The base of the Maastrichtian

WALTER KEGEL CHRISTENSEN, JAKE M. HANCOCK, NORMAN B. PEAKE & WILLIAM JAMES KENNEDY

Christensen, W.K., Hancock, J.M., Peake, N.B. & Kennedy, W.J. 2000–09–18: The base of the Maastrichtian. *Bulletin of the Geological Society of Denmark*, Vol. 47, pp. 81–85, Copenhagen.
https://doi.org/10.37570/bgsd-2000-47-06

At the Brussels Symposium on Cretaceous Stage Boundaries in 1995, the Maastrichtian Working Group decided to recommend the first occurrence of the ammonite *Pachydiscus neubergicus* in the Tercis quarry near Dax in the Landes, southwest France as the boundary stratotype for the base of the Maastrichtian stage. On the basis of the echinoid genus *Echinocorys* the Campanian-Maastrichtian boundary beds of Tercis are correlated with the succession in north Norfolk, England, which in turn is correlated with the succession at Kronsmoor, northwest Germany on the basis of belemnites and brachiopods. If the possible correlation between Tercis and northwest Germany is true, the *P. neubergicus* and *Belemnella lanceolata* standards for the base of the Maastrichtian stage are not separated by more than 0.2 m.y.

Key words: Maastrichtian stage, base, Tercis, SW France, correlations.

Walter Kegel Christensen [*wkc@savik.geomus.ku.dk*], *Geological Museum, University of Copenhagen, Øster Voldgade 5-7, DK-1350 Copenhagen, Denmark. Jake M. Hancock* [*j.hancock@ic.ac.uk*], *T.H. Huxley School, Imperial College, Prince Consort Road, London SW7 2BP, U.K. Norman B. Peake, 30 St. Benedict's Street, Norwich NR2 4AQ, U.K. William James Kennedy* [*jim.kennedy@earth.ox.ac.uk*], *Geological Collections, Oxford University Museum, Parks Road, Oxford OX1 3PW, U.K. 11 August 2000.*

At the Brussels Symposium on Cretaceous Stage Boundaries in 1995, the Maastrichtian Working Group recommended the level of the lowest *Pachydiscus neubergicus* (Hauer) in the abandoned Tercis quarry near Dax in the Landes, southwest France as the Global Stratotype Section and Point for the base of the Maastrichtian stage (Odin 1996). Hancock et al. (1993) provided a lithological log of the section at Tercis and subdivided the limestones into two formations, the lower Hontarède Formation and the upper Tercis Formation. The latter was subdivided into three members, the lower Tercis Marly Member, the middle Tercis Pale Flint Member, and the upper Tercis Dark Flint Member. Hancock & Kennedy (1993) described the ammonites from Tercis, Dhondt (1993) the inoceramid fauna, Hancock et al. (1993) reviewed nannofossil and echinoid occurrences, Simmons et al. (1996) described the planktic foraminiferal succession, and Ward & Orr (1997) recorded the ranges of Upper Campanian and Lower Maastrichtian ammonites and planktic foraminifera.

The potential of the Tercis section as a boundary stratotype was discussed by Kennedy et al. (1995), who noted that it is of key importance, because it provides a section where Tethyan nannofossil and planktic foraminiferal occurrences can be directly or indirectly related to boreal marker fossils. Hancock et al. (1993), on the basis of the echinoid genus *Echinocorys*, correlated the Tercis section with Norfolk, which in turn can be linked to the refined Lower Maastrichtian *Belemnella* zonation of northwest Germany (Schulz 1979). This comprises six zones, in ascending order: the lower Lower Maastrichtian *B. lanceolata*, *B. pseudobtusa* and *B. obtusa* Zones and the upper Lower Maastrichtian *B. sumensis*, *B. cimbrica* and *B. fastigata* Zones (Fig. 1). The lower Lower Maastrichtian *B. lanceolata-obtusa* Zones approximately correlate with the conventional *B. lanceolata* Zone, and the upper Lower Maastrichtian *B. sumensis-fastigata* Zones with the conventional *B. occidentalis* Zone (Christensen 1996, Fig. 3) (Fig. 1). Kennedy et al. (1995, Fig. 3) showed that the inferred FADs of *P. neubergicus* and *Hoploscaphites constrictus* (Sowerby) at Tercis are at a level which can be correlated with a level within the lower part of the *Belemnella obtusa* Zone. Therefore, Burnett (1998, Fig. 6.6) placed the Campanian-Maastrichtian boundary in the lower part of the *B. obtusa* Zone, implying that the *B. lanceolata* and *B. pseudobtusa* Zones, in addition to the lowermost part of the *B. obtusa* Zone are of latest Campanian age.

