late Campanian of Daghestan

"*Inoceramus*" *smirnovi* nom. nov. (Text-figs 43A-D)

?part 1981. *Inoceramus planus* MÜNSTER; TZANKOV, p. 86, pl. 33, fig. 2 [non pl. 32, figs 1-2; pl. 33, fig. 1]

part 1993. "*Inoceramus*" *borilensis* JOLKICEV; DHONDT, p. 215, pl. 1, fig. 1 [non pl. 3, fig. 2, text-fig. 3].

2002. "*Inoceramus*" *cobbani* sp. nov.; WALASZCZYK, ODIN & DHONDT, p. 301, text-fig. 10.

TYPE: The holotype is IW-186 from level 93.2 of the Tercis section (illustrated in WALASZCZYK, ODIN & DHONDT, text-fig. 10); Upper Campanian, "*Inoceramus*" *oblongus* Zone.

MATERIAL: 6 specimens, MWG ZI/35/035 through MWG ZI/35/037, and MWG ZI/35/122, represented by internal moulds of single and double-valve specimens. Small fragments of shell attached to some of the specimens.

DESCRIPTION: The species is of moderate to large size for the genus, inequilateral, most probably equivalve or semi-equivalve, although no undeformed double-valved specimen was found. The valve is moderately inflated, with the maximum inflation dorsocentral, although all the specimens studied are to some extent secondarily flattened. The valve outline is subquadrate, weakly oblique. The umbonal part is massive, with the beak projecting markedly above the hinge line. The posterior auricle is weakly separated from the disc, besides the dorsal part, where the umbonal part is distinctly inflated. The hinge line is straight, moderately long. The anterior margin is slightly concave below the umbo, then straight or broadly convex, passing into the rounded ventral margin; the posterior margin is not observed.

The ornament is composed of distinct, raised rugae, subregular in the juvenile and early adult stages. Then the rugae become low, indistinct and widely spaced. In the adult stage distinct raised growth lines are seen both on rugae and in the interspaces.

REMARKS: "*Inoceramus*" *smirnovi* is a replacement name for the species "*Inoceramus*" *cobbani* described recently by WALASZCZYK, ODIN & DHONDT (2002). As I was informed by Dr. W.A. COBBAN, US Geological Survey, the name *I. cobbani* is preoccupied by *Inoceramus cobbani* KELLUM 1964, which is a new name for KELLUM's (1962) *Inoceramus radiatus*.

The species is quite common is the studied material, although all are fragmentarily preserved and deformed. Even strongly compressed specimens show well the robust rugae with distinctly raised growth lines in the adult stage.

OCCURRENCE: The species is known from the top of the *Nostoceras hyatti* ammonite Zone (level 93) of the Tercis section (corresponding to the top part of the *Inoceramus oblongus* Zone). All the specimens studied herein are from Piotrawin, from the "*Inoceramus*" *inkermanensis* Zone (which is an equivalent of the *I. oblongus* Zone), and from the *Nostoceras hyatti* ammonite Zone. The Bulgarian specimen (Tzankov 1981, pl. 33, fig. 2), referred here with a query was dated originally as coming from the basal Maastrichtian but it may well be from the same interval.

"*Inoceramus*" *tenuilineatus* HALL & MEEK, 1856 (Text-fig. 20D)

1856. *Inoceramus tenuilineatus* HALL & MEEK, p. 387, pl. 2, fig. 3.

1876. *Inoceramus tenuilineatus* HALL & MEEK; MEEK, p. 57, pl. 12, fig. 6.

non 1880. *Inoceramus tenuilineatus* HALL & MEEK; WHITFIELD, p. 400, pl. 9, figs 12-13.

2001. "*Inoceramus*" *tenuilineatus* HALL & MEEK; WALASZCZYK, COBBAN & HARRIES, p. 198, pl. 8, fig. 4; pl. 9, figs 1-5; ?pl. 13, fig. 4.

TYPE: The lectotype, designated by WALASZCZYK & *al*. (2001, p. 198) is AMNH 0362/1, the original of HALL & MEEK (1856, pl. 2, fig. 3)(re-illustrated by WALASZCZYK & *al*. 2001, pl. 8, fig. 4) from the topmost Middle Campanian (in the tripartite North American subdivision of this stage) *Baculites gregoryensis* – *Baculites scotti* ammonite zones of the Great Bend of the Missouri River, South Dakota.

MATERIAL: A single specimen, MZ ML1416.

DESCRIPTION: MZ ML1416 is a fragmentarily preserved internal mould of the LV with the juvenile and part of the adult part preserved. The valve outline is subrhombic, moderately oblique with adult d=52°. The maximum h=43.5 and L=42.4 mm. The valve is

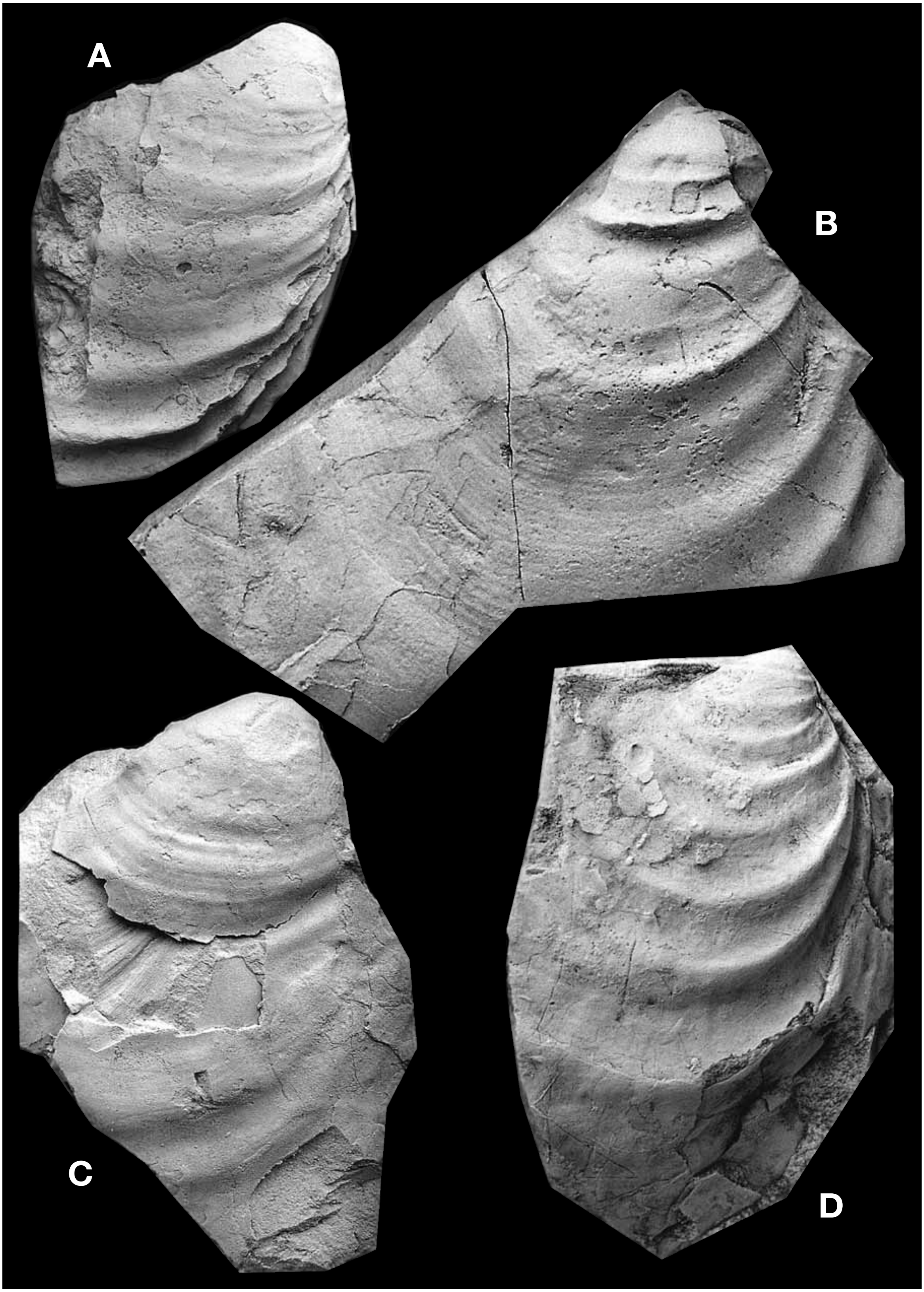

Fig. 43. "*Inoceramus*" *smirnovi* nom.nov.; A – MWG ZI/35/034, × 0.82; B – MWG ZI/35/029, × 1; C – MWG ZI/35/033, × 0.90; D – MWG ZI/35/030 , × 1; all specimens from the Piotrawin quarry; "*Inoceramus*" *inkermanensis* Zone.

moderately convex, with the umbonal region markedly projecting above the hinge line. The anterior margin is short, forming 46% of the respective axial length at h=43 mm. It passes ventrally into the broadly convex antero-ventral margin. The posterior margin is not preserved. The hinge line is straight and relatively long, forming in the adult stage about 70 % of the respective axial length. The valve surface is ornamented with relatively weak, quite regular ribs, and low to very low irregularly spaced rugae.

