The inoceramid succession across the Campanian – Maastrichtian boundary

IRENEUSZ WALASZCZYK, WILLIAM A. COBBAN & GILLES S. ODIN

Walaszczyk, I., Cobban, W.A. & Odin, G.S. 2002–06–26: The inoceramid succession across the Campanian – Maastrichtian boundary. *Bulletin of the Geological Society of Denmark*, Vol. 49, pp. 53–60. Copenhagen.

Recent study revealed a high correlation potential of inoceramid bivalves across the Campanian – Maastrichtian (Upper Cretaceous) boundary within the Euroamerican biogeographical region. In inoceramid terms the Campanian/Maastricthian boundary, as currently defined, lies in the topmost part of the "*Inoceramus*" *redbirdensis* Zone, close to the base of the *Endocostea typica* Zone. Both zones, as well as the whole late Campanian and early Maastrichtian inoceramid succession is well recognisable across the European sections and across the Atlantic to the US Western Interior succession.

Key words: Inoceramid zonation, Campanian – Maastrichtian boundary, Euramerican biogeographical region, correlations.

Ireneusz Walaszczyk [*walas@geo.uw.edu.pl*] , *Institute of Geology, University of Warsaw, Al. Zwirki i Wigury 93, PL-02-089 Warszawa, Poland. William A. Cobban, 70 Estes Street, Lakewood, Colorado 80226, USA. Gilles S. Odin, Université P. & M. Curie, Unité de Géochronologie et Sédimentologie Océanique; 4, Place Jussieu, Case 119 A, F75252, Paris Cedex 05, France.* 13 May 2002.

Inoceramid bivalves were not considered as a possible marker group for defining the Campanian/Maastrichtian boundary either at the Copenhagen Symposium (Birkelund et al. 1984) or the Brussels Symposium (Odin 1996). The reason was the very poor recognition of Campanian and Maastrichtian inoceramid fauna, absence of agreed nomenclature, and the common belief that late Late Cretaceous inoceramids lost rapid rate of evolution and consequently their biostratigraphical potential. Although the group was used in local biostratigraphical schemes, as e.g. in Japan (Toshimitsu et al. 1995), southern Russia (Aliev et al. 1986), or the US Western Interior (Kauffman et al. 1994), no supra-regional correlation had been proposed, and taxonomic concepts remained highly controversial. Simultaneously, however, the works by Kauffman et al. (1994) in the US Western Interior and Walaszczyk (1996, 1997) in Europe, suggested that Campanian and Maastrichtian inoceramids retained their evolutionary dynamics and were potentially as useful biostratigraphically as they were in the Cenomanian through Santonian. In addition, the FO of the genus *Trochoceramus* has been used by the Maastrichtian Working Group, led by one of us (GO) among the 12 criteria defining the stage boundary level at Tercis (Odin 2001c). The need for the restudy of the group became obvious.

In 1998 two of us (IW and WAC), together with Peter J. Harries, Tampa, began systematic and stratigraphical revision of the Campanian and Maastrichtian inoceramids of the US Western Interior. This region provides the best record of the group for the interval and, moreover, the Campanian – Maastrichtian succession there has been subdivided into a refined, ammonite-based zonal sequence (Cobban 1994 and references therein). The study revealed a clear and unequivocal inoceramid succession that forms the basis for the construction of a refined inoceramid zonation for the Campanian and Lower Maastrichtian. As demonstrated by Walaszczyk et al. (2001) the turnover rate and taxonomic diversity of inoceramid assemblages was particularly high in the latest Campanian and earliest Maastrichtian. The question, however, as to what extent this was a local succession or a record of a valid supra-regional succession of inoceramid faunas remained open, because the correlation with Europe, as well as with other areas appeared difficult. Existing and/or published collections were either without systematic description, or the material was not representative, or lacked stratigraphical control. The answer was revealed when two of us (IW and GO), together with Dr. A.V. Dhondt, Brussels, started to work on new inoceramid collections from the Tercis section in SW France, the now accepted Global Standard stratotype