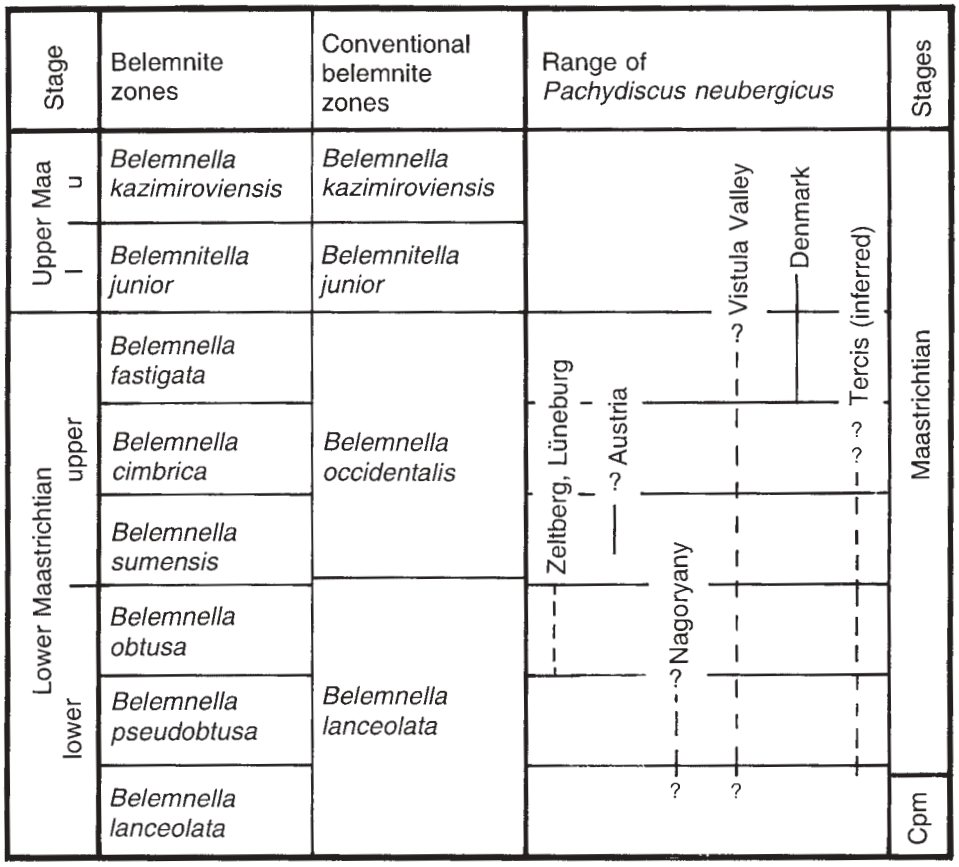

Fig. 1. Stratigraphical diagram, showing the known or inferred distribution of *Pachydiscus neubergicus* on the northwest European belemnite scale. The column to the right shows the location of the base of the Maastrichtian on the ammonite scale.
Maa – Maastrichtian; Cpm – Campanian.
Vertical axis not to scale.

