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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, biostratigraphy and correlation potential

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ABSTRACT:

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Thirty-three inoceramid species from the upper Upper Campanian and Lower Maastrichtian of the Tercis section (SW France), the Global Boundary Stratotype Section and Point for the Campanian – Maastrichtian boundary, are described, of which 8 are left in open nomenclature. Two species are described as new: *Endocostea jolkicevi* and "*Inoceramus*" *cobbani*. The described species represent four inoceramid genera *Cataceramus* HEINZ, 1932, *Sphaeroceramus*, HEINZ, 1932, *Enodcostea* WHITFIELD, 1877, *Trochoceramus* HEINZ, 1932, and thirteen species are referred to the genus "*Inoceramus*" *sensu lato*. The inoceramids allow the subdivision of the upper Upper Campanian and of the Lower Maastrichtian into seven zones and their correlation with the ammonite scheme, as well as with the chronostratigraphic standard. The Campanian – Maastrichtian boundary falls in the topmost part of the "*Inoceramus*" *redbirdensis* Zone, and the base of the successive, *Endocostea typica* Zone is a good proxy for this stage boundary. Besides the *Trochoceramus costaecus* Zone all other zones are also distinguishable in the US Western Interior.

Key words: Tercis, SW France, Global Boundary Stratotype Section and Point, ampanian, Maastrichtian, Upper Cretaceous, Inoceramid paleontology, Inoceramid stratigraphy,

INTRODUCTION

This paper provides the taxonomic description and biostratigraphy of the Upper Campanian and Lower Maastrichtian inoceramids from the Tercis section, SW France, the Global Standard stratotype Section and Point for the Campanian-Maastrichtian boundary. This section was proposed and positively voted during the second Symposium on Cretaceous Stage Boundaries in Brussels, 1995 (ODIN 1996a; see also KENNEDY & *al*. 1995, ODIN 1996b) and officially proposed a year later by GSO, voted on by the Subcommission on

Stratigraphy in 2000, and ratified by the International Union of Geological Sciences in February 2001 (ODIN & LAMAURELLE 2001).

Inoceramid material from Tercis represents a unique collection among Late Campanian – Early Maastrichtian European inoceramid collections. Firstly, it was collected bed-by-bed, secondly, it has a very precise stratigraphical control by other fossil groups, such as ammonites, echinoids, brachiopods, asteroids, and microfossil groups represented by calcareous nannofossils, dinoflagellates, and foraminifers, and thirdly, it is rich and represented by relatively well preserved specimens.

The very poor inoceramid material hitherto available from the European Campanian and Maastrichtian was the reason for numerous misconceptions concerning the inoceramid succession and the evolutionary history of the group in the late Late Cretaceous, as well as its supposed almost total uselessness in biostratigraphy. As recently demonstrated for the Campanian and Lower Maastrichtian inoceramids from the US Western Interior (WALASZCZYK & *al.* 2001), and shown herein by the record from Tercis, inoceramids retained high taxonomic diversity and high evolutionary rate up to their extinction at the Early/Late Maastrichtian boundary (excluding the representatives of the genus *Tenuipteria*), which places them, similarly to the early Late Cretaceous representatives of the group, among the most efficient biostratigraphical tools.

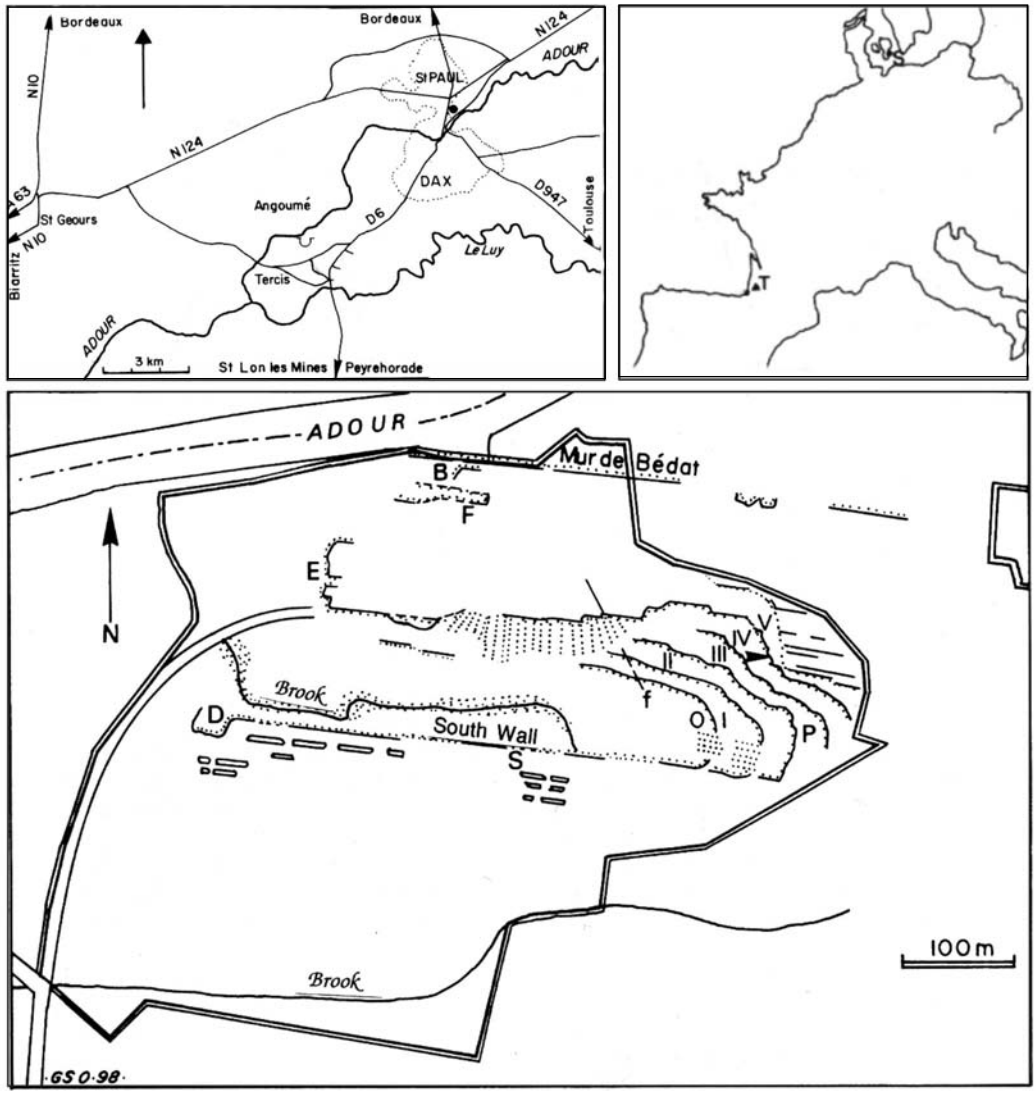

Fig. 1. Geographical location of the geological site at Tercis-les-Bains (compiled after ODIN 2001); A-B. Geographical location of Tercis; C. The sketch map of the Tercis Quarry; B, D, E, F, P – particular outcrops of the Tercis site, with P marking the main outcrop, and E the additional one used in the present paper; I, II, III, IV, and V – exploitation platforms within the main (P) outcrop (see figure 2 for the stratigraphical range of particular platforms)

Inoceramids in the Tercis section, studied here, were first collected in the 1980s, with their subsequent taxonomic description (DHONDT 1993). Most of that material came, however, from a part well below the Campanian-Maastrichtian boundary and numerous specimens were imprecisely located in the succession. New collecting between 1993 and 2001 brought markedly richer and more precisely horizoned material, with the number of determinable specimens raised to above 300, and good representation of almost the complete succession as available in the Tercis section. A small part of this new collection was recently commented on by Odin (2001, chapter D3a; with determinations by A.V DHONDT), but the greater part is treated herein for the first time.

THE TERCIS SECTION

The Geological Site at Tercis, SW France (Text-fig. 1), comprises several sections where Triassic to Palaeogene deposits can be observed. The Campanian – Maastrichtian succession is accessible in the Grande Carrière Moderne. The first detailed lithostratigraphic log and biostratigraphic interpretation of the Campanian – Maastrichtian succession was provided by HANCOCK & *al*. (1993), with further refinement by ODIN & ODIN (1994) and ODIN (1996a, b). HANCOCK & KENNEDY (1993) and WARD & ORR (1997) described the ammonite fauna and DHONDT (1993) the inoceramids available at that time. The comprehensive survey on the succession with detailed lithological and sedimentological studies, multistratigraphic investigations, as well as detailed history of researches appeared recently (ODIN 2001a) in a comprehensive volume collecting a series of papers of group of palaeontologists and geologists working on the Tercis section in the late 1990s.

The quarry is composed of two sections. The main section, composed of five exploitation platforms, located one above the other, and one independent section (the E section), 400 metres distant (Text-fig. 2). The successions of particular platforms of the main section, and of section E, have been compared and correlated using distinct sedimentological characters. The base of section E correlates with level 114.1 of the main quarry (Text-fig. 2). All five platforms of the main section are characterised by very similar succession with the same thickness relationships. Slightly different thicknesses were measured in section E.

The lithological succession of the Tercis section has been subdivided into two units: the d'Avezac Unit, composed of pithonellid bearing limestones, with 5 to 15 % of clay, from level 0 to level 100, and the lithologically similar Les Vignes Unit, characterised by flint nodules (Text-fig. 2). The d'Avezac Unit has been subdivided further into 5 subunits, depending on the glaucony content. The Les Vignes Unit was subdivided into 2 subunits, based on the colour of the flint nodules (Text-fig. 2) (see ODIN 2001a, chapter B1a).

Precise correlation with the lithological log of HANCOCK & *al*. (1993) is rather difficult. The approximate correlation is shown in Fig. 2 and a more detailed discussion is provided by Odin (2001A, chapter B1a, fig. 11 and chapter D3a, figure 1). Among the most convincing correlation levels is the boundary between units J and K of HANCOCK & *al*. (1993) with level 98 of ODIN (2001a).

INOCERAMID SUCCESSION IN TERCIS

Inoceramid bivalves are the dominant macrofossil group in the Tercis succession. Intact shells or inoceramid shell debris have been observed sub-continuously from level 4.5 to level 171.0 (Text-figs 3-4; see ODIN 2001, chapter D3a). Very rich shell material occurs between levels 45.1 and 47.4 and between levels 66.5 and 67.3, referred to here as the lower and the upper interval with inoceramid concentration respectively. Both intervals give good opportunities for collecting. Although shell debris is present and sometimes abundant, the intact specimens are difficult to collect, and several other intervals (e.g. 11 to 21, 52 to 65, 68 to 80 and 114 to 117) are completely barren in respect of inoceramid remains. Taxonomic diversity is relatively high throughout the succession with a distinct peak around level 93 (Text-fig. 5)

The oldest finds come from levels 6.5 to 6.7, where inoceramids are represented by rare but relatively large specimens of *Cataceramus paraheberti* (SORNAY, 1968), *C. subcompressus* (MEEK & HAYDEN, 1856) and *C*. ex gr. *balticus* (BÖHM, 1907). Above, up to the lower interval with inoceramid concentration around level 47, the record is very scanty, with single finds of "*Inoceramus*" *conlini* WALASZCZYK, COBBAN & HARRIES, 2001, *Cataceramus* ex gr. *balticus* (BÖHM, 1907), *C. goldfussianus* (D'ORBIGNY, 1847), *C. mortoni* (MEEK & HAYDEN, 1860), *Cordiceramus heberti* (FALLOT, 1885), "*Inoceramus*" *algeriensis* HEINZ, 1932, and "*Inoceramus*" *borilensis* JOLKIČEV, 1962. A very characteristic form, representing most probably a new species, comes from level 42.4 (Pl. 2, fig. 6). Unfortunately it is represented by a single specimen and further material is needed to make a reasonable final decision.

All of these taxa are either known to span a relatively large interval ranging from the upper Lower through lower Upper Campanian, or their stratigraphical position is poorly known. Therefore, they do not allow a more precise stratigraphical classification of that part of the section.

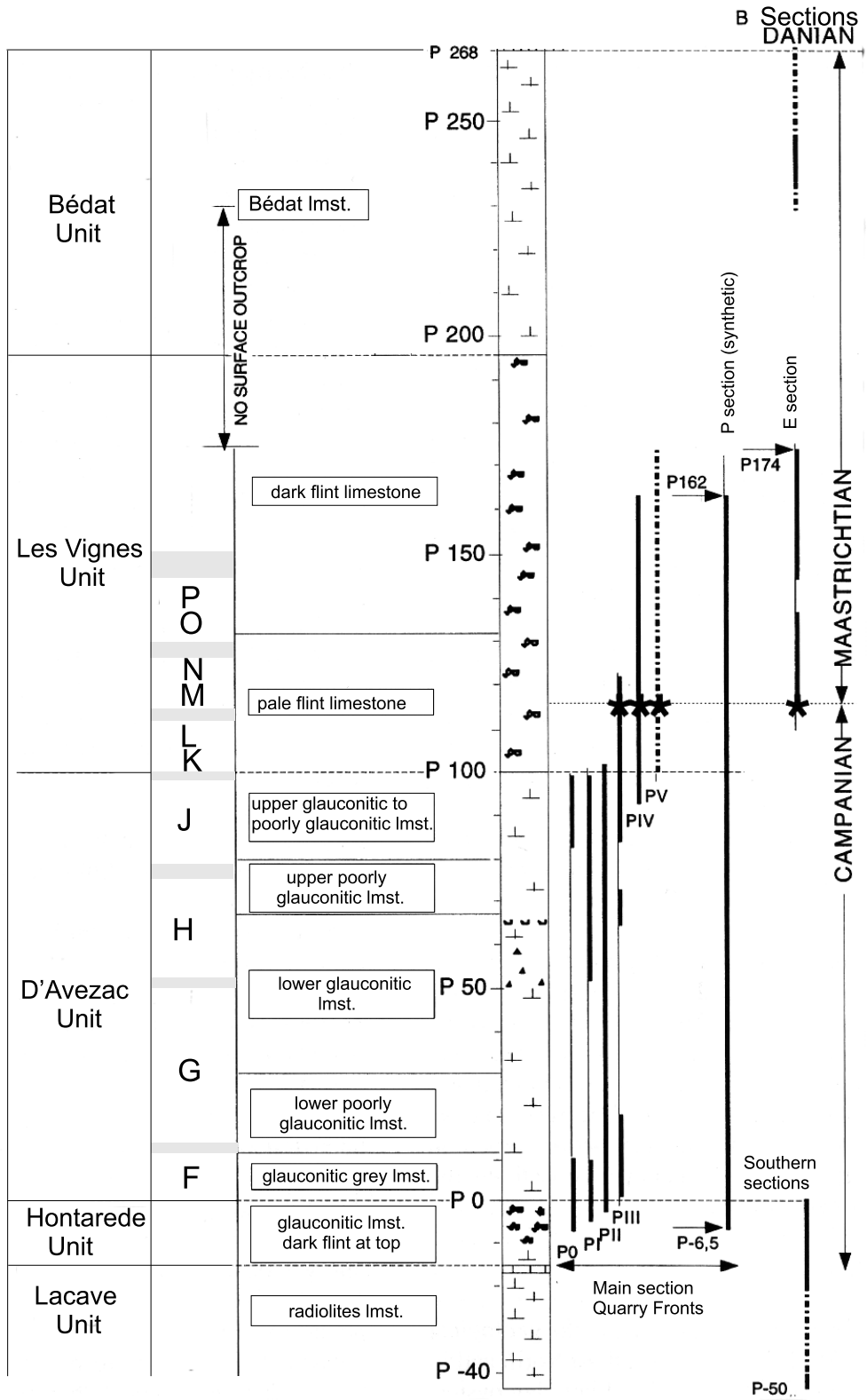

Fig. 2. Composite section of the Campanian and Maastrichtian succession of the Tercis Quarry (compiled after ODIN, 2001); the letter symbols to the left are lithological units of HANCOCK & *al*. (1993)

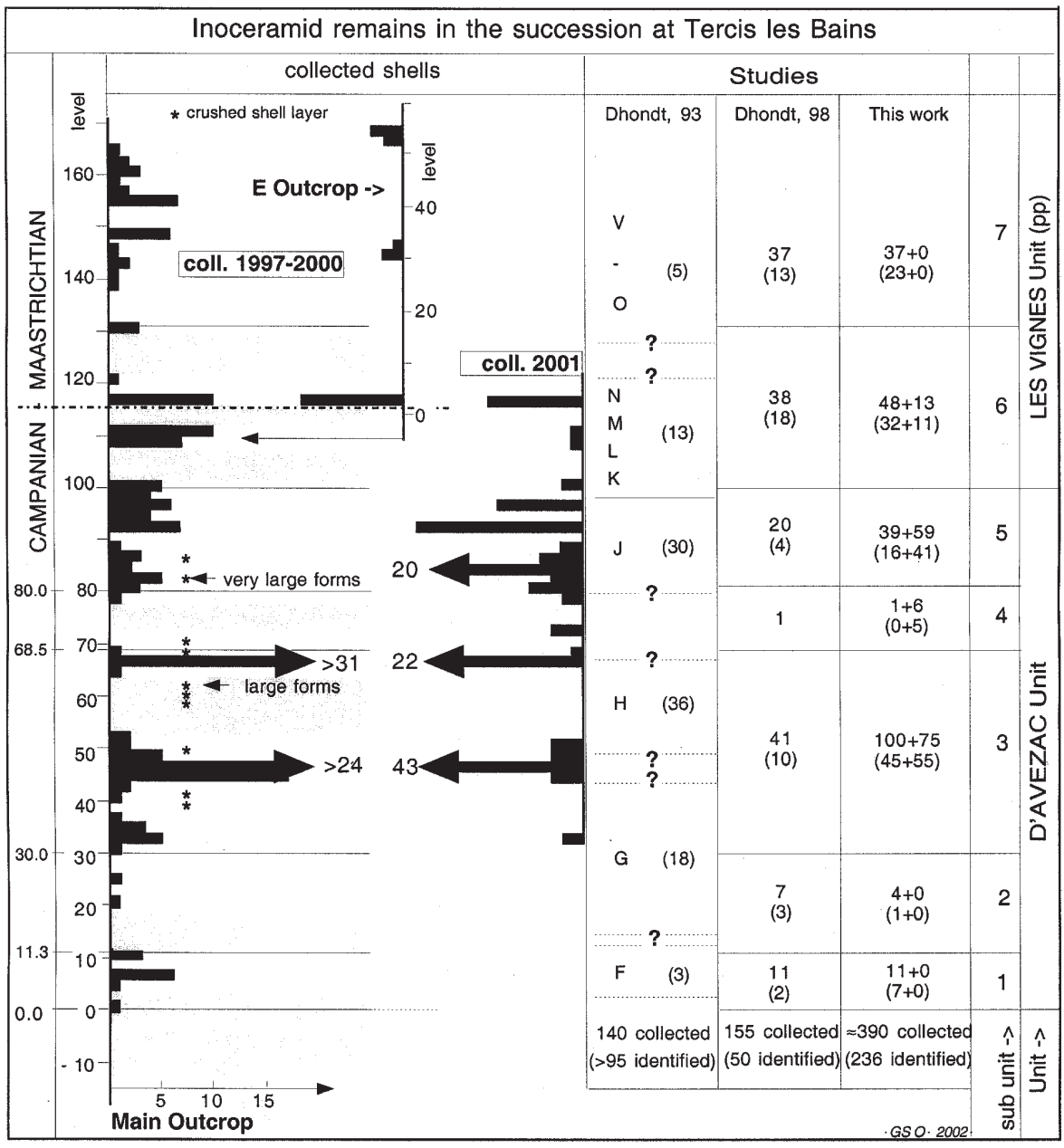

Fig. 3. Quantitative distribution of inoceramids in the Tercis section

Around level 47 (more precisely between level 45.1 and 47.4) occurs the lower interval with frequent inoceramids. The assemblage here is very distinctive and diverse taxonomically. The most common taxa are *Cataceramus goldfussianus* (D'ORBIGNY, 1847), *Cataceramus palliseri* (Douglas, 1942), and *Sphaeroceramus pertenuiformis* WALASZCZYK, COBBAN & HARRIES, 2001. Also noted are *Cataceramus?* aff. *barabini* (MORTON, 1834), and "*Inoceramus*" *borilensis* JOLKIČEV, 1962.

Above this level, up to the next interval with abundant inoceramids located around level 67, there is an about 20 metre thick barren succession with almost no inoceramid record (this is also the case with the ammonites). To what extent this is a local phenomenon or a record of supra-regional Late Campanian events remains unclear and more detailed studies on other Upper Campanian sections are required to answer the question.

The barren interval finishes sharply at the base of the second interval with high inoceramid concentration, in the interval between levels 66.5 and 67.4. The dominant inoceramids of this interval differ markedly from those characterising the lower 'concentration' level. The main

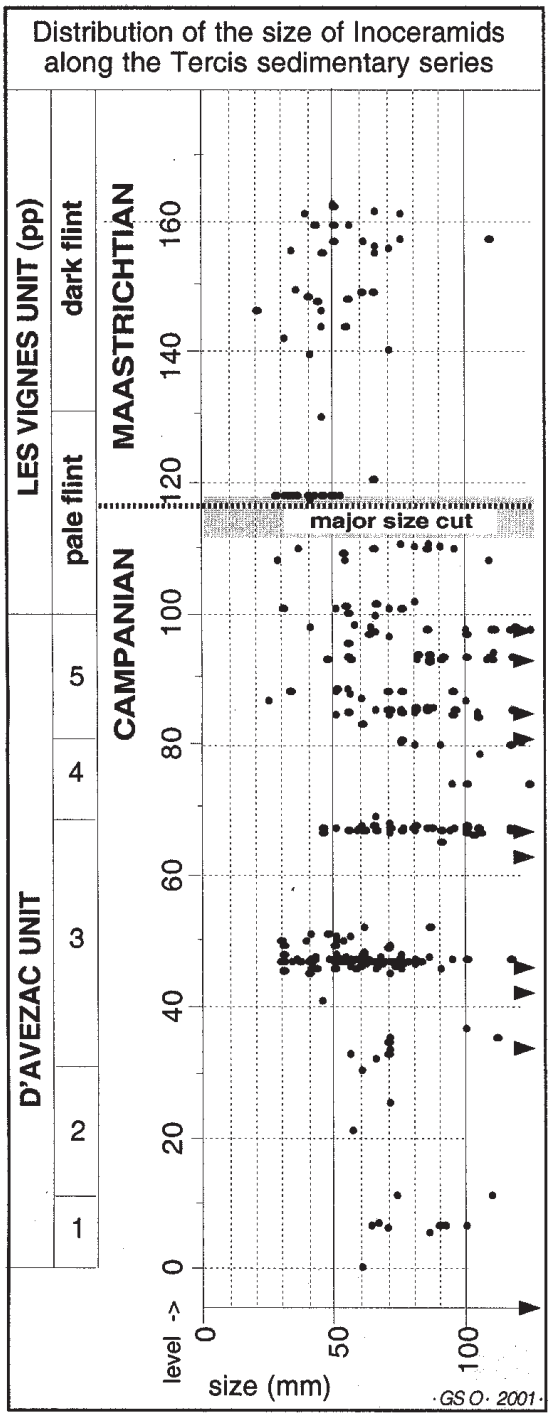

Fig. 4. Size distribution of inoceamid specimens in the Tercis section

morphotypes are represented by moderate to moderately large, regularly ribbed, usually weakly oblique forms of the following species: "*Inoceramus*" *altus* MEEK, 1871, "*Inoceramus*" *sagensis* OWEN, 1852, *Cataceramus goldfussianus* (D'ORBIGNY, 1847), and "*Inoceramus*" *vanuxemi* MEEK & HAYDEN, 1869.

Above the second inoceramid concentration interval (around level 67.0) the group very quickly becomes rare. A few specimens of "*I.*" *vanuxemi* and "*I.*" *sagensis*, found at level 73.9 show, however, that the assemblage characteristic of the second inoceramid concentration continues distinctly higher. Its exact range is not recognised, but in the next level with frequent inoceramids, around level 84, the taxonomic composition of the inoceramid assemblage is very different, with most of the species characteristic of the interval below, disappearing.

The interval around level 84 is dominated by *Cataceramus palliseri* (DOUGLAS, 1942)(= *Inoceramus regularis* D'ORBIGNY). The number of associated species is, however, relatively high. Among the well-represented forms are: *Cataceramus goldfussianus* (D'ORBIGNY, 1847), "*Inoceramus*" aff. *gandjaeformis* WALASZCZYK, COBBAN & HARRIES, 2001, and *Endocostea* aff. *typica* (WHITFIELD). Two specimens were provisionally referred to *Inoceramus oblongus* WHITE. From level 84 comes a single specimen of a large, strongly rugate form, which represents presumably the herein newly described "*Inoceramus*" *cobbani*.

A very similar assemblage is noted higher, in the next interval with nuemerous inoceramids around level 93. Besides "*Inoceramus*" *oblongus* MEEK, 1871, *Cataceramus? palliseri* (DOUGLAS, 1942), "*Inoceramus*" *gandjaeformis* WALASZCZYK, COBBAN & HARRIES, 2001, it also contains "*Inoceramus*" *alaeformis* ZEKELI, 1852, of authors, "*Inoceramus*" *balchiformis* WALASZCZYK, COBBAN & HARRIES, 2001, "*Inoceramus*" *magniumbonatus* DOUGLAS, 1942 and "*Inoceramus*" *cobbani* sp. nov.

Above level 93, but still in the topmost Campanian, appear two successive faunas, with distinctly lower taxonomic variability than in the assemblages below, but with very characteristic and easily identifiable species. The stratigraphically older fauna is dominated by forms belonging to the genus *Trochoceramus* occurring in the interval between levels 97.5 and 102, represented here by *T. costaecus* (KHALAFOVA, 1966) characterised by fine ornament, with closely spaced rugae, a weak inflation and a relatively small size. The non-trochoceramid taxa are rare and the collected material at hand is not specifically identifiable, but at least three non-trochoceramid species are present.