REMARKS: The studied specimen most closely resembles the forms from Rio Blanco County, Colorado (US Western Interior) (WALASZCZYK & *al.* 2001, pl. 10, figs 1, 3). It shows the same general outline and ornament pattern. All the other specimens, including the lectotype, are more inflated. However, this apparently greater degree of inflation is at least to some extent due to secondary compression.

OCCURRENCE: The studied specimen comes from the middle part of the *Didymoceras donezianum* ammonite Zone (=upper part of the "*Inoceramus*" *tenulineatus* Zone) of Ciszyca Górna. The American specimens are from the upper part of the *Baculites gregoryensis* – *Baculites scotti* ammonite zones of the US Western Interior.

"*Inoceramus*" *alaeformis* ZEKELI, 1852, of authors
(Text-figs 9C, 44A, D, ?C, ?F)

non 1852. *Inoceramus Cripsi* MANTELL var. *alaeformis* ZEKELI, p. 102, pl.1, fig. 1.
non 1866. *Inoceramus Cripsi* MANT. var. *alaeformis* ZEKELI; ZITTEL, p. 97, pl. 14, fig. 5.
non 1959. *Inoceramus alaeformis* ZEKELI; DOBROV & PAVLOVA, p. 154, pl. 18, fig. 1 [=*Trochoceramus costaecus* (KHALAFOVA, 1966].
1978. *Inoceramus* (*Platyceramus*) aff. *alaeformis* ZEKELI; SORNAY in SORNAY & BILOTTE, p. 30, pl. 1, figs 1, 3. [in plate captions both specimens are referred to as *Inoceramus* (*Platyceramus*) *alaeformis*].
non 1988. *Inoceramus alaeformis* ZEKELI; ALIEV & KHARITONOV in ALI-ZADE & *al*., p. 262, pl. 16, figs 1-3 [=*Trochoceramus costaecus* (KHALAFOVA, 1966)].
? 1993. *Platyceramus alaeformis* (ZEKELI); DHONDT, p. 228, pl. 5, figs 2, 4.
non 2001. *Platyceramus alaeformis* (ZEKELI); ODIN, pl. 2, fig. 14. [=*Cataceramus barabini* (MORTON)].
non 2001. *Platyceramus alaeformis* (ZEKELI, 1852); TRÖGER & *al*., p. 152, pl. 3, fig. 6, text-fig. 8.
?pars 2002. "*Inoceramus*" *alaeformis* ZEKELI, 1852, of authors; WALASZCZYK, ODIN & DHONDT, p. 291, pl. 8, fig. 4; pl. 9, figs 3-4; ?pl. 10, fig. 1.

MATERIAL: MWG ZI/35/089, MWG ZI/35/090 and MZ ML1368, all from the "*I.*" *inkermanensis* Zone of the Piotrawin quarry; MZ ML1498/3 from the Piotrawin quarry and MZ ML1357/1 from Kamień, are referred here to as *Cataceramus gandjaeformis* WALASZCZYK, COBBAN & HARRIES, 2001 – "*Inoceramus*" *alaeformis* ZEKELI of authors transitional form.

DESCRIPTION: The specimens are of medium size, weakly inflated, orthocline and with subquadrate outline. The beak is small and projects very slightly above the hinge line. The anterior, posterior, and ventral margins arre convex; in MWG ZI/35/089 and MWG ZI/35/090 the posterior and anterior margins are almost symmetrical against the growth axis. The posterior auricle is not separated. The hinge line is relatively short.

The valve is covered with regularly and clsosely spaced rugae, with interspaces increeasing very slowly ventralward.

REMARKS: The studied specimens correspond well to the concept of "*Inoceramus*" *alaeformis* as accepted in recent literature, and which, as mentioned by WALASZCZYK, ODIN & DHONDT (2002), is probably distinct from the original concept of this species of ZEKELI (1852, pl. 1, fig. 1) and ZITTEL (1866, pl. 14, fig. 5). Although the type of ZEKELI's variety can no longer be found (TRÖGER & *al*. 2001) it was rather a *balticus*-like form, with strongly extended anterior part, and was rather close to the specimen recently illustrated by TRÖGER & *al*. (2001, pl. 3, fig. 6). Consequently, the forms referred hitherto, most probably incorrectly, to this species, are referred to here as "*I.*" *alaeformis* ZEKELI, 1852, of authors.

"*I.*" *alaeformis* ZEKELI, 1852, of authors seems to be related in some way to other similar morphologically similar species, such as *Cataceramus gandjaeformis* (see e.g. Text-fig. 44C, F for forms referred herein to as *C. gandjaeformis* – "*Inoceramus*" *alaeformis* of authors transitional form) or *C.* aff. *gandjaeformis*. As these relationships are not quite clear at the moment no new species is proposed herein.

This species seems to be a direct ancestor of Late Campanian radially ribbed forms, referred to *Trochoceramus costaecus* (KHALAFOVA, 1966).

OCCURRENCE: The species is known from the "*I.*" *inkermanensis* Zone of the Piotrawin section and from Kamień, most probaby from the basal *T. costaecus*