Kennedy et al. (1995) showed, however, that the FAD of *P. neubergicus* in northern Europe is apparently diachronous (Fig. 1). In northwest Germany *P. neubergicus* has been recorded only from the *B. obtusa* Zone of the Zeltberg pit at Lüneburg (Schmid 1955, Schulz et al. 1984, Schulz 1979), but it is worthy of note that Schmid (1955) recorded only a single specimen of this species. The type occurrence of *P. neubergicus* in Steiermark, Austria can be dated as middle *B. sumensis* Zone, or younger, but possibly not younger than the upper part of the *sumensis* Zone (Kennedy & Summesberger 1986). At Nagoryany in the Ukraine it occurs in the *B. lanceolata* or *B. pseudobtusa* Zones (Kennedy & Summesberger 1987, Christensen 1987). In the Central Vistula Valley section in Poland *P. neubergicus raricostata* Błaszkiewicz (= *P. n. neubergicus*; see Kennedy & Summesberger 1986) occurs in the Lower Maastrichtian *B. lanceolata* Zone, and the nominotypical subspecies occurs in the overlying upper Lower Maastrichtian *B. occidentalis* Zone (Błaszkiewicz 1980). The first occurrence of *P. neubergicus* in Denmark is in the uppermost Lower Maastrichtian in beds correlative with the *B. fastigata* Zone (Birkelund 1993), but she had only three stratigraphically located specimens.

A possible new dating for the boundary at Tercis

There are two anomalies in the correlation by Hancock et al. (1993) and Burnett (1998).

1. The base of the Maastrichtian at the boundary-stratotype (Tercis) would be distinctly higher than the long used belemnite standard in northern Europe from Ireland to Russia. This might be inevitable but would lead to confusion in the future. 2. Ammonites are relatively common at Tercis. The team led by Professor G. Odin had collected 452 specimens by September 1999 (Odin 2000), even though the quarry is now disused. It would be curious if the lowest *Pachydiscus neubergicus* at Tercis was actually higher than its lowest occurrences in Ukraine and Poland.

We have therefore re-examined the correlation of the critical part of the section at Tercis with the successions in north Norfolk in England and Kronsmoor in north Germany (Fig. 2).

In spite of the variety of fossils at Tercis, the only correlator-taxon with even the hope of precision in terms of the thin belemnite zones of Kronsmoor, as discerned by Schulz (1979), is the echinoid genus *Echi-*