The younger assemblage, and actually the youngest Campanian inoceramid assemblage recognised so far in the Tercis section, occurs between levels 108 and 111. It contains two species described recently from the US Western Interior: "*Inoceramus*" *redbirdensis* WALASZCZYK, COBBAN & HARRIES, 2001, occurring fairly frequently and, more rarely, "*Inoceramus*" *wyomingensis* WALASZCZYK, COBBAN & HARRIES, 2001. The former is a very distinctive morphotype, which may easily be identi-

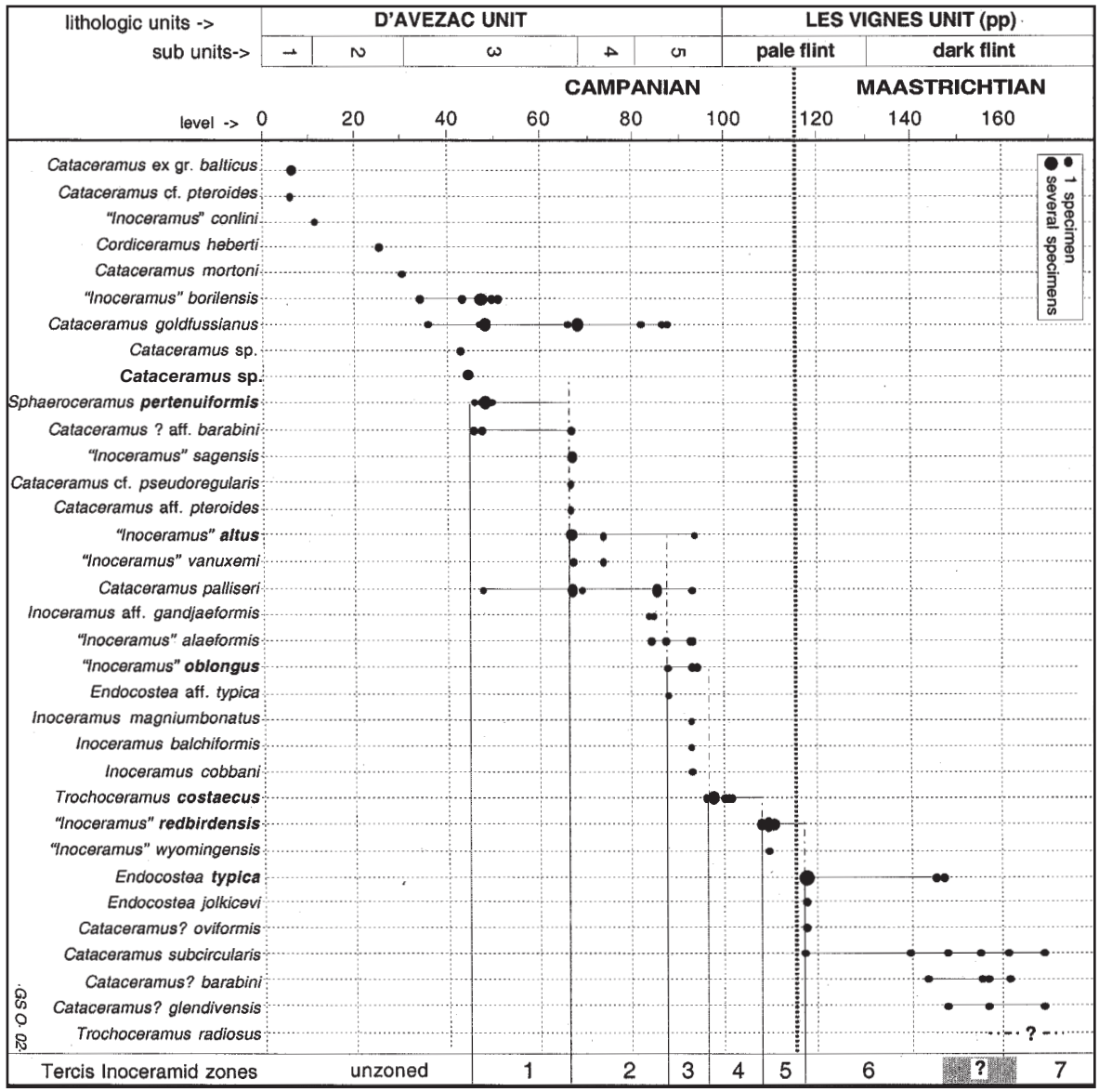

Fig. 5. Stratigraphical distribution of inoceramid species and inoceramid zonation of the upper Upper Campanian and of the Lower Maastrichtian in the Tercis section; inoceramid zones at the bottom are as follows: 1 – *Sphaerocermus pertenuiformis* Zone; 2 - "*Inoceramus*" *altus* Zone; 3 – "*Inoceramus*" *oblongus* Zone; 4 – *Trochceramus costaecus* Zone; 5 – "*Inoceramus*" *redbirdensis* Zone; 6 – *Endocostea typica* Zone; 7 – *Trochoceramus radiosus* Zone

fied and thus appears to be a good taxon for recognition of the Campanian – Maastrichtian boundary interval.

Six metres higher, at level 117.1, the main change in inoceramid fauna takes place (see also Text-fig. 4). Here, in an interval about 1 metre thick, appears a fauna, composed almost exclusively of small-sized *Endocostea typica* WHITFIELD, 1880, accompanied by very rare *Cataceramus subcircularis* (MEEK, 1876). Although the collected material is rich, it must be emphasised that the level around 117 is very widely exposed for easy sampling and this may be the reason for the apparent inoceramid abundance there. [The change in the inoceramid fauna may actually take place below, somewhere in the interval between the last "*Inoceramus*" *wyomingensis* and the level with numerous *Endocostea typica*, but so far no data from that interval are available]. Higher up the section, almost at the top of the exposed part of the Tercis section, *Endocostea typica* disappears (two specimens are known from level around 145) and the assemblage is composed of dominant *Cataceramus subcircularis*, associated with rare *C.? barabini* (MORTON, 1834) and, in the highest part of the section, at level 150-160, *C.? glendivensis* WALASZCZYK, COBBAN & HARRIES, 2001.

Of importance is the single find of *Trochoceramus* well above the base of the Maastrichtian, and well above the level with common trochoceramids between 97.5 and 102 m. It is *Trochoceramus radiosus* (Quaas, 1902), found in unit V of HANCOCK & *al*. (1993; see DHONDT 1993), estimated to be about 50 m above the base of the *Endocostea typica* Zone.

INOCERAMID BIOSTRATIGRAPHY AND ITS CORRELATION WITH THE US WESTERN INTERIOR SUCCESSION

Besides the lowermost part of the succession at Tercis, which in inoceramid terms, does not reveal a clear stratigraphical pattern (Text-fig. 5), the inoceramid record enabled the establishing of the inoceramid zonal scheme. Seven zones are recognised, which with slight modification, correspond closely to the zonation proposed recently for the Campanian – Lower Maastrichtian of the US Western Interior (WALASZCZYK & *al*. 2001), reflecting a high similarity of both areas in respect of their inoceramid faunas (WALASZCZYK & *al*. 2002). From bottom upward, these are zones of (Text-fig. 5): *Sphaeroceramus pertenuiformis*, "*Inoceramus*" *altus*, "*Inoceramus*" *oblongus*, *Trochoceramus costaecus*, "*Inoceramus*" *redbirdensis*, *Endocostea typica*, and *Trochoceramus radiosus*. All of the zones are defined as interval range zones with the base of particular zones defined by the first occurrence of the eponynous species.

The applied zonation, its chronostratigraphic interpretation and correlation with the Western Interior inoceramid and *Baculites* zonation is as follows (from top downward):

Sphaeroceramus pertenuiformis Zone

The base of the *Sphaeroceramus pertenuiformis* Zone is placed at the base of the lower interval with inoceramid concentration, which corresponds to level 45.1. The actual position of this boundary may, however, be lower, due to the very incomplete inoceramid record below that interval. Similarly, there is a problem with the actual position of the upper boundary of the zone. Its present location at level 66.5, indicated by the FO of the index taxon of the successive zone of "*Inoceramus*" *altus*, may appear too high. The reason is the almost complete absence of inoceramids from between the lower and upper interevals with inoceramid concentration.

The *Sph. pertenuiformis* Zone is characterised by a very distinctive inoceramid assemblage. Besides the nominative species, common species are: "*Inoceramus*" *borilensis* JOLKIČEV, 1962, *C. goldfussianus* (D'ORBIGNY, 1847), *Cataceramus palliseri* (DOUGLAS, 1942), and *Cataceramus*? aff. *barabini* (MORTON, 1834).

The inoceramid assemblage of the *Sph. pertenuiformis* Zone in Tercis corresponds well to the time-equivalent assemblage recognised in the US Western Interior. In the latter area the *Sph. pertenuiformis* Zone corresponds

Chronostratigraphy	Inoceramid zones, Tercis	Western Interior *Baculites* and *Inoceramus* Zonations (after COBBAN 1994, and references therein; and WALASZCZYK & *al*. 2001)	
L. Maastrichtian (pars	*Trochoceramus radiosus*	*T. radiosus*	*Baculites grandis*
	Endocostea typica	"*I.*" *incurvus* *E. typica*	*Baculites baculus*
U. Campanian (pars)	"*Inoceramus*" *redbirdensis*	"*Inoceramus redbirdensis*	*Baculites eliasi*
	Trochoceramus costaecus	"*Inoceramus*" *oblongus*	*Baculites jenseni*
	"*Inoceramus*" *oblongus*		*Baculites reesidei*
	"*Inoceramus*" *altus*	"*Inoceramus*" *altus*	*Baculites cuneatus* *Baculites compressus* *Didymoceras cheyennense*
	Sphaeroceramus pertenuiformis	*Sphaeroceramus pertenuiformis*	*Exiteloceras jenneyi* *Didymoceras stevensoni*

roughly to the ammonite zones of *Exiteloceras jenneyi* and of *Didymoceras stevensoni*, which in the subdivision of the Campanian applied in the USA, places it in the lower Upper Campanian.

"*Inoceramus*" *altus* Zone

The base of the zone is placed at the base of the higher level with inoceramid concentration, which corresponds to level 66.5. As mentioned above, the actual position of this boundary may, however, be slightly lower, in view of the lack of inoceramid records in the interval below. The upper boundary of the zone is marked by the first occurrence of "*Inoceramus*" *oblongus*, somewhere between levels 80 and 88. The highest record of "*I.*" *altus* comes from level 93.6, although the highest record of the assemblage characterising the zone comes from level 73.9.

This zone contains a very characteristic assemblage, with numerous weakly oblique and regularly rugate species. The record is limited, however, mostly to the lowermost 2 metres of the zone. The most typical taxa are: "*Inoceramus*" *altus* MEEK, 1871, "*Inoceramus*" *sagensis* OWEN, 1852, *Cataceramus?* aff. *barabini* (MORTON, 1834), and "*Inoceramus*" aff. *pseudoregularis* SORNAY, 1962; also well represented is *C. goldfussianus* (D'ORBIGNY, 1847) (see Pls 4-6). From the upper part of the zone come some other forms with unknown specific affinities (Pl. 7, figs 2, 5).

In the US Western Interior it is the assemblage that characterises above all, the *Baculites compressus* ammonite Zone, known from the famous material of the Sage Creek section, as well as from the mass occurrences in western Colorado. The stratigraphically oldest representatives of the assemblage come, however, from the underlying *Didymoceramas cheyenense* Zone, whereas the youngest come from the basal part of the overlying *Baculites cuneatus* Zone. The precise correlation of the ammonite and inoceramid zonal boundaries at that interval has yet to be worked out.

"*Inoceramus*" *oblongus* Zone

The base of the zone, marked by the FO of the index taxon, lies somewhere between levels 80 and 88, and its precise location still needs further collecting. Its upper boundary lies at level 97.5, the level of the FO of representatives of the genus *Trochoceramus*.

The inoceramid assemblage of this zone is inevitably the most diverse taxonomically within the whole Tercis succession. The most common species in the lower part (around level 85) of the zone is *Cataceramus? palliseri* (Douglas, 1942) (Pl. 8, Figs 1-2) accompanied by "*Inoceramus*" aff. *gandjaeformis* Walaszczyk, Cobban & Harries, 2001 (see Pl. 8, Figs 3,6), which is very characteristic of this level. The index species of the zone is more common higher up, around level 93, which is also the level with the highest taxonomic diversity of inoceramid fauna. Besides "*I.*" *oblongus* MEEK, 1871 , *Cataceramus goldfussianus* (D'ORBIGNY, 1847), "*Inoceramus*" *alaeformis* ZEKELI, 1852 (of authors), "*Inoceramus*" aff. *gandjaeformis* WALASZCZYK, COBBAN & HARRIES, 2001, and *C. palliseri* (DOUGLAS, 1942) (see Pls 8-10), also encountered here are: "*I.*" *magniumbonatus* DOUGLAS, 1942, "*I.*" *cobbani* sp.nov., "*I.*" *balchiformis* WALASZCZYK, COBBAN & HARRIES, 2001, and "*Inoceramus*" sp., an elongated, regularly ornamented (not illustrated herein), which represents presumably a new species. From a level slightly below, around level 88, comes *Endocostea* sp. (Text-fig. 7), which seems to be the oldest member of the genus.

The details of the inoceramid succession within the "*I.*" *oblongus* Zone are still not sufficiently known to give a precise distribution of particular taxa, but it seems that further subdivision of the zone is possible.

In the US Western Interior, the "*I.*" *oblongus* Zone characterises roughly the ammonite zone of *Baculites reesidei*. The precise correlation of its lower and upper boundaries is, however, unknown.

***Trochoceramus costaecus* Zone**

The lowest specimen of the eponymous species was found at level 96.7, marking the base of the zone. The top of the zone is placed at level 108, the level of the FO of "*Inoceramus*" *redbirdensis* WALASZCZYK, COBBAN & HARRIES, 2001. The occurrence of *Trochoceramus* (Pl. 11; Pl. 12, figs 1-3, 7) is limited to the lower part of the zone. The stratigraphically highest specimen was found at level 101.9. From higher levels of the zone the inoceramid fauna is practically unknown.

The inoceramid assemblage of the *Trochoceramus costaecus* Zone has not been recognised in the Western Interior succession, but this does not preclude its presence there. In terms of the Western Interior *Baculites* zonation the *T. costaecus* Zone may correspond to the *Baculites jenseni* ammonite Zone or even higher, to the lower part of the *Baculites eliasi* ammonite Zone.

"*Inoceramus*" *redbirdensis* Zone

The base of the zone is located at level 108, the lowest occurrence level of the index taxon. As in the case of the preceeding zone, the index taxon was found so far only in the lowermost part of the zone (the stratigraphically higest specimen was found at level 110.5). A relatively thick, 7 m interval of the zone has no inoceramid

record. A single species, "*Inoceramus*" *wyomingensis* WALASZCZYK, COBBAN & HARRIES, 2001, was found associated with the index taxon.

Both species (Pl. 12, Figs 5-6; Pl. 13, Figs 12-16) were recognised originally in the US Western Interior (WALASZCZYK & *al*. 2001) in the lower and middle parts of the *Baculites eliasi* ammonite Zone.

"*I.*" *redbirdensis* is a very characteristic species, and its occurrence may be used as a very practical proxy for the Campanian – Maastrichtian boundary. Using the mean rate of deposition calculated in that portion of the quarry (Odin 2001a, chap. B1c) the taxon would have lived about 0.2 Ma before the boundary.

***Endocostea typica* Zone**

The base of the zone is placed at level 117.1 and marks a radical change in inoceramid faunas. At the base of the zone the inoceramid assemblage is an almost monospecific assemblage of the eponymous species (Pl. 13, Figs 1-5, 7-8. 11). The associated forms represented by *Endocostea jolkicevi* sp.nov., *Cataceramus subcircularis* (MEEK, 1876), *Cataceramus? oviformis* WALASZCZYK, COBBAN & HARRIES 2001 and *Cataceramus? barabini* (MORTON, 1834) are very rare (Pl. 13, Figs 6, 9-10; Pl. 14, Figs 1-4, 6, 8-9, 11-14). The middle and upper parts of the zone are poorly documented. However, the eponymous species does not dominate any more. In the upper part of the zone appears the very characteristic species *Cataceramus? glendivensis* WALASZCZYK, COBBAN & HARRIES, 2001 (Pl. 14, Figs 5, 7, 12). The species also appears in a similar stratigraphical position in the US Western Interior (WALASZCZYK & *al*. 2001), where it ranges higher into the successive *Trochoceramus radiosus* Zone, and in Austria (TRÖGER & *al*. 2002), and it seems to be a potentially a very useful biostratigraphical marker. Its record in the Tercis section is, however, very limited and consequently we did not distinguish a separate *C.? glendivensis* Zone.

The zone is well represented in the US Western Interior, where the mass occurrence of *E. typica* at its base is a very good marker of the ammonite zone of *Baculites baculus*. The upper boundary of the zone lies in the topmost part of the *B. baculus* Zone.

***Trochoceramus radiosus* Zone**

It is the highest inoceramid zone distinguished in the Tercis succession. The presence of this zone is documented by a single specimen of *Trochoceramus radiosus* (QUAAS, 1902) (see Pl. 14, Fig. 10), found in unit V of HANCOCK & *al*. (1993; see DHONDT 1993). It corresponds roughly to level 170 in the present scheme. This zone is well represented in the US Western Interior, where it corresponds to the uppermost part of the *Baculites baculus* ammonite Zone and the overlying *Baculites grandis* Zone.

INOCERAMIDS AT THE CAMPANIAN/MAASTRICHTIAN BOUNDARY

As recently discussed (WALASZCZYK & *al*. 2002), the base of the Maastrichtian, in inoceramid terms, falls in an interval between the last occurrence of "*Inoceramus*" *redbirdensis* and the first appearance of *Endocostea typica* Whitfield. When the respective zones are defined as interval zones, the boundary is located in the topmost part of the former. In practice, the FO of *E. typica* is a very useful proxy of the boundary. In Tercis and also in the Western Interior, this species appears in abundance, in monospecific concentrations that are easily located in the section. It is accompanied by rare *Cataceramus subcircularis* (MEEK) and an unassigned specifically *Cataceramus*. The first appearance of *E. typica* also marks a significant size descrease of inoceramid faunas (see Text-fig. 4), what may be used as a very convenient practical tool for the boundary position.

Close to the boundary is also the FO of the genus *Trochoceramus*, used as one of the boundary events by Odin (2001). The very characteristic ornamentation of this species makes it easy to use. This occurrence characterises the deosists about 0.8 Ma older that the stage boundary.

In the US Western Interior, according to the inoceramid correlation, the Campanian/Maastrichtian falls in the topmost part of the *Baculites eliasi* ammonite Zone (above the highest record of "*I.*" *redbirdensis* and just below the first occurrence of *E. typica*) (see WALASZCZYK & *al*. 2001, 2002).

REPOSITORIES AND CATALOGUING SYSTEM

The whole collection is housed at the Université P. & M. Curie and will be preserved in the Museum facilities planned to be realised in the future near the Geological site at Tercis.

The location of the specimens in the succession is referred to "levels", distinguished in the quarry and not to a metre scale, although these two values are probably very close (see ODIN 2001). It is because of the homogeneity of the succession and problems with the precise lateral correlation within the quarry with the original measurements made and marked in 1992.

The levels of the specimens collected from the E section are characterised by a level quoted later with "a" in

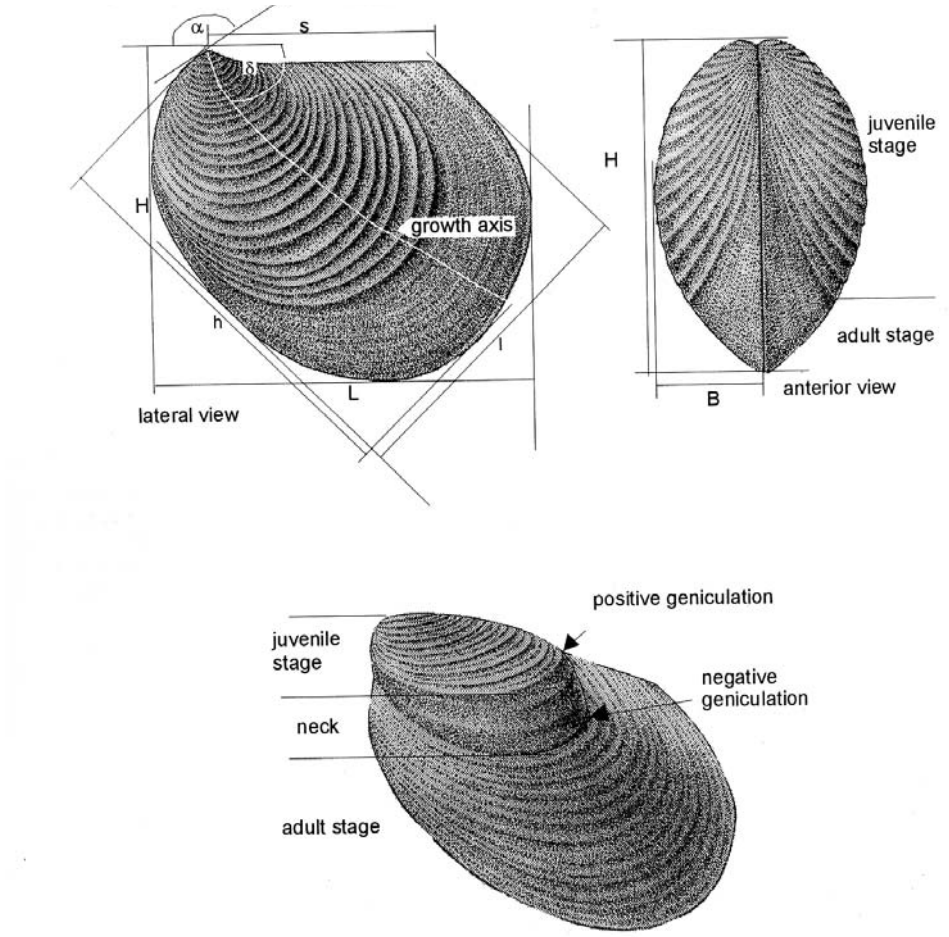

Fig. 6. Terminology and measurements of the external inoceramid features as here applied

order to indicate that precise correspondence with the main section may possibly be slightly biased. Specimens collected loose, but which can be attributed to lithological units on lithological grounds are marked with the level shown in brackets.

SYSTEMATIC ACCOUNT

Genus *Cordiceramus* HEINZ, 1932

TYPE SPECIES: *Inoceramus cordiformis* SOWERBY (1823, p. 61, pl. 440), from Gravesand, England, *Micraster coranguinum* echinoid Zone, Santonian.

Cordiceramus heberti (FALLOT, 1885)
(Pl. 1, Fig. 6)

1885. *Inoceramus heberti* FALLOT, p. 249, pl. 7, fig. 1.
2001. *Cordiceramus heberti* (FALLOT); WALASZCZYK & *al*., pl. 7, figs 4, 8, 11 (full synonymy therein)

TYPE: The holotype is the original of FALLOT (1885, pl. 7, fig. 1) housed in the E. FALLOT collection of the Laboratoire de Paléontologie, Muséum national d'Histoire naturelle de Paris. The specimen comes most probably from the Middle Campanian (see discussion in WALASZCZYK & *al*. 2001).

MATERIAL: Single specimen IW-9 from level 25.5.

DESCRIPTION: The specimen is the internal mould of a single RV, with postero-ventral part missing, with h max = 69 mm. The umbonal part is indistinct, with the beak projecting only slightly above the hinge line. The hinge line is moderately long, straight. The growth axis is almost straight, slightly convex anteriorly. The broadly convex

anterior margin passes into the rather narrowly convex ventral margin. The postero-ventral margin is not preserved, but the postero-dorsal margin is straight, parallel to the growth axis.

The surface is ornamented with sharp-edged concentric rugae, with flat-floored interspaces increasing in size distinctly ventralward. The rugae are superimposed by distinct growth lines. Anteriorly of the growth axis the rugae display a narrow flexure zone, where they cross the growth lines obliquely.

REMARKS: The moderate obliquity, subquadrate outline, and the character of ornament (with a characteristic anteriorly located flexure zone) show the Tercis specimen to belong to *Cordiceramus heberti* (FALLOT, 1885). From *Cataceramus beckumensis* (GIERS, 1964), which is very similar in respect of general outline, it differs in its type of ornament. WALASZCZYK & *al*. (2001) recently discussed the species based on North American material.

OCCURRENCE: In the US Western Interior it is known from the *Baculites gregoryensis* ammonite Zone of the Middle Campanian. The holotype comes from SE France, most probably from an equivalent level.

Genus: *Cataceramus*, HEINZ, 1932

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

Cataceramus ex gr. *balticus* (BÖHM, 1907)
(Pl. 1, Fig. 5)

MATERIAL: IW-1, IW-3, IW-5, all from level 6.5, and and IW-6 from level 7.0.

REMARKS: From the bottom part of the section comes a series of poorly preserved, moderately large single valve internal moulds, which may be called the *'balticus*" morphotype. All are characterised by the "*balticus*" outline, with moderate to weak inflation and a regular concentric ornament. The rugae are widely spaced. The character of the growth lines cannot be observed.

The *balticus* group, as understood here, comprises *C. balticus* (BÖHM, 1907), *C. pteroides* (GIERS, 1964) and *C. marcki* (GIERS, 1964)(see also WALASZCZYK 1997). The Tercis specimens most closely resemble the latter species, which, in contrast to *C. balticus* (BÖHM, 1907), possesses a more robust ornament and moderate inflation (see GIERS 1964). Having only a few specimens to hand it is rather difficult to make a more proper identification.

OCCURRENCE: In Tercis, *Cataceramus* ex gr. *balticus* is limited to the lowermost part of the section.

Cataceramus? barabini (MORTON, 1834)
(Pl. 14, Figs 4, 11, 14)

1834. *Inoceramus Barabini* MORTON, p. 62, pl. 13, fig. 11; pl. 17, fig. 3.
?1860. *Inoceramus cuneatus* MEEK & HAYDEN, p. 181.
1876a. *Inoceramus Cripsii*?, var. *Barabini*, MORTON; MEEK, p. 49, pl. 12, fig. 3; [?pl. 13, fig. 1]; text-figs 1-4.
1880. *Inoceramus barabini* MORTON; WHITFIELD, p. 398 (?pars), [?pl. 7, fig. 7]; pl. 9, fig. 8.
1898. *Inoceramus barabina* MORTON; LOGAN, p. 504, pl. 109, fig. 2.
1913. *Inoceramus Barabini* MORTON; BÖSE, p. 35 (pars), pl. 4, fig. 1; [non pl. 3, figs 1, 7; pl. 3, fig. 1 = *Endocostea typica* WHITFIELD].
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*]
1970. *Inoceramus barabini* MORTON; KAUFFMAN, p. 217 (pars), pl. 1, fig. 8 [non pl. 1, fig. 3].
?1974. *Inoceramus barabini* MORTON; KOCIUBYNSKIJ, p. 83 (?pars), ?pl. 23, fig. 2 [non pl. 20, fig. 1 = ?*Cataceramus subundatus* (MEEK)].
2001. *Cataceramus? barabini* (MORTON); WALASZCZYK & *al*.; 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
2001. *Platyceramus alaeformis*; ODIN, pl. 2, fig. 14.
2001. *Inoceramus* sp.indet.; ODIN, pl. 3, fig. 26.

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

MATERIAL: Three specimens IW-157 from level 155.6; IW-111 from level 143.8; IW-147 from level 161.1, IW-148 from 140.1.

DESCRIPTION: All of the specimens are internal moulds of single valves. IW-157 (Pl. 14, Fig. 11) is an incompletely preserved LV; its antero-dorsal part is missing. IW-111 (Pl. 14, Fig. 4) is a small-sized specimen. All of the specimens are markedly oblique, with δ = 20-25°, strongly elongated posteriorly. The umbo is indistinct, with the beak projecting very slightly above the hinge line.

The hinge line is long and straight. The anterior margin is short, convex, passing into long and broadly convex antero-ventral and ventral margins. The posterior margin is moderately short, convex. The valves are covered with subregular concentric rugae, usually narrowly spaced.

REMARKS: The specimens referred herein to *C.? barabini* correspond well to the American material as recently illustrated and discussed by WALASZCZYK & *al*. (2001). IW-147 (Pl. 14, Fig. 14) differs slightly in respect of the surface ornament, possessing more widely spaced rugae. Its surface is, however, not particularly well preserved and thus its ornament may have been changed secondarily to some extent.