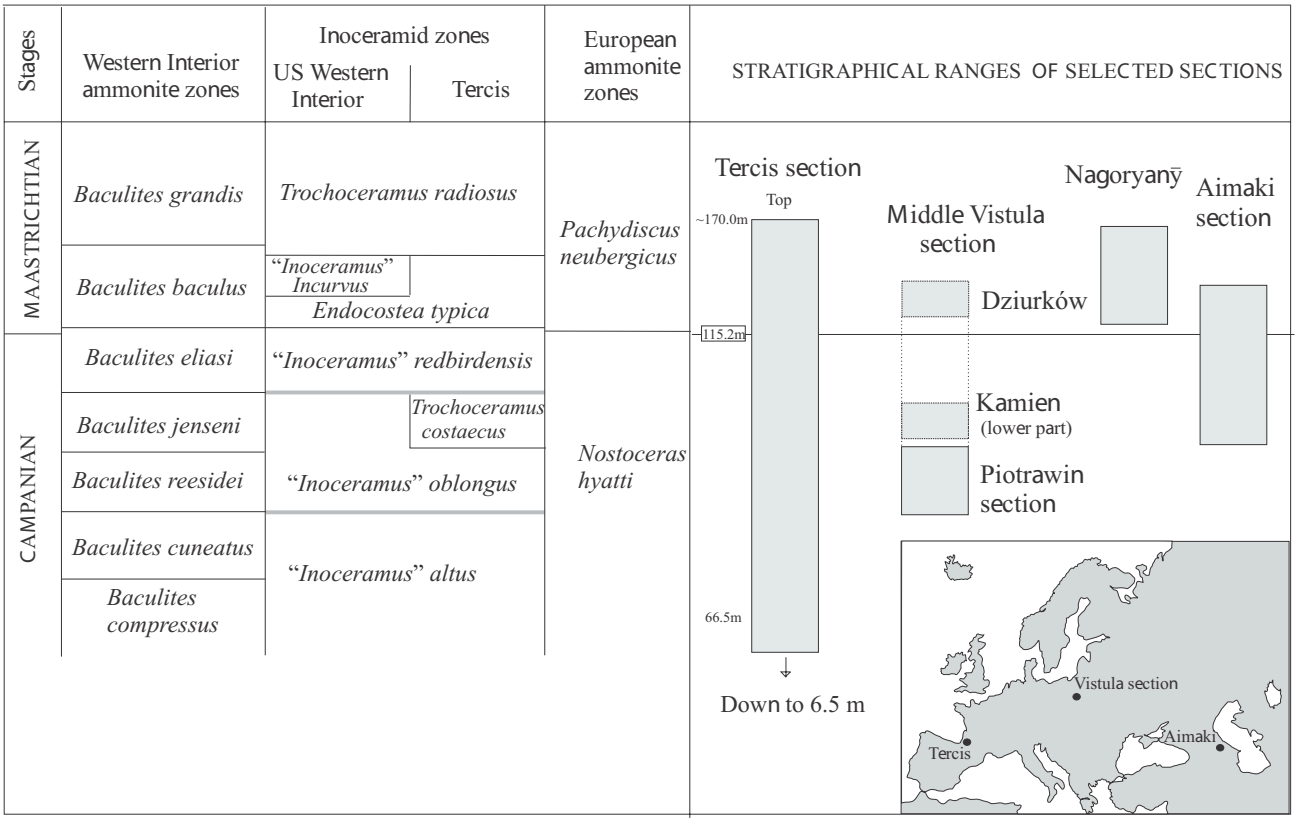

Fig. 1. The correlation of the Upper Campanian and Lower Maastrichtian inoceramid zonation with the US Western Interior *Baculites* zones (after Cobban 1994) and the European ammonite zones, and the inoceramid based correlation of the selected sections in Europe.

Section and Point (GSSP) for the Campanian – Maastrichtian Stage boundary. The section has been extensively collected since the first modern description by Hancock et al. (1993; see also Hancock & Kennedy, 1993, Dhondt, 1993, Odin & Odin 1994) and more recently, thanks to the large collection of inoceramids, as well as ammonites, echinoids and others among nine macrofossil groups which were collected by one of us (GO) from that outcrop (see Odin 2001a). The collections span an interval corresponding to the Upper Campanian (in North American usage) and lower Maastrichtian (see Walaszczyk et al. 2001) and revealed an almost identical inoceramid succession to that recently established for the US Western Interior. Moreover, at Tercis, inoceramids allow a precise location of the Campanian/Maastrichtian boundary as currently defined, i.e. at level 115.2 at Tercis (i.e. correspondence with a biological change marked by 12 biohorizons, including last and first occurrences of four macrofossils and eight microfossils (Odin 2001c, Odin & Lamaurelle 2001). Taking into account the wide geographical range of the inoceramid species concerned, and their apparently isochronous appearance in the whole of their geographical range, inoceramids are clearly a very good marker of the Campanian/Maastrichtian boundary interval, within the Euramerican biogeographical region (sensu Kauffman 1973).