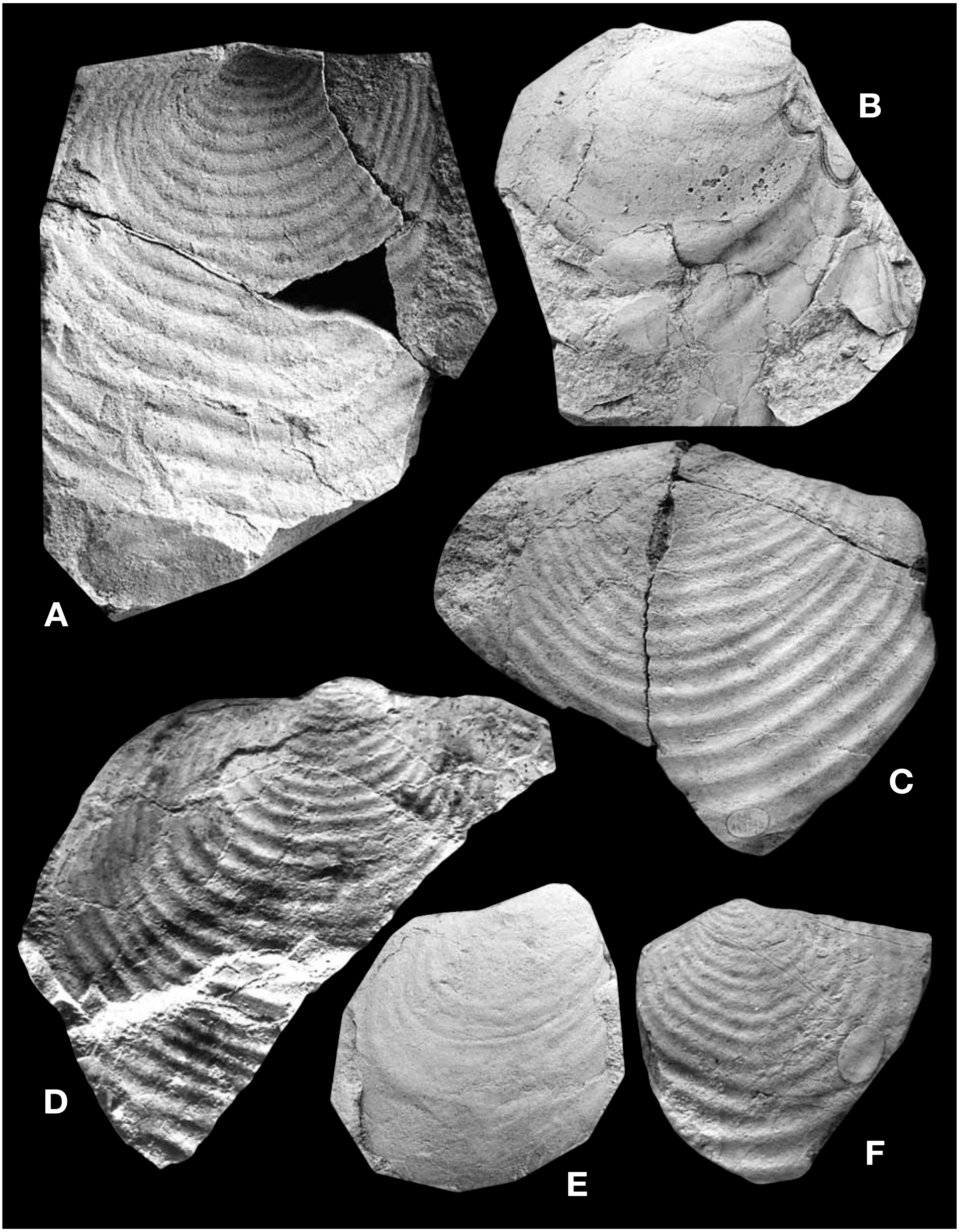

Fig. 44. A, D – "*Inoceramus*" *alaeformis* ZEKELI, 1852, of authors; A – MWG ZI/35/090, Piotrawin, × 0.9; D – MWG ZI/35/089, Piotrawin, × 0.9; B, E – "*Inoceramus*" *inkermanensis* DOBROV & PAVLOVA, 1959, B – MWG ZI/35/014, × 0.95, E – MWG ZI//35/013, × 0.85; both from Piotrawin; C, F – transitional form between *Cataceramus gandjaeformis* WALASZCZYK, COBBAN & HARRIES, 2001 and "*Inoceramus*" *alaeformis* ZEKELI, 1852 of authors; C – MZ ML1498/3, Piotrawin, × 0.7; F – MZ ML1357/1, Kamień, × 0.95

Zone. It is known from the quivalent horizon in the Tercis section.

"*Inoceramus*" sp. A
(Text-figs 45)

MATERIAL: PIG unnumbered; from Kadłubek (coll. POŻARYSKI); moreover MWG ZI/35/109 and MWG ZI/35/110, both from the *Sphaeroceramus pertenuiformis* Zone (=upper part of the *Didymoceras donezianum* Zone) of the Wola Pawłowska section.

Dimensions:

Specimen	h	l	H	L	s	VR	α	δ	hmax
ZI/35/109	46	49	43	51	28	–	120	60	46
PIG	70.5	65	62	–	–	–	120	48	70.5

DESCRIPTION: All three specimens are internal moulds of single valve. The species possesses two distinct growth stages, contacting along well developed positive geniculation. The juvenile stage is subrounded in outline, moderately oblique, weakly inflated. The umbo, preserved only in the PIG unnumbred specimen, is subterminal, small, projecting very slightly above the hinge line. The anterior margin is relatively short, convex, and passes into the rounded anteror-ventral and ventral margins. The posterior margin is short and straight. The hinge line is moderatelylong, straight. The posterior auricle is visible only in the umbonal region, thereafter not separated from the disc at all. The adult stage contacts the adult at a high angle; in the anterior margin the juvenile part may even overhang the early adult anterior face (Fig. 47A-B). In the dorso-posterior part the boundary is marked by a distinct step.

The juvenile and adult stages differ in surface ornament. The juvenile stage is ornamented with regularly spaced commarginal rugae, with interspaces increasing very slowly ventralward; in h distance between 20 and 50 mm, the number of rugae is 8. The adult ornament is less regular: rugae similar to the juvenile ones are still recognisable but another set of rugae, less regular and less distinctly developed, and with much wider interspaces, is superimposed. The adult stage may at least be much higher than the juvenile one; in ZI/35/110 it is at least 2.5 times higher than the juvenile. In the two other specimens the adult stage is incompletely preserved.

The geniculation is most distinct in the PIG unnumbered specimen. To some extent this may be due to preservation. It is preserved in more sandy opoka. Its juvenile stage is weakly inflated, 70.5 mm long along the growth axis; its H =60. It is moderately oblique, with δ = 48. Its anterior margin is strongly convex.

REMARKS: The juvenile stage of this species when preserved alone would probably be referred to juvenile *Cataceramus goldfussianus*. However, the presence of the adult stage, growing at a high angle, and contacting the juvenile stage along a well developed geniculation, make it a very distinctive form. The question, whether or not this feature makes it a separate species, or represents simply a phenotypic expression of some environmental condition on a species, must remain open. It is yet another example of the number of geniculated species that are particularly common in the Early Coniacian, but also present in other intervals of the Late Cretaceous, the taxonomic interpretation of which is very difficult (see discussion e.g. in TRÖGER 1981).

OCCURRENCE: All the specimens studied are from the *Sphaeroceramus pertenuiformis* Zone (upper part of the *Didymoceras donezianum* ammonte Zone) of the Wola Pawłowska section and of the Kadłubek section, west of the Vistula River.

"*Inoceramus*" sp. B
(Text-figs 37A, C-E, G; 40A)

MATERIAL: Six specimens, MWG ZI/35/019 through MWG ZI/35/24.

DESCRIPTION: Besides MWG ZI/35/021 (Text-fig. 37A) which is preserved as a double-valve specimen the rest of the specimens are internal moulds of single valves. No shell fragments are preserved. The characteristic features of this form are shown the best by MWG ZI/35/023 and ZI/35/024; the rest of the specimens is either deformed to a considerable extent, such as ZI/35/020 or their surface ornament is not very well preserved. The characteristcs presented below is thus based almost entirely on these two specimens.

All the specimens are small-sized, weakly inflated and strongly oblique. The obliquity changes markedly in ontogeny; after the juvenile stage, growing ventrally, follows the adult stage, elongated postero-ventrally. Its anterior margin is short and passes into the very long, broadly convex anterro-ventral margin. The hinge line is long and straight.

The ornament is quite regular in the juvenile stage, and then it becomes markedly less regular. The most characteristic feature is the occurrence of oblique rugae; following the anterior part where the rugae are