OCCURRENCE: All Tercis specimens are from the Lower Maastrichtian, as in the case of the American forms illustrated by MEEK (1876a, pl. 13, fig. 1) or recently by WALASZCZYK & *al*. (2001). The precise location of MORTON's type still has to be worked out.

Cataceramus ? aff. *barabini* (MORTON, 1834)
(Pl. 3, Figs 4, 9; Pl. 4, Fig. 1)

?1880. *Inoceramus simpsoni* Meek; WHITFIELD, p. 395, pl. 8, fig. 1.
?1959. *Inoceramus barabini* MORTON; DOBROV & PAVLOVA, p. 140, pl. 22, fig. 2.
2001. *Cataceramus*? aff. *barabini* (MORTON, 1834); WALASZCZYK & *al*., p. 43, pl. 11, figs 1-4; pl. 15, fig. 3.

MATERIAL: IW-33 from level 45.5 and IW-38 from level 47.4; IW-229 from level (47); IW-66 from level 66.5
.
DESCRIPTION: IW-33 and IW-229 are small-sized internal moulds of a LV. IW-38 is a slightly larger internal mould of a RV. All are strongly oblique and elongated posteriorly. The beaks are small, projecting above the hinge line. The hinge line is long and straight. All three specimens possess a subtriangular, axially elongated posterior auricle, well separated from the disc. The shells are regularly to subregularly ornamented by concentric rugae. The rugae pass on to the posterior auricle.

REMARKS: *Cataceramus*? aff. *barabini* was recently described by WALASZCZYK & *al*. (2001) from the *Didymoceras nebrascense* through *Exiteloceras jenneyi* ammonite Zone of the Western Interior. Besides small differences in the ornament and absence of a weak radial sulcus *C*.? aff. *barabini* is very similar to *C.? barabini*. Both forms, however, differ in stratigraphical location; *C*.? *barabini* occurs in the topmost Campanian (*Baculites eliasi* Zone) through lowermost Maastrichtian (to *Baculites grandis* Zone), whereas *C*.? aff. *barabini* occurs in the middle Upper Campanian.

OCCURRENCE: Known from the *Sph. pertenuiformis* Zone and basal "*I.*" *altus* Zone of the Tercis section; described from the lowermost Upper Campanian (*Didymoceras nebrascense* through *Exiteloceras jenneyi* ammonite Zones) of the US Western Interior.

Cataceramus? glendivensis WALASZCZYK, COBBAN & HARRIES, 2001
(Pl. 14, Figs 5, 7, 12)

2001. *Cataceramus? glendivensis* WALASZCZYK, COBBAN & HARRIES, pl. 42, fig. 2, 11; pl. 44, figs 2, 4
2001. *Inoceramus* sp.indet.; ODIN, pl. 3, fig. 27.

TYPE: The holotype, by original designation, is YPM 191001, the original of WALASZCZYK & *al*. (2001, pl. 42, fig. 2), from the upper part of the *Baculites baculus* ammonite Zone of the Glendive section, Montana, USA. YPM 191002 (pl. 42, fig. 11), USNM 507649 and USNM 507650 are paratypes.

MATERIAL: Three specimens; IW-141 from level 148.2; IW-137 from level 157.0 and IW-124 from level 169.0.

DESCRIPTION: All three specimens are internal moulds of single valves. The valves are of rather small to moderate size, weakly inflated. The umbo is delicate, with the beak projecting clearly above the hinge line. The valves are moderately oblique and are characterised by a relatively long, broadly convex anterior margin, passing into a regularly rounded ventral margin, and with a rather short, almost straight posterior margin. The hinge line is long and straight. The posterior auricle is subtriangular and moderately well separated from the disc.

The valves are regularly ornamented with subevenly spaced concentric rugae, with interspaces increasing in size gradually ventralward and weakening slightly when passing onto the posterior auricle.

REMARKS: As remarked already by WALASZCZYK & *al*. (2001) *C.? glendivensis* resembles SORNAY's (1973) species *Inoceramus bebahoaensis* described from the Lower Maastrichtian of Madagascar. The Madagascan species is, however, markedly more inflated and moreover, is characterised by different ornament. It also resembles *Cataceramus beckumensis* (GIERS, 1964) known from the upper Lower and lowermost Upper Campanian of Europe and North America. GIERS' species is less regular in ornament.

OCCURRENCE: In the Tercis section the species is limited to the upper part of the *Endocostea typica* Zone. In the same stratigraphical position it is also known from the US Western Interior, where it ranges higher, into the *Baculites grandis* ammonite Zone.

Cataceramus goldfussianus (D'ORBIGNY, 1847)
(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)

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.
1957. *Inoceramus goldfussi* D'ORBIGNY; SORNAY, no. 57.
? 1968. *Inoceramus balticus* BOEHM; KOCIUBYNSKIJ, p. 142, pl. 27, figs 1-2.
non 1969. *Inoceramus* (*Cataceramus*) *goldfussianus* D'ORBIGNY; COX in MOORE, 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
2001. *Cataceramus gandjaensis* (ALIEV); WALASZCZYK & *al*., pl. 13, figs 2-3; pl. 19, fig. 1

TYPE: The lectotype, by subsequent designation of SORNAY (1957) is MNHP 7593, the original of D'ORBIGNY [1847, pl. 411, figs 1-2; reillustrated by SORNAY (1957, fig. 3) and Sornay (1976, fig. Fig. 5], from the ?Upper Campanian of Royan (Charente-Maritime), SW France.

MATERIAL: IW-27 from level 47.1; IW-12 from level 34.5; IW-28 from level 45.6; ?IW-29 from level 46.1; IW-37 from level 47.5; IW-45 from level 65.0; IW-50 from level 66.5; IW-73 from level 86.5; IW-91 from level 66.5; IW-203 from level 67; IW-232 from level (47); IW-245 from level (47) [or it may be a juvenile of a very large *Sph. pertenuiformis*]; IW-253 and IW-254 from level (47); IW-282 from level 85.1; IW-296 from level 80.5.

DESCRIPTION: Species of moderate to large size for the genus, inequilateral, ?equivalve, moderately inflated. The valve outline is subquadrate to subrectangular. The anterior margin is moderately long, passing into broadly convex antero-ventral and ventral margins. The posterior margin is regularly rounded. The hinge line is long and straight. The Beak projecta slightly above the hinge line. The posterior auricle is only slightly separated from the disc. The ornament is composed of regular to subregular co-marginal rugae, with the interspaces increasing in size gradually ventralward.

REMARKS: The obliquity, valve outline and the type of ornament are the main features displaying a wide range of intraspecific variability. The valve outline ranges from distinctly subrectangular (e.g. Pl. 5, Fig. 2) to subquadrate (e.g. Pl. 3, Fig. 10). Most of the specimens are moderately oblique, with δ around 60°, although the actual values range between 40 (e.g. in the type of the species) and 75°. Although the ornament consists usually of subregularly spaced, round-edged rugae, with interspaces of moderate size, specimens with distinctly larger interspaces do occur (see e.g. SORNAY 1976, pl. 4, figs 1-2).

Into the synonymy of *C. goldfussianus* we put *Inoceramus gandjaensis* ALIEV, 1956. The latter species was interpreted as a separate species based on the different valve outline and ornament (WALASZCZYK & *al*. 2001). High variability in respect of both features, as found in the Tercis material, makes separation of "*I.*" *gandjaensis* and *C. goldfussianus* rather arbitrary.

OCCURRENCE: In Tercis the species is known from the interval spanning the *Sphaeroceramus pertenuiformis* Zone through basal "*Inoceramus*" *oblongus* Zone (which corresponds to the *Bostrychoceras polyplocum* through lower *Nostoceras hyatti* ammonite Zones). Known from the *Didymoceras stevensoni* through the *Baculites compressus* Zones of the US Western Interior.

Cataceramus mortoni (MEEK, 1876)
(Pl. 1, Fig. 4)

non 1856. *Inoceramus proximus* TOUMEY, p. 171 [nomen nudum]
1876a. *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; BOLANOS & 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 & HAYDEN, 1860); WALASZCZYK & *al*., Pl. 7, figs 2-3, 6; Pl. 11, figs 6-8, 10, 12.

TYPE: The holotype is MEEK's (1876, pl. 12, fig. 7) original, reillustrated by WALASZCZYK & *al*. (2001, pl. 11, fig. 12) from the Middle/Upper Campanian boundary interval of the Great Bend of the Missouri River, below Pierre,

South Dakota; USA, Gregory Member of the Pierre Shale. In ammonite terms, this corresponds to the uppermost Middle Campanian *Baculites gregoryensis* and *B. scotti* Zones.

MATERIAL: Single specimen IW-23 from level 30.1.

DESCRIPTION: The Tercis specimen is a single internal mould of the LV. The shell is of moderate size with h_{max} = 56 mm, weakly inflated. The beak is small, not projecting above the hinge line. The anterior margin is relatively long, passing into a broadly convex ventral margin. The posterior margin is short, almost straight. The hinge line is moderately long, straight. The Posterior auricle is of moderate size, not separated from the disc. The shell is covered with closely and regularly spaced, sharp-edged concentric rugae.

REMARKS: WALASZCZYK & *al*. (2001) provided the re-description and illustration of the original American material of the species. The general outline of the shell displays a relatively wide range of infraspecific variation.

OCCURRENCE: In Tercis *Cataceramus mortoni* comes from level 30.1. The species is known from the US Western Interior, from the middle Upper Campanian (*Baculites gregoryensis* through *Didymoceras nebrascense* ammonite Zones of the US Western Interior ammonite division). It probably also occurs in Japan.

Cataceramus? oviformis WALASZCZYK, COBBAN & HARRIES, 2001
(Pl. 14, Fig. 13)

1929. *Inoceramus* sp. DANE, pl. 25, fig. 1.
1988. *Inoceramus balticus* BÖHM; ALIEV & KHARITONOV *in* ALI-ZADE & *al*., p. 266, pl. 21, fig. 1.
1996. *Endocostea* ex gr. *baltica* (BÖHM); WALASZCZYK & *al*., pl. 3, fig. 6.
2001. *Cataceramus? oviformis* WALASZCZYK, COBBAN & HARRIES, pl. 41, fig. 3

TYPE: The holotype, by original designation, is USNM 131542, the original of *Inoceramus* sp. in DANE (1929, pl. 25, fig. 1) (reillustrated by WALASZCZYK & *al*. 2001, pl. 41, fig. 3), from the Nacatoch Sand of the high bluff on the Ouachita River, 1.5 miles north of Arkadelphia, Clark County, Arkansas, USA.

MATERIAL: Single specimen, IW-120 from level 117.8.

DESCRIPTION: The specimen is an internal mould of a single RV, moderate-size, with Lmax = 80 mm. The beak projects only slightly above the hinge line. The hinge line is very long and straight. The valve possesses characteristically a strongly convex anterior margin, passing into a very long, broadly convex ventral margin. The posterior margin is not completely preserved but may be inferred to be similar to the anterior one. The valve is weakly inflated, the disc not separated from the posterior auricle.

The valve is ornamented with regular, subevenly spaced concentric rugae with round-floored interspaces, which increase in size very slowly ventralward.

REMARKS: The species is characterised by a strongly convex anterior margin and strong valve elongation. The type of ornament is identical with that of *Cataceramus? palliseri* (DOUGLAS). In deformed material this may cause difficulties in specific identification of the taxa.

OCCURRENCE: The single specimen from Tercis comes from the very base of the Maastrichtian. The type comes from the Lower Maastrichtian of Arkansas, in the Gulf Coast Plain, but no precise location is known so far. Also known from Montana (*Baculites baculus* ammonite Zone) in the US Western Interior, from the Lower Maastrichtian (*Belemnella lanceolata* Zone) of the Middle Vistula section, central Poland, and from the lowermost Maastrichtian of the Caucasus.

Cataceramus ? *palliseri* (DOUGLAS, 1942)
(Pl. 8, Figs 1-2; Pl. 10, Fig. 4)

1847. *Inoceramus regularis* D'ORBIGNY, p. 516, pl. 410, figs 1-2
1880. *Inoceramus vanuxemi* MEEK & HAYDEN; WHITFIELD, p. 396 (pars), pl. 7, figs 8, ?9 [non pl. 7, fig. 10 = ?*Inoceramus vanuxemi* MEEK & HAYDEN].
1942. *Inoceramus palliseri* DOUGLAS, p. 62, pl. 1, fig. 2.
1958. *Inoceramus balticus* BÖHM; KOCIUBYNSKIJ, p. 18 (pars), pl. 8, fig. 33.
1958. *Inoceramus impressus* D'ORBIGNY; KOCIUBYNSKIJ, p. 20, pl. 9, fig. 36.
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, figs 3-4.
1968. *Inoceramus impressus* D'ORBIGNY; KOCIUBYNSKIJ, p. 144 (pars), pl. 28, fig. 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.

1976. *Inoceramus artigesi* SORNAY, p. 3 (pars), pl. 1, fig. 2 [non pl. 1, fig. 1].
1993. *Selenoceramus sornayi* DHONDT, p 236, pl. 6, fig. 3; pl. 7, fig. 5.
1995. *Endocostea* ?(*Cataceramus*) sp. indet.; MORRIS, p. 261, fig. 2.
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. 57, pl. 27, fig. 2; pl. 33, fig. 2; pl. 37, fig. 1

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, Canada.

MATERIAL: 12 specimens: IW-76 from level 84.7; IW-174 from level 93; IW-192 from level 67; IW-193 from level 67.1; IW-195 from level 69.2; ?IW-197 from level 67; IW-200 from level 66.9; close form is IW-211 from level 47.9; IW-262 from level 85.3; IW-278 from level 85.3; IW-280 from level 85.3 and IW-281 from level 85.3

DESCRIPTION: All of the specimens are represented by internal mould of single valves. The species is of moderate size, mostly with preserved juvenile stage, sometimes with part of the adult stage. Both stages contact along positive geniculation. The anterior margin is broadly convex, passing into the broadly convex ventral margin and thence into the rounded posterior margin. The hinge line is long and straight. The posterior auricle is not separated from the disc. The beak is indistinct, projecting weakly above the hinge line. The juvenile stage is covered with closely and regularly spaced concentric rugae. The adult stage possesses irregular ornament or is almost smooth, at least in the part preserved.

REMARKS: *C? palliseri* (DOUGLAS, 1942) is the correct name for forms referred in Europe to *C? sornayi* (DHONDT, 1993), which was a new name proposed by DHONDT (1993) for D'ORBIGNY's pre-occupied *Inoceramus regularis* (see WALASZCZYK & *al*. 2001). [the name *sornayi* was moreover also pre-occupied at that date – see CHAPA 1963]. The species is very similar to the early Campanian *Cataceramus balticus* (BÖHM, 1907), from which it differs in higher obliquity, finer ornament, and distinctly higher stratigraphical location.

OCCURRENCE: The species comes from the middle part of the *Nostoceras hyatti* ammonite Zone of the Tercis section. It is known from the *Baculites reesidei* and *Baculites baculus* ammonite Zones of the US Western Interior. It is probably common in the topmost Campanian and ?Lower Maastrichtian of Europe, but details on its distribution are still to be studied.

Cataceramus cf. *pseudoregularis* (SORNAY 1962) (Pl. 6, Fig. 1)

1962. *Inoceramus* (*Haenleinia*) *pseudoregularis* SORNAY, p. 118, pl. 7, fig. 1.
1968. *Inoceramus* (*Cordiceramus*) *pseudoregularis* SORNAY; SORNAY, p. 32, pl. D, figs 1-2.

TYPE: By original designation the holotype is 721 B from Collignon collection of the Laboratoire de Paléontologie, Paris, the original of SORNAY (1962, pl. 7, fig. 1), from the region between Apamba and Antsira, Madagascar; boundary beds between Lower and Middle Campanian.

MATERIAL: IW-201 from level 66.5

DESCRIPTION: IW-201 is a moderate sized double-valved internal mould. The beak is small, projecting slightly above the hinge line. The posterior auricle is not separated from the disc. The anterior margin is relatively short, passing into broadly convex, long antero-ventral and ventral margins. The posterior margin is regularly rounded. The hinge line is straight and long.

The specimen shows the presence of two ornamental stages. The juvenile stage, comprising most of the shell is ornamented with regularly spaced, sharp-edged co-marginal rugae. Interspaces increase in size gradually ventralward in the very juvenile part (up to 30 mm axial length), then remain almost constant over the entire shell surface. The adult ornament stage, at least in the part preserved, is almost smooth.

REMARKS: Our specimen resembles *C. pseudoregularis* in general outline and type of ornament. It differs from the type in the lack of the "*Cordiceramus*" sulcus in the posterior part of the shell. It must be emphasized, however, that this feature does not appear regularly (as e.g. in SORNAY's 1968, pl. D, fig. 2).

OCCURRENCE**:** The Madagascan material was dated as Lower – Middle Campanian; a single specimen from SW France, referred by SORNAY (1962) to *Inoceramus* (*Haenleinia*) cf. *pseudoregularis* comes from the Upper Campanian; our specimen is from the "*Inoceramus*" *altus* Zone, cooresponding to the lower *Nostoceras hyatti* ammonite Zone of the upper Upper Campanian.

Cataceramus cf. *pteroides* (GIERS,1964)
(Pl. 1, Fig. 2)

Compare to:

1964. *Inoceramus balticus pteroides* GIERS, p. 240, pl. 1, fig. 6.

1997. *Cataceramus pteroides* (GIERS); WALASZCZYK, p. 25, pl. 9, figs 1, 3-5; pl. 10, figs 1-5; pl. 11, figs 1, 4-5 [and synonymy therein].

TYPE: The holotype, by original designation, is specimen Kr 1025, the original of GIERS (1964, pl. 1, fig. 6), from the *Bostrychoceras polyplocum* ammonite Zone of Haldem, Westphalia, Germany. The specimen is housed in the Niedersächsisches Landesamt für Bodenforschung, Hannover, Germany

MATERIAL: Single specimen, IW-4, from level 6.7.

DESCRIPTION: IW-4 is an incomplete LV, with the ventral and posterior parts missing and with a poorly preserved juvenile part. It is strongly oblique, moderately inflated in the juvenile and weakly inflated in the adult stage, with a long, straight hinge line. The maximum inflation is in the umbonal part. The beak projects moderately above the hinge line. The surface is ornamented with relatively strong concentric rugae, which seem to weaken with growth. The juvenile ornament, as may be judged despite the poor preservation, was more regular.

DISCUSSION: The character of ornament, the umbonal part projecting above the hinge line and the general outline of the specimen allow it to be assigned questionably to *Cataceramus pteroides* (GIERS, 1964).

OCCURRENCE: The Tercis specimen comes from the basal part of the section. Known from the lower Upper Campanian (from the base of the substage up to *Bostrychoceras polyplocum* ammonite Zone) of Westphalia, Germany.

Cataceramus aff. *pteroides* (GIERS, 1964)
(Pl. 10, Fig. 2)

Compare:

1976. *Inoceramus balticus pteroides* GIERS; SORNAY, p. 6, pl. 3, figs 1-2.

MATERIAL: Single specimen; IW-175 from level 93.5

DESCRIPTION AND REMARKS: IW-187 is a single, incomplete RV, with the postero-ventral part missing. The preserved part suggests a distinctly posteriorly elongated valve outline, typical for members of the "*balticus*" group, with a relatively short, convex anterior margin, passing into a broadly convex ventral margin, and with a long and straight hinge line. The juvenile part is markedly inflated, with a massive appearance, and with the umbo projecting clearly above the hinge line. Toward the ventral and posterior parts the valve becomes gradually less convex. The posterior auricle is large, triangular in outline and rather weakly separated from the disc.

The surface is covered with subregular, asymmetrical co-marginal rugae, which weaken ventrally and dorsally. Growth lines are clearly visible, parallel to the rugae.

The valve outline and type of ornament of *C*. aff. *pteroides* described herein resembles closely representatives of *Inoceramus balticus pteroides* GIERS of SORNAY (1976, pl. 3, figs 1-2), from the Upper Campanian of Dau. Although Tercis specimen differs from Sornay's specimens in juvenile valve outline it is difficult to judge to what extent this may be a result of secondary deformation. The evolutionary relationship to *Cataceramus pteroides* (GIERS, 1964) is unknown.

OCCURRENCE: A single specimen from the "*Inoceramus*" *oblongus* Zone (*Nostoceras hyatti* ammonite Zone) of the upper Upper Campanian.

Cataceramus subcircularis (MEEK, 1876a)
(Pl. 13, Figs 6, 10; Pl. 14, Figs 1-3, 6, 8-9)

?1834. *Inoceramus Barabini* MORTON, p. 62 (pars), pl. 13, fig. 11 [non pl. 17, fig. 3 = *Inoceramus barabini* MORTON, 1834].

1876a. *Inoceramus proximus*? var. *subcircularis* MEEK, p. 55, pl. 12, fig. 2.

?1880. *Inoceramus vanuxemi* MEEK & HAYDEN; WHITFIELD, p. 396 (pars), pl. 7, fig. 9 [non pl. 7, figs 8, 10].

?1913. *Inoceramus proximus* TOUMEY var. *subcircularis* MEEK; BÖSE, p. 32, pl. 2, fig. 7.

1958. *Inoceramus regularis* D'ORBIGNY; KOCIUBYNSKIJ, p. 19, pl. 9, figs 34-35.

1959. *Inoceramus buguntaensis* DOBROV & PAVLOVA, p. 140, pl. 22, fig. 1.

1968. *Inoceramus regularis* D'ORBIGNY; KOCIUBYNSKIJ, p. 143, pl. 29, figs 1-2.

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

1974. *Inoceramus regularis* ORBIGNY; KOCIUBYNSKIJ, p. 85, pl. 21, fig. 2; pl. 23, fig. 1.

1993. *Inoceramus regularis* D'ORBIGNY; COBBAN & KENNEDY (pars), pl. 1, figs 16-17. [pl. 1, figs 18, 22 – *Trochoceramus* sp.].

pars 1993. *Trochoceramus nahorianensis* (KOCIUBYNSKIJ); DHONDT, p. 238, pl. 7, fig. 4.
1995. *Endocostea* (*Selenoceramus*) *semaili* MORRIS, p. 260, pl. 1, figs 5-6.
1996. "*Inoceramus*" sp. cf. *planus* (of authors) MÜNSTER; WALASZCZYK & *al*., pl. 5, fig. 4.
1997. *Inoceramus buguntaensis* DOBROV & PAVLOVA; ATABEKIAN, p. 68, pl. 27, fig. 1.
2001. *Cataceramus subcircularis* (MEEK); WALASZCZYK & *al*., pl. 31, fig. 3; pl. 34, fig. 8; pl. 37, figs ?1, 2; pl. 39, figs 3, 6; pl. 41, fig. 1, ?2; pl. 42, fig. 1; pl. 43, fig. 6; pl. 44, fig. 5 *Selenoceramus sornayi*; ODIN, pl. 2, fig. 17.
?2001. (tentatively) *Trochoceramus* aff. *ianjonaensis* (SORNAY); ODIN, pl. 2, fig. 19.
2001. *Inoceramus* sp. indet.; ODIN, pl. 3, figs 28-29.

TYPE: The holotype, by original designation, is USNM 479, the specimen illustrated by MEEK (1876a, 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 strata [upper part of Pierre Shale near Glendive, Montana, USA].

MATERIAL: IW-140 from level 148.2; IW-129 from level 155; IW-135 from level 161.4; IW-139 from level 169.1a; IW-138 from level (155); IW-136 from level (155); IW-156 from level 149.0; IW-122 from level 169.1a; IW-133 from level 117.4a; IW-123 from level 161.5; IW-300 from level 117.4a; IW-116 from level 117.4a.

DESCRIPTION: All of the specimens are small-sized internal moulds of single valves and are partly deformed. The valves are subrounded in outline, with rounded anterior, ventral and posterior margins. The umbo is indistinct with the beak projecting only slightly above the hinge line. The hinge line is of moderate length and straight. The posterior auricle is usually not separated or only weakly separated from the disc.

The valves are ornamented with regularly spaced, subcircular, symmetrical rugae, with interspaces increasing in size gradually ventralward.

REMARKS: The species, including the type material, was recently discussed and illustrated by WALASZCZYK & *al*. (2001). In Europe, small-sized representatives of the species were hitherto commonly referred to *Inoceramus planus*, and larger specimens to either *I. buguntaensis* DOBROV or *I. regularis* D'ORBIGNY. The species is very difficult to interpret and, as in WALASZCZYK & *al*. (2001), the concept presented herein encompasses a series of forms with subcircular outline and regular ornament, which undoubtedly require further study.

OCCURRENCE: In the Tercis section the species starts at the base of the Maastrichtian, where it is rare, and ranges to the top of the exposed part of the succession. Known from the *Baculites reesidei* through *Baculites clinolobatus* ammonite Zones of the US Western Interior. Also known from the Lower Maastrichtian of Poland, The Ukraine, Russia, the Caucasus, the Arabian Peninsula, and from Madagascar.

Cataceramus sp.
(Pl. 2, Fig. 6)

MATERIAL: Single specimen, IW-13 from level 42.4 m.

DESCRIPTION: The specimen is a large-sized (h max = 150) internal mould of a RV, incompletely preserved; its posterior part is missing. The valve is weakly inflated, prosocline, subrounded in outline, with estimated δ attaining about 65°. The anterior growth angle is relatively large, approximately 135° . The anterior margin is long, almost straight, passing into the rounded ventral margin. The posterior margin is not preserved. The umbo is moderately inflated with the beak projecting distinctly above the hinge line. The hinge line is not completely preserved, but where preserved it is apparently of moderate length and straight.

The valve is ornamented with regularly spaced, round-topped rough rugae, with interspaces increasing in size slowly ventralward. The rugae are slightly asymmetrical with ventral slopes steeper. Growth lines are not visible.

REMARKS: In the studied material there is one other specimen (IW-155), from the same stratigraphic level, equally large (h max = 180 mm), which may belong to the same species. It is, however, too incompletely preserved to allow an unequivocal identification.

In general outline, and in their robust type of ornament, the specimens resemble large representatives of late Early/earliest Late Campanian inoceramids of the group of *Cataceramus dariensis*. Even the most similar species, however, such as "*Inoceramus*" *karakalaensis* (ARZUMANOVA 1964, pl. 2, fig. 1) or *Inoceramus* sp. (ARZUMANOVA 1965, fig. 1) possess much less regular ornament.

OCCURRENCE: The specimen comes from level 42.4, which is referred to the *Bostrychoceras polyplocum* Total Range Zone (ODIN & *al*. 2001), which corresponds to the basal *Didymoceras donezianum* ammonite Zone of the Boreal Realm, and probably corresponds to the lower part of the *Sphaeroceramus pertenuiformis* Zone.

Genus *Sphaeroceramus* HEINZ, 1932

TYPE SPECIES: *Inoceramus subsarumensis* RENNGARTEN, 1926 (=*Inoceramus pila* HEINZ, 1932) from the Lower Campanian of England (locality unknown).