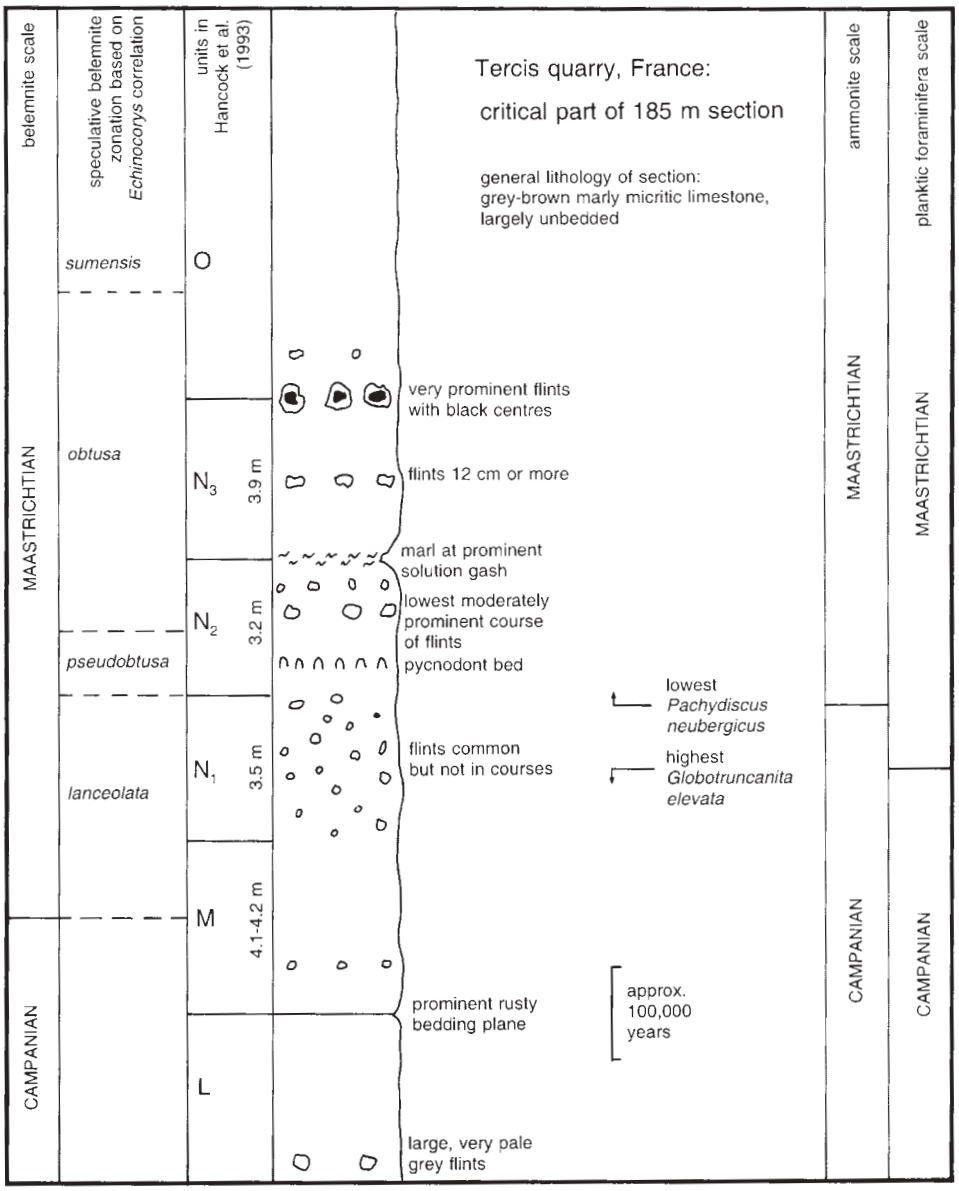

Fig. 2. The part of the section which spans the Campanian-Maastrichtian boundary at La Grande Carrière, Tercis-les-bains, 7 km southwest of Dax Landes, France. The correlation with the belemnite zones of northern Europe is based on *Echinocorys* as explained in the text, and is partly speculative. The level of the lowest *Pachydiscus neubergicus* is from Odin (2000); the lowest *P. neubergicus* collected by Kennedy & Hancock (1993) came from Unit N_2. The level of the highest *Globotruncanita elevata*, marking a possible planktic foraminiferal standard for the base of the Maastrichtian, is taken from Simmons et al. (1996). The scale of 100,000 years is based on the length of the combined *Belemnella lanceolata-pseudobtusa-obtusa* Zones lasting 650,000 years (Christensen 1996). Since the limits of these zones at Tercis are uncertain, this time-scale is only to give an idea of the order of the lengths of time involved.

nocorys. Unfortunately, at Kronsmoor undamaged and identifiable *Echinocorys* are very rare. They are not common in north Norfolk (except for occasional concentrations, such as at the Pyramidata Hardground at the top of the Campanian), but there are sufficient specimens known to provide some correlation. Essentially, one has to try to correlate the *Echinocorys* of Tercis with the imperfect succession in Norfolk and then correlate between Norfolk and Kronsmoor on belemnites (Christensen 1995) and brachiopods (Surlyk 1982, Johansen & Surlyk 1990). Even this approach is hampered by the rarity on the Norfolk coast of exposures of the basal part of the conventional Maastrichtian, the Zone of *Belemnella lanceolata* s.s. Of the 25–30 m of Maastrichtian in Norfolk, as much as 10 m at the bottom have seldom been exposed and rarely yield any macrofossils.

From Units M to O in the Tercis Pale Flint Member there are the following species of *Echinocorys* recorded by Peake in Hancock et al. (1993).

Echinocorys ovata (Leske) from the upper part of Unit M. In Norfolk this species is only known loose on the shore but they are believed to come from an offshore exposure near Cromer Lighthouse which is very high Campanian on the belemnite scale. This species has often been misinterpreted but it has been correctly interpreted by Gongadze (1979), who provided a detailed description and excellent figures. He records *E. ovata* from both unequivocal Campanian and Maastrichtian.

