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Cretaceous Stages Boundaries in central Tunisia: how to follow the Brussels 1995 Symposium Recommendations

by Francis ROBASZYNSKI

Abstract

At the Copenhagen (1983) and Brussels (1995) symposia, the lower boundaries of the stages were defined by a biological or physical event considered as having a global value. Following the criteria recommended at the Brussels (1995) symposium, the base of each Upper Cretaceous stage in Central Tunisia is discussed following recent publications with multibiostratigraphic charts.

Key-words: Upper Cretaceous - stage boundaries - Tunisia

Résumé

Après les Symposiums de Copenhagen en 1983 et de Bruxelles en 1995, les étages sont maintenant définis à leur base par un événement biologique ou physique considéré comme ayant une valeur mondiale. En ayant pour but de suivre au plus près les critères recommandés à Bruxelles (1995), la base de chaque étage du Crétacé supérieur de Tunisie centrale est discutée à la lumière de travaux récents portant sur des échelles multibiostratigraphiques.

Mots-clefs: Crétacé supérieur - limites d'étage - Tunisie

Резюме

На симпозиумах в Копенгагене (1983) и в Брюсселе (1995) нижние границы ярусов были определены биологическим или физическим событием, имеющим всемирную ценность. Следуя рекомендованным в Брюсселе критериям, основа каждого верхнего мелового яруса Центрального Туниса обсуждается в свете новых исследований, изучающих макробиостратиграфические масштабы.

Ключевые слова: Верхний мел, границы ярусов, Тунис

Introduction

Since 1990, the Upper Cretaceous of the Kalaat Senan region in Central Tunisia is being studied. Its succession and its palaeontological content are compared with those of Boreal regions, and especially with the type areas of the stages and "type sections" previously studied in the Paris Basin (Albian to Santonian: ROBASZYNSKI, AMÉDRO coord. *et al.*, 1980; type Turonian: ROBASZYNSKI *et al.*, 1982; Campanian-Maastrichtian of the Maastricht area: ROBASZYNSKI *et al.*, 1983). Moreover, several sections have been studied in the Northern Tethys margin (DEVALQUE *et al.*, 1983).

From these data, it became obvious that Tunisia was an excellent area for representing the "Southern" Tethys.

Ten years long, our aim was to find a continuous section in the Upper Cretaceous permitting a comparison between Tethys and Boreal regions. Therefore, the same biostratigraphic tools were applied to both areas, especially the study of Ammonites, Planktonic Foraminifera and Calcareous Nannoplankton. The region of Kalaat Senan seemed suitable because of its palaeogeographical position. Kalaat Senan is situated between a platform to the south and a basin to the north. Distal sedimentation took place in a very subsiding region. This resulted in a thick sedimentary lithological succession, which often contains all elements of a deposition sequence (Shelf Margin Wedge or Lowstand Systems Tract, Transgressive Systems Tract and High Stand Systems Tract). This sedimentation is largely continuous and the palaeontological assemblages are of a mixed type, containing both platform organisms (such as bivalves, including rudists and inoceramids, echinoderms but also ammonites) and basin organisms (such as planktonic and benthic foraminiferans, nannoplancton and dinoflagellates).

A few vertical faults influence the succession. The correlation between partial sections is achieved by the use of characteristic beds. The tectonics are nevertheless sufficient for a dip between 15° and 30°, which allows easy observation of the beds, good fossil collecting and sampling of non-altered levels.

From the Albian to the Maastrichtian the succession has a thickness of almost 3700 m, distributed over several formations, from top to bottom:
El Haria Marls (700 m, of which 200 m are Cretaceous): Upper Maastrichtian.
Abiod Limestones and Marls (500 m): Upper Campanian to Lower Maastrichtian.