REMARKS: As emphasised by Chris WOOD (personal communication, letter August 12, 2002) it is not sure whether WOODS' (1911, text-fig. 48) original, the type of the type species of *Sphaeroceramus* HEINZ, 1932, comes from the Lower Campanian. The specimen is very close to representatives of the genus *Cremnoceramus* COX, 1969, and might come from the Lower Coniacian. If this would be proved [e.g. by nannofloral analysis] a series of species, as *Sphaeroceramus sarumensis* (WOODS, 1912), *S. subsarumensis* (HEINZ, 1932), *S. pertenuis* (MEEK & HAYDEN, 1856) and *S. pertenuiformis* (WALASZCZYK, COBBAN & HARRIES, 2001), should be referred to a new genus.

Sphaeroceramus pertenuiformis WALASZCZYK, COBBAN & HARRIES, 2001
(Pl. 2, Figs 1-2, 4-5; Pl. 3, Figs 1-3, 5-6)

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

TYPE: The holotype, by original designation, is USNM 507552, the original of WALASZCZYK & *al.* (2001, pl. 14, fig. 2) from the Pierre Shale near Red Bird, Niobrara County, Wyoming, USA (the USGS Mesozoic locality D 1948); the *Didymoceras stevensoni* and the *Exiteloceras jenneyi* ammonite Zones.

MATERIAL: IW-29 from level 46.1; IW-40 from level 47.5; IW-42 from level 47.4; IW-30 from level 45.4; IW-41 from level 47.0; IW-39 from level (47.2); IW-212 from level 45.4; IW-217 from level 45.9; IW-218 from level 49.2; IW-224 from level 47; ?IW-227 from level (47); IW-231 from level (47); ?IW-234 from level (47)[or it is *Inoceramus* aff. *tenuilineatus*]; IW-239 from level (47); IW-241 from level (47); IW-242 from level (47); ?IW-243 from level (47); IW-247 from level (47); IW-248 from level (47); IW-250 from level (47); IW-251 from level (47); IW-252 from level (47); IW-255 through 257, all from level (47).

DESCRIPTION: All of the specimens are internal moulds of single valves, with only fragments of shell preserved. Except for IW-42 (Pl. 3, Fig. 2) all specimens are juveniles and are medium sized. The juvenile stage, with subrounded outline, is relatively small, with small to moderate obliquity. The umbo is indistinct with the beak projecting slightly above a straight, moderately long hinge line. The posterior auricle is clearly separated from the disc only in more oblique specimens. The adult stage is preserved in a single specimen. It is relatively large, growing in a plane almost perpendicular to the plane of the juvenile stage. The adult anterior margin is long, straight, slightly concave, passing into the rounded ventral margin. The adult posterior auricle is well separated from the disc. One specimen possesses distinct "Hohlkehle" (Pl. 10, Fig. 3).

Juvenile and adult stages are covered with irregular rugae, in parts almost smooth. The rugae are low, indistinct, covered with raised growth lines.

REMARKS: The species was described and illustrated by WALASZCZYK & *al.* (2001) based on the rich material from the US Western Interior. "*Inoceramus*" *borilensis* JOLKIČEV, 1962 is similar to *S. pertenuiformis* in general adult outline. It differs, however, in its juvenile stage, which in contrast to that of *S. pertenuiformis* is distinctly posteriorly elongated and regularly rugate (see Pl. 3, Fig. 7 of the present paper).

OCCURRENCE: The Tercis specimens come from levels 45.4 through 47.5, which belong to the upper part of the *Bostrychoceras polyplocum* Total Range ammonite Zone, and correspond to the *Sphaeroceramus pertenuiformis* inoceramid Zone. The species is known from the *Didymoceras stevensoni* and the *Exiteloceras jenneyi* ammonte Zones 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 Fork of the Cheyenne River, Black Hills area in easternmost Wyoming, USA.

Endocostea typica WHITFIELD, 1880
(Pl. 13, Figs 1-5, 7-8, 11)

1877. *Endocostea typica* WHITFIELD, p. 32.
1880. *Endocostea typica* WHITFIELD; WHITFIELD, p. 403 (pars), 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 1936. *Endocostea typica* WHITFIELD; BEYENBURG, p. 295.
?1958. *Inoceramus* (*Endocostea*) *stanislausensis* ANDERSON, p. 105 (pars), pl. 74, fig. 4-6.
1967. *Inoceramus* (*Endocostea*) *typicus* WHITFIELD; SEITZ, pp. 50-55, pl. 2, figs 3-4.
1967. *Inoceramus* (*Cordiceramus* ?) juv. sp. SEITZ, p. 51, pl. 2, fig. 1.
1967. *Inoceramus* (*Endocostea*) cf. *cymba* J. BÖHM; SEITZ, p. 52, pl. 2, fig. 2.
1968. *Inoceramus impressus* ORBIGNY; KOCIUBYNSKIJ, p. 144 (pars), pl. 29, figs 4-5 [non pl. 28, fig. 1 = *Cataceramus palliseri* (DOUGLAS)]
1970. *Inoceramus* (*Endocostea*) *typicus* (WHITFIELD); KAUFFMAN, pl. 1, figs 2, 7.
non 1984. *Inoceramus* (*Endocostea*) *typicus* WHITFIELD; BOLANOS & BUITRON, p. 410, pl. 1, figs 2-3.
?1995. *Endocostea* (*Endocostea*) *coxi* (REYMENT); MORRIS, p. 258, pl. 1, figs 2-4.
2001. *Endocostea typica* WHITFIELD; WALASZCZYK & *al.*; pl. 40, figs 1-4, 7-8.
2001. *Inoceramus* sp.indet.; ODIN, pl. 1, figs 10-11; pl. 3, fig. 24.
2001. *Trochoceramus* sp.; ODIN, pl. 3, fig. 22.

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 Woman Fork of the Cheyenne River in the Black Hills, Wyoming, USA.

MATERIAL: IW-114 from level 117.4a, IW-109 from level 117.2a; IW-115 from level 117.5a; IW-119 from level 117.3; IW-132 from level 117.7; IW-131 from level 117.7; IW-113 from level 117.7; IW-128 from level 117.7; IW-110 from level 117.5a; IW-117 from level 147.6a; IW-112 from level 145.6a; IW-118 from level 117.7; IW-301 from level 117.5a; IW-303 from level 117.5a; IW-305 from level 117.5a; IW-306 from level 117.4a; IW-308 from level 117.4a and IW-309 from level 117.2a.

DESCRIPTION: All of the specimens are small-sized, internal moulds of single valves. The valves are strongly prosocline, moderately inflated with maximum inflation dorso-centrally and with the beak projecting slightly to moderately above the hinge line. The disc is usually well separated from the posterior auricle, which is small, subtriangular and elongated parallel to the hinge line. Most of the specimens possess a variably developed internal rib.

The valves are covered with subregularly and closely spaced concentric regular, weakening when passing on to the posterior auricle.

REMARKS: The taxonomy and stratigraphic position of the species was recently discussed by WALASZCZYK & *al.* (2001), who showed that the species concepts formerly applied in Europe were mostly incorrect.

OCCURRENCE: In Tercis *E. typica* appears suddenly approximately at the base of the Maastrichtian. It ranges up to about level 150 m but occurs only sporadically there. The species occurs commonly in the basal Lower Maastrichtian (*Baculites baculus* ammonite Zone) of the Western Interior and the Gulf Coast, USA. Known from numerous places in Europe (see synonymy list), presumably from equivalent horizons.

Endocostea aff. *typica* WHITFIELD, 1880
(Text-fig. 7)

2001. *Endocostea* sp. aff. *typica* WHITFIELD; WALASZCZYK & *al.*, p. 182, pl. 26, fig. 3.

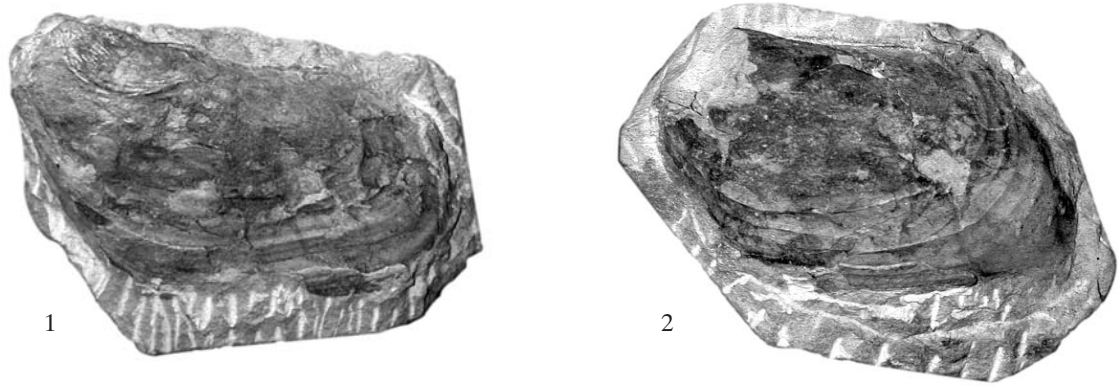

Fig. 7. *Endocostea* aff. *typica* Whitfield, 1877; 1 – IW-259 from level 88.1; 2 – IW-260 from level 88.1 [both specimens – section I]; ×1.2

MATERIAL: IW-259 and IW-260 from level 88.1

DESCRIPTION AND REMARKS: We have two specimens from level 88.1 matching closely the characteristics of US Western Interior forms compared with *E. typica* and referred consequently to *E*. sp. aff. *typica* by WALASZCZYK & *al*. (2001). Although our specimens are not very well preserved they still show the characteristic ornament, composed of lamellate, asymmetrical, evenly spaced rugae, as well as the general valve outline.

OCCURRENCE: Known from Tercis and the US Western Interior; in both areas limited to the *Inoceramus oblongus* Zone, corresponding to the *Baculites reesidei* ammonite Zone in the Western Interior ammonite succession.

Endocostea jolkicevi sp. nov.
(Pl. 13, Fig. 9)

1996. "*Inoceramus*" ex gr. *impressus* D'ORBIGNY; WALASZCZYK & *al*., p. pl. 4, fig. 1.
2001. *Endocostea* sp.; WALASZCZYK & *al*., pl. 39, fig. 9.
2001. *Inoceramus* sp.indet.; ODIN, pl. 3, fig. 25.

HOLOTYPE: The holotype is IW-121 from level E3.3 of the Tercis quarry; lowermost Maastrichtian, lowermost part of the *Endocostea typica* Zone.

MATERIAL: Two specimens; W-121 from level 117.4a, and W-304 from level 117.3a.

DERIVATION OF NAME: After Nikola JOLKIČEV, Bulgarian geologist, who made a significant contribution to the knowledge of the late Cretaceous inoceramids.

DESCRIPTION: The following description is based mainly on a well preserved specimen IW-121, an internal mould of a small-sized RV. The beak projects very slightly above the hinge line. The valve is subquadrate, increasing in size ventrally, with a well developed, wide, radial sulcus. The hinge line is long and straight. The posterior auricle is subtriangular in outline, elongated parallel to the hinge line and well separated from the distinctly raised disc, along a well developed auricular sulcus. The disc is subtriangular in outline. In the axial part of the radial sulcus lies a "Hohlkehle".

The valve is ornamented with strong, regular concentric rugae, which emphasise the radial sulcus. The rugae almost disappear on the posterior auricle.

REMARKS: The specimen differs from all other *Endocostea* specimens in the collection studied in distinctly lower obliquity, strong and regular rugae, and in the well developed radial sulcus. Probably conspecific with the specimen from Tercis is *Endocostea* sp. illustrated by WALASZCZYK & *al*. (2001, pl. 39, fig. 9), from the lowermost Maastrichtian of the US Western Interior. Also apparently identical is "*Inoceramus*" ex gr. *impressus* D'ORBIGNY, reported from the basal Maastrichtian of Aimaki section by WALASZCZYK & *al*. (1996, pl. 4, fig. 1), showing all the characteristic features of *E. jolkicevi*, despite being clearly deformed. In general outline, *E. jolkicevi* resembles *Endocostea coxi* (REYMENT, 1955), from which it differs in possessing a radial sulcus and by a lack of radial ornament, the typical feature of REYMENT's species.

OCCURRENCE: The specimen comes from level 117.8 of the Tercis section, lowermost Maastrichtian.

Genus *Trochoceramus* HEINZ, 1932

TYPE SPECIES: *Trochoceramus helveticus* HEINZ (1932, p. 19).

Trochoceramus costaecus (KHALAFOVA, 1966)
(Pl. 11, Figs 1-7; Pl. 12, Figs 2-3, ?7)

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.
2001. *Trochoceramus costaecus* (KHALAFOVA); WALASZCZYK & *al*., p. 157, pl. 1, figs 1-5; pl. 3, fig. 3; pl. 6, fig. 2.
2001. *Trochoceramus morgani* (SORNAY); WALASZCZYK & *al*., p. 156, pl. 2, figs 1-8; pl. 3, fig. 2.
2001. *Trochoceramus* sp.; WALASZCZYK & *al*., pl. 42, fig. 10; Pl. 43, figs 7-9.
2001. *Trochoceramus* sp.; ODIN, pl. 3, fig. 23.
2001. *Trochoceramus nahorianensis*; ODIN, pl. 2, fig. 20.

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

MATERIAL: Numerous specimens with variable preservation; IW-90 from level 97.5 and IW-85 from level 98.2; IW-86 from level 101.1; IW-88 from level 101.9; IW-89 from level 101; IW-160 from level 96.7; IW-161 from level 97.7; IW-164 from level 98.6; IW-165 from level 98.6; IW-

166 from level 100.8; IW-167 from level 96.7; IW-168 from level 96.9; IW-169 from level 100; IW-170 from level 97.8.

DESCRIPTION: The specimens are medium-sized internal moulds of single valves. The valve outline ranges from ellipsoidal to subquadrate, with variable obliquity, δ ranging between 40 and 90°. Complete valves show two distinct growth stages, separated by a positive positive geniculation. The juvenile stage is weakly inflated, with its anterior margin strongly convex anteriorly, passing into a broadly convex ventral margin. The posterior margin is relatively long, weakly convex. The hinge line is moderately long and straight. The posterior auricle is not separated from the disc. The umbo is indistinct, with the beak very weakly or not projecting above the hinge line. The hinge line is straight, relatively long.

The valve is ornamented with closely spaced, fine rugae, and with superimposed radial ribs. Radial ribs become dominant over the concentric ornament in the ventral part of the valve.

REMARKS: The species as interpreted herein, ranges between elliptically shaped, weakly oblique forms, very close to the type of the species, and markedly oblique, posteriorly elongated subquadrate forms. Previously the oblique forms were referred to a separate species, *Trochoceramus morgani* (SORNAY, 1973) (see WALASZCZYK & *al*. 1996), or to *Trochoceramus* sp. (WALASZCZYK & *al*. 2001). The collection from Tercis showed, however, that firstly these two extremes are more tightly linked by intermediate forms than thought previsouly, and secondly, a similar pattern of variability is seen in an ancestral species, i.e. "*Inoceramus*" *alaeformis* of authors, as well as in forms transitional between these two species, e.g., IW-160, IW-168, and IW-167, from levels 96.7 and 96.9 (Pl. 11, Figs 1, 5). *Trochoceramus morgani* (SORNAY, 1973), to which the more oblique forms were referred, comes from a distinctly higher stratigraphical level, and seems to represent the more oblique form of *Trochoceramus ianjonaensis* (SORNAY, 1973).

To *Trochoceramus costaecus* belong most forms referred in the Russian literature to *Inoceramus alaeformis* (see also discussion in DHONDT 1993).

OCCURRENCE: All of the Tercis specimens come from an interval between lelves 96.7 and 101.9. The species is known from the ?uppermost Campanian of the Nacatoch Sand, Canyon Creek, Texas, US Gulf Coast, and from the topmost Campanian of Daghestan (Caucasus) in Europe.

Trochoceramus radiosus (QUAAS, 1902)
(Pl. 14, Fig. 10)

1902. *Inoceramus Cripsi* var. *radiosa* QUAAS, p. 170 (pars), pl. 20, fig. 9 (only).
1962. *Inoceramus* (*Inoceramus*) *regularis* var. *radiosa* (QUAAS) ; ABBASS, p. 41, pl. 5, fig. 1.
1970. *Inoceramus* (*Trochoceramus*) *radiosus* QUAAS; SEITZ, p. 123, pl. 23, fig. 1.
1974. *Inoceramus* aff. *monticuli* FUGGER & KASTNER; KOCIUBYNSKIJ, p. 86, pl. 22, fig. 1.
1989. *Inoceramus monticuli* FUGGER & KASTNER; BŁASZKIEWICZ & CIEŚLIŃSKI, p. 257, pl. 162, fig. 1.
?1993. *Trochoceramus radiosus* (QUAAS); DHONDT, p. 240, pl. 7, fig. 3.
pars 1993. *Trochoceramus nahorianensis* (KOCIUBYNSKIJ); DHONDT, p. 238, unfigured specimen [pl. 7, fig. 4 – *Cataceramus subcircularis* (MEEK)].
1996. *Trochoceramus radiosus* (QUAAS); WALASZCZYK & *al*., p. 158, pl. 4, fig. 4; pl. 5, fig. 1; pl. 6, figs 3-4.
1996. *Inoceramus* (*Trochoceramus*) *radiosus* QUAAS; SEIBERTZ, p. 329 (pars), figs 16-17.
pars 2000. *Trochoceramus radiosus* (QUAAS); DHONDT *in* ROBASZYNSKI & *al*., p. 417, pl. 11, fig. 4 [non pl. 11, figs 1-2]
2000. *Trochoceramus nahorianensis* (KOCIUBYNSKIJ); DHONDT *in* ROBASZYNSKI & *al*., p. 417; fig. 45; pl. 9, fig. 5.
2001. *Trochoceramus radiosus* (QUAAS); WALASZCZYK & *al.*, pl. 42, figs 3-4, 6-9; Pl. 43, figs 3-5
?2001. (tentatively) *Trochoceramus* aff. *ianjonaensis* (SORNAY); ODIN, pl. 2, fig. 19.

TYPE: The lectotype, designated by WALASZCZYK & *al.* (1996, p. 158), is the original of QUAAS (1902, pl. 20, fig. 9) from the Maastrichtian of Ammonitenberge, Egypt. The original is probably lost; its plaster cast preserved in the collections of Niedersächsisches Landesamt für Bodenforschung, Hannover, Germany.

MATERIAL: Specimen V1 from unit V of HANCOCK & *al*. (1993), and possibly also M1 (KBIN TCM 10538), the original to DHONDT (1993, pl. 7, fig. 3).

DESCRIPTION AND REMARKS: Specimen V1 is a very incomplete internal mould of a RV. The preserved part is a fragment of the posterior portion of the valve; part of the hinge line and posterior auricle are visible. Only a fragment of the posterior part of the umbonal section of the valve is present. The hinge line is clearly straight and moderately long. It may be inferred that the posterior auricle is clearly separated from the disc. This is also emphasised by differences in ornament; rugae weaken markedly or disappear completely on the posterior auricle. The ornament of the disc is composed in the adult of strong, widely spaced, concentric rugae with

superimposed radial ribs, clearly seen in the ventral part of the valve.

All of the discerned features, despite the poor preservation state of the specimen, allow a fairly confident specific identification. DHONDT (1993, p. 240) referred this specimen to *Trochoceramus nahorianensis* (KOCIUBINSKIJ). In contrast to our specimen, *T. nahorianensis* is characterised by fine ornament and a posterior auricle that is not separated from the disc. Specimen M1, the original of *T. radiosus* in DHONDT (1993, pl. 7, fig. 4; reillustrated herein in Pl. 12, Fig. 1), is a problem. Although it resembles the juveniles of the QUAAS species it also resembles *T. costaecus*, particularly forms with stronger concentric ornament.

OCCURRENCE: Among the Tercis specimens only V1 possesses a certain stratigraphical location; it comes from the V unit of HANCOCK & *al*. (1993) from the *Pachydiscus epiplectus* Zone. The other specimen, M1 (=KBIN TCM 10538), referred questionably to *T. radiosus*, was found loose. In the US Western Interior the species is known from the *Baculites grandis* ammonite Zone (*Trochoceramus radiosus* inoceramid Zone); known from the Lower Maastrichtian (without further details) of Europe (The Ukraine, Poland, Germany - Rügen) and North Africa (Egypt).

Inoceramids with unknown generic affiliation

Several forms are referred here to *Inoceramus sensu lato*. Based on overall similarity, some of them are clustered into informal groups, suggesting their evolutionary connections. Their generic affinities require, however, further study.

"*Inoceramus*" *alaeformis* ZEKELI, 1852, *of authors*
(Pl. 8, Fig. 4; Pl. 9, Figs 3-4; Pl. 10, Fig. 1)

?non 1852. *Inoceramus Cripsi* MANTELL var. *alaeformis* ZEKELI, p. 102, pl. 1, fig. 1.
?non 1866. *Inoceramus Cripsi* MANT. var. *alaeformis* ZEKELI; ZITTEL, pl. 14, fig. 5.
non 1959. *Inoceramus alaeformis* ZEKELI; DOBROV & PAVLOVA, p. 154, pl. 18, fig. 1.
non 1978. *Inoceramus* (*Platyceramus*) aff. *alaeformis* ZEKELI; SORNAY *in* SORNAY & BILOTTE, p. 30, pl. 1, figs 1, 3.
non 1988. *Inoceramus alaeformis* ZEKELI; ALIEV & KHARITONOV *in* ALI-ZADE & *al*., p. 262, pl. 16, figs 1-3.
?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)]

MATERIAL: 5 specimens: IW-78 from level 93.5 and IW-81 from level 87.6; IW-172 from level 93; IW-173 from level 93.3; IW-291 from level 84.4

DESCRIPTION: IW-78 is a moderately large internal mould of LV, with h max = 88 mm, almost completely preserved. IW-81 is a small outer mould of LV, with Lmax = 46 mm.

The species is of moderate size, inaequilateral, ?equivalve. The valve is weakly inflated, with maximum inflation in the dorso-central part. The posterior auricle is very weakly separated from the disc. The umbonal part is only slightly raised with the umbo projecting very slightly above the hinge line. The valve outline is subrounded to subquadrate. Low obliquity, with δ ranging between 65 and 75°. The anterior margin is moderately long, broadly convex, passing into the long, convex antero-ventral margin. The regularly rounded ventral margin passess into long, broadly rounded posterior margin. The hinge line is straight and moderately long.

The valve possesses two ornament stages. The juvenile stage, possesses regularly and closely spaced co-marginal rugae; the growth lines are parallel to the rugae. The adult ornament stage is covered with irregular, low rugae, or the shell is covered exclusively with growth lines.

REMARKS: The juveniles of the species resemble closely finely ribbed specimens of *Cataceramus goldfussianus*. The presence of two distinct ornament stages as well as the lack of distinct ventralward increase of interspaces in "*I.*" *alaeformis* of authors make these two species clearly distinct.

In the character and outline of rugae "*I.*" *alaeformis* of authors is also close to "*I.*" aff. *gandjaeformis*. The latter possesses, however, a distinct anterior auricle and oblique rugae.

"*Inoceramus*" *alaeformis of authors*, the commonly accepted concept of the Austrian species, is most probably different from ZEKELI's type. Although ZEKELI's original specimen can no longer be found (TRÖGER & *al*. 2002), the type, as may be judged from drawings in ZEKELI (1852, pl. 1, fig. 1) and ZITTEL (1866, pl. 14, fig. 5) [ZITTEL's drawing seems to be based on ZEKELI's original], was rather a "*balticus*"-like form with extended anterior margin.

"*Inoceramus*" *alaeformis of authors* seems to be a direct ancestor of *Trochoceramus costaecus*; the transitional forms are represented (see Pl. 11, Figs 1-2, 5). They are all from an interval between levels 96.7 and 96.9.

Conspecific with "*Inoceramus*" *alaeformis of authors* are probably two specimens from Tercis illustrated by DHONDT (1993, pl. 5, figs 2, 4), although they may represent incompletely preserved "*Inoceramus*" aff. *gandjaeformis*.

OCCURRENCE: The Tercis specimens are from levels 87.6 and 93.5, which are upper *Nostoceras hyatti* ammonite Zone, corresponding to the "*Inoceramus*" *oblongus* Zone. The specimens described by DHONDT (1993) come from a similar level. Known from the same level in the Piotrawin Quarry in the Middle Vistula section, Central Poland (WALASZCZYK, in prep.). So far not reported outside Europe.

"*Inoceramus*" *borilensis* JOLKIČEV, 1962
(Pl. 3, Fig. 7)

1962. *Inoceramus borilensis* nov. sp.; JOLKIČEV, 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* JOLKIČEV; SORNAY, p. 7, pl. 2, fig. 1; pl. 3, fig. 3.
part 1982. *Inoceramus* cf. *borilensis* JOLKIČEV; SORNAY, p. 9, pl. 3, fig. 2. (non pl. 3, fig. 1)
non 1993. "*Inoceramus*" *borilensis* JOLKIČEV; DHONDT, p. 215, pl. 1, fig. 1; pl. 3, fig. 2.
non 1993. "*Inoceramus*" cf. *borilensis* JOLKIČEV; DHONDT, p. 216, pl. 4, fig. 1.
1997. *Inoceramus* aff. *borilensis* JOLKIČEV; WALASZCZYK, p. 37, pl. 28, figs 1-5.
non 1999. *Inoceramus* cf. *borilensis* JOLKIČEV; TRÖGER & *al*., p. 46, text-fig. 10.
non 2001. *Inoceramus borilensis* JOLKIČEV; ODIN, pl. 1, figs 8-9 [=*Inoceramus redbirdensis*]

TYPE: The holotype, by original designation, is the specimen of JOLKIČEV (1962, pl. 7, fig. 1), from the Campanian of Medven, Bulgaria [originally interpreted as Maastrichtian – see WALASZCZYK, LEES & JOLKIČEV, in prep]. The specimen is housed at the University Museum of Sofia University.

MATERIAL: IW-34, from level 47.4; IW-158 from level 33.8; IW-213 from level 45.4; IW-214 from level 49.2; IW-215 from level 43; IW-216 from level 46.8; IW-219 from level 46.9; IW-220 from level 50.6; ?IW-223 from level II 50.6; IW-225 from level 47; ?IW-228 from level (47); IW-237 from level (47); IW-238 from level (47); IW-244 from level (47) [or it may be juvenile palliseri]; IW-246 from level (47).

DESCRIPTION: IW-34 is a mould of a single RV, with preserved juvenile and part of the adult stage. The juvenile contacts the neck stage at approximately a right angle, with a well developed positive geniculation. The contact between the neck and adult stages is marked by a negative geniculation. The juvenile stage is *balticus*-like, strongly oblique, and elongated postero-ventrally. The beak is small, indistinct, projecting slightly above the hinge line. The hinge line is straight and long. The surface is covered with closely and regularly spaced concentric rugae. Growth lines not observed. Neck and adult parts ornamented with very low, indistinct rugae or smooth.

REMARKS: The species is characterised by a small juvenile stage, with *balticus*-like outline and ornament, a short neck, and a very long, irregularly ornamented adult stage. The juvenile/neck stage boundary is marked by positive geniculation and the neck/adult stage boundary by a negative geniculation (the species is discussed at length by WALASZCZYK, LEES & JOLKIČEV, in prep.).