Echinocorys stellaris Lambert is also longer ranging than some other *Echinocorys*, being found in both Units M and N_1 at Tercis. In Norfolk it is known from the Porosphaera Beds (= upper half of the Sidestrand Chalk Member of Johansen & Surlyk 1990), which belong to the Zones of *Belemnella pseudobtusa* and *B. obtusa*. Because of the scarcity of exposures below the Porosphaera Beds, *Echinocorys* has seldom been found in the bottom 10 m of the local Maastrichtian. There is a reasonable possibility that *E. stellaris* ranges down into the Zone of *Belemnella lanceolata* s.s. Thus Units N_1 and the top of Unit M could belong to the true *lanceolata* Zone. This possibility is strengthened by the fact that the more typical Porosphaera Beds *Echinocorys*, *E. belgica* Lambert sensu Smiser, has not been found in Unit N_1 at Tercis.

Echinocorys aff. *heberti* Seunes from Unit N_2 is found in Norfolk in the upper part of the Porosphaera Beds and the lower part of the Sponge Beds (= the upper part of the Sidestrand Chalk Member and the lower part of the Trimingham Sponge Beds Member of Johansen & Surlyk 1990). This definitely correlates with the Zone of *Belemnella obtusa*.

Echinocorys arnaudi Seunes is common in the bottom third of Unit O. In Norfolk this species is confined to the White Chalk with '*Ostrea lunata*' (= upper part of the Little Marl Point Chalk Member of Johansen & Surlyk 1990), which belongs to the Zone of *Belemnella sumensis*. This correlation is confirmed by the highest occurrence of the nannofossil *Broinsonia parca* low in Unit O. The upper limit of this species at Kronsmoor lies near the top of the *obtusa* Zone (Burnett in Hancock et al. 1993).

These suggested correlations are shown in Figure 2.

The lowest known *Pachydiscus neubergicus* at Tercis is apparently from Odin's level 115.7 (Odin 2000). This lies approximately one metre below the pycnodont bed which itself is 0.85 m above the base of N_2, i.e. the lowest *P. neubergicus* is from the top few cm of Unit N_1. We suggest that this lies within the Zone of *Belemnella lanceolata* s.s., albeit probably high in the zone.

The *Belemnella* zones are relatively brief (Christensen 1996). If our possible correlation is true, the *neubergicus* and *lanceolata* standards for the base of the Maastrichtian stage are not separated by more than about 0.2 m.y. Considering that the average length of an ammonite zone in the Campanian of the U.S.A. is more than 0.5 m.y., 0.2 m.y. would be a small discrepancy.

Dansk sammendrag

På et møde i Bruxelles i 1995 vedrørende etagegrænser i Kridt besluttede Maastrichtien Arbejdsgruppen, at basis af Maastrichtien etagen skal defineres ved den første forekomst af ammonitten *Pachydiscus neubergicus* i Tercis kalkbruddet i det sydvestlige Frankrig. Campanien-Maastrichtien grænselagene i Tercis er her forsøgsvist korreleret med skrivekridtet i Norfolk, England på basis af søpindsvin tilhørende slægten *Echinocorys*. Skrivekridtet i Norfolk er derefter korreleret med skrivekridtet ved Kronsmoor ved hjælp af belemniter og brachiopoder.

Ud fra disse korrelationer synes den første forekomst af *P. neubergicus* ved Tercis at være i toppen af *Belemnella lanceolata* Zonen. Hvis denne korrelation er rigtig, så er den første forekomst af *P. neubergicus* ikke mere end 0.2 millioner år senere end den første forekomst af *B. lanceolata*.

References

Birkelund, T. 1993: Ammonites from the Maastrichtian White Chalk of Denmark. Bulletin of the Geological Society of Denmark 40, 33–81.