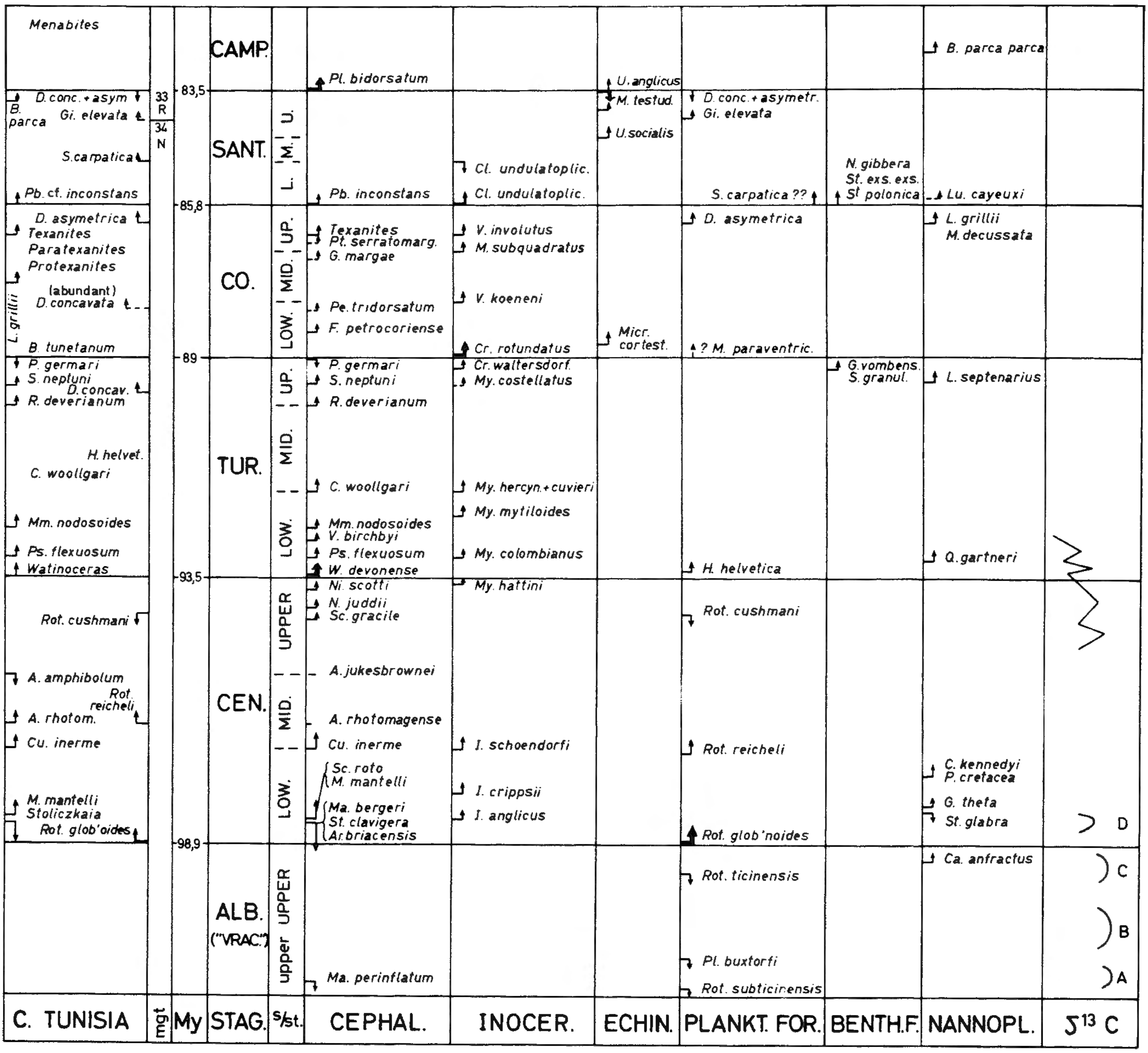

Fig. 1 — Bioevents and magnetic reversal from Upper Albian to Lower Campanian.
Abbreviations for Figs. 1 and 2. AMMONITES, A: *Acanthoceras*, Ar: *Arraphoceras*, B: *Barroisiceras*, C: *Collignoniceras*, Cu: *Cunningtoniceras*, F: *Forresteria*, G.: *Gauthiericeras*, M: *Mantelliceras*, Ma: *Mariella*, Mm: *Mammites*, Mo: *Mortoniceras*, N: *Neocardioceras*, Ni: *Nigericeras*, P: *Prionocyclus*, Pb: *Pseudoschloenbachia*, Pe: *Peroniceras*, Pl: *Placenticeras*, Ps: *Pseudaspidoceras*, Pt: *Paratexanites*, Py: *Pachydiscus*, R: *Romaniceras*, S: *Subprionocyclus*, Sc: *Sciponoceras*, St: *Stoliczkaia*, T: *Texanites*, V: *Vascoceras*, W: *Watinoceras*. INOCERAMIDS, Cl: *Cladoceramus*, Cr: *Cremnoceramus*, I: *Inoceramus*, M: *Magadiceramus*, My: *Mytiloides*, V: *Volviceramus*. ECHINODERMS, M: *Marsupites*, Micr: *Micraster*, U: *Uintacrinus*. FORAMINIFERA: A: *Abathomphalus*, C: *Contusotruncana*, D: *Dicarinella*, G: *Gavelinella*, Gi: *Globotruncanita*, Gs: *Gansserina*, H: *Helvetoglobotruncana*, M: *Marginotruncana*, N: *Neoflabellina*, Pl: *Planomalina*, Rot: *Rotalipora*, S: *Sigalia*, St: *Stensioeina*. NANNOPLANCTON, B: *Broinsonia*, Ca: *Calculites*, G: *Gartnerago*, L: *Lithastrinus*, Li: *Lithraphidites*, Lu: *Lucianorhabdus*, M: *Micula*, P: *Prediscosphaera*, Q: *Quadrum*, St: *Staurolithites*.

Aleg or Kef Marls (1250 m): middle Turonian to Campanian.
Trilogy of Bireno Limestones - Annaba - Marls Bahloul Limestones (250 m): Upper Cenomanian Lower Turonian.
Fahdène Marls (1500 m): Albian-Cenomanian.

For the lithology, from the Cenomanian to the K/T boundary, about 3000 m of marls and limestones were measured and described. Samples were taken every 2 to 6 m when possible, according to the needs of the studies on planktonic foraminifera and calcareous nannoplankton. Over the whole succession, macrofaunas were collected especially ammonites and inoceramids.