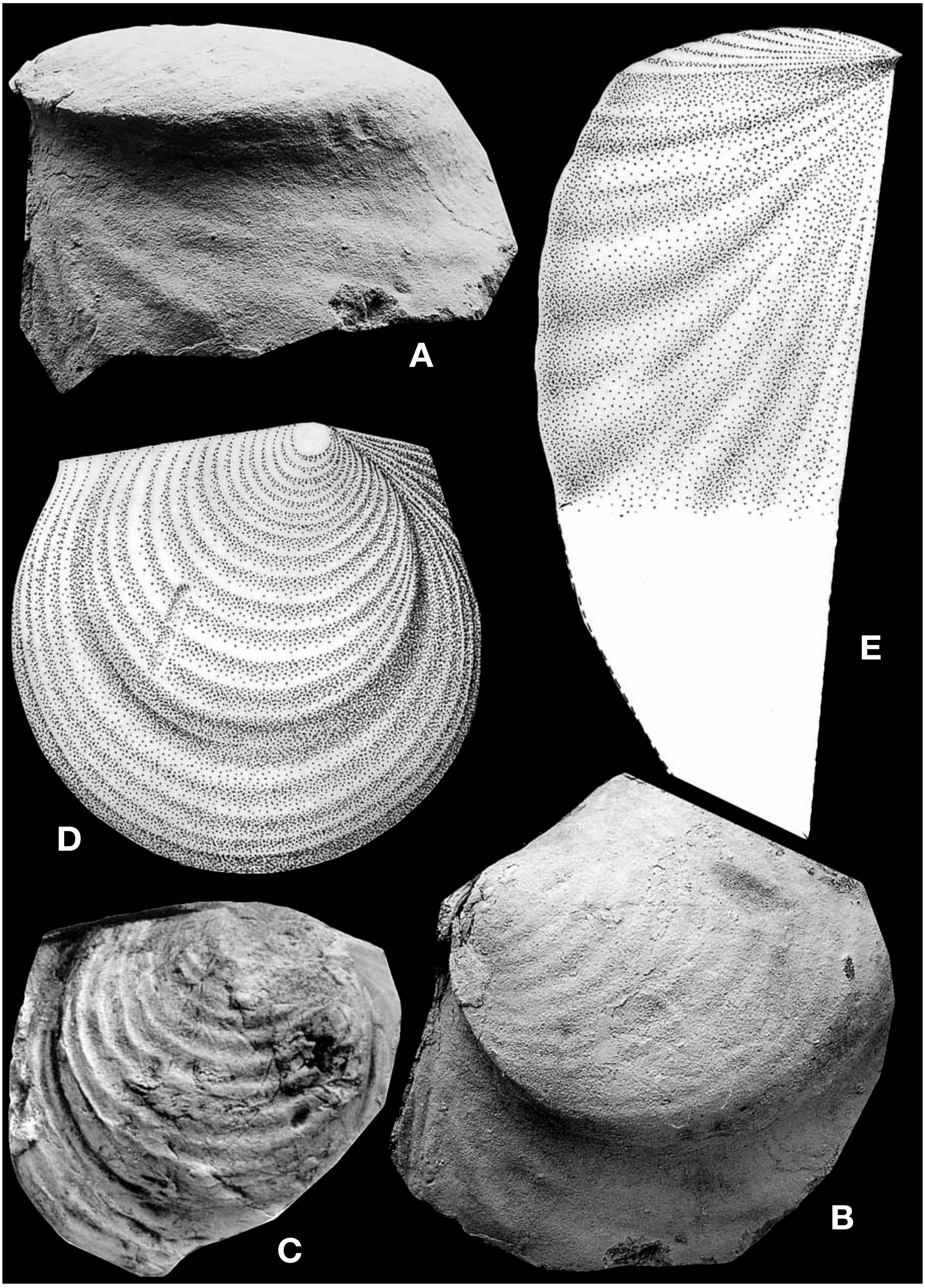

Fig. 45. "*Inoceramus*" sp. A; A-B – PIG 12 II, Kadłubek (WSW of Solec)[coll. W. POŻARYSKI], × 1; A – anterior view, B – lateral view of the juvenile stage; C-E – MWG ZI/35/109, Wola Pawłowska, × 1; C – lateral view of the juvenile stage; D-E – recosntruction of the juvenile stage and of the anterior view

parallel to the growth lines, they cross them obliquely in the antero-ventral part; again the rugae are parallel in the axial and posterior parts.

REMARKS: Although the very characteristic ornament makes an impression of sufficiently distinct form to be separated as a new species, the preservation of all of the specimens leaves doubts to its actual characteritics. Consequently, the form is left here in open nomenclature.

OCCURRENCE: All the specimens are from the "*I.*" *inkermanensis* Zone of the Piotrawin quarry.

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LITERATURE

ABDEL-GAWAD, G.I. 1986. Maastrichtian non-cephalopod mollusks (Scaphopoda, Gastropoda and Bivalvia) of the Middle Vistula Valley, Central Poland. *Acta Geologica Polonica*, **36** (1-3), 69-224.

ALIEV, M.M. 1939. Inoceramidae of the Cretaceous deposits in the northern part of the Minor Caucasus. *Trudy Geologitscheskovo Instituta Akademii Nauk SSSR, Azerbaydjanskij Filial*, **12** (63), 213-259. [*In Russian*]

— 1956. On a new inoceramid species. *Doklady Akademii Nauk Azerbaydjanskoy SSR*, **12** (7), 463-465. [*In Russian*]

— 1978. The stratigraphic importance and the distribution of *Inoceramus agdjakendensis* Aliev M. and *Inoceramus gandjaensis* Aliev M. *Izvestia Akademii Nauk SSSR, Seria Geologicheskaya*, **5**(1978), 3-8. [*In Russian*]

ALIEV, M.M. & KHARITONOV, V.M. 1981. Stratigraphical distribution of inoceramids in the Upper Cretaceous deposits of Azerbaijan. *Izvestia Akademii Nauk Azerbaijanskoy SSR, Seria Nauk o Zemlie*, (1981) **2**, 3-13. [*In Russian*]

ALIEV, M.M., PAVLOVA, M.M. & KHARITONOV, V.M. 1982. Biostratigraphical division of the Upper Cretaceous deposits of Daghestan by means of inoceramid bivalves. *Izvestia Akademii Nauk Azerbaijanskoy SSR, Seria Nauk o Zemlie*, (1982) **4**, 3-11. [*In Russian*]

ALI-ZADE, A., ALIEV, G.A., ALIEV, M.M., ALIYULLA, KH. & KHALILOV, A.G. 1988. Cretaceous fauna of Azerbaijan. Akademia Nauk Azerbaijanskoy SSR. Institut geologii im I.M. Gubkina. *Izd. Elm*, 1-648. [*In Russian*]

ARZUMANOVA, E.M. 1964. Some representatives of the family Inoceramidae from the Upper Cretaceous deposits of the western Kopet-Dag. *Izvestia Akademii Nauk Turkmenskoy SSR*, **3** (1964), 102-110. [*In Russian*]

— 1965. New representatives of the family Inoceramidae from the lower Campanian deposits of eastern Kopet-Dag. *Izvestia Akademii Nauk Terkmenskoy SSR, Seria Fizyko-technicheskich, Chimitscheskich i Geologitscheskich Nauk*, **1** (1965), 100-110. [*In Russian*]

ATABEKIAN, A.A. 1974. Inoceramids.. *In*: Atlas of fossil fauna of Armenian SSR. *Izdatelstvo Akademii Nauk Armianskoy SSR*, 211-424. [*In Russian*]

— 1997. Inoceramidae. *In:* V.V. ARKADIEV & T.N. BOGDANOVA (*Eds*), Atlas of the Cretaceous fauna of southwestern Crimea, 63-70. [*In Russian*]

BARROIS, C. 1879. Sur quelques espèces nouvelles ou peu connues du terrain cretacé du Nord de la France. *Annales de la Société Géologique du Nord*, **6**, 44-457.

BŁASZKIEWICZ, A. 1969. Uwagi o stratygrafii kampanu i mastrychtu doliny środkowej Wisły. *Kwartalnik Geologiczny*, **13** (3).

— 1980. Campanian and Maastrichtian ammonites of the Middle Vistula River valley, Poland: a stratigraphic-paleontological study. *Prace Instytutu Geologicznego*, **92**, 1-63.

BÖHM, J. 1907. Über *Inoceramus Cripsi* Mant. *Zeitschrift der Deutschen Geologischen Gesellschaft*, **59**, 113-114.

— 1909. *Inoceramus Cripsi* auct. *Abhandlungen der Königlich-Preussischen Geologischen Landesanstalt. Neue Folge*, **56**, 41-58.

BOLANOS, L. & Buitron, B.E. 1984. Contribucion al Conocimiento de los inoceramidos de Mexico. Memoria III. Congreso Latinoamericano de Paleontologia, 406-414.
BÖSE, E. 1913. Algunas faunas del Cretacico superior de Coahuila y regiones limitrofes. *Boletin del Instituto Geologico de Mexico*, **30**, 3-56.

BURNETT, J.A., HANCOCK, J.M., KENNEDY, W.J. & LORD, A.R. 1992. Macrofossil, planktonic foraminiferal and nannofossil zonation at the Campanian/Maastrichtian boundary. *Newsletter in Stratigraphy*, **27** (3), 157-172.