Błaszkiewicz, A. 1980: Campanian and Maastrichtian ammonites of the middle Vistula Valley, Poland: A stratigraphic-paleontological study. Prace Instytutu Geologicznego 92, 63 pp.

Burnett, J. 1998: Upper Cretaceous. In Bown, P.R. (Ed.) Calcareous nannofossil biostratigraphy, 132-164. Chapman & Hall, London.

Christensen, W.K. 1987: *Belemnella* (*Pachybelemnella*) *inflata* (Arkhangelsky) from Nagoryany, USSR. Beiträge zur Paläontologie von Österreich 13, 79–84.

Christensen, W.K. 1995: *Belemnitella* from the Upper Campanian and Lower Maastrichtian Chalk of Norfolk, England. Special Papers in Palaeontology 51, 84 pp.

Christensen, W.K. 1996: A review of the Upper Campanian and Maastrichtian belemnite biostratigraphy of Europe. Cretaceous Research 17, 751-766.

Dhondt, A. 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.

Gongadze, G.S. 1979: Upper Cretaceous echinoids of Georgia and their stratigraphical value. Izdatelstvo Tbilisskogo Universiteta, 151 pp. Tbilisi. [In Russian].

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, Science 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, southwest France. Bulletin de l'Institut Royal des Science Naturelles de Belgique, Sciences de la Terre 63, 133–148.

Johansen, M.B. & Surlyk, F. 1990: Brachiopods and the stratigraphy of the Upper Campanian and Lower Maastrichtian Chalk of Norfolk, England. Palaeontology 33, 823–872.
Kennedy, W.J., Christensen, W.K. & Hancock, J.M. 1995: Defining the base of the Maastrichtian and its substages. Unpublished Report to the Maastrichtian Working Group at the Second International Symposium on Cretaceous Stage Boundaries, 16 pp. Brussels.
Kennedy, W.J. & Summesberger, H. 1986: Lower Maastrichtian ammonites from Neuberg, Steiermark, Austria. Beiträge zur Paläontologie von Österreich 12, 181–242.
Kennedy, W.J. & Summesberger, H. 1987: Lower Maastrichtian ammonites from Nagoryany (Ukrainian SSR). Beiträge zur Paläontologie von Österreich 13, 25–78.
Odin, G. (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 66 – Supplement, 111–117.
Odin, G. (compiler) 2000: Proposal for a Global boundary stratotype section and point (GSSP) at Tercis-les-Bains: the Campanian-Maastrichtian boundary definition. Unpublished submission to the Subcommission on Cretaceous Stratigraphy.
Schmid, F. 1955: Biostratigraphie der Grenzschichten Maastricht / Campan in Lüneburg und in der Bohrung Brunhilde. 1. Teil: Megafauna und Schichtfolge. Geologisches Jahrbuch 70, 340–356.
Schulz, M.-G. 1979: Morphometrisch-variationsstatistische Untersuchungen zur Phylogenie der Belemniten-Gattung *Belemnella* im Untermaastricht NW-Europas. Geologisches Jahrbuch A47, 3–157.
Schulz, M.-G., Ernst, G., Ernst, H. & Schmid, F. 1984: Coniacian to Maastrichtian stage boundaries in the standard section for the Upper Cretaceous white chalk of NW Germany (Lägerdorf-Kronsmoor-Hemmoor): Definitions and proposals. Bulletin of the Geological Society of Denmark 33, 203–215.
Simmons, M.D., Williams, C.L. & Hancock, J.M. 1996: Planktonic foraminifera across the Campanian / Maastrichtian boundary at Tercis, south-west France. Newsletters on Stratigraphy 34, 65–80.
Surlyk, F. 1982: Brachiopods from the Campanian-Maastrichtian boundary sequence, Kronsmoor (NE Germany). Geologisches Jahrbuch A61, 259–277.
Ward, P. & Orr, W. 1997: Campanian-Maastrichtian ammonite and planktonic foraminiferal biostratigraphy from Tercis, France: Implications for defining the stage boundary. Journal of Paleontology 71, 407–418.