The inoceramid succession across the Campanian – Maastrichtian boundary

US Western Interior

The US Western Interior succession is critical for the recognition of inoceramid occurrences across the Campanian/Maastrichtian boundary. Its exceptional character stems from the continuous record of abundant inoceramids throughout the succession, and from the highly refined stratigraphical control provided by ammonites (see Cobban 1994 and literature cited therein). Kauffman et al. (1994) were the first to demonstrate a high turnover rate of inoceramid assem-

blages throughout this interval in the area; more recently Walaszczyk et al. (2001) documented the succession, and provided a taxonomic interpretation of the inoceramid fauna. These authors recognised six inoceramid zones in the interval starting approximately in the Late Campanian *Baculites compressus* Zone and ranging upward into the Early Maastrichtian *Baculites grandis* Zone. The inoceramid succession and its correlation with the ammonite zonation is shown in Figure 1.

With some exceptions, the precise correlation of the respective boundaries between ammonite and inoceramid zonations requires further study. Two exceptions are the base of the *Endocostea typica* Zone, which is characterised by sudden, mass appearance of the index taxon at the base of the *Baculites baculus* Zone, and the base of the *Trochoceramus radiosus* Zone, well documented in sections from Montana, and corresponding to the topmost part of the *Baculites baculus* ammonite Zone. The general succession is, however, well established.

The Tercis section

The rich fauna, comprising both Boreal and Tethyan macro- and microfaunal elements, makes the Tercis Quarry (SW France) a very important section for interprovincial correlation. That is the reason the section was supported by a vast majority as the Stratotype Section and Point for the base of the Maastrichtian Stage at the Brussels Symposium in 1995 (see Odin 1996). Hancock et al. (1993) provided the first modern description and Hancock & Kennedy (1993) described the ammonite fauna from the succession. There is now an integrated palaeontological and stratigraphical survey edited by Odin (2001a).

Dhondt (1993) described the inoceramid fauna from the Tercis section. However, with the exception of seven specimens (of a total of 105) all the specimens at her disposal were from an interval well below the boundary. The subsequent studies, spanning also the boundary interval were undertaken later and reported in Odin (2001b), and the complete succession, comprising markedly larger collection, with revision of the material treated previously, was described only recently (Walaszczyk, Odin & Dhondt, unpublished). The succession encountered corresponds well to that described recently by Walaszczyk et al. (2001) from the US Western (Fig. 1).

The base of the *Endocostea typica* Zone corresponds to the base of the *Pachydiscus neubergicus* Zone. This boundary marks, moreover, a very clear change in the inoceramid faunas.

The inoceramid sequence

As demonstrated by the US Western Interior succession and Tercis sections (and confirmed by some other European sections, as discussed below), the latest Campanian and earliest Maastrichtian inoceramid bivalves of the Euramerican biogeographic region (*sensu* Kauffman 1973) are characterised by a rapid rate of evolution and high morphological variability. They form the basis of a series of successive zones, with very high resolution potential, comparable to the resolution offered by baculitid ammonites in the Western Interior (see e.g. Cobban 1994). Taxonomic studies of the inoceramids are provided by Walaszczyk et al. (2001) and Walaszczyk, Odin & Dhondt (unpublished).

Starting from the *Baculites compressus* Zone of the late Campanian to the *Baculites grandis* Zone of the early Maastrichtian the following zones are recognised (Fig. 2).

The Zone of "*Inoceramus*" *altus*. – The "*I.*" *altus* Zone is characterised by a very peculiar fauna, consisting of the index taxon, in addition to "*I.*" *altusiformis*, "*I.*" *vanuxemi*, "*I.*" *sagensis* and "*I.*" *nebrascensis*. In Europe the zone corresponds to the basal part of the highest Campanian ammonite Zone of *Nostoceras hyatti*. In the US Western Interior it probably embraces the *Didymoceras cheyennense*, *Baculites compressus* Zone, and *Baculites cuneatus* Zones. In Europe, because of a lack of suitable sections, the zone is recognised so far exclusively at Tercis.