CALDWELL, W.G.E. & KAUFFMAN, E.G. (*Eds*) 1994 [for 1993]. Evolution of the Westen Interior Basin. *Special Paper of the Geological Association of Canada*, **39**, 1-680.

CHRISTENSEN, W.K. 1995. *Belemnitella* from the Upper Campanina and Lower Maastrichtian chalk of Norfolk, England. *Special Papers in Palaeontology*, **51**, 1-84.

— 1997. The Late Cretaceous belemnite family

Belemnitellidae: taxonomy and evolutionary history. *Bulletin of the Geological Society of Denmark*, **44**, 59-88.

— 2001. The Campanian-Maastrichtian Stage boundary. *Bulletin of the Geological Society of Denmark*, **48**, p. 208.

CHRISTENSEN, W.K., HANCOCK, J.M., PEAKE, N.B. & KENNEDY, W.J. 2000. The base of the Maastrichtian. *Bulletin of the Geological Society of Denmark*, **47**, 81-85.

COBBAN, W.A. 1994 [for 1993]. Diversity and distribution of Late Cretaceous ammonites, Western Interior, United States. *In*: W.G.E. CALDWELL & E.G. KAUFFMAN (*Eds*), Evolution of the Westen Interior Basin. *Special Paper of the Geological Association of Canada*, **39**, 435-451.

COBBAN, W.A. & KENNEDY, W.J. 1991. Upper Cretaceous (Maastrichtian) ammonites from the *Nostoceras alternatum* Zone in southwestern Arkansas. *Bulletin of the US Geological Survey*, **1985**, E1-E6.

COX, R. R. 1969. Family Inoceramidae GIEBEL, 1852. 314-321. *In*: MOORE, R. C. (*Ed*.), Treatise on Invertebrate Paleontology. Part N. Mollusca 6 (1), Bivalvia. *Geological Society of America and Kansas University Press*; Boulder.

DANE, C.H. 1929. Upper Cretaceous formations of southwestern Arkansas. *Bulletin of Arkansas Geological Survey*, **1**, 1-206.

DHONDT, A.V. 1993. Upper Cretaceous bivalves from Tercis, Landes, SW France. *Bulletin de l'Institut Royal des Sciences Naturelles de Belgique, Sciences de la Terre*, **63**, 211-259.

DOBROV, S. A. & PAVLOVA, M.M. 1959. Inoceramids. *In*: M.M. MOSKVIN (*Ed.*). *Atlas of the Upper Cretaceous fauna of northern Caucasus and Crimea*, 130-165. *Gostoptechizdat*; Moscow. [*In Russian*].

DOUGLAS, R.J.W. 1942. New species of *Inoceramus* from the Cretaceous Bearpaw Formation. *Transactions of the Royal Society of Canada, Section*, **4**, 59-65.

FALLOT, J.E. 1885. Etude géologique sur les étages moyens et du Terrain Crétacé dans le Sud-ouest de la France. *Thèse*, 1-269.

GAMBASHIDZE, R.A. 1963. Fauna of the Santonian – Danian deposits of the marginal parts of the Lokskij and Khramskij Massives. Akademia Nauk GSSR, *Trudy Geologitschekovo Instituta, Seria Geologitscheskaya*, **13** (18), 161-196. [*In Russian*]

GAŹDZICKA, E. Calcareous nannoplankton from the uppermost Cretaceous and Paleogene deposits of the Lublin Upland. *Acta Geologica Polonica*, **28**, 335-375.

GIERS, R. 1964. Die Großfauna der Mukronatenkreide (unteres Obercampan) im östlichen Münsterland. *Fortschritte Geologie Rheinland und Westfalen*, **7**, 213-294.

GILBERT, G.K. 1896. The underground water of the Arkansas Valley in eastern Colorado. Seventeenth Annual Report of the United States Geological Survey to the Secretary of the Interior 1895-96. Part II, Economic Geology and Hydrography, Washington, 557-601.

GILL, J.R. & COBBAN, W.A. 1966. The Red Bird Section of the Upper Cretaceous Pierre Shale in Wyoming. *United States Geological Survey, Professional Paper*, **393A**, A1-A73.

— & — 1973. Stratigraphy and geologic history of the Montana Group and equivalent rocks, Montana, Wyoming, and North and South Dakota. *United States Geological Survey, Professional Paper*, **776**, 1-37.

GOLDFUSS, A. 1834-1840. Petrefacta Germaniae. 1-312. *Arnz & Co.*; Düsseldorf.

HALL, J. & MEEK. F.B. 1856. Descriptions of new species of fossils, from the Cretaceous formations of Nebraska with observations upon *Baculites ovatus* and *B. compressus*, and the progressive development of the septa in *Baculites*, *Ammonites*, and *Scaphites*. *Memoirs of the American Academy of Arts and Sciences, New Series*, **5**, 379-411.

HANCOCK, J.M. 1991. Ammonite scales for the Cretaceous System. *Cretaceous Research*, **12**, 259-291.

— 1993. Transatlantic correlation in the Campanian-Maastrichtian Stages by eustatic changes of sea-level. *In:* E.A. HAILWOOD & R.B. KIDD (*Eds*), High resolution stratigraphy. *Geological Society Special Publication*, **70**, 241-256.

HANCOCK, J.M. & GALE, A.S. (with contributions from GARDIN, S., KENNEDY, W.J., LAMOLDA, M.A., MATSUMOTO, T. & NAIDIN, D.P.) 1996. The Campanian Stage. *In*: Proceedings "Second International Symposium on Cretaceous Stage Boundaries" Brussels 8-16 September 1995. *Bulletin de l'Institut Royal des Sciences Naturelles de Belgique (Supplement)*, **66**, 103-109.

HANCOCK, J.M. & KAUFFMAN, E.G. 1989. Use of eustatic changes of sea level to fix Campanian-Maastrichtian boundary in Western Interior of USA. *International Geological Congress*, 28 (Washington, D.C.), *Abstracts, vol*. **2**, 23.

HANCOCK, J.M., PEAKE, N.B., BURNETT, J.A., DHONDT, A.V., KENNEDY, W.J. & STOKES, R.B. 1993. High Cretaceous biostratigrpahy at Tercis, south-west France. *Bulletin de l'Institut Royal des Sciences Naturelles de Belgique*, **63**, 133-148.

HARDENBOL, J., THIERRY, J., FARLE, M.B., JACQUIN, T., GRACIANSKY, P.C. & VAIL, P.R. 1998. Mesozoic and Cenozoik sequence chronostratigraphic framework of european basins. Chart 5: Cretaceous biochronostratigraphy. *In*: GRACIANSKY & *al.* (*Eds*), Mesozoik and Cenozoik sequence stratigraphy of European basins. *Society of Sedimentary Geology, Special Publication*, **60**.

HEINZ, R. 1932. Aus der neuen Systematik der Inoceramen. Beiträge zur Kenntnis der oberkretazischen Inoceramen XIV. *Mitteilungen aus dem Mineralogisch-Geologischen Staatinstitut, Hamburg*, **13**, 1-26.

HICKS, J.F., OBRADOVICH, J.D. & TAUXE, L. 1999. Magnetostratigraphy, isotopic age calibration and intercontinental correlation of the Red Bird section of the Pierre Shale, Niobrara County, Wyoming, USA. *Cretaceous Research*, **20**, 1-27.

IVANNIKOV, A.V. 1979. Inoceramids of the Upper Cretaceous in southwestern part of the Easteuropean Platform, 102 pp. Akademia Nauk Ukrainskoy SSR, Institut Geologicheskich Nauk, Kiev. [*In Russian*]

JOHNSON, D.W. 1903. The geology of the Cerrillos Hills, New Mexico. Part II. Paleontology. *School of Mines Quarterly*, **24** (2), 101-171.

JOLKICEV, N. 1962. Inoceramen aus dem Maastricht Bulgariens. *Travaux sur la Géologie de Bulgarie, Série Paléontologie*, **4**, 133-169.

KAPLAN, U. & KENNEDY, W.J. 1996. Stratigraphie und Ammonitenfaunen des Campan im südöstlichen Münsterland. *Geologie und Paläontologie in Westfalen*, **43**, 1-133.