In the Upper Campanian distinctly geniculated forms assigned to "*Inoceramus*" *borilensis* are not rare. They differ, however, from the Bulgarian species in the characters of the juvenile stage and the outline of the adult. Some of these forms, e.g. SORNAY & BILOTTE (1978, fig. 4), SORNAY, from the Pyrenees, and of DHONDT (1993, pl. 1, fig. 1; pl. 3, fig. 2 and pl. 4, fig. 1) from Tercis, are characterised by a regularly ornamented juvenile stage, the outline of which is, however, quite different. Moreover, they possess only a single, positive geniculation and are much less oblique.

Also distinct from JOLKIČEV's species is *Inoceramus borilensis dauensis*, described by SORNAY (1976) from the Upper Campanian of south-western France. *I. dauensis* was subsequently synonymised with *I. borilensis* by SORNAY (1982). It possesses, however, a subcircular, almost smooth juvenile stage, and the species is very weakly oblique. This subspecies should be retained as a separate taxon, and is regarded here as a separate species, which is closely related to *Sphaeroceramus pertenuiformis* WALASZCZYK, COBBAN & HARRIES, 2001.

To "*I.*" *borilensis* belongs most probably *Inoceramus* aff. *borilensis* described by WALASZCZYK (1997) from the lower Upper Campanian of Westphalia. WALASZCZYK (op. cit.) referred the Westphalian form to as aff. *borilensis* because of the supposed stratigraphical gap when compared to the Bulgarian material. However, it is now known that the type and other Bulgarian specimens of *I. borilensis* were misdated and come actually from the mid-Upper Campanian (see WALASZCZYK, LEES & JOLKIČEV, in prep.).

OCCURRENCE: The described specimen comes from level 47 of the Tercis section. As currently demonstrated (WALASZCZYK, LEES & JOLKIČEV, in prep.) the type of the species comes from the middle Upper Campanian of

Bulgaria. It is also known from the lower Upper Campanian of Westphalia (WALASZCZYK 1997).

"*Inoceramus*" *conlini* WALASZCZYK, COBBAN & HARRIES, 2001
(Pl. 1, Fig. 3)

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

2001. "*Inoceramus*" *conlini*; WALASZCZYK, COBBAN & HARRIES, p. 76, pl. 3, figs 1-2.

TYPE: The holotype, by original designation, is USNM 507476, the original of WALASZCZYK & *al*. (2001, pl. 3, fig. 2) from near the top of the Telegraph Creek Formation, in the NW part of Fergus County, Montana, USA (USGS Mesozoic locality 21568); *Haresiceras placentiforme* ammonite Zone of the Lower Campanian.

MATERIAL: Single specimen, IW-8, from level 11.

DESCRIPTION: IW-8 is a medium-sized, single RV, relatively complete, with parts of the shell preserved in the neck and adult stages. The specimen clearly displays the characters of the species, i.e. the presence of three growth stages, with two geniculation points. The juvenile part, 44 mm in h, is weakly inflated, strongly oblique, with the posterior auricle well separated from the disc. The hinge line is long and straight. The beak is indistinct, pointed anteriorly, weakly projecting above the hinge line. The disc is covered with regularly spaced concentric rugae, weakening markedly when passing onto the posterior auricle, where the ornament is represented mainly by growth lines. The adult stage is elongated posteriorly. The adult and neck stages are covered with widely spaced and low rugae, disappearing in the posterior part.

REMARKS: The morphotype represented by "*Inoceramus*" *conlini* is characterised by the generally *balticus*-like shape of the adult stage and the presence of a juvenile part separated from the adult by a neck, with two geniculation points. It is the same morphotype as represented by "*Inoceramus*" *incurvus* MEEK & HAYDEN 1856, "*Inoceramus*" *mclearni* DOUGLAS, 1942, and "*Inoceramus*" *furnivali* DOUGLAS, 1942, from the Late Campanian and Early Maastrichtian of the US Western Interior (see WALASZCZYK & *al*. 2001). To the same group belongs "*Inoceramus*" *cymbaeformis* described by PERGAMENT (1974, pl. 45, fig. 9) from the ?Upper Campanian of Koryakia, Russian Far East. All of these species are distinctly younger stratigraphically. The other American forms differ, moreover, in the ornamentation of the juvenile stage (see also discussion in WALASZCZYK & *al*. 2001).

OCCURRENCE: The species is known from the *Scaphites hippocrepis* III ammonite Zone in the US Western Interior and from the lower Lower Campanian (probably *Sphaeroceramus patootensiformis* Zone) of Germany.

"*Inoceramus*" aff. *gandjaeformis* WALASZCZYK, COBBAN & HARRIES, 2001
(Pl. 8, Figs 3, 6)

1978. *Inoceramus* (*Platyceramus*) aff. *alaeformis* ZEKELI; SORNAY & BILOTTE, p. 30, pl. 1, figs 1, 3.

MATERIAL: IW-293 from level 84.0; IW-294 from level 84.7.

DESCRIPTION: Species of medium to moderately lage size, ?equivalve, ?inequilateral. The valves are weakly inflated, with the maximum inflation dorso-central. The obliquity is small, with δ ranging up to 90°. The beak does not project above the hinge line. The posterior auricle is large, expanded posteriorly, and well separated from the disc along a shallow and wide auricular sulcus. The species possesses a well developed anterior auricle, well separated from the disc. The anterior margin is convex, moderately long, passing into the broadly convex, long ventral margin. The posterior margin is not preserved in the available specimens. The hinge line is straight and long.

The shell surface is ornamented with regularly spaced and sharp-edged rugae, with v-shaped interspaces. The rugae are distinctly oblique. They pass onto the posterior auricle, where they curve outward when crossing the auricular sulcus and then beak-ward when reaching the hinge line.

REMARKS: The presence of the anterior auricle, the distinct obliquity of the rugae, and the sinuous trace of the rugae on the posterior auricle make this species a very distinct form. Incomplete juveniles (lacking the anterior auricle) are very similar to juveniles of "*Inoceramus*" *alaeformis of authors*, and juvenile "*Inoceramus*" *gandjaeformis*.

OCCURRENCE: In Tercis the species is known from levels 84 and 84.7. The Pyrenean report of SORNAY & BILOTTE (1978) [as *Inoceramus* (*Platyceramus*) aff. *alaeformis*] from the transitional beds between Marnes de la

Plagne and la Calcaire Nankin in Maillau was originally regarded as Late Maastrichtian in age, but was shown recently to be latest Campanian, thus correponding well to its position in Tercis.

"*Inoceramus*" *redbirdensis* WALASZCZYK, COBBAN & HARRIES, 2001
(Pl. 13, Figs 12-16)

2001. "*Inoceramus*" *redbirdensis* sp. nov.; WALASZCZYK, COBBAN & HARRIES, pl. 31, figs 1, 4; pl. 32, figs 2-3; pl.34, fig. 1
2001. *Endocostea baltica elliptica*; ODIN, pl. 1, fig. 4.
2001. *Inoceramus borilensis*; ODIN, pl. 1, figs 8-9.

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; USNM 507653, USNM 5076554, and USNM 507656 through USNM 507660, from the same locality are paratypes.

MATERIAL**:** IW-101 from level 108.4; IW-102 from level 108.4; IW-95 from level 110.0; IW-97 from level 110.1; IW-99 from level 110.1; IW-96 from level 109; IW-98 from level 110.5; IW-100 from level 110.5; IW-103 from level 110.8; IW299 from level –2.8a.

DESCRIPTION: Besides IW-103 (Pl. 13, Fig. 15) all of the other specimens are single valves; all are internal moulds with only small fragments of shell preserved. Although all of the specimens are deformed they display clearly the set of features characterising the species. The moderately to strongly inflated valves, with maximum inflation dorso-centrally, possess a subpentagonal outline (similar to the stratigraphically older cordiceramids) with a well separated posterior auricle and with the radial sulcus located posteriorly to the growth axis, less distinctly developed. The umbo is markedly inflated, with the beak projecting distinctly above the hinge line. The anterior margin is relatively short, straight, passing into the long, broadly convex antero-ventral margin, and thence into a short, postero-ventral one. The posterior margin is short and almost straight. Two specimens (IW-96 and IW-99 in Pl. 13, Figs 12 and 13 respectively) possess a well developed "Hohlkehle".

The valves are covered with strong, subregularly spaced, sharp-edged rugae, passing onto the posterior auricles. The rugae are usually closely spaced in the umbonal part, with interspaces distinctly increasing in size in the adult stage. Irregular ribs appear sometimes in various parts of the interspaces.

REMARKS: Despite the deformations, the Tercis material leaves no doubt as to its conspecifity with the recently described "*Inoceramus*" *redbirdensis* WALASZCZYK, COBBAN & HARRIES, 2001.

Very close to "*I.*" *redbirdensis* are two other specimens, i.e. IW-101 and IW-102 (Pl. 12, Figs 4 and 8), which, however, differ in their valve outline and more regular ornament. Both specimens are less oblique, with subrectangular outline, and possess subevenly spaced rugae. They have a well developed radial sulcus in the posterior part of the disc. Taking into account these morphological differences, and the fact that both specimens occur stratigraphically below the typical "*I.*" *redbirdensis*, they may represent its ancestral form, and are referred consequently to "*I.*" aff. *redbirdensis* WALASZCZYK, COBBAN & HARRIES 2001.

OCCURRENCE: The species was described from the *Baculites eliasi* ammonite Zone of the US Western Interior. In Tercis it is limited to the narrow interval between levels 109 and 110.8. Both specimens referred herein to "*I.*" aff. *redbirdensis* come from level 108.4.

The group of *Inoceramus altus*

This group, comprising beside "*I.*" *altus* also "*Inoceramus*" *sagensis*, "*Inoceramus*" *vanuxemi*, and "*Inoceramus*" *altusiformis*, is a very characteristic inoceramid fauna of the *Baculites compressus* ammonite Zone in the US Western Interior, ranging slightly down into the *Didymoceras cheyennense* Zone and slightly up into the *Baculites cuneatus* Zone. As is demonstrated by the Tercis succession, this fauna is also well represented here in Europe. *Inoceramus launartensis* SORNAY, 1978, and *Inoceramus lapparenti* SORNAY, 1978, described from the Pyrenean Cretaceous are synonymous with *I. altus*.

"*Inoceramus*" *altus* MEEK, 1871
(Pl. 4, Figs 4-5; Pl. 5, Fig. 1; Pl. 6, Figs 2, 6)

1871. *Inoceramus altus* MEEK, p. 302.
1876a. *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, p. 36, pl. 5, fig. 1; pl. 6, figs 1-2.
1978. *Inoceramus launartensis* SORNAY, 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*., pl. 22, figs 1-8; pl. 23, figs 1, 3-5; pl. 24, fig. 1

TYPE: The holotype, by original designation, is USNM 12462, the specimen illustrated by MEEK (1876a, pl. 14, fig. 1) from near Medicine Bow station, Wyoming, USA; *Baculites compressus* ammonite Zone.

MATERIAL: IW-47 from level 67; IW-46 from level 67; IW-52 from level 66.5; IW-68 from level 93.6; IW-190 from level 67.1; IW-196 from level 67.1; IW-204 from level 67.1; IW-205 from level 66.5; IW-206 from level 66.5; IW-207 from level 66.5; IW-208 from level 66.9.

DESCRIPTION: All of the specimens are internal moulds of single valves, of moderate to moderately large size (h max of IW-46 equals 98; of IW-52 equals 98; of IW-47 –equals 88.4, and of IW-68 equals 130 mm). The valves are weakly inflated (although the specimens are more or less laterally compressed), moderately to weakly oblique, with δ ranging from 55° to 65°, inequilateral, prosocline. The umbo is weakly developed, with the beak only slightly projecting above the hinge line. The hinge line is relatively short, straight. The posterior auricle is relatively small, very poorly separated from the disc. The aAnterior margin is long, broadly convex, passing into the narrowly convex ventral margin, which passes into the long weakly convex posterior margin.

The valves are ornamented with closely, regularly spaced, round-topped rugae. The rugae are asymmetrical (with steeper ventral slope).

REMARKS: The species was recently re-described and illustrated by WALASZCZYK & *al*. (2001), based on the originals and additional material from the US Western Interior.

"*Inoceramus*" *altus* closely resembles "*I.*" *altusiformis* WALASZCZYK, COBBAN & HARRIES, 2001, from which it differs in smaller l/h value (see IW-209 from level 67.6 – Pl. 13, fig. 5). From the equally close "*Inoceramus*" *vanuxemi* MEEK & HAYDEN, 1860 it differs in higher obliquity, slightly higher inflation, and in the ornament; "*I.*" *vanuxemi* possesses more regular rugae, sharp-edged with more distinct interspaces.

Into the synonymy of "*I.*" *altus* falls *Inoceramus lapparenti* SORNAY, 1978, described from the Spanish Pyrenees. This species possesses an identical valve outline and type of ornament. The source locality was thought to be Maastrichtian but it was shown recently to be Upper Campanian (Prof. M. BILOTTE, personal communication, March 2002). Similarly, synonymous with "*I.*" *altus* is another species described from the same region by Sornay (*in* SORNAY & BILOTTE 1978), *Inoceramus launartensis*. The specimen illustrated is a huge, well preserved specimen, the juvenile part of which shows clearly the outline and type of ornament characteristic of MEEK's species. As in the case of *I. lapparenti*, it was thought originally to be of Maastrichtian age but was shown recently to be Late Campanian (Prof. M. BILOTTE, personal communication).

Small specimens of "*I.*" *altus* resemble some of the Santonian platyceramids; compare e.g. with *Platyceramus ahsenensis* (SEITZ, 1961, pl. 1, figs 9-10). The latter possesses usually finer ornament. However, almost identical specimens are to be found.

To MEEK's species should also be referred the specimen from Tercis referred to *Endocostea balticus beckumensis* (GIERS) by DHONDT (1993, pl. 3, fig. 3). GIERS' species possesses less regular ornament and higher obliquity (see WALASZCZYK 1997, pl. 14, fig. 4; pl. 15, figs 2-5; pls 16-18).

OCCURRENCE: In Tercis the species is noted from levels 66 up to 93.6, thus being limited to the *Nostoceras hyatti* ammonie Zone as applied in Europe. In inoceramid terms, it ranges from the "*I.*" *altus* through "*I.*" *oblongus* Zone, which in North American ammonite zonation would correspond to the *Baculites compressus* Zone through the *Baculites reesidei* Zone. The species is known from the US Western Interior from the *Didymoceras cheyennense*, *Baculites compressus* and *Baculites cuneatus* Zones. A single specimen is known from the Piotrawin quarry, where it is assgined to the Upper Campanian "*I.*" *oblongus* Zone, corresponding to the middle *Nostoceras hyatti* ammonite Zone (WALASZCZYK, in press).

"*Inoceramus*" *sagensis* OWEN, 1852
(Pl. 4, Fig. 3 ; Pl. 5, Figs 4, 6 ; Pl. 6, Fig. 4)

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 [=*Inoceramus pierrensis* WALASZCZYK, COBBAN & HARRIES].
1898. *Inoceramus sagensis* var. *nebrascensis* OWEN; LOGAN, p. 506, pl. 109, fig. 2.
non 1913. *Inoceramus* cfr. *Sagensis* OWEN; BÖSE, pl. 3, fig. 6.
1959. *Inoceramus sagensis* OWEN; DOBROV & PAVLOVA, p. 155 (pars), pl. 22, fig. 3 [non pl. 23, fig. 5 = ?*Inoceramus nebrascensis* OWEN].
?1963. *Inoceramus nebrascensis* OWEN; TSAGARELI, p. 98, pl. 4, fig. 4.

1970. *Inoceramus sagensis* OWEN; SOBOLEVA, p. 145, pl. 1, figs 1-2.
1970. *Inoceramus balchii* MEEK; SOBOLEVA, p. 148, pl. 4, fig. 1.
1970. *Inoceramus djusaliensis* SOBOLEVA, p. 151, pl. 5, fig. 1; pl. 7, fig. 1
1970. *Inoceramus convexus* HALL & MEEK; SOBOLEVA, p. 149, pl. 5, fig. 2; pl. 7, fig. 2.
1970. *Inoceramus karakatensis* SOBOLEVA, p. 152, pl. 8, fig. 5.
?1974. *Inoceramus sagensis* OWEN; KOCIUBINSKIJ, p. 85, pl. 24, fig. 2.
1974. *Inoceramus armenicus* ATABEKIAN, p. 217, pl. 111, fig. 1.
non 1974. *Inoceramus sagensis* OWEN; ATABEKIAN, p. 217, pl. 111, fig. 2; pl. 112, fig. 1.
pars 1993. "*Cataceramus*" *goldfussianus* (D'ORBIGNY); DHONDT, p. 218, pl. 1, fig. 2 [only].
non 1999. *Inoceramus sagensis* OWEN; TRÖGER & *al*., p. 48, pl. 2, fig. 4. [=*Sphaeroceramus sarumensis* (WOODS).
2001. "*Inoceramus*" *sagensis* OWEN; WALASZCZYK & *al*., pl. 24, fig. 2-4; pl. 36, fig. 9-10

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

MATERIAL: Three specimens: IW-43 from level 66.5, IW-48 from level 66.8 and IW-55 from level 67.0; IW-191 from level 67.

DESCRIPTION: All three specimens are internal moulds of single valves. IW-48 and IW-55 are larger representatives, with h_{max} 92 and 98.6 mm respectively. IW-43 is smaller, with h_{max} = 76 mm. All are moderately inflated, prosocline, with subrounded outline. In IW-48 and IW-55 the umbo is weakly inflated, and the beak projects only moderately above the hinge line. Stronger inflation is observed only in IW-43. All of the specimens possess a broadly convex anterior margin, passing into a rounded ventral margin and weakly convex posterior margin. The small posterior auricle is very weakly separated from the moderately inflated disc. The juvenile stage is ornamented with subregularly spaced, round-topped rugae. In adult stages the rugae become much less regular.

REMARKS: The specimens from Tercis do not differ from the American material (see recent discussion and illustration by WALASZCZYK & *al*. 2001). IW-43 most closely resembles OWEN's (1952, pl. 7, fig. 3) type. Two other specimens are more rounded in outline but they closely match other representatives of the species from the Pierre Shale as illustrated by WALASZCZYK & *al*. (2001). Juveniles of "*I.*" *sagensis* may be very similar and difficult to separate from "*Inoceramus*" *altusiformis* WALASZCZYK, COBBAN & HARRIES, 2001.

OCCURRENCE: All of the specimens in Tercis come from around level 66.0, from the lower *Nostoceras hyatti* ammonite Zone. It is known from the *Baculites compressus* ammonite Zone of the US Western Interior. Reported from the Upper Campanian of The Ukraine and Western Central Asia, but without more precise location.

"*Inoceramus*" *vanuxemi* MEEK & HAYDEN, 1860
(Pl. 4, Fig. 2; Pl. 5, Fig. 5; Pl. 7, Figs 1, 4)

1860. *Inoceramus Vanuxemi* MEEK & HAYDEN, p. 180.
1876. *Inoceramus Vanuxemi* MEEK & HAYDEN; MEEK, p. 57, pl. 14, fig. 2.
non 1880. *Inoceramus vanuxemi* MEEK & HAYDEN; WHITFIELD, p. 396, pl. 7, figs 8-9; pl. 8, figs 4-5.
?1880. *Inoceramus vanuxemi*, var. ?; WHITFIELD, p. 398, pl. 7, fig. 10.
non 1941. *Inoceramus vanuxemi* MEEK & HAYDEN?; STEPHENSON, p. 99, pl. 13, figs 1-4
non 1961. *Inoceramus* sp. ex gr. *vanuxemi* MEEK & HAYDEN; SORNAY, pl. 2, fig. 4.
1993. *Platyceramus* cf. *artigesi* (SORNAY); DHONDT, p. 231, pl. 5, fig. 5.
2001. "*Inoceramus*" *vanuxemi* MEEK & HAYDEN; WALASZCZYK & *al*., pl. 35, fig. 3; pl. 37, fig. 3

TYPE: The holotype, by original designation is USNM 483 from the Upper Campanian of Sage Creek (probably *Baculites compressus* ammonite Zone), South Dakota, USA.

MATERIAL: 2 specimens; IW-49 and IW-54; both from level 67.0; IW-273 from level 73.9; IW-285 from level 73.9.

DESCRIPTION: IW 49 is an incomplete internal mould of the LV of a large specimen. h_{max} of the preserved part is 92 mm. The specimen is weakly oblique, with $\delta = 63^{\circ}$, and with a straight growth axis. The anterior margin is broadly rounded, convex. The hinge margin is long and straight. The posterior auricle is large, poorly separated from the disc. The ornament is composed of regularly to subregularly spaced, sharp-edged , increasing in size ventralward concentric rugae. Rugae well developed on the posterior auricle. IW 54 is large sized (h_{max} of the preserved part 121 mm) incomplete LV, with hinge margin and posterior auricle missing. The specimen is clearly of very low obliquity, with a straight growth axis. The anterior margin is broadly convex.

REMARKS: The low obliquity, ventral shell elongation, and the concentric ornament composed of sharp-edged, regular to subregular rugae allow the two specimens to be referred to "*I.*" *vanuxemi* MEEK & HAYDEN, 1860. From "*I.*" *altus*, a very similar Late Campanian species, it differs in its smaller obliquity, more regular ornament and the sharp edges of the concentric rugae. The species closely resembles the Santonian representatives of the genus *Platyceramus*, e.g. *Platyceramus cycloides* cf. *vanuxemiformis* NAGAO & MATSUMOTO *in* SEITZ (1961, pl. 2, fig. 7). The species was recently discussed by WALASZCZYK & *al*. (2001).

OCCURRENCE: Upper Campanian, basal part of the *Nostoceras hyatti* amonite Zone of the Tercis section; Known from the *Baculites compressus* Zone of the US Western Interior.

The group of "*Inoceramus*" *oblongus*

"*Inoceramus*" *magniumbonatus* DOUGLAS, 1942
(Text-fig. 8)

1942. *Inoceramus barabini* var. *magniumbonatus* DOUGLAS, p. 63, pl. 1, fig. 1.
?non 1962. *Inoceramus barabini* aff. var. *magniumbonatus* DOUGLAS; JOLKIČEV, p. 142, pl. 5, fig. 1.
?1981. *Inoceramus borilensis* JOLKIČEV, TZANKOV, p. 91, pl. 40, fig. 1.
2001. "*Inoceramus*" *magniumbonatus* DOUGLAS; WALASZCZYK & *al*., p. 225, pl. 19; pl. 31, fig. 2; pl. 32, figs 1, 4-5.

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, Saksatchewan, Canada.

MATERIAL: Single specimen, IW-181 from level 93.2.

DESCRIPTION: It is a huge (hmax = 165 mm), single, internal mould of a RV. It is a strongly convex, posteriorly elongated valve, with a subrectangular outline. The anterior margin is short, passing into a broadly rounded ventral margin. The posterior margin is not completely preserved.

The juvenile part is covered with strong, widely spaced co-marginal rugae. The medium and adult parts of the shell are almost smooth.

DISCUSSION: The Tercis specimen is very close to the Canadian type, which is characterised by strong inflation, a rugate juvenile part and a large, almost smooth adult part. The geniculation, seen clearly in the type, is not seen in our specimen, but this may be due to subsequent lateral compression.

To "*I.*" *magniumbonatus* belongs most probably the specimen illustrated by TZANKOV (1981, pl. 40, fig. 1) and referred by him to *Inoceramus borilensis*. It is a massive, posteriorly elongated double-valved specimen, with strong rugae in the juvenile and medium parts, weakening ventralward, with the shell almost smooth in the ventralmost part. It is quite different from *I. borilensis*, which possesses a regularly rugate, relatively small juvenile part, succeeded by a large, almost smooth adult part, characterised by much lower obliquity than DOUGLAS' species.

Inoceramus barabini aff. var. *magniumbonatus* DOUGLAS of JOLKIČEV (1962, pl. 5, fig. 1) possesses much finer ornament, with round-topped rugae and rounded interspaces. Moreover, it seems to be less oblique than the Canadian species.

OCCURRENCE: The type, and other American specimens come from the "*Inoceramus*" *oblongus* Zone of the Upper Campanian, which corresponds to the *Baculites reesidei* ammonite Zone. The species is known from the *Nostoceras hyatti* Zone of the Vistula section, central Poland. The Bulgarian specimen (=*I. borilensis* in TZANKOV, 1981, pl. 40, fig. 1) comes from Medven, which was dated originally as Maastrichtian. However, at least part of the material from that locality (e.g. the type of *Inoceramus borilensis*) represents the Campanian as dated recently with nannofossils by Jackie Lees (WALASZCZYK, LEES & JOLKIČEV, in prep.). *I. magniumbonatus* reported by GALLEMI & *al*. (1995, 1997) from the Lower Maastrichtian of southeast Spain should be re-examined.

"*Inoceramus*" *oblongus* MEEK, 1871
(Pl. 9, Figs 1-2; Pl. 10, Fig. 5)

1871. *Inoceramus oblongus* MEEK, p. 297.
1879. *Inoceramus oblongus* MEEK; WHITE, p. 285, pl. 2, fig. 1.
2001. "*Inoceramus*" *oblongus* MEEK; WALASZCZYK & *al*., pl. 26, figs 2, 5; pl. 27, figs 1, 3; pl. 28; pl. 31, fig. 5

TYPE: The holotype, by MEEK's original designation, is USNM 774, also the original of WHITE (1879, p. 285, pl. 2, fig. 1; reillustrated by WALASZCZYK & *al.* 2001, pl. 31, fig. 5), from the uppermost Campanian, south of Fort Collins, Colorado, USA.

MATERIAL: IW-67 from level (93.6); IW-80 from level 94.0; IW-74 from level 93.0; IW-258 from level 87.1; IW-263 from level (85).