The Zone of "*Inoceramus*" *oblongus.* – The "*I.*" *oblongus* Zone is represented by the taxonomically richest inoceramid assemblage in the interval studied. The rich assemblage was described from US Western Interior (Walaszczyk et al. 2001) with about 10 species recognised, and most of them was also recognised in Tercis. Very rich material from the zone is known from the Piotrawin Quarry in the Vistula Valley section in Poland. The zone corresponds to the middle part of the *Nostoceras hyatti* Zone as distinguished in Europe, and to the *Baculites reesidei* and *Baculites jenseni* Zones of the US Western Interior. *Inoceramus alaeformis* Zekeli, 1852, auctorum, is a very characteristic species of this zone in Europe.

The Zone of *Trochoceramus costaecus*. – This zone was definitely recognised only in Europe, where it is well documented in the Tercis section (Odin 2001b, Walaszczyk, Odin & Dhondt, unpublished) and in the Aimaki section, Daghestan (Walaszczyk et al. 1996). Trochoceramids characteristic of the zone are also known, however, in the US Gulf Coast and should oc-

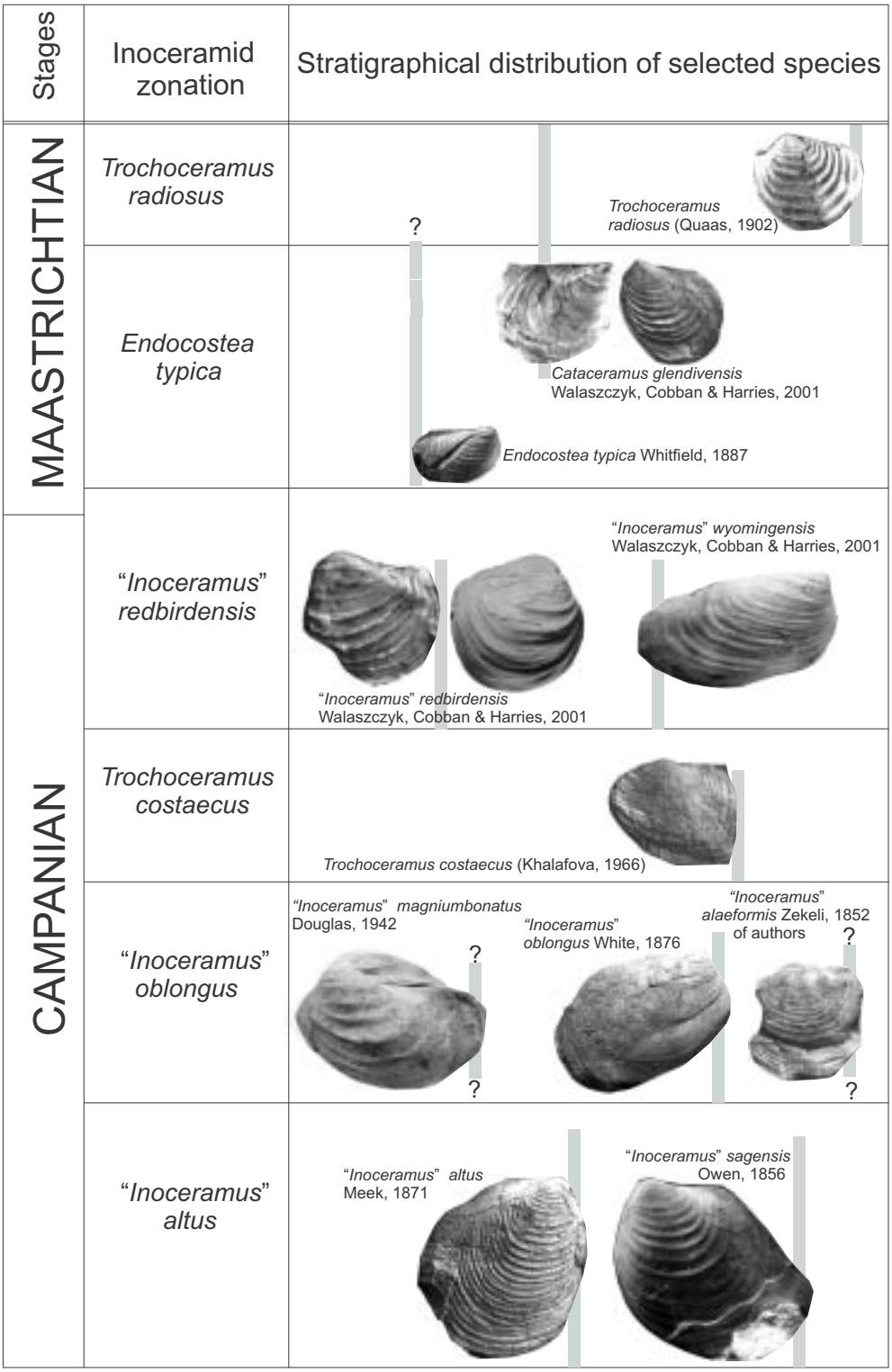

Fig. 2. Inoceramid vertical distribution and zonation in the upper Upper Campanian and Lower Maastrichtian; based on data from the US Western Interior and Tercis, SW France.

cur also in the US Western Interior somewhere in the basal *Baculites eliasi* Zone or in the top part of the *Baculites jenseni* Zone. Further detailed works on the interval in the US Western Interior are planned.

The Zone of "*Inoceramus*" *redbirdensis*. – This is the highest Campanian inoceramid zone. The zone was first recognised in the US Western Interior (Walaszczyk et al. 2001) and confirmed subsequently in Tercis (Walaszczyk et al. unpublished). In the latter section it lies distinctly below level 115.2, the formally accepted lower boundary of the Maastrichtian stage (Odin & Lamaurelle 2001). Its correspondence to the *Baculites eliasi* Zone in the US Western Interior, places the zone in the topmost Campanian. "*Inoceramus*" *redbirdensis* and "*I.*" *wyomingensis* are the two most characteristic species of the zone.