KAUFFMAN, E.G. 1970. The Upper Cretaceous Inoceramus of the Puerto Rico. Transactions of Fourth Geological Conference, Trinidad 1965, 203-218.

KAUFFMAN, E.G. 1973. Cretaceous bivalvia. pp. 353-383. *In*: A. HALLAM (*Ed*.), Atlas of Palaeobiogeography. *Elsevier*; Amsterdam.

KAUFFMAN, E.G., SAGEMAN, B.B., KIRKLAND, J.I., ELDER, W.P., HARRIES, P.J. & VILLAMIL, T. 1994 [for 1993]. Molluscan biostratigraphy of the Cretaceous Western Interior Basin, North America. *In*: W.G.W. CALDWELL & E.G. KAUFFMAN (*eds*). Evolution of the Western Interior Basin. *Special Paper of the Geological Association of Canada*, **39**, 397-434.

KELLUM, L.B. 1962. Paleontology. Upper Cretaceous Mollusca from Niobrara County, Wyoming. *Papers of the Michigan Academy of Science, Arts, and Letters*, **47**, 37-81.

— 1964. *Inoceramus cobbani*, new name for *Inoceramus radiatus* KELLUM, 1962. *Journal of Paleontology*, **38** (5).

KENNEDY, W.J. 1986. Campanian and Maastrichtian ammonites from northern Aquitaine, France. *Special Papers in Palaeontology*, **36**, 1-145.

KENNEDY, W.J., CHRISTENSEN, W.K. & HANCOCK, J.M. 1995. Defining the base of the Maastrichtian and its substages. Unpublished Report to the Maastrichtian Working group at the Second International Symposium on Cretaceous Stage Boundaries, 16 pp. Brussels.

KENNEDY, W.J., COBBAN, W.A. & SCOTT, G.R. 1992. Ammonite correlation of the uppermost Campanian of Western Europe, the U.S. Gulf Coast, Atlantic Seaboard and Western Interior, and the numerical age of the base of the Maastrichtian. *Geological Magazine*, **129** (4), 497-500.

KENNEDY, W.J. & SUMMESBERGER, H. 1987. Lower Maastrichtian ammonites from Nagoryany (Ukrainian SSR). *Beiträge zur Paläontologie von Österreich*, **13**, 25-78.

KHALAFOVA, R. A. 1966. New species of Inoceramidae from Senonian deposits of Daghestan. *Doklady Akademii Nauk Azerbaijanskoy SSR*, **22** (2), 52-56. [*In Russian*]

— 1969. Fauna and stratigraphy of the Upper Cretaceous deposits of the SE part of the Minor Caucasus and Nachitchewan area of ASSR. *ASS Academy of Sciences*, 1-330. [*In Russian*]

KOCIUBYNSKIJ, S. P. 1958. Inoceramids of the Cretaceous deposits of the Volhynian-Podolian Plate. *Akademia Nauk Ukrainskoy SSR*; Kiev, 1-49. [*In Ukrainian*]

— 1968. Inoceramidae. *In*: PASETERNAK, S.I., GAVRILISHIN, V.I., GINDA, V.A. KOCIUBYNSKIJ, S.P. & SENKOVSKI, J.M. Fauna of the Cretaceous deposits of the Western Ukraine. Naukovaya Dumka, 115-148. [*In Ukrainian*]

— 1974. Inocerams. *In*: G.J. KRYMGOLTZ (*Ed.*). Atlas of the Upper Cretaceous Fauna of Donbass, pp. 76-86. *Nedra*; Moscow. [*In Russian*]

KONGIEL, R. 1962. On belemnites from Maastrichtian, Campanian and Santonian sediments in the Middle Vistula valley (Central Poland). *Prace Muzeum Ziemi*, **5**, 3-148.

KUZNETZOV, V.I. 1968. Stratigraphy and inoceramids of the Upper Cretaceous deposits of Tuarkyr. *Unpublished Ph.D. Thesis*, State University of Leningrad,1-339.

LOGAN, W.N. 1898. The Invertebrates of the Benton, Niobrara and Fort Pierre Groups. *University Geological Survey of Kansas*, **4** (Paleontology) (Upper Cretaceous 8), 431-518.

LUPU, D. & SORNAY, J. 1978. Noi date biostratigrapfice asupra senonianului din regiunea vidra (Muntii Metaliferi). *Studii si Cercetări de Geologie, Geofizică et Geografie; Geologie*, **23** (1), 73-82.

MASLENNIKOVA, L.H. 1982. Inoceramids. *In*: Atlas of the Invertebrates of the Late Cretaceous seas of the Pericaspian depression, pp. 82-96. *Nauka*; Moscow. [*In Russian*]

MEEK, F.B. 1861. Descritpions of new Cretaceous fossils collected by the north-western boundary Comission on Vacnouver and Sucia Islands. *Proceedings of the Philadelphia Academy of Natural Sciences*, **13**, 314-318.

— 1871. Preliminary paleontological report, consisting of list of fossils, with descriptions of some new types etc. *U.S. Geological Survey of Wyoming (Hayden) Preliminary Report*, **4**, 287-318.

— 1876. A report on the invertebrate Cretaceous and Tertiary fossils of the upper Missouri country. *United States Geological Survey of the Territories (Hayden) Report*, **9**. 1-629 + LXIV.

MEEK, F.B. & HAYDEN, F.V. 1856. Descriptions of new species of gastropoda and cephalopoda from the Cretacous formations of Nebraska Territory. *Proceedings of the Philadelphia Academy of Natural Sciences*, **8**, 63-126.

— & — 1860. Description of new organic remains from the Tertiary, Cretaceous and Jurassic rocks of Nebraska. *Proceedings of the Philadelphia Academy of Natural Sciences*, **12**, 175-185.

MORRIS, N. 1995. Maastrichtian Inoceramidae from the United Arab Emirates-Oman border region. *Bulletin Natural History Museum, London (Geology)*, **51** (2), 257-265.

MORTON, S.G. 1834. Synopsis of the organic remains of the Cretaceous group in the United States. Key and Biddle, 1-88.

NIEBUHR, B. 2003. Late Campanina and Early Maastrichtian ammonites from the white chalk of Kronsmoor (northern Germany) – taxonomy and stratigraphy. *Acta Geologica Polonica*, **53** (4), 257-281.

NIEBUHR, B., VOLKMANN, R. & SCHONFELD, J. 1997. Das obercampane polyplocum-Event der Lehrter Westmulde (Oberkreide, N-Deutschland): Bio-/ Litho-/Sequenzstratigraphie, Fazies-Entwicklung und Korrelation. Freiberger Forschungshheft, C468, 211-243.

NODA, M. 1983. Some Cretaceous inoceramids (Bivalvia) from the Ominega-dai Hills of Matsuyama, Shikoku. *In*: Memorial Papers of Late Prof. Michtoshi Miyahisa, Earth Sciences, Ehime, 103-117. [*In Japanese*]

NODA, M. & KANIE, Y. 1978. campanian Inoceramus from the Menabe Area, southwestern Madagascar, Part 1. Bulletin of the National Science Museum, Series C (Geology & Paleontology), 4 (1), 11-32.

OBRADOVICH, J.D. 1994. Cretaceous time scale. *In*: W.G.E. CALDWELL & E.G. KAUFFMAN (*Eds*), Evolution of the Western Interior Basin. *Geological Association of Canada*, **39**, 379-396.

ODIN, G.S. (compiler) (with contributions by J.M. HANCOCK, E. ANTONESCU, M. BONNEMAISON, M. CARON, W. A. COBBAN, A.V. DHONDT, D. GASPARD, J. ION, J. W.M. JAGT, W. J. KENNEDY, M. MELINTE, D. NERAUDEAU, K. VON SALIS, P. D. WARD.) 1996. Definition of a Global Boundary Stratotype Section and Point for the Campanian/Maastrichtian boundary. *In*: Proceedings "Second International Symposium on Cretaceous Stage Boundaries" Brussels 8-16 September 1995. *Bulletin de l'Institut Royal des Sciences Naturelles de Belgique (Supplement)*, **66**, 111-117.