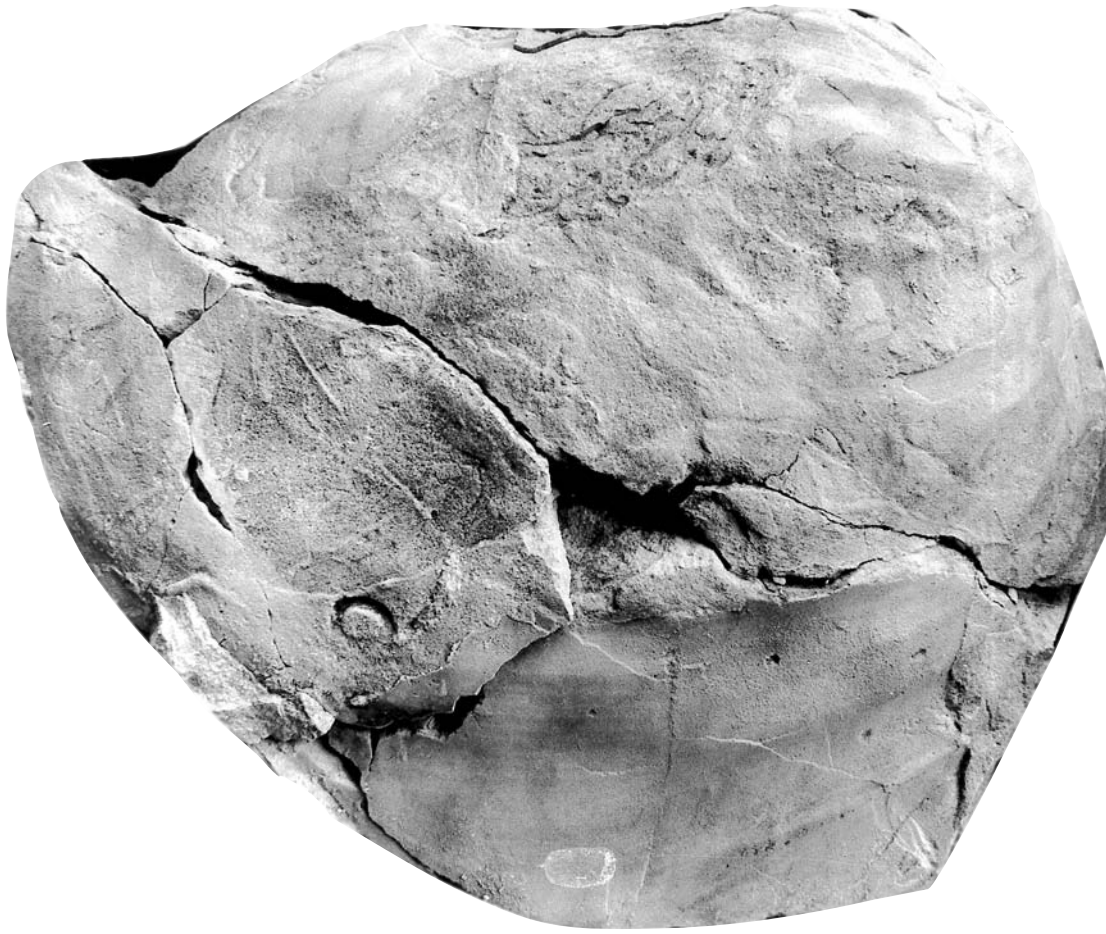

Fig. 8. "*Inoceramus*" *magniumbonatus* Douglas, 1942, IW-181 from level 93.2 [section I];×0.8

DESCRIPTION: All of the specimens are internal moulds of single RVs. IW-67 and IW-74 are moderately large sized (with h_{max} = 151 and 131 respectively). IW-80 is a small-sized specimen, with h_{max} = 63.8 mm. The valves are prosocline, subtriangular in outline, moderatly inflated and strongly elongated posteriorly. The anterior margin is relatively short, weakly convex, passing into a long to very long anterior-ventral margin, which forms a very characteristic feature of the species. The posterior margin is narrowly rounded. The hinge line is long, straight. The posterior auricle is poorly separated from the disc and elongated parallel the hinge line.

Juvenile valves are ornamented with regularly and closely spaced rugae. In the adult stage the rugae are much less regular. In parts the ornament is dominated by raised growth lines.

REMARKS: North American material, including the type, was recently re-described and illustrated by WALASZCZYK & *al*. (2001). The general outline of the Tercis specimens, characterised by an extremely long antero-ventral margin, strong obliquity and postero-ventral elongation, as well as the type of ornament, makes them very similar to the American material.

"*I*." *oblongus* resembles "*I*." *wyomingensis* WALASZCZYK, COBBAN & HARRIES 2001. The latter is, however, markedly more inflated and possesses a different rugae outline, running parallel to the hinge line in the axial part of the valve.

OCCURRENCE: Tercis specimens are all from a level around 93-94, which represents the "*I*." *oblongus* Zone, corresponding to the upper part of the *Nostoceras hyatti* ammonite Zone. American specimens, known exclusively from the *Baculites reesidei* Zone, come from the same stratigraphical level as those from Tercis. Also known from the upper *Nostoceras hyatti* Zone of the Piotrawin section in the Middle Vistula section, in central Poland (WALASZCZYK, in prep.).

"*Inoceramus*" *wyomingensis* WALASZCZYK, COBBAN & HARRIES, 2001
(Pl. 12, Figs 5-6)

2001. *"Inoceramus" wyomingensis* sp. nov.; WALASZCZYK, COBBAN & HARRIES, pl. 34, figs 2-5.

TYPE: The holotype is USNM 507735, the original of WALASZCZYK & *al*. (2001, pl. 34, fig. 5), from the *Baculites eliasi* ammonite Zone of the Lewis Shale, Natrona County, Wyoming, USA.

MATERIAL: Two specimens; IW-105 from level 109.8 and IW-104 from level 109.8.

DESCRIPTION: Both specimens are medium sized (h max of IW-105 and IW-104 is 109 mm and 82 mm respectively) internal moulds of a single LV. The valves are strongly elongated postero-ventrally with a massive, markedly inflated umbo. The beak projects slightly above the hinge line. The hinge line is long, straight. The valve outline is characterised by a relatively short anterior margin passing into a broadly rounded, very long antero-ventral margin. The posterior auricle is small, subtriangular, relatively well separated from the disc.

The juvenile portion is covered with subregularly spaced, rounded rugae and the adult posrtion is ornamented with irregularly spaced rugae. In the antero-ventral part the rugae display the characteristic elongation parallel to the hinge line.

REMARKS: The Tercis specimens closely resemble the American forms recently described (WALASZCZYK & *al*. 2001, pl. 34, figs 2-3, 5). They differ slightly in more rigorous ornament in the adult part, but this may partly be due to preservation. For further discussion see WALASZCZYK & *al*. (2001).

Fig. 9. "*Inoceramus*" *balchiformis* Walaszczyk, Cobban & Harries, 2001, IW-180 from level 93.2 [section I]; ×0.7

OCCURRENCE: The species was described from the *Baculites eliasi* ammonite Zone of the US Western Interior. In Tercis it is known from level 109.7-109.8.

The group of "*Inoceramus*" *scotti*

"*Inoceramus*" *balchiformis* WALASZCZYK, COBBAN & HARRIES, 2001
(Text-fig. 9)

2001. "*Inoceramus*" *balchiformis* sp. nov.; WALASZCZYK, COBBAN & HARRIES, p. 210, pl. 25, figs 2, 5; pl. 30.

TYPE: The holotype, by original designation, is USNM 507622 from Round Butte, north of Fort Collins, Latimer County, Colorado, USA (USGS Mesozoic locality D372); *Baculites reesidei* ammonite Zone.

MATERIAL: Single specimen IW-180, from level 93.2.

DESCRIPTION: The Tercis specimen is a huge (hmax = 174mm) LV, very weakly inflated, with maximum inflation in the umbonal part. The anterior margin is long (60 % of the respective axial length), straight, passing into the regularly rounded ventral margin. The posterior margin is broadly rounded. The hingeline is long and straight. The anterior face is low. The umbo projects only slightly above the hingeline and curves slightly anteriorly. The shell is weakly ornamented. The regular rugae are well developed in the anterior juvenile part. The rest of the shell is almost smooth, covered in parts with raised growth lines.

DISCUSSION: Our specimen is very close to the huge USNM 507621 from the US Western Interior (WALASZCZYK & *al*. 2001, pl. 30).

Fig. 10. "*Inoceramus*" *cobbani* sp. nov., IW-186 from level 93.2 [section I]; ×0.8

OCCURRENCE: The Tercis specimen comes from level 93.2; it occurs in the *Baculites reesidei* Zone of the US Western Interior.

"*Inoceramus*" *cobbani* sp. nov.
(Text-fig. 10)

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

TYPE: The holotype is IW-186 from level 93.2 of the Tercis section (Text-fig. 10).

DERIVATION OF NAME: After William A. COBBAN, American paleontologist and geologist, who made a very significant contribution to Cretaceous paleontology and stratigraphy.

DIAGNOSIS: Medium to large-sized, weakly oblique, prosocline. Umbo massive, projecting distinctly above hingeline. Anterior margin moderately long, straight, concave below umbo. Ventral margin narrowly rounded. Hingeline moderately long, straight. Posterior auricle triangular, well separated from disc in juvenile part. Valve ornamented with subregular, strong rugae, with interspaces increasing in size gradually ventralward. Rugae continue onto posterior auricle.

MATERIAL: IW-179 from level 93.3; IW-185 from level 93.3; IW-186 from level 93.2; IW-177 from level 93.

DESCRIPTION: The material consists of three specimens, represented by internal moulds of single valves. The holotype is a large LV, completely preserved, with h_{max} = 160 mm. It possesses a massive umbo, incurved dorso-anteriorly. The anterior margin is straight and concave below the umbo, which in the type is slightly obliterated by lateral compression. The ventral margin is regularly rounded, passing into a moderately long, stratigth posterior margin. The hingeline is long and straight. The valve is covered with strong rugae, slightly asymmetrical in cross section, with interspaces increasing in size distinctly ventralward. The rugae are best developed in the anterior and antero-ventral parts, whereas they weaken in the axial part and over the posterior auricle.

IW-185 is similarly large specimen, with hmax = 150 mm. The specimen is crushed in its anterior part, but it shows the type of ornament well, as well as the general outline of the holotype.

The third specimen, IW-177, is markedly smaller, but it displays all the characters of the species well: low obliquity, the umbo projecting above the hingeline, and the rugae pattern.

REMARKS: "*Inoceramus*" *cobbani* sp. nov. resembles representatives of the Lower Campanian group of *Cataceramus dariensis* (DOBROV & PAVLOVA, 1959) (see e.g. ARZUMANOVA 1964, 1965; WALASZCZYK 1997). In contrast to our species some species of the *'dariensis'* group are characterised by a more massive umbo, located more posteriorly, and have a broadly convex anterior margin. Some specimens, e.g. the type of *Cataceramus karakalensis* (ARZUMANOVA, 1964, pl. 2, fig. 1), are very close.

Into the synonymy of our species most probably falls the large specimen of *Inoceramus planus* MÜNSTER in TZANKOV (1981, pl. 33, fig. 2). It possesses a weakly oblique outline, posterior umbo, straight anterior margin, slightly concave below the umbo, and similar ornament.

OCCURRENCE: The specimens studied here are all from around level 93 of the Tercis section, corresponding in the ammonite scheme to very high *Nostoceras hyatti* Zone. It equates with the upper part of the "*Inoceramus*" *oblongus* Zone in the inoceramid scheme. The species is also known from the *Nostoceras hyatti* Zone of the Piotrawin quarry, central Poland. The stratigraphical position of the Bulgarian specimen, referred here with a question mark, is poorly known. It was originally assigned to the Maastrichtian, but it may appear to be highest Campanian.

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REFERENCES

ABBASS, H.L. 1962. A monograph on the Egyptian Cretaceous pelecypods. *Geological Survey and Mineral Research Department, Geological Museum, Palaeontological Series, Monograph*, **1**, 1-224.

ALIEV, M.M. 1939. Inoceramidae of the Cretaceous deposits in the northern part of the Minor Caucasus. *Trudy Geologicheskogo 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*]

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*]

ANDERSON, F.M. 1958. Upper Cretaceous of the Pacific Coast. *Memoir of the Geological Society of America*, **71**, 1-378.

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 Turkmenskoy SSR, Seria Fizyko-technicheskich, Khimicheskich i Geologicheskich 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. Sankt-Peterburgskij gosudarstvennij gornij institut im. GV Plekhanova, 3-70. [*In Russian*]

BŁASZKIEWICZ, A. & CIEŚLIŃSKI, S. 1989. Mollusca. Bivalvia (BOUNANNI, 1681) LINNÉ, 1758. *In*: L. MALINOWSKA (*Ed.*), Geology of Poland, Vol. III. Atlas of guide and characteristic fossils; Part 2c, Mesozoic, Cretaceous, *Wydawnictwa Geologiczne*, 251-259.

BEYENBURG, E. 1936. Die Fauna der Haltener Sandfazies im westfälischen Untersenon. *Jahrbuch der Preußischen Geologischen Landesanstalt*, **57**, 284-332.

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. Contribución 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.

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.

CANTU-CHAPA, A. 1963. Étude biostratigraphique des ammonites du centre et de l'est du Mexique (Jurassique supérieure et Crétacé). *Mémoir de la Societé Géologique de France, N.S.*, **99**, 1-99.

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.

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*, 1-489.

DANE, C.H. 1929. Upper Cretaceous formations of southwestern Arkansas. *Bulletin of the 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 the Crimea*. Trudy VNIIGAZ Gostoptechizdat, 130-165. [*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 du Terrain Crétacé dans le Sud-ouest de la France. *Thèse*, 1-269.

GALLEMI, J., LOPEZ, G., MARTINEZ, R., MUNOZ, J. & PONS, J.M. 1995. Distribution of some Campanian and Maastrichtian macrofauna from southeast Spain. *Cretaceous Research*, **16**, 257-271.

GALLEMI, J., LOPEZ, G., MARTINEZ, R., MUNOZ, J. & PONS, J.M. 1997. Albian-Cenomanian and Campanian-Maastrichtian biostratigraphy of southeast Spain. *Cretaceous Research*, **18**, 355-372.

GIERS, R. 1964. Die Großfauna der Mukronatenkreide (unteres Obercampan) im östlichen Münsterland. *Fortschrritte 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.

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. & KENNEDY, W.J. 1993. The high Cretaceous ammonite fauna from Tercis, Landes, France. *Bulletin de l'Institut Royal des Sciences Naturelles de Belgique, Série Sciences de la Terre,* **63**, 149-209.

HANCOCK, J.M., PEAKE, N.B., BURNETT, J., DHONDT, A.V,

KENNEDY, W.J. & STOKES, R.B. 1993. High Cretaceous biostratigraphy at Tercis, south-west France. *Bulletin de l'Institut Royal des Sciences Naturelles de Belgique*, *Série Sciences de la Terre,* **63**, 133-148.

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

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

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

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.

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*: Pasternak, S.I., Gavrilishin, V.I., Ginda, V.A. Kociubynskij, S.P. & Senkovskij, 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. Nedra, 76-86. [*In Russian*]

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.

MEEK, F.B. 1961. Descriptions of new Cretaceous fossils collected by the north-western boundary Commission on Vancouver 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.

— 1876a. 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.

— 1876b. Descriptions and illustrations of fossils from Vancouver's and Sucia Islands, and other northwestern localities. *Bulletin of the United States Geological and Geographical Survey of the Territories*, **2**, 351-374.

MEEK, F.B. & HAYDEN, F.V. 1856. Descriptions of new species of Gastropoda and Cephalopoda from the Cretaceous 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.

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*]

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)*, *Série Sciences de la Terre,* **66**, 111-117.

— 1996b. Observations stratigraphique sur les Maastrichtien. Arguments pour la localisation et la corrélation du Point Stratotype Global de la limite Campanien-Maastrichtien. *Bulletin de la Société Géologique de France*, **167**, 637-643.

— (*Ed.*) 2001a. 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, 881 pp. Elsevier Sciences Publication.

— 2001b. 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, pp. 452-461. Elsevier Sciences Publication.

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

ODIN, G.S. & ODIN, P. 1994. Première description d'une coupe dans la localité aturienne de Tercis (Landes): contribution á l'étude de la limite Campanien-Maastrichtien. *Géologie France*, **2**, 31-37.

ORBIGNY, A. DE, 1842-1847. Paléontologie Franćaise. Terrains Crétacés III. Lamellibranches. Baillière, 1-807.

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*]

QUAAS, A. 1902. Beitrag zur Kenntnis der Fauna der obersten Kreidebildungen in der libyschen Wüste (Overwegischichten und Blätterthon). *Palaeontographica*, **30** (2), 153-336.

RENNGARTEN, V. 1926. La faune des dépôts cretacés de la région d'Assamabiléevka, Caucase du Nord. *Mémoire du Comité Géologique, Nouvelle Série*, **147**, 1-132.

REYMENT, R.A. 1955. Upper Cretaceous mollusca (Lamellibranchia and Gastropoda) from Nigeria. *Colonial Geology and Mineral Resources*, **5** (2), 127-155.

RIEDEL, L. 1931 [for 1930]. Zur Stratigraphie und Faciesbildung 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.

SEIBERTZ, E. 1996. Endemic and cosmopolitan Inoceramus species from Egyptian Upper Cretaceous trans- and regression cycles. *Mitteilungen aus dem Geologisch-Paläontologischen Institut der Universität Hamburg,* **77** *(Jost Wiedmann Memorial Volume)*, 315-355.

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.

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.

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

— 1962. Étude 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 á la connaisance du Crétacé supérieur de Barra do Dande, Angola. *Revista da Faculdade de Ciéncias de Lisboā, 2, Série C*, **16** (1), 65-104.

— 1973. Sur les Inocérames du Maestrichtien de Madagascar et sur une espèce de la Craie á *Baculites* du NW de la France. *Annales de Paléontologie (Invertébrés)*, **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 (Invertébrés)*, **64** (1), 27-45.

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

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

TRÖGER, K.-A. & RÖHLICH, P. 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. (in press). Early Maastrichtian (Late Cretaceous) inoceramids from the Piesting Formation (Gosau Group; Austria). *Beiträge zur Paläontologie.*

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

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.

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, *Abtract 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 the Campanian – Maastrichtian boundary. *Bulletin of the Geological Society of Denmark*, **49**, 53-60.

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.

WARD, P.D. & ORR, W. 1997. Campanian-Maastrichtian ammonite and planktonic foraminiferal biostratigraphy from Tercis, France. *Journal of Paleontology*, **71**, 407-418.

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.

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.

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.

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PLATE 1

1 – *Cataceramus goldfussianus* (D'ORBIGNY, 1847), IW-12 from level 34.7 [section II]; × 0.85
2 – *Cataceramus* cf. *pteroides* (GIERS, 1964), IW-4 from level 6.7 [section II]; × 1
3 – "*Inoceramus*" *conlini* WALASZCZYK, COBBAN & HARRIES, 2001, IW-8 from level 11 [section III]; × 1
4 – *Cataceramus mortoni* (MEEK, 1876), IW-23 from level 30.1 [section I]; × 1
5 – *Cataceramus* ex gr. *balticus* (BÖHM, 1907), IW-5 from level 6.5 [section II]; × 1
6 – *Cordiceramus heberti* (GIERS, 1964), IW-9 from level 25.5 [section II]; × 1

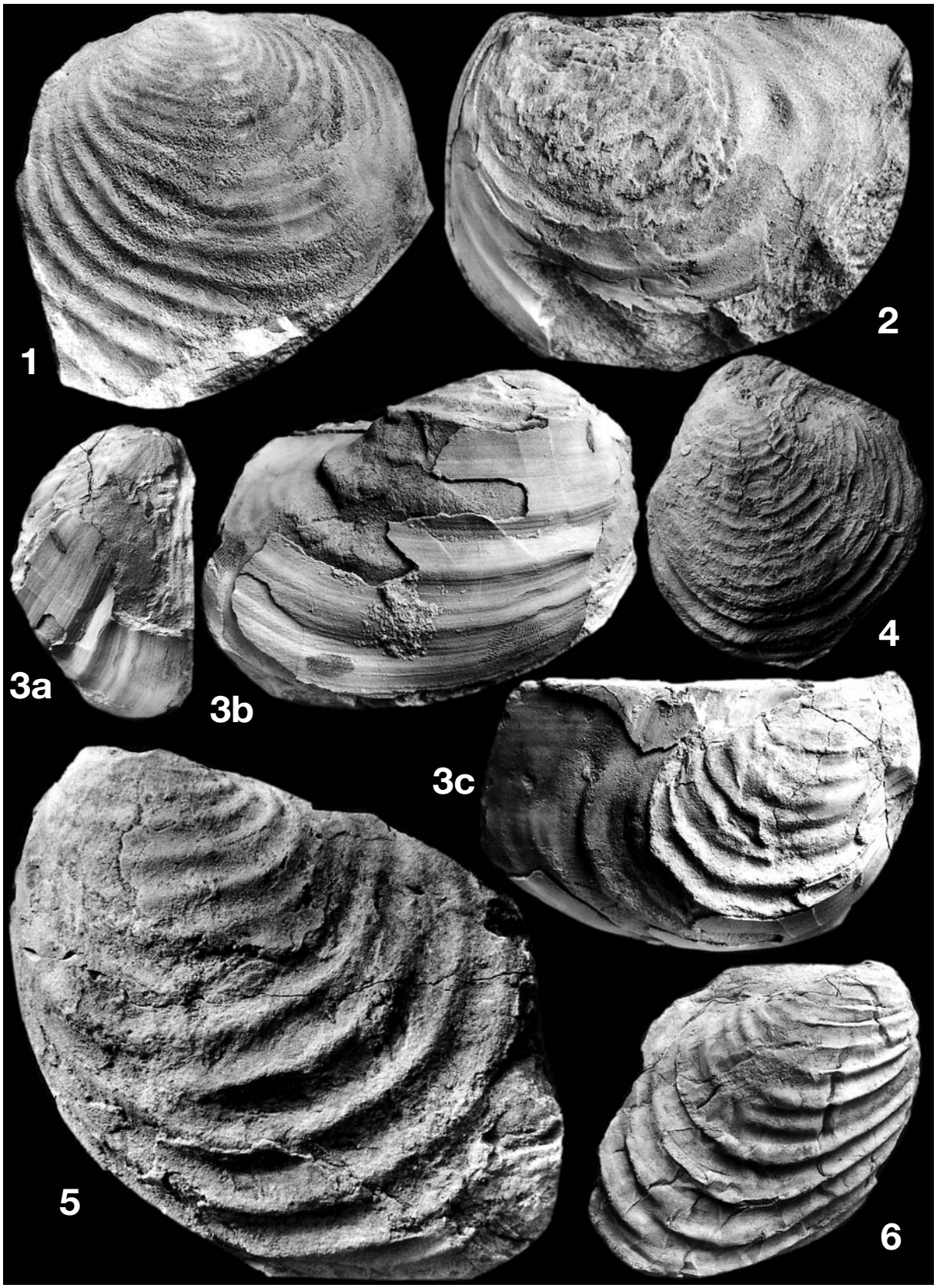
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PLATE 2

1-2, 4-5 – *Sphaeroceramus pertenuiformis* WALASZCZYK, COBBAN & HARRIES, 2001; 1 – IW-250 from level (47) [section II]; 2 – IW-29 from level 46.1 [section II]; 4 – IW-227 from level (47) [section II]; 5 – IW-242 from level (47) [section II]; 1-2, 5 × 1; 4 × 0.9

3 – *Cataceramus goldfussianus* (D'ORBIGNY, 1847), IW-28 from level 45.6 [section II]; × 1

6 – "*Cataceramus*" sp., IW-13 from level 42.4 [section II]; × 0.95

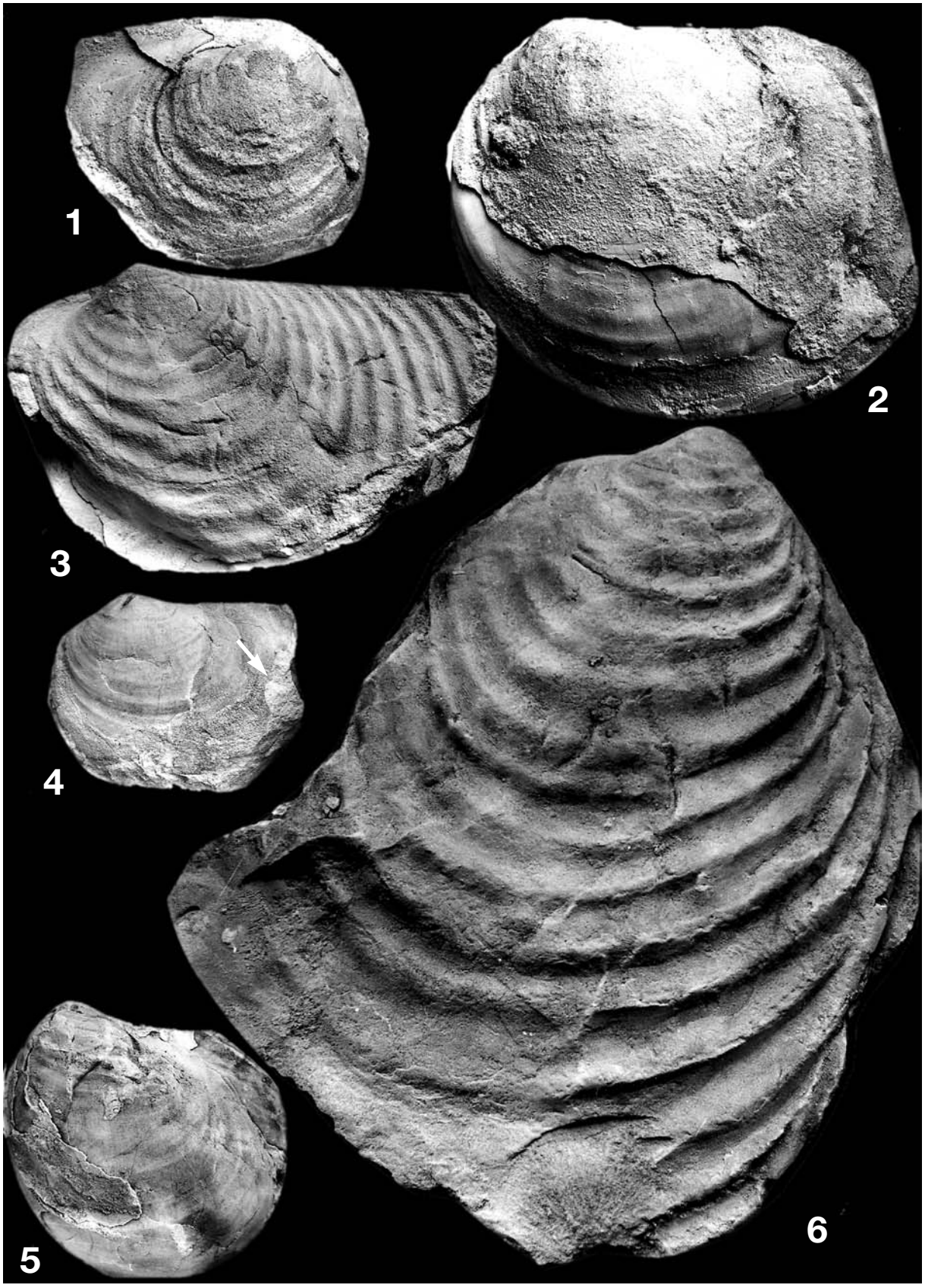
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PLATE 3

1-3, 5-6 – *Sphaeroceramus pertenuiformis* (WALASZCZYK, COBBAN & HARRIES, 2001); 1 – IW-40 from level 47.5 [section II]; 2 **–** IW-42 from level 47.4 [section II]; 3 – IW-30 from level 45.4 [section II]; 5 – IW-41 from level 47 [section II]; 6 – IW-39 from level (47.2) [section II]; 1, 3 × 1; 2 × 0.85; 5 × 0.95; 6 × 0.9

4, 9 – *Cataceramus* ? aff. *barabini* (MORTON, 1834); 4 – IW-33 from level 45.6 [section II]; 9 – IW-38 from level 47.4 [section II]; 4 × 0.9; 9 × 1

7 – "*Inoceramus*" *borilensis* JOLKIČEV, 1962; IW-34 from level 47.4 [section II]; × 0.8