The Zone of *Endocostea typica*. – This zone marks the main change in the inoceramid fauna through the top Campanian - lowermost Maastrichtian. The base of the *E. typica* Zone is characterised by a sudden, often mass appearance of the index taxon in the Western Interior. At Tercis the base of the zone lies approximately 2 metres above level 115.2, making *E. typica* a very useful proxy for the Campanian/Maastrichtian boundary. It also allows the precise correlation with the Western Interior indicating that the base of the Maastrichtian should be placed at, or slightly below the base of the *Baculites baculus* Zone, as suggested earlier (Jeletzky 1968, Hancock & Kauffman 1989, Hancock 1993). In the Western Interior the higher parts of the zone, as here defined, is characterised by "*Inoceramus*" *incurvus* Meek & Hayden, 1856. A very characteristic species, *Cataceramus glendivensis* Walaszczyk, Cobban & Harries, 2001 appears in the upper part of the Zone, and it may be possible in the future to recognise a separate *C. glendivensis* Zone.

The Zone of *Trochoceramus radiosus*. – This zone is characterised by the occurrence of large trochoceramids, represented mainly by *Trochoceramus radiosus* (Quaas, 1902) and much rarer *T. tenuiplicatus* (Tzankov, 1980) and *T. helveticus* (Heinz, 1932). Other characteristic species are "*Inoceramus*" *stephensoni* Walaszczyk, Cobban & Harries, "*I.*" *balchii* Meek & Hayden, 1860, *C.? barabini* (Morton, 1834) and *C. subcircularis* (Meek, 1876).

In the US Western Interior the zone corresponds roughly to the *Baculites grandis* Zone. In the Tercis section the zone is very poorly represented. It is documented by a single specimen collected by A.V. Dhondt from the very top of the succession (see Walaszczyk et al. unpublished). The zone corresponds to the upper part of the *Pachydiscus neubergicus* Zone.

Correlation with some other sections

The general validity of the recognised succession is confirmed by other European sections spanning the topmost Campanian and/or lowermost Maastrichtian, with a good inoceramid record. The Piotrawin Quarry section, a part of the Middle Vistula succession in central Poland; the Nagoryanýy section in the Ukraine, and the Aimaki section, the key section for the Upper Cretaceous in Daghestan, are discussed below (Fig. 1).