— 2001. Inoceramid bivalves in the Campanian-Maastrichtian of Tercis-les-Bains (Landes, France). *In*: ODIN G. S. (*Ed.*), The Campanian -Maastrichtian Boundary: characterisation and correlation from Tercis (Landes, SW France) to Europe and other continents. *IUGS Special Publication (monograph) Series*, **36**; Developments in Palaeontology and Stratigraphy Series, 19, *Elsevier Sciences Publication*.

ODIN, G.S. & LAMAURELLE, M.A. 2001. The glogal Campanian-Maastrichtian stage boundary. *Episodes*, **24** (4), 229-238.

ODIN, G.S. & WALASZCZYK, I. 2003. Sur les inocérames de Tercis (Landes, France): le meilleur outil corrélatif entre Europe et Amérique du Nord autour de la limite Campanien – Maastrichtien. *C.R. Geoscience*, **335**, 239-246.

ORBIGNY, A. D' 1842-1847. Paléontologie Française. Terrains Crétacés. Lamellibranches. 1-807. *Baillière*; Paris.

OWEN, D.D. 1852. Report of a geological survey of Wisconsin, Iowa, and Minnesota and incidentally of a portion of Nebraska Territory, Lippincott, Grambo & Co., 1-638.

PERGAMENT, M.A. 1974. Biostratigraphy and Inocerams of Senonian (Santonian-Maestrichtian) of the USSR Pacific Regions. *Transactions of the Geological Institute of the Academy of Sciences of the USSR*, **260**, 1-267. [*In Russian*]

PERGAMENT, M.A. & SMIRNOV, J.P. 1972. Vertical distribution and stratigraphic importance of inocerams in the Upper Cretaceous section of Daghestan. *In*: M.A. Pergament (*Ed.*), *Transactions of the All-Union colloquium on inocerams*, 94-113. [*In Russian*]

PERYT, D. 1980. Planktic foraminifera zonation of the Upper Cretaceous in the Middle Vistula river Valley, Poland. *Paleontologia Polonica*, **41**, 1-96.

— 1995. The Campanian/Maastrichtian boundary in the Piotrawin quarry (central Poland): the benthic foraminiferal evidence. *In*: 2nd International Symposium on Cretaceous Stage Boundaries, Brussels, 1995, Abstract Volume, p. 92.

— 2000. On the age of siliceous chalk in the Piotrawin quarry, Middle Vistula River valley, Central Poland. *Biuletyn Państwowego Instytutu Geologicznego*, **393**, 81-94. [*In Polish with English summary*]

PETRASCHECK, W. 1906. Ueber Inoceramen aus der Gosau und dem Flysch der Nordalpen. *Jahresbericht der Geologisches Reichsanstalt*, **56,** 155-168**.**

POŻARYSKI, W. 1938. Senonstratigraphie im Durchbruch der Weichsel zwischen Rachów und Puławy in Mittelpolen. *Biuletyn Państwowego Instytutu Geologicznego*, **6**, 1-94. [*In Polish with extended German Summary*]

— 1948. Jurassic and Cretaceous between Radom, Zawichost and Kraśnik (Central Poland). *Biuletyn Państwowego Instytutu Geologicznego*, **46**, 1-141.

RENNGARTEN, V. 1926. LA FAUNE DES DEPOTS CRETACE DE LA REGION D'ASSAMABILEEVKA. CAUCASE du Nord. *Memoire du Comite Geologique, Nouvelle Serie*, 147, 1-132.

RIEDEL, L. 1931 [for 1930]. Zur Stratigraphie und Faziesbildung im Oberemscher und Untersenon am Südrande des Beckens von Münster. *Jahrbuch der Preußischen Geologischen Landesanstalt zu Berlin*, **51** (2), 605-713.

ROBASZYNSKI, F., GONZÁLEZ DONSO, J.M., LINARES, D., AMÉDRO, F., CARON, M., DUPUIS, C., DHONDT, A.V. & GARTNER, S. 2000. Le Crétacé supérieur de la région de Kalaat Senan, Tunisie Centrale. Litho-biostratigraphie intégrée: zones d'ammonites, de foraminifères planctoniques et de nannofossiles du Turonien supérieur au Maastrichtien. *Bulletin des Centres de Recherches Exploration-Production Elf-Aquitaine*, **22** (2), 359-490.

SCHÖNFELD, J. 1990. Zur Stratigraphie und Ökologie benthischer Foraminiferen im Schreibkreide-Richtprofil von Lägerdorf/Holstein. *Geologisches Jahrbuch*, **A117**, 3-151.

SCHULZ, M.-G. 1979. Morphometrisch-variationsstatistische Untersuchungen zur Phylogenie der Belemniten-Gattung *Belemnella* im Untermaastrichti NW-Europas. *Geologisches Jahrbuch*, **A47**, 3-157.

SCHULZ, M.-G. 1982. Erster Nachweis der Belemnitengattung *Belemnitella* (*B. pulchra* n.sp.) im mittleren Untermaastricht NW-Deutschlands. *Geologisches Jahrbuch*, **A61**, 279-293.

SEITZ, O. 1961. Die Inoceramen des Santon von Nordwestdeutschland. Teil I. Die Untergattungen *Platyceramus*, *Cladoceramus* und *Cordiceramus*. *Beihefte zum Geologischen Jahrbuch*, **46**, 1-186.

— 1967. Die Inoceramen des Santon und Unter-Campan von Nordwestdeutschland. III. Teil. Taxonomie und Stratigraphie der Untergattungen *Endocostea*, *Haenleinia*, *Platyceramus*, *Cladoceramus*, *Selenoceramus* und *Cordiceramus* mit besonderer Berücksichtigung des Parasitismus bei diesen Untergattungen. *Beihefte zum Geologischen Jahrbuch*, **75**, 1-171.

— 1970. Über einige Inoceramen aus der Oberen Kreide. 2. Die Muntigler Inoceramenfauna und ihre Verbreitung im Ober-Campan und Maastricht. *Beihefte zum Geologischen Jahrbuch*, **86**, 105-171.

SHUMARD, B.F. 1858. Description of new fossils from the Tertiary of Oregon and Washington Territories and the Cretaceous of Vancouver's Island, collected by Dr. Jno. Evans U.S. Geologist. *Transactions of the Academy of Science of St. Luis*, 1, 120-125.

SOBOLEVA, R.P. 1970. The presence of the Upper Campanian in central Kuzylkum. *Trudy VSEGEI, New Series*, 127, 139-173. [*In Russian*]

SORNAY, J. 1957a. *Inoceramus goldfussi* D'ORBIGNY 1842. *Palaeontologia Universalis, New Series*, **57**, 1-2.

— 1957b. *Inoceramus impressus* D'ORBIGNY. *Palaeontologia Universalis, New Series*, **129**, 1-2.

— 1961. Ammonites et Inocérames de Vonso (Bas-Congo). *Annales Musée Royal de l'Afrique Central – Tervuren Belgique, Serie in 8, Sciences Geologiques*, **38**, 43-52.

— 1962. Etude d'une faune d'Inocérames du Sénonien supérieur des Charentes et description d'une espèce nouvelle du Sénonien de Madagascar. *Bulletin de la Société Géologique de France*, (7) **4**, 118-122.

— 1968. Inocérames sénoniens du sud-ouest de Madagascar. *Annales de Paléontologie (Invertébrés)*, **54** (1), 25-47.

— 1969. Ammonites et Inocérames. *In*: M.T. ANTUNES & J. SORNAY. Contribution à la connaisance du Crétacé supérieur de Barra do Dande, Angola. *Revista da Faculdade de Ciéncias de Lisboã, 2, Série C*, **16** (1), 65-104.

— 1973. Sur les Inocérames du Maestrichtien de Madagascar et sur une espèce de la Craie à *Baculites* du NW de la France. *Annales de Paléontologie (Inveretébrés)*, **59** (1), 83-93.

— 1976. La faune d'Inocérames de Dau (Région de Royan, Charente-Maritime) et remarques sur deux espéces de d'Orbigny: *I. regularis* et *I. goldfussi*. *Annales de Paléontologie (Invertébrés)*, **62** (1), 1-18.