8 – *Cataceramus* sp.; IW-32 from level 46.9 [section II]; × 0.75

10 – *Cataceramus goldfussianus* (D'ORBIGNY, 1847); IW-37 from level 47.5 [section II]; × 0.9

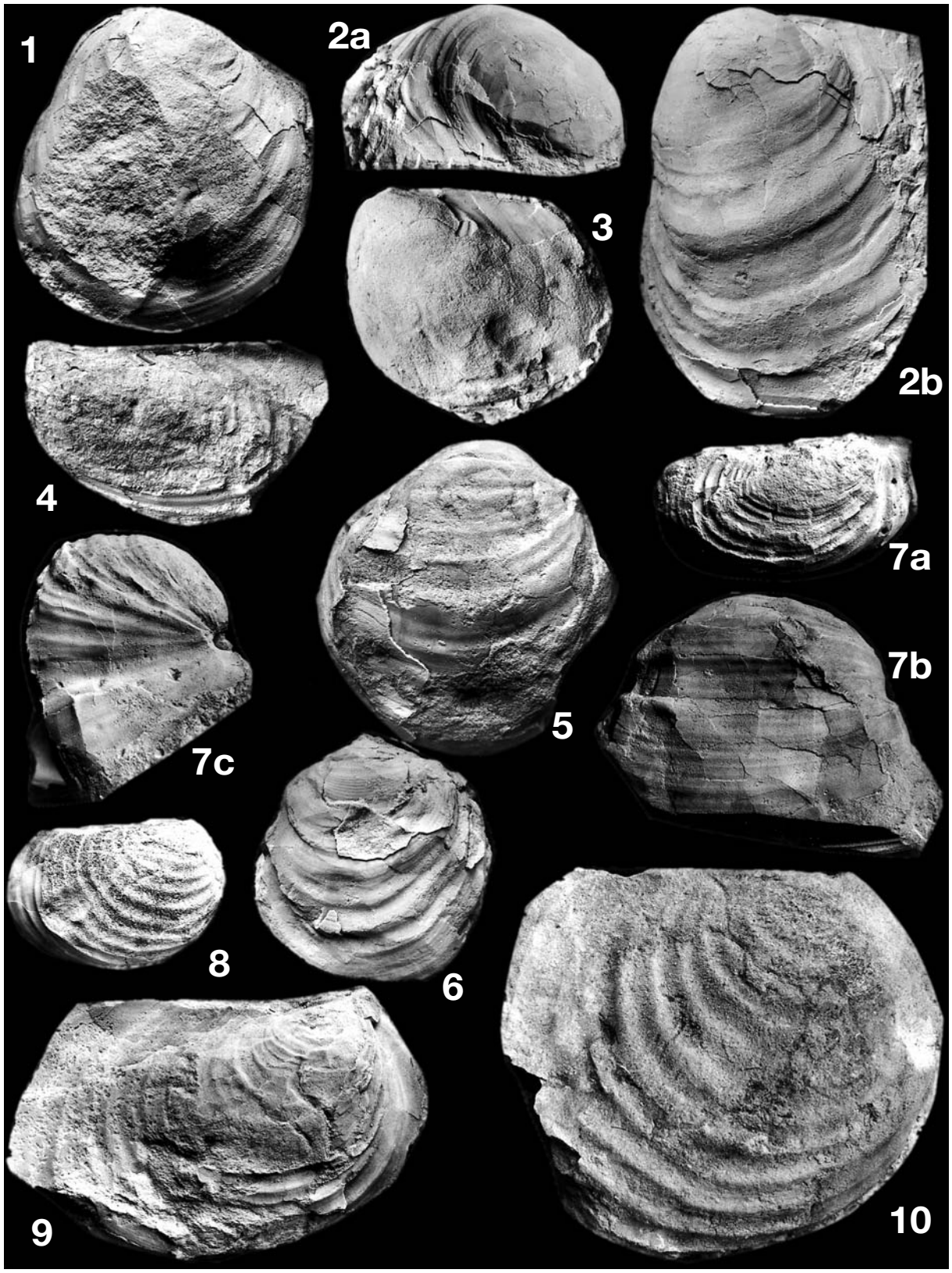
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PLATE 4

1 – *Cataceramus*? aff. *barabini* (MORTON, 1834); IW-66 from level 66.5 [section II]; × 1
2 – "*Inoceramus*" *vanuxemi* MEEK & HAYDEN, 1860; IW-49 from level 67.0 [section II]; × 1
3 – "*Inoceramus*" *sagensis* OWEN, 1852, IW-48 from level 66.8 [section II]; × 1
4-5 – "*Inoceramus*" *altus* MEEK, 1871, 4 – IW-47 from level 67 [section I]; 5 – IW-46 from level 67 [section I]; × 1
6 – *Cataceramus goldfussianus* (D'ORBIGNY, 1847), IW-203 from level 66.5 [section II]; × 0.75

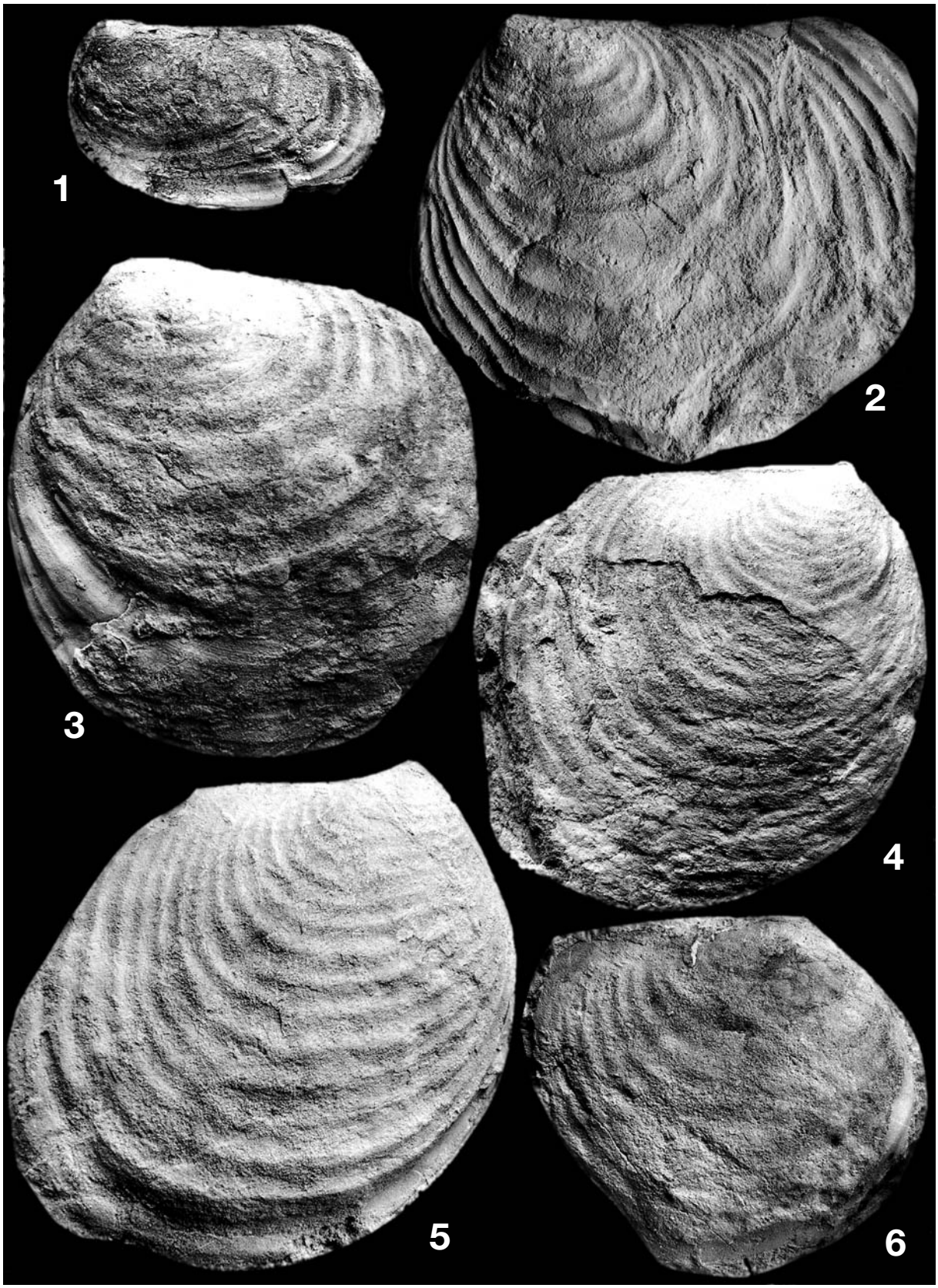
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PLATE 5

1 – "*Inoceramus*" *altus* MEEK, 1871; IW-52 from level 66.5 [section II]; × 0.8

2-3 – *Cataceramus goldfussianus* (D'ORBIGNY, 1847), 2 – IW-53 from level 67.0 [section II]; 3 – IW-91 from level 66.5 [section II]; 2 × 0.85; 3 × 1

4, 6 – "*Inoceramus sagensis*" OWEN, 1852; 4 – IW-43 from level 66.5 [section II]; 6 **-** IW-55 from level 67.0 [section I]; 4 × 0.92; 6 × 1

5 – "*Inoceramus*" *vanuxemi* MEEK & HAYDEN, 1860; IW-54 from level 67.0 [section II]; × 0.85

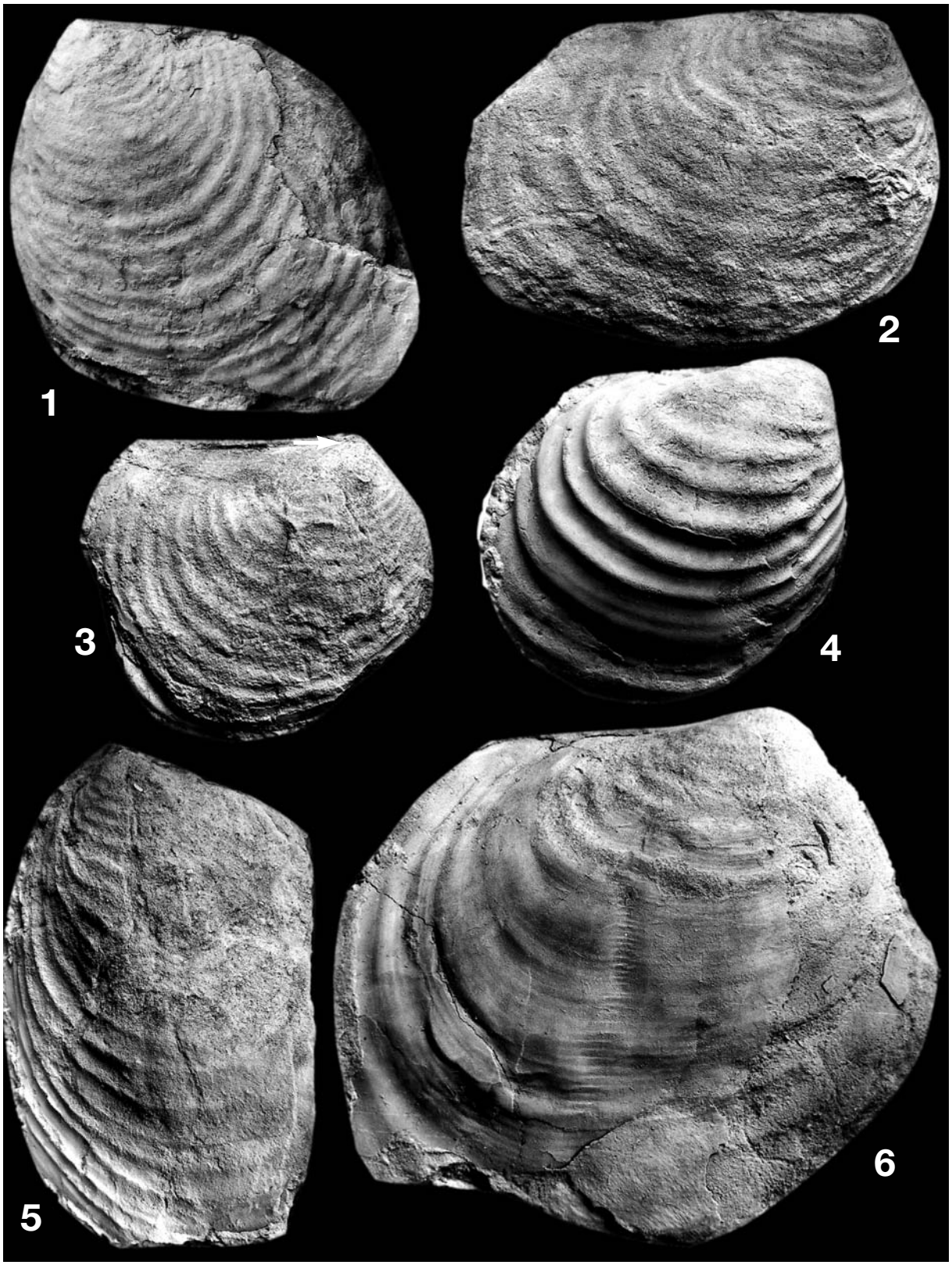
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PLATE 6

1 – *Cataceramus* cf. *pseudoregularis* (SORNAY, 1962) IW-201 from level 66.5 [section I]; × 0.65

2-3, 6 – "*Inoceramus*" *altus* MEEK, 1871; 2 – IW-204 from level 67.1 [section II], 3 – IW-205 from level 66.5 [section II]; 6 – IW-207 from level 66.5 [section II]; 2, 6 × 0.7; 3 × 0.6

4 – "*Inoceramus sagensis*" OWEN, 1852; IW-191 from level 67.0 [section II]; × 0.7

5 – "*Inoceramus*" *altusiformis* WALASZCZYK, COBBAN & HARRIES, 2001; IW-209 from level 67.6 [section II]; × 0.7

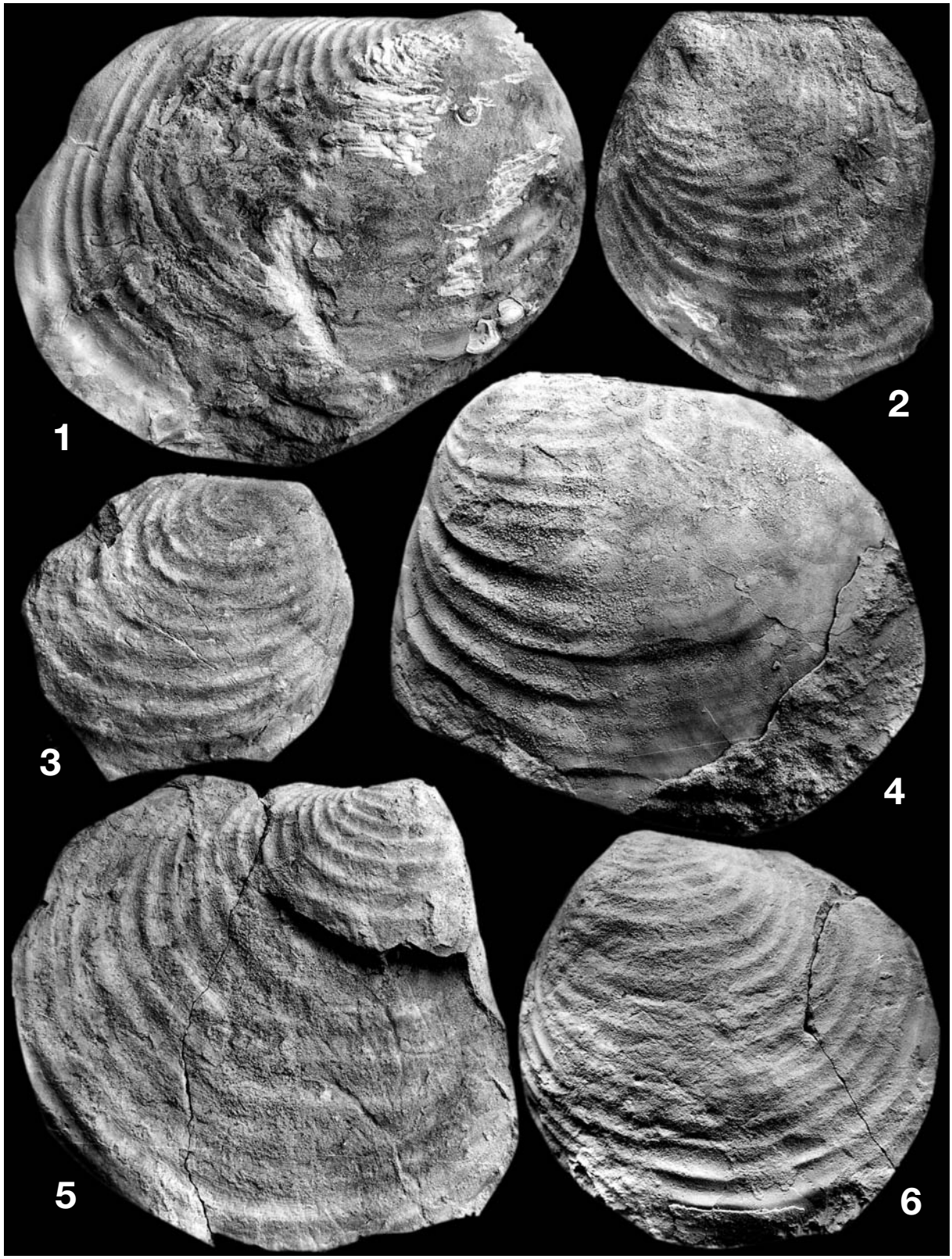
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PLATE 7

1, 4 – "*Inoceramus*" *vanuxemi* MEEK & HAYDEN, 1860; 1 – IW-285 from level 73.9 [section I]; 4 – IW-273 from level 73.9 [section I]; 1 × 0.9; 4 × 1

2 – "*Inoceramus*" sp., IW-267 from level 79.8 [section I]; × 0.9

3 – *Cataceramus goldfussianus* (D'ORBIGNY, 1847), IW-296 from level 80.5 [section I]; × 0.75

5 – "*Inoceramus*" sp., IW-286 from level 79.8 [section I]; × 0.9

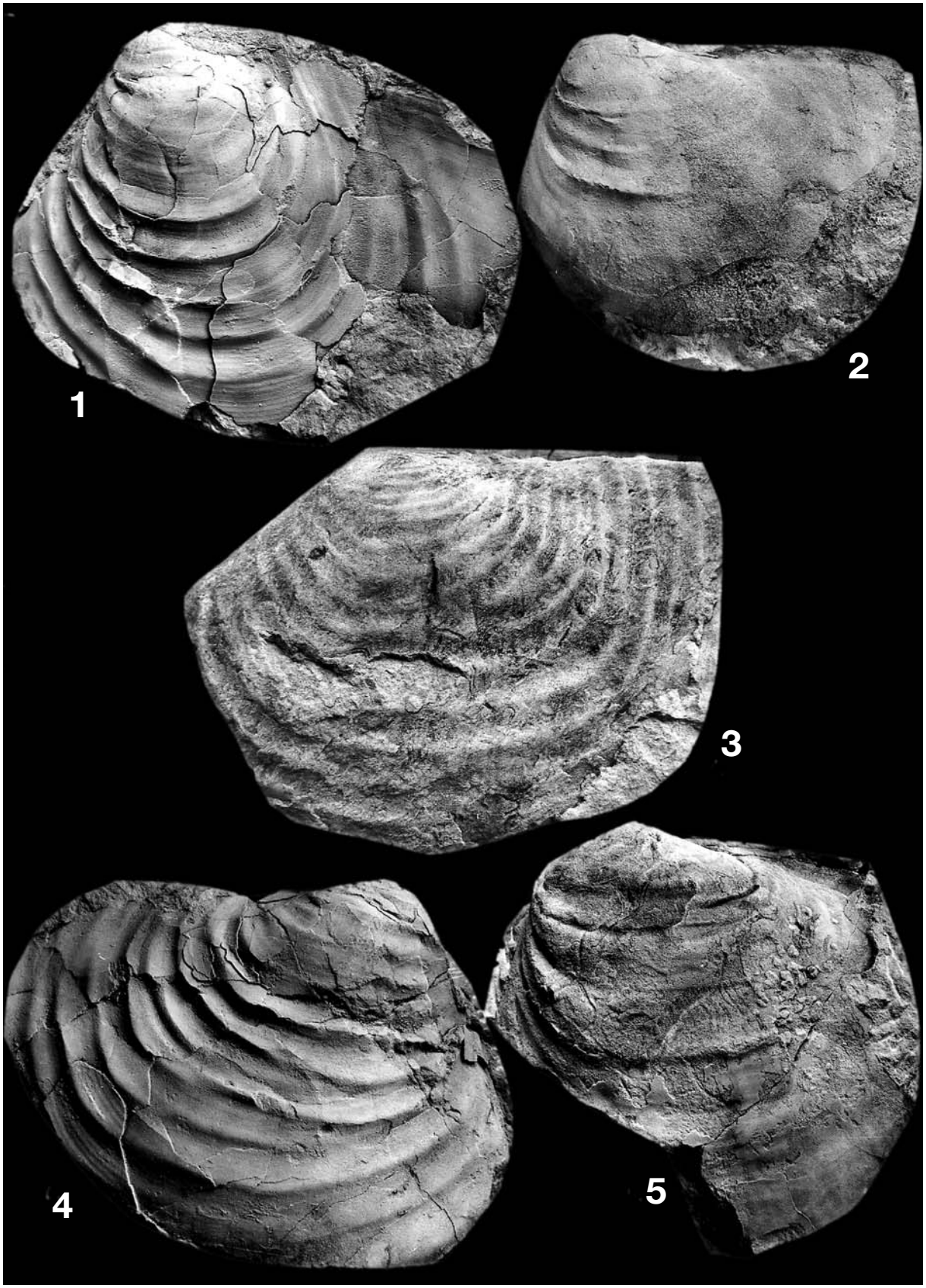
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PLATE 8

1-2 – *Cataceramus palliseri* (DOUGLAS, 1942), 1 – IW-278 from level 85.3 [section I], 2 – IW 76 from level 84.7 [section II]; × 1

3, 6 – "*Inoceramus*" aff. *gandjaeformis* WALASZCZYK, COBBAN & HARRIES, 2001, 3 – IW-294 from level 84.7 [section I]; 6 – IW-293 from level 84.0 [section I]; × 0.75

4 – "*Inoceramus*" *alaeformis* ZEKELI 1852 *of authors*; IW-81 from level 87.6 [section II]; × 1

5 – *Cataceramus goldfussianus* (D'ORBIGNY, 1847), IW-282 from level 85.1 [section I]; × 0.95

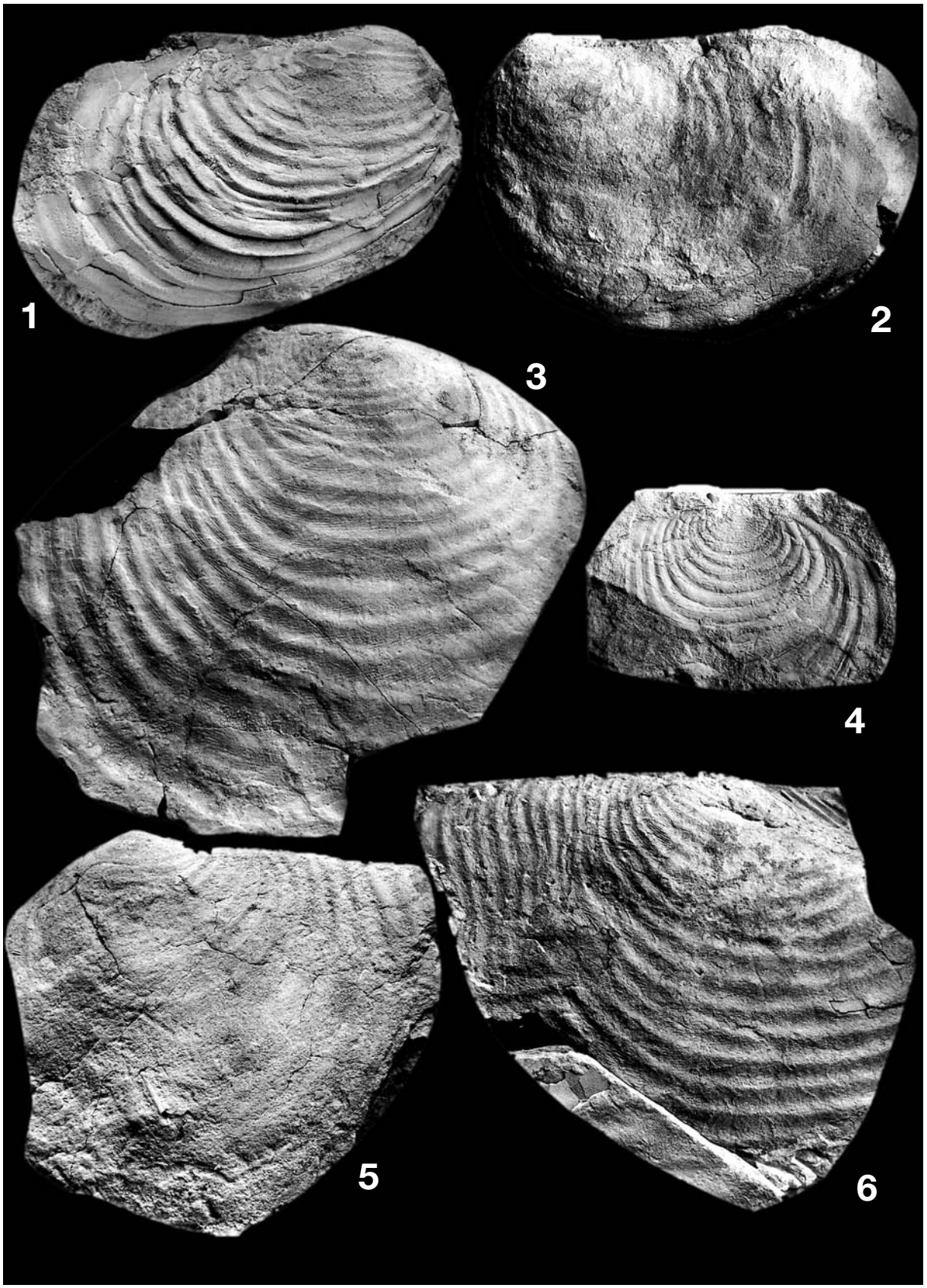
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PLATE 9

1-2 – "*Inoceramus*" *oblongus* MEEK, 1871; 1 – IW 80 from level 94.0 [section I], 2 – IW 74 from level 93.0 [section II]; × 0.85

3-4 – "*Inoceramus*" *alaeformis* ZEKELI, 1852 *of authors*; 3 – IW 173 from level 93.3 [section I], 4 **-** IW-172 from level 93.0 [section I]; × 0.85