For placing stage boundaries, the first papers on the Cenomanian and the Turonian (ROBASZYNSKI *et al.*, 1990, 1993, 1994) followed the recommendations of the 1983 Copenhagen Symposium (BIRKELUND *et al.*, 1984). Some changes in these recommendations were proposed at the 1995 Brussels Symposium (RAWSON *et al.*, edit., 1996). The goal of the next paragraph is to explain how the 1996 recommendations should be followed when the type palaeontological marker is not present or not found in the succession.

Stage boundaries

Albian-Cenomanian boundary

— Before the Brussels CSB (Cretaceous Stage Boundaries) meeting (1995): appearance of the ammonite genus *Mantelliceras*.

— Since Brussels 1995: appearance of the planktonic foraminiferan *Rotalipora globotruncanoides* (= *brotzeni*) which is earlier than the appearance of *Mantelliceras*.

— In Tunisia: *R. globotruncanoides* is present together with many *Mantelliceras* and *Stoliczkaia* specimens (cf. Fig. 1).

Now *Stoliczkaia* is present in the basal Cenomanian and *Mantelliceras* in no longer the first appearing Cenomanian ammonite genus.

Note: the Cenomanian is the beginning of an important global transgressive pulse, its base is generally marked by a level with phosphates (in Tunisia, in Algeria, in the Paris Basin and also in SE France, even in the proposed boundary stratotype).

Cenomanian-Turonian boundary

— Before the Brussels CSB meeting (1995): appearance of the ammonite *Pseudaspidoceras flexuosum* (recommendation of the Copenhagen 1983 meeting).

— Since Brussels 1995: appearance of the ammonite *Watinoceras devonense*, which means a zone lower.

— In Tunisia: in 1990 the boundary was placed at *P. flexuosum*, at the top of the Bahloul Formation.

Now the boundary has to be placed within the Bahloul Fm. The presence of the planktonic foraminiferan *Helvetoglobotruncana* cf. *praehelvetica/helvetica* together with some *Watinoceras* specimens is now demonstrated below *P. flexuosum*.

Note: importance of δ13C of OAE 2 for long distance correlations (Pueblo - Dover - Menoyo Kalaat (cf. ACCARIE *et al.*, 1996).