— 1982. Sur la faune d'inocérames de la Smectite de Herve (Campanien) et sur quelques inocérames du Campanien et du Maastrichtien de la Belgique. *Bulletin de l'Institut Royal des Sciencs Naturelles de Belgique, Sciences de la Terre*, **54**, 1-15.

SORNAY, J. & BILOTTE, M. 1978. Faunes d'Inocérames du Campanien et du Maastrichtien des Pyrénées. *Annales de Paléontologie (Inveretébrés)*, **64** (1), 27-45.

STANTON, T.W. 1894. The Colorado Formation and its invertebrate fauna. *Bulletin of the United States Geological Survey*, 106, 3-189.

STEPHENSON, L.W. 1941. The larger invertebrate fauna of the Navarro Group of Texas. *The University of Texas Publication*, **4101**, 1-641.

STINNESBECK, W. 1986. Zu den faunistischen und palökologischen Verhältnissen in der Quiriquina Formation (Maastrichtium) Zentral-Chiles. *Palaeontographica*, **A194**, 99-237.

SUMMESBERGER, H., WAGREICH, M., TRÖGER, K.-A. & JAGT, J.W.M. 1999. Integrated biostratigraphy of the Santonian/Campanian Gosau Group of the Gams area (Upper Cretaceous; Styria. Austria. *Beiträge zur Paläontologie,* **24**, 155-205.

TOUMEY, M. 1856. Description of some new fossils, from the Cretaceous rocks of the southern states. *Proceedings of the Academy of Natural Sciences of Philadelphia*, **8** (5), 167-172.

TRÖGER, K.-A. 1967. Bemerkungen zur Variabilität von *Inoceramus balticus* BÖHM aus der subherzynen Kreide. *Freiberger Forschungshelft*, **C213**, 7-21.

— 1980. Zur Variabilität und Paläobiogeographie von *Inoceramus* (*Trochoceramus*) *ianjonaensis* Sornay aus dem Maastricht von Libyen. *Freiberger Forschungsheft*, **C357**, 93-103.

— 1981. Zur Bedeutung der Wachstumsknicke bei Inoceramen der Obekreide. *Freiberger Forschungsheft*, **C363**, 101-110.

TRÖGER, K.-A. & RÖHLICH, P. 1981. *Inoceramus* (*Selenoceramus*) *ghadamesensis* n.sp. from the Upper Cretaceous of NW Libya. *Vestnik Ustredniho Ustavu Geologickeho*, **56**, 93-103.

— & — 1982. Zur Variabilität von *Inoceramus balticus haldemensis* GIERS aus dem Campan von Libyen. *Freiberger Forschungshelft*, **C375**, 101-111.

— & — 1991. Campanian-Maastrichtian inoceramid (Bivalvia) assemblages from NW Libya. *In:* M.J. SALEM, O.S. HAMMUDA & B.A. ELIASGOUBI (*Eds*), *The Geology of Libya*, Elsevier, **4**, 1357-1381.

TRÖGER, K.-A., SUMMESBERGER, H. & SKOUMAL, P. 1999. Inoceramidae from the Campanian (Upper Cretaceous) of the Gschliefgraben (Ultrahelvetic; Austria). *Beiträge zur Paläontologie,* **24**, 41-61.

TRÖGER, K.-A., SUMMESBERGER, H. & WAGREICH, M. 2001. Early Maastrichtian (Late Cretaceous) inoceramids from the Piesting Formation (Gosau Group, Austria). *Beiträge zur Paläontologie*, **26**, 145-167.

TSAGARELI, A.L. 1963. Upper Cretaceous fauna of Daghestan. Akademia Nauk GSSR, *Trudy Geologitschekovo Instituta, Seria Geologitscheskaya*, **13** (18), 79-108.

TSAGARELI, A.L. & GHAMASHIDZE, R.A. 1984. On the systematics of Cretaceous inoceramids. *Paleontologicheskij Sbornik*, **21**, 47-53.

TZANKOV, V. 1981. Les fossiles de Bulgarie. V. Crétacé Supérieur. Grands Foraminifères, Anthozoaires, Gastéropodes, Bivalvia. *Édition de l'Académie Bulgare des Sciences*, 1-233 pp..

VOUTE, C. 1951. Inoceramus algeriensis Heinz, une espece mal connue d'Algerie; avec quelques observation sur le mode de vie des Inocerames. *Bulletin de la Société Géologique de France*, serie 6, 1, 205-211.

WALASZCZYK, I. 1996. Biostratigraphical potential of the Campanian – Lower Maastrichtian inoceramids. Fifth International Cretaceous Symposium and Second Workshop on Inoceramids, Freiberg/Saxony, Germany – September 16-24, 1996, *Abstract Volume*, 187-188.

— 1997. Biostratigraphie und Inoceramen des oberen Unter-Campan und unteren Ober-Campan Norddeutschlands. *Geologie und Paläontologie in Westfalen*, **49**, 1-111.

WALASZCZYK, I., COBBAN, W.A. & HARRIES, P.J. 2001. Inoceramids and inoceramid biostratigraphy of the Campanian and Maastrichtian of the United States Western Interior Basin. *Revue de Paleobiologie*, **20** (1), 117-234.

WALASZCZYK, I., COBBAN, W.A. & ODIN, G.S. 2002. The inoceramid succession across te Campanian – Maastrichtian boundary. *Bulletin of the Geological Society of Denmark*, **49**, 53-60.

WALASZCZYK, I., ODIN, G.S. & DHONDT, A.V. 2002. Inoceramids from the Upper Campanian and Lower Maastrichtian of the Tercis section (SW France), the Global Stratotype Section and Point for the Campanian – Maastrichtian boundary; taxonomy, biostratigrpahy and correlation potential. *Acta Geologica Polonica*, **52** (3), 269-305.

WALASZCZYK, I., SMIRNOV, J.P. & TRÖGER, K.-A. 1996. Trochoceramid bivalves (Inoceramidae) from the Lower Maastrichtian of Daghestan (Aimaki section, NE Caucasus) and south-central Poland. *Acta Geologica Polonica*, **46** (1-2), 141-164.

WHITE, C.A. 1879. Contributions to invertebrate paleontology, No. 1: Cretaceous fossils of the Western States and Territories. Department of the Interior. United States Geological Survey. Eleventh Annual Report of the Survey for the year 1877, 273-319.

WHITEAVES, J.F. 1879. On the fossils of the Cretaceous rocks of Vancouver and adjacent islands in the Strait of Georgia. *Geological Society of Canada, Mesozoic Fossils*, **1** (2), 93-190.

WHITFIELD, R. P. 1877. Preliminary report on the paleontology of the Black Hills, containing descriptions of new species of fossils from the Potsdam, Jurassic, and Cretaceous formations of the Black Hills of Dakota. United States Geographical and Geological Survey of the Rocky Mountain Region, 1-49.

— 1880. Paleontology of the Black Hills of Dakota. *In:* H. NEWTON & W.P. JENNEY, Report on the geology and resources of the Black Hills of Dakota. *United States Geographical and Geological Survey of the Rocky Mountain Region*, 325-468.

— 1885. Brachiopoda and Lamellibranchiata of the Raritan Clays and Greensand Marls of New Jersey. *Monographs of the United States Geological Survey*, **9**, 1-269.

WOODS, H. 1912. A monograph of the Cretaceous Lamellibranchia of England. Volume 2, Part 8. *Monographs of the Palaeontographical Society*, (for 1911), 285-340

ZEKELI, L.F. 1852. Das Genus *Inoceramus* und seine Verbreitung in den Gosaugebilden der östlischen Alpen. *Jahresbericht des naturwissenschaftlichen Vereins in Halle*, **4**, 79-105.

ZITTEL, K.A. 1866. Die Bivalven der Gosaugebilde in den nordöstlichen Alpen. Beitrag zur Charakteristik der Kreideformation in Österreich. *Denkschriften der kaiserlichen Akademie der Wissenschaften, mathematisch-naturwissenschaftliche Classe*, **25**, 1-198.

ZONOVA, T.D. 1980. New type of ligament in inoceramids from the Central Asia. *Ezhegodnik VPO*, **23**, 50-56. [*In Russian*]

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