5 – "*Inoceramus*" *altus* MEEK, 1871; IW 68 from level 93.6 [section I]; × 1

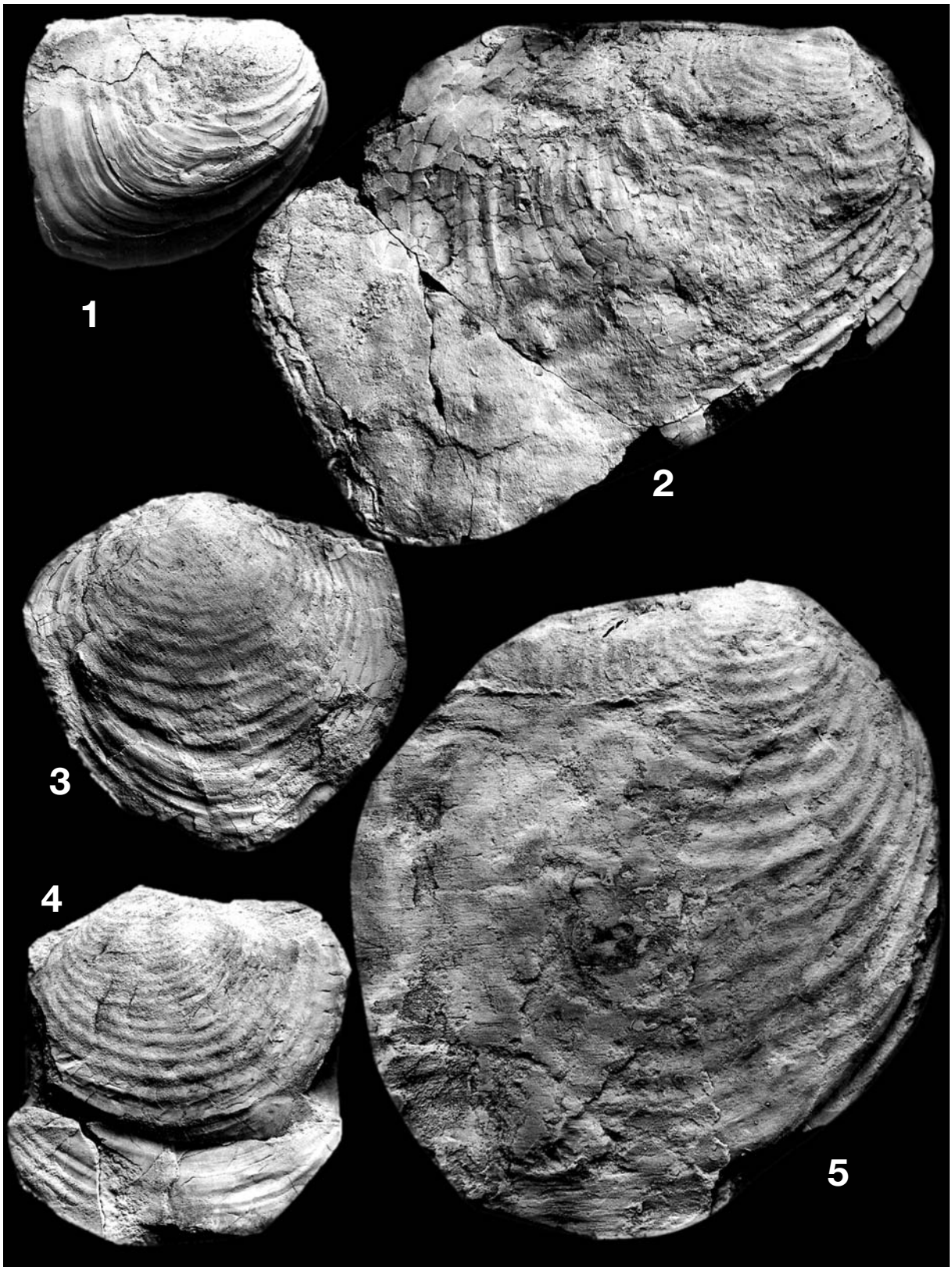
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PLATE 10

1 – "*Inoceramus*" *alaeformis* ZEKELI, 1852 *of authors*; IW-78 from level 93.5 [section I]; × 0.95
2 – *Cataceramus* aff. *pteroides*, IW-175 from level 93.5 [section I]; × 0.92
3 – "*Inoceramus*" sp., IW 153 from level 93.6 [section I]; × 1
4 – *Cataceramus palliseri* (DOUGLAS, 1942), IW-174 from level 93.0 [section I]; × 0.95
5 – "*Inoceramus*" *oblongus* MEEK, 1871; IW 67 from level (93.6) [section I]; × 1

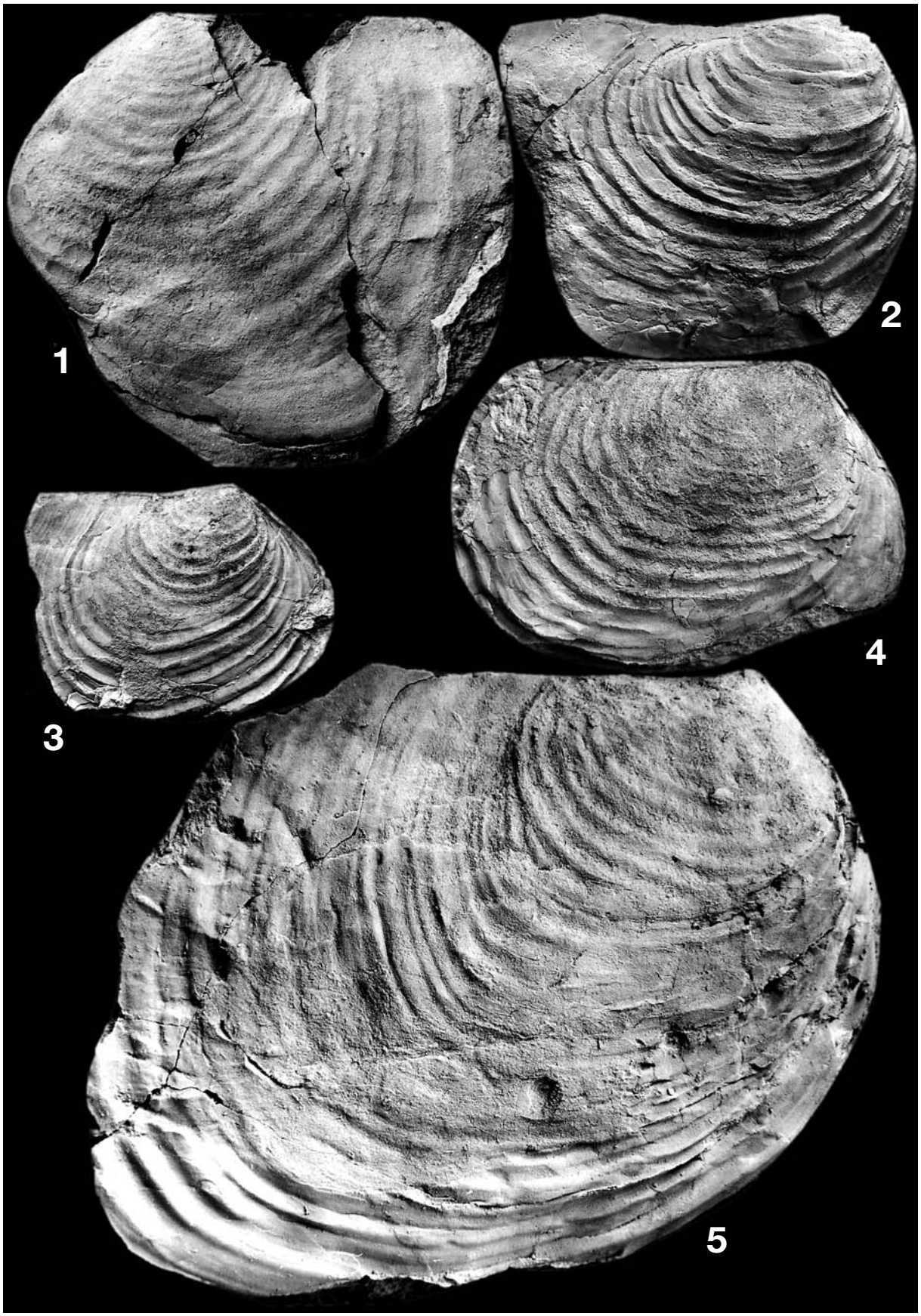
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PLATE 11

1-5 – *Trochoceramus costaecus* (KHALAFOVA, 1966), 1 – IW-160 from level 96.7 [section IV]; 2 – IW-167 from level 96.7 [section IV]; 3 – IW-90 from level 97.5 [section IV]; 4 – IW-170 from level 97.8 [section IV]; 5 – IW-168 from level 96 [section IV]; 6 – IW-86 from level 101.1 [section IV]; 7 – IW-161 from level 97.7 [section IV]; 1-2, 5-7 × 1; 3-4 × 0.9

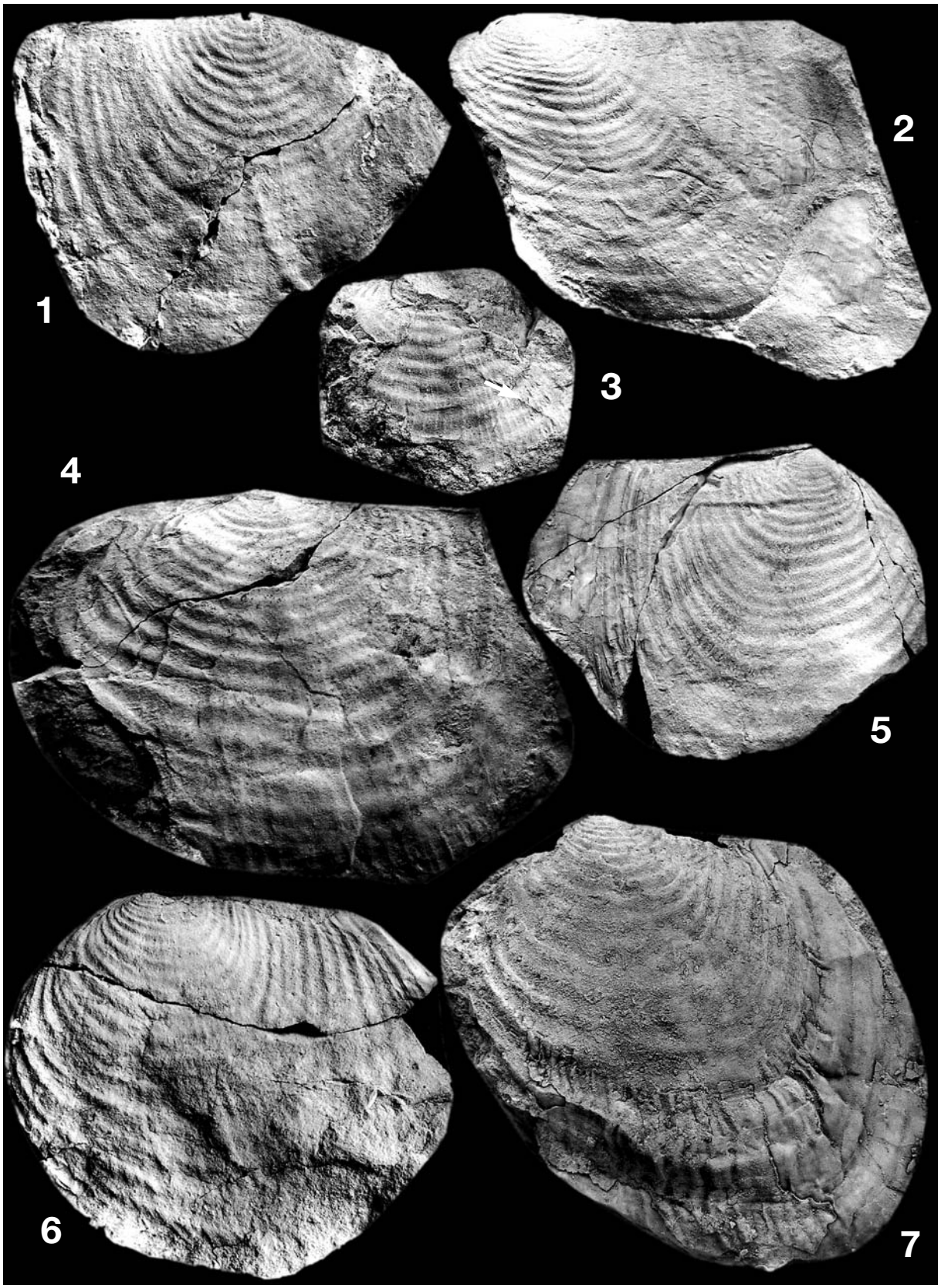
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PLATE 12

1 – ?*Trochoceramus radiosus* (QUAAS, 1902) or juvenile of a large *Trochoceramus costaecus* (KHALAFOVA, 1966) [=DHONDT, 1993, pl. 7, fig. 3], KBIN TCM 10538, A.V. DHONDT collection; × 1

2-3, ?7 – *Trochoceramus costaecus* (KHALAFOVA, 1966); 2 – IW-85 from level 98.2 [section II]; 3 – IW-88 from level 101.9 [section IV]; 7 – from A.V. DHONDT collection; 2, 7 × 1; 3 × 0.9

4, 8 – *Inooceramus*" aff. *redbirdensis* WALASZCZYK, COBBAN & HARRIES, 2001; 4 – IW-101 from level 108.4; 8 – IW-102 from level 108.4 [both secpecimens section IV]; × 1

5-6 – "*Inoceramus*" *wyomingensis* WALASZCZYK, COBBAN & HARRIES, 2001; 5 – IW-105 from level 109.8; 6 – IW-104 from level 109.8 [both specimens section III]; 5 × 1; 6 × 0.85

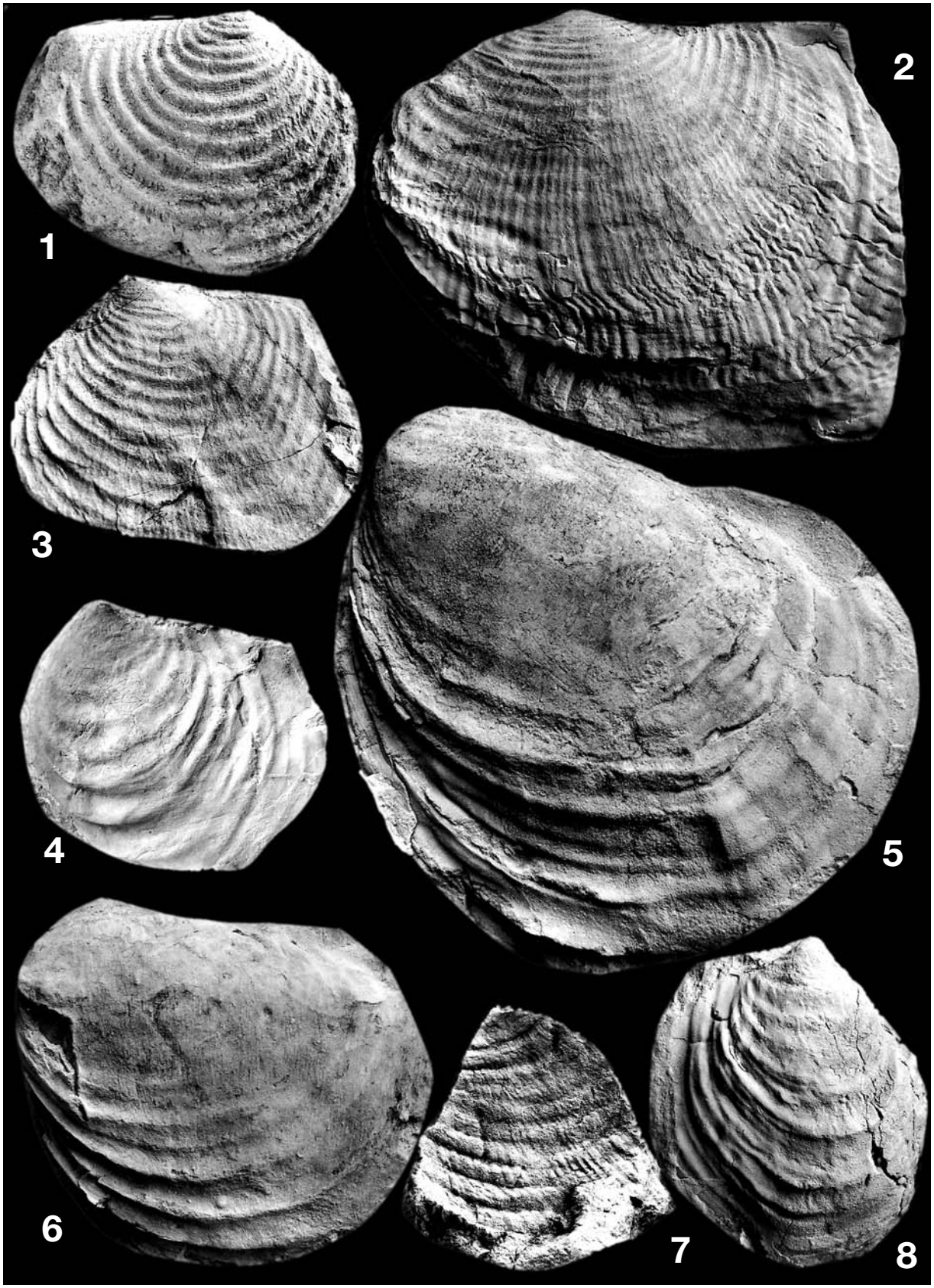
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PLATE 13

1-5, 7-8, 11 – *Endocostea typica* WHITIFELD 1880; 1 – IW 114 from level 117.4a [section E] 2 – IW 109 from level 117.2a [section E]; 3 – IW 110 from level 117.5a [section E]; 4 – IW 128 from level 117.7 [section V]; 5 – IW 132 from level 117.7 [section V]; 7 – IW 115 from level 117.5a [section E]; 8 – IW 131 from level 117.7 [section V]; 11 – IW 117 from level 147.6a; 1, 3-5, 8, 11 × 1; 2 × 0.75; 7 × 0.8

6, 10 – *Cataceramus subcircularis* (MEEK, 1876); 6 – IW 116 from level 117.4a [section E]; 10 – IW 133 from level 117.4a [section E]; × 1

9 – *Endocostea jolkicevi* sp. nov.; IW 121 from level 117.4a [section E]; × 1

12-16 – "*Inoceramus*" *redbirdensis* WALASZCZYK, COBBAN & HARRIES, 2001; 12 – IW-96 from level 109.0 [section IV]; 13 – IW-99 from level 110.0 [section III]; 14 – IW-98 from level 110.5 [section III]; 15 – IW-103 from level 110.8; 16 – IW-95 from level 110.0 [section IV]; all × 1

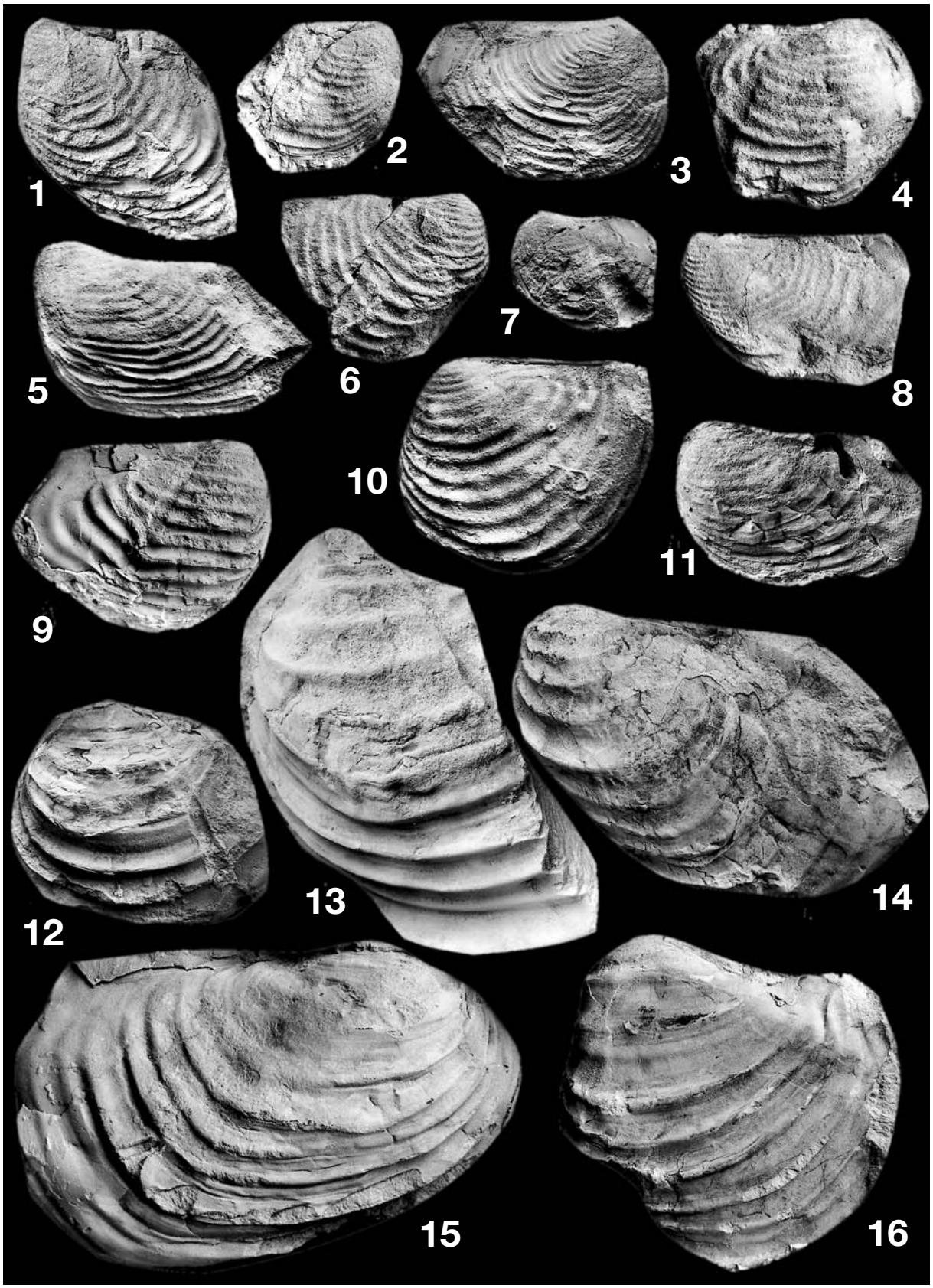
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PLATE 14

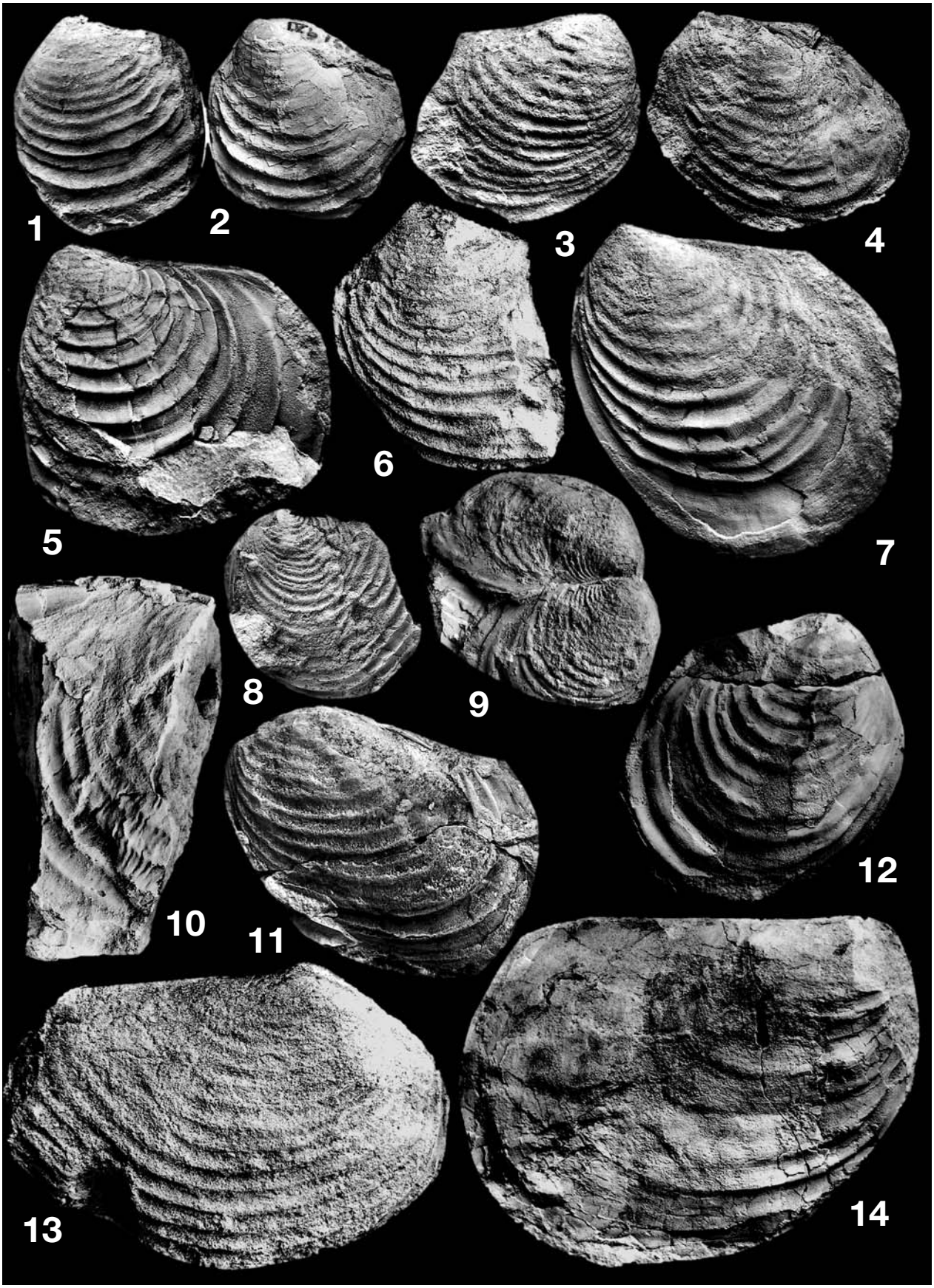
1-3, 6, 8-9 – *Cataceramus subcircularis* (MEEK, 1876), 1 – IW 140 from level 148.2 [section IV]; 2 – IW 135 from level 161.4 [section IV]; 3 – IW 139 from level 169.1a [section E]; 6 – IW 123 from level 161.5 [section IV]; 8 – KBIN TCM 10539, A.V. DHONDT collection; 9 – IW 136 from level 155.0; 1-3, 8-9 × 1; 6 × 0.8

4, 11, 14 – *Cataceramus? barabini* (MORTON, 1834); 4 – IW 111 from level 143.8 [section IV]; 11 – IW 157 from level 155.6 [section IV]; 14 – IW 147 from level 161.1 [section IV]; 4, 11 × 1; 14 × 1.2

5, 7, 12 – *Cataceramus? glendivensis* WALASZCZYK, COBBAN & HARRIES, 2001; 5 – IW 137 from level 157 [section IV]; 7 – IW 141 from level 148.2 [section IV];12 – IW 124 from level 169.1a [section E]; all × 1

10 – *Trochoceramus radiosus* (QUAAS, 1902); A.V. DHONDT collection, unit V; × 1

13 – *Cataceramus? oviformis* WALASZCZYK, COBBAN & HARRIES, 2001; IW 120 from level 117.8 [section III]; × 1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