Turonian-Coniacian boundary

— Before the Brussels CSB meeting (1995): appearance of the ammonite *Forresteria petrocoriensis*

— Since Brussels 1995: appearance of the inoceramid *Cremnoceramus rotundatus* sensu Tröger non Fiege, which means earlier.

— In Tunisia: the characteristic inoceramid species is not present and the appearance of *Globotruncana paraventricosa* is not really valid.

However, several ammonites allow to place the boundary quite correctly: the extinction of the ammonite *Prionocyclus germari* coincides in Germany with the appearance of *C. rotundatus*. Moreover, the abundance of the ammonite *Barroisiceras* cf. *tunetanum* is a good proxy for marking the basal Coniacian.

Coniacian-Santonian boundary

— Before the Brussels CSB meeting (1995): appearance of the ammonite *Texanites*.

— Since Brussels 1995: appearance of the inoceramid *Cladoceramus undulatoplicatus* (which is earlier than the appearance of *Texanites*) and which some palaeontologists consider isochronous with the appearance of the planktonic foraminiferan *Sigalia carpatica*.

— In Tunisia: no *Cladoceramus* have been collected so far, but *Texanites*, *Pseudoschloenbachia* and *Platyceramus cycloides* occur frequently.

Since the ammonite *Pseudoschloenbachia* is known in Germany and in USA just above *I. undulatoplicatus* (SUMMESBERGER, 1980; KENNEDY & COBBAN, 1991), the coexistence of *Texanites* and *Pseudoschloenbachia* is a good proxy for placing the base of the Santonian stage. However, the first *Texanites* are Coniacian. Some problems arise: the first *Sigalia carpatica* in the succession are present clearly at a higher level (+ 50 m) and the planktonic foraminiferan marker *Dicarinella asymetrica* appears clearly below (-30 m) the "proxy" boundary.

Santonian-Campanian boundary

— Before the Brussels CSB meeting (1995): appearance of the ammonite *Placenticeras bidorsatum* (occurs rarely).

— Since Brussels 1995: *id.*, but a preference has been expression for the extinction of the planktonic foraminifera *Dicarinella concavata* and *D. asymetrica* (cf. Fig. 2).

— In Tunisia: neither *Placenticeras bidorsatum*, nor *Marsupites testudinarius* have been found.

The extinction of *Dicarinella concavata* is clearly seen and happens after the appearance of *Globotruncanita elevata*. The appearance of *Globotruncana arca* between the first *G. elevata* and the last *D. asymetrica* is also a good proxy for the base of the Campanian.

Campanian-Maastrichtian boundary.

— Before the Brussels CSB meeting (1995): appearance of *Belemnella lanceolata*.

— Since Brussels 1995: appearance of *Pachydiscus neubergicus* (below this appearance there are two ammonite zones, the upper one is the *Nostoceras hyatti* Zone with *Pseudokossmaticeras brandti*, the lower one the *Bostrychoceras polyplocum* Zone, which was previously considered as the last Campanian zone in the Tethyan