The Piotrawin Quarry section

The Piotrawin Quarry, central Poland (see Błaszkiewicz 1980 for locality) exposes approximately 30 metres of Upper Campanian siliceous chalks, well known from its abundant macrofossils. According to Kennedy & al. (1992) the succession represents the highest Campanian Zone of *Nostoceras hyatti* (= *Nostoceras pozaryskii* Zone of Błaszkiewicz, 1980). The nannofossils, indicating the CC22C nannofossil Zone (Burnett et al. 1992) also prove a very high Campanian age.

Inoceramids are very common and taxonomically diverse in the Piotrawin Quarry. The most common forms are: *Cataceramus palliseri* (Douglas, 1942), "*Inoceramus*" *magniumbonatus* Douglas, 1942, *Cataceramus? goldfussianus* (d'Orbigny, 1847), "*Inoceramus*" *alaeformis* Zekeli, 1852, auctorum "*Inoceramus*" *balchiformis* Walaszczyk, Cobban & Harries, 2001, and "*Inoceramus*" *oblongus* Meek, 1871. It is an assemblage characteristic of the "*Inoceramus*" *oblongus* Zone.

In Tercis the "*I.*" *oblongus* Zone represents approximately the middle part of the Zone of *N. hyatti*. Unfortunately, higher parts of the succession in the Vistula Valley are very poorly exposed. From Kamień, a locality just north of Piotrawin, and slightly younger stratigraphically, comes, however, a specimen of *Trochoceramus costaecus* (Khalafova, 1966) (see Walaszczyk et al. 1996, pl. 3, fig. 3). The whole succession of that locality was referred by Błaszkiewicz (1980) to the Lower Maastrichtian traditional *Belemnella lanceolata lanceolata* Zone. At Tercis, *T. costaecus* occurs in the *Trochoceramus costaecus* Zone, in the upper part of the Zone of *N. hyatti*. That means that the base of the *B. lanceolata lanceolata* Zone, the traditionally basal zone of the Maastrichtian in the northern Europe, may appear to be stratigraphically much lower than suggested on other grounds (see Christensen et al. 2000, Odin 2001c).

Lowermost Maastrichtian inoceramids, i.a. *Endocostea typica* and *Cataceramus subcircularis*, are known from Dziurków, a locality still higher in the succession.

Aimaki section

The highest Campanian and lowermost Maastrichtian inoceramids are well represented in the Aimaki section (Daghestan, Caucasus), the key section for the Upper Cretaceous of Daghestan (Aliev et al. 1986), and described recently by Walaszczyk et al. (1996). The succession studied starts just below a level with *Trochoceramus*, dominated by *Trochoceramus costaecus*. The morphotypes encountered correspond well to the trochoceramid fauna that occurrs in the topmost Campanian of the Tercis section. Higher up in the section occur forms referable to *Endocostea typica*, provisionally determined as *Endocostea* ex gr. *impressus* by Walaszczyk et al. (1996, pl. 3, fig,. 1; pl. 4. fig. 1). Still higher is an interval with forms referred by Walaszczyk et al. (1996) to "*I.*" ?*planus* Münster and "*I.*" cf. *dobrovi* Pavlova, 1955, which are both better referred to *Cataceramus subcircularis* (Meek, 1955). The *Endocostea* ex gr. *baltica* of Walaszczyk et al. (1996, pl. 3, fig. 6) represents the species *Cataceramus oviformis* Walaszczyk, Cobban & Harries, 2001 described recently from the lowermost Maastrichtian (Walaszczyk et al. 2001).

Nagoryany section

There have been no exposures at Nagoryany for many years and all our knowledge is based on 19th century collections scattered through various museums. The present discussion is based on inoceramids from Nagoryany as described and illustrated by Kociubynskij (1958, 1968), and a single specimen illustrated by Geinitz (1872–75). The reinterpretation of their specimens is given below.

