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The Campanian of the European palaeobiogeographical region

By

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With 1 text figure and 3 tables

ABSTRACT

Within the European palaeobiogeographical region (EPR) extending from the Atlantic coast of Europe in the west to the Transcaspian area (Mangyshlak, Ustiurt, Tuarkyr, Western Kopetdag) in the east a subdivision and correlation of Campanian deposits for separate regions are made on the basis of common complexes of fauna.

The paper gives schemes of a biostratigraphic subdivision of the stage based on macrofauna (belemnites, ammonites, certain bivalves and echinoids), as well as on microfauna for the east of the EPR (Mangyshlak, Precaspian). It should be noted that biostratigraphic boundaries based on macro- and microfauna do not coincide. We compare our subdivision schemes of the stage with the schemes of a biostratigraphic subdivision of the EPR Campanian established for the north of the GFR (G. ERNST, F. SCHMID, W. KOCH a. o.); at present this scheme is the most fully justified. We trace the lower limit of the Campanian at the top of beds with *Marsupites* which

are well represented in Mangyshlak and at the base of the so-called "Pteria beds" of the Russian Platform. Consequently the Santonian/Campanian boundary is traced within the *Anomalina stelligera* zone as understood by Soviet micropalaeontologists and within the *Bolivinoidea strigillatus* zone sensu W. KOCH (1977). The Lower/Upper Campanian boundary is traced, as it is in the west of the EPR at the top of the "Quadratensenon" s. l. In other words – at the top of the *Gonioteuthis quadrata gracilis* & *Belemnelloccamax mammillatus* zone. By foraminifers this corresponds to the beginning of the *Cibicidoides aktulagayensis* zone in the Russian schemes and the *Neoflabellina numismalis* zone in GFR. The replacement of *Belemnitella* by *Belemnella* gives a sharp upper boundary to the Campanian. By foraminifers this corresponds to deposits within the *Grammostomum incrassatum* zone in the Russian scheme and the beginning of the *Neoflabellina reticulata* zone of W. KOCH in the GFR.

KURZFASSUNG

Ein Korrelationsversuch der Unterstufen des Campan für die Europäische paläobiogeographische Region vom Atlantik im Westen bis zur Transkaspischen Region (Mangyshlak, Ustiurt, Tuarkyr, West-Kopetdag) im Osten wird anhand gemeinsamer Faunenkomplexe vorgestellt.

Als Zonen-Fossilien werden Belemniten, Ammoniten, Echiniden, einige Bivalven sowie die Mikrofauna verwendet; es wird mit dem für Norddeutschland aufgestellten Schema von G. ERNST, F. SCHMID, W. KOCH u. a. verglichen. Die Untergrenze des Campan wird an die Oberkante der Schichten mit *Marsupites* (Mangyshlak) und an die Basis der s. g. "Pteria beds" der Russischen Tafel belegt. Somit verläuft die Santon/Campan Grenze innerhalb der *Anomalina stelligera*

Zone (im Sinne der sowjetischen Mikropaläontologen) und innerhalb der *Bolivinoidea strigillatus* Zone (sensu W. KOCH, 1977). Die Grenze Unter-/Ober-Campan wird über der *Gonioteuthis quadrata gracilis* und *Belemnelloccamax mammillatus* Zone gezogen; dies korrespondiert mit dem Beginn der *Cibicidoides aktulagayensis* Zone in den russischen Gliederungen bzw. *Neoflabellina numismalis* Zone in der norddeutschen Gliederung. Die Ablösung der *Belemnitella* durch *Belemnella* ist die scharfe Obergrenze des Campan, dies entspricht Ablagerungen innerhalb der *Grammostomum incrassatum* Zone der russischen Gliederung bzw. dem Beginn der *Neoflabellina reticulata* Zone in Norddeutschland.

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I.

During the Late Cretaceous the seas, flooding the Russian Platform and its palaeozoic framework, made this area part of the European palaeobiogeographical region (EPR) (NAIDIN, 1969, 1979). Over the very wide areas of EPR – from its western limits at the Atlantic shores in northwestern Europe to its eastern parts in Transcaspia – lived the same organisms: belemnites, ammonites, a certain number of bivalves, echinoderms, bryozoans (VOIGT, 1964, 1967; TRÖGER, 1981). It make possible to determine using palaeontological data, to which stages the Upper Cretaceous sections of the Platform and its framework belong. More completely studied sections at present are situated in Western Europe. The very wide sublatitudinal area of EPR reflects the climatological zonation of the Late Cretaceous in Eurasia. This basic fact is proved by the settling of the Late Cretaceous marine invertebrates. The influence of regional currents on the settling of the fauna is beyond doubt; A. D. ARKHANGELSKY (1916) already stated this 65 years ago. At present, it is possible by using the distribution of typical necton organisms (belemnites) and planktonic foraminifera to come near the recognition of the phenomenon which recent oceanologists call “water mass”. The combination of the sublatitudinal climatological zonation and the facts known on the currents and development of the water masses show that within the limits of the seas of EPR the settling of organisms was not the same everywhere. The character of the settling of organisms within the limits of parts of the EPR, including the Platform and the Transcaspian area is well illustrated by the biogeography of belemnites (NAIDIN, 1973, Figs 1–5). Thus, for instance, specimens of *Gonioteuthis* s. s. (Santonian to Lower Campanian) are far more numerous in

the western part of EPR (Europe); it has been shown that only a few isolated goniotuthids have penetrated into the northern part of the Mediterranean province. In its eastern part their distribution area wedges out in the shape of a “tongue” (Fig. 1), reaching the Don and Donetz basin. They are exceptionally rare in Crimea. This kind of feature in the distribution of *Gonioteuthis* s. s. does not allow to observe the *Gonioteuthis* Zones of the Santonian and Lower Campanian recognised in the GFR, over a large part of the Platform and the palaeozoic adjoining areas.

Another example: representatives of the genus *Belemnello-*
camax (as understood by NAIDIN, 1964, but not by W. K. CHRISTENSEN, 1975 who includes *Paractinocamax* NAIDIN in *Belemnello-*
camax) show a very narrow vertical distribution – limited to the top of the Lower Campanian – what would make them highly valuable for stratigraphic purposes. Unfortunately they are characterized by a relatively narrow geographical distribution (northern part of EPR: southern Sweden, Denmark, north western part of GFR, very rare in the northern part of the Anglo-Paris basin; within the boundary of the USSR: Lithuania, Volga region, Don basin and isolated guards in Eastern Precaspia and in Mangyshlak).

The irregularity of the settling of organisms can be shown by the distribution of benthonic foraminifera. Even only within the eastern EPR three groups of species can be recognised: the first with species which have a diffusion which is almost the same everywhere, the second with species which have a different stratigraphic range in different regions, the third with species which have a narrow local diffusion.