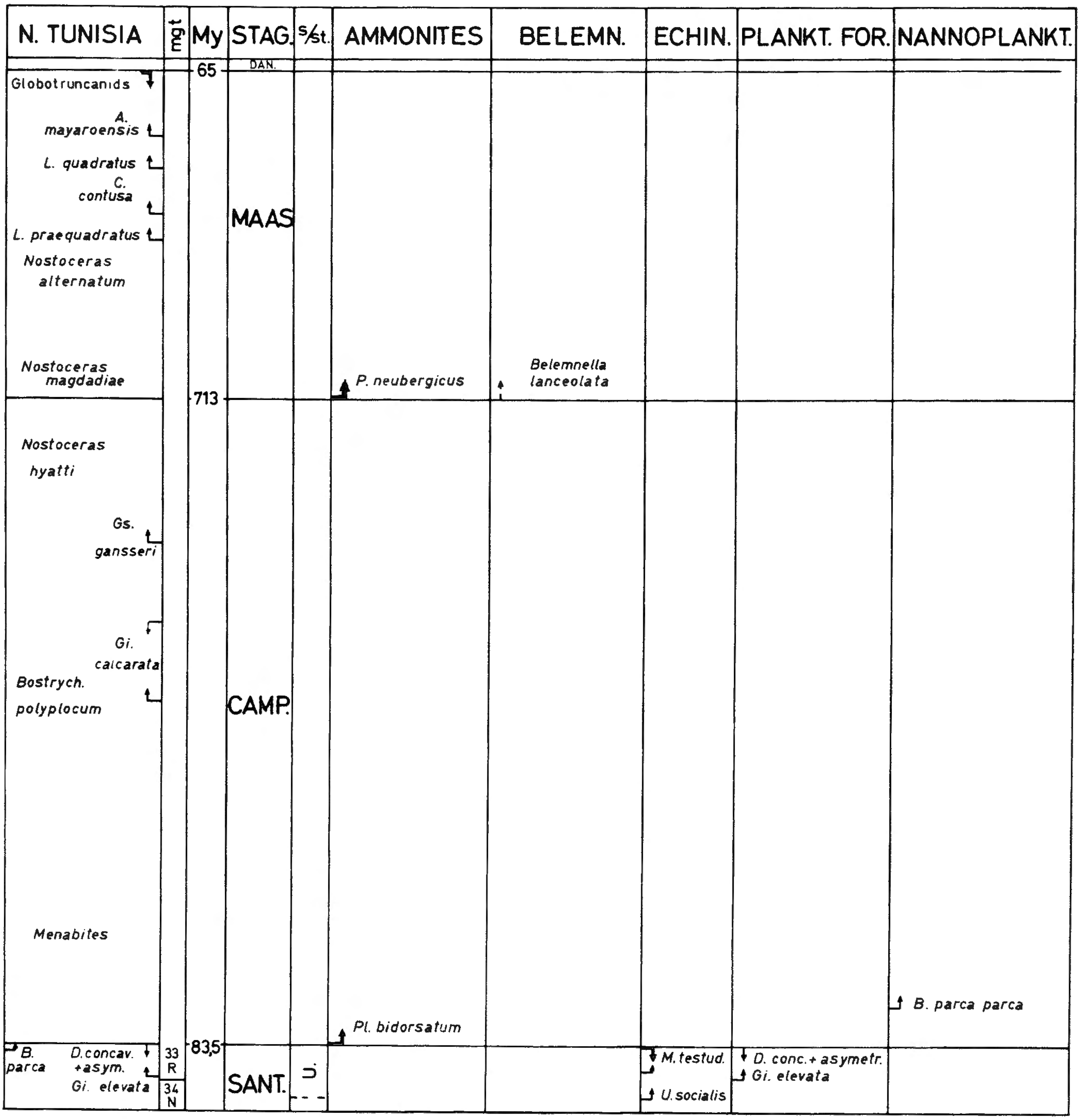

Fig. 2 — Bioevents for the Campanian-Maastrichtian. For Figs 1 and 2: time scale after GRADSTEIN *et al.* (1994); biological and physical events from RAWSON *et al.* edit (1996).

domain, cf. historic aspects *in* ROBASZYNSKI *et al.*, in press),

— In Tunisia: *Bostrychoceras polyplocum*, *Nostoceras hyatti*, *Pseudokossmaticeras brandti* are found but not *Pachydiscus neubergicus*. The extinction of *Globotruncanita calcarata* occurs after the last *B. polyplocum*, but before the first *N. hyatti*. In the absence of *P. neubergicus*, *Nostoceras (Nostoceras)*, aff. *magdadiae* is used, a species that indicates the Maastrichtian in the USA according to COBBAN & KENNEDY (1995).

Maastrichtian-Danian boundary.

— The boundary is indicated by the extinction of 45 planktonic foraminiferan taxa among which *Abathomphalus mayaroensis* and *Plummerita reicheli (= Pl. hantkeninoides)*.

The first Danian zone with a thickness of only 0.5 m, is the *Guembellita cretacea* Zone, even though this species is already present in the terminal Maastrichtian. Above this first zone, begins the *Parvularugoglobigerina eugubina* Zone.

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F. ROBASZYNSKI
Faculté Polytechnique, 9,
rue de Houdain,
B-7000 MONS Belgium
[e-mail : Francis.Robaszynski@fpms.ac.be]

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