The presence of *Cataceramus subcircularis* (which seems to be the dominant species), rare *Endocostea typica* Whitfield, 1880, and rare *Cataceramus? glendivensis*, suggest the upper part of the *Endocostea typica* Zone. Although there is no data on the vertical range of particular species in this section, the succession in Nagoryany could have ranged down to the very base of the Maastrichtian. More clear is the upper stratigraphical limit. The large trochoceramids reported by Kociubynskij (1968, pl. 28, fig. 4) and Geinitz (1872–72, pl. 14, fig. 1), which may safely be referred to *T. helveticus* (Heinz, 1932) and *T. radiosus* (Quaas, 1902) respectively, indicate the presence of at least the lowest part of the succeeding inoceramid zone of *Trochoceramus radiosus*.

Conclusions

Inoceramids in the uppermost Campanian and lowermost Maastrichtian allow a refined biozonation and correlation within the Euramerican biogeographic region. In the interval spanning the North American Zones of *Baculites compressus* to *Baculites grandis*, six inoceramid zones are recognised, both in the US Western Interior and in the Tercis section in SW France. The validity of the succession is also confirmed by some of the other European sections. The base of the Maastrichtian Stage, as defined by level 115.2 in the Tercis quarry, correlates in inoceramid terms with the topmost part of the "*Inoceramus*" *redbirdensis* Zone, which lies very closely to the base of the *Endocostea typica* Zone, which makes this inoceramid index taxon a very useful tool for the recognition of the Campanian/Maastrichtian boundary. Of importance also is the fact that very closely related, and possibly conspecific forms, were reported from South America [as *Inoceramus* (*Endocostea*) *biroi* by Stinnesbeck, 1986, pl. 2, figs 4–7] and from US Pacific Coasts by Anderson (1958, pl. 74, figs 4–6) under the name *Inoceramus* (*Endocostea*) *stanislausensis.*

Acknowledgements

We thank Jake Hancock, Jim Kennedy, and Marcin Machalski for critical reading and comments on the

Kociubynskij 1968,	Original determination	Revised name
pl. 27, figs 1–2	*I. balticus* Böhm	?*Cataceramus* sp.
pl. 28, fig. 1	*I. impressus* d'Orbigny	*Cataceramus subcircularis* (Meek, 1876)
pl. 28, fig. 4	*I. nahorianensis* Kociubynskij	*Trochoceramus helveticus* (Heinz, 1932)
pl. 29, fig. 2	*I. regularis* d'Orbigny	*Cataceramus subcircularis* (Meek, 1876)
pl. 29, fig. 3	*I. barabini* Morton	*Cataceramus? barabini* (Morton, 1834)
pl. 29, fig. 4–5	*I. impressus* d'Orbigny	*Endocostea typica* Whitfield, 1880
pl. 29, fig. 7	*I. planus* Muenster	*Cataceramus* cf. *glendivensis* Walaszczyk, Cobban & Harries 2001
Geinitz (1872–75)		
Pl. 14, fig. 1	*Inoceramus lamarcki*	*Trochoceramus radiosus* (Quaas, 1902)

early drafts of this paper. The Director of the US Geological Survey is thanked for the free access to the paleontological collections housed in Denver. Walaszczyk acknowledges the financial support of the Fulbright Foundation, of the Polish Committee for Scientifc Researches (Grant no. 6 PO4D 065 20), and of the Geological Department of the University of Warsaw (BW 1527/06), enabling him the study of North American inoceramids and visits to France to study the Tercis inoceramids.

References

Aliev, M.M., Krylov, N.A., Pavlova, M.M. et al. 1986: Upper Cretaceous of southern USSR. 232 pp. Nauka: Moscow. [In Russian].

Anderson, F.M. 1958: Upper Cretaceous of the Pacific Coast. Memoir of the Geological Society of America 71, 1–378.

Birkelund, T., Bromley, R., Christensen, W.K., Håkanson, E. & Surlyk, F. (Eds) 1983: Abstracts: Cretaceous Stage Boundaries Symposium, Copenhagen, 210 pp.

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

Burnett, J.A., Hancock, J.M., Kennedy, W.J. & Lord, A.R. 1992: Macrofossil, planktonic foraminiferal and nannofossil zonation at the Campanian/Maastrichtian boundary. Newsletter on Stratigraphy 27, 157–172.

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: Diversity and distribution of Late Cretaceous ammonites, Western Interior, United States. In Caldwell, W.G.E. & Kauffman, E.G. (Eds) Evolution of the Westen Interior Basin. Special Paper of the Geological Association of Canada 39, 435–451. [Misdated 1993].

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.

Geinitz, H.B. 1872-75: Das Elbthalgebirge in Sachsen. 2. Theil: Der mittlere und obere Quader. II. Brachiopoden und Pelecypoden. Palaeontographica 20, 21–52.

Hancock, J.M. 1993: Transatlantic correlation in the Campanian-Maastrichtian Stages by eustatic changes of sea-level. In Hailwood, E.A. & Kidd, R.B. (Eds) High resolution stratigraphy. Geological Society Special Publication 70, 241–256.

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

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, 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, Sciences de la Terre 63, 133–148.

Jeletzky, J.A. 1968: Macrofossil zonation of the marine Cretaceous of the Western Interior of Canada and their correlation with zones and stages of Europe and the Western Interior of the United States. Geological Survey of Canada, Paper 67–72, 1–66.

Kauffman, E.G. 1973: Cretaceous bivalvia. In Hallam, A. (Ed.) Atlas of Palaeobiogeography. pp. 353–383. Amsterdam: Elsevier.

Kauffman, E.G., Sageman, B.B., Kirkland, J.I., Elder, W.P., Harries, P.J. & Villamil, T. 1994: Molluscan biostratigraphy of the Cretaceous Western Interior Basin, North America. In Caldwell, W.G.W. & Kauffman, E.G. (Eds) Evolution of the Western Interior Basin. Special Paper of the Geological Association of Canada 39, 397–434. [Misdated 1993].

Kennedy, W.J., Cobban, W.A. & Scott, G.R. 1992: Ammonite correlation of the uppermost Campanian of Western Europe, the U.S. Gulf Coast, Atlantic Seaboard and Western Interior, and the numerical age of the base of the Maastrichtian. Geological Magazine 129, 497–500.

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

Kociubynskij, S. P. 1968: Inoceramidae. In Pasternak, S.I., Gavrilishin, V.I., Ginda, V.A. Kociubynskij, S.P. & Senkovski, J.M. Fauna of the Cretaceous deposits of the Western Ukraine. Naukovaya Dumka, 115–148. [In Ukrainian].

Odin, G.S. (compiler) 1996: Definition of a Global Boundary Stratotype Section and Point for the Campanian/Maastrichtian boundary. Bulletin de l'Institut Royal des Sciences Naturelles de Belgique, Sciences de la Terre (Supplement) 66, 111–117.

Odin, G.S. 2001a: The Campanian-Maastrichtian stage boundary: characterisation at Tercis les Bains (France): correlation with Europe and other continents. Development in Palaeontology and Stratigraphy 19, xxviii + 881 pp.

Odin, G.S. 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. Developments in Palaeontology and Stratigraphy 19, 452–461.

Odin, G.S. 2001c: The Campanian – Maastrichtian boundary: definition at Tercis (Landes, SW France) principle, procedure, and proposal. In Odin, G.S. (Ed.) The Campanian-Maastrichtian stage boundary: characterisation at Tercis les Bains (France): correlation with Europe and other continents. Development in Palaeontology and Stratigraphy, 19, 820–833.

Odin, G.S. & Lamaurelle, M.A. 2001: The global Campanian-Maastrichtian stage boundary at Tercis les Bains, Landes, SW France. Episodes 4, 229–238.

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

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

Toshimitsu, S., T. Matsumoto, M Noda, T. Nishida & S. Maiya 1995: Towards an integrated mega-, micro- and magneto-

stratigraphy of the Upper Cretaceous in Japan. Journal of Geological Society of Japan 101, 19–29.
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.
Walaszczyk, I. 1997: Biostratigraphie und Inoceramen des oberen Unter-Campan und unteren Ober-Campan Norddeutschlands. Geologie und Paläontologie in Westfalen 49, 111 pp.
Walaszczyk, I., Cobban, A.W. & Harries, P.J. 2001 Inoceramids and inoceramid biostratigraphy of the Campanian and Maastrichtian of the United States Western Interior Basin. Revue de Paleobiologie 20, 117–234.
Walaszczyk, I., J.P. Smirnov & K.-A. Tröger 1996: Trochoceramid bivalves (Inoceramidae) from the Lower Maastrichtian of Daghestan (Aimaki section, NE Caucasus) and south-central Poland. Acta Geologica Polonica 46, 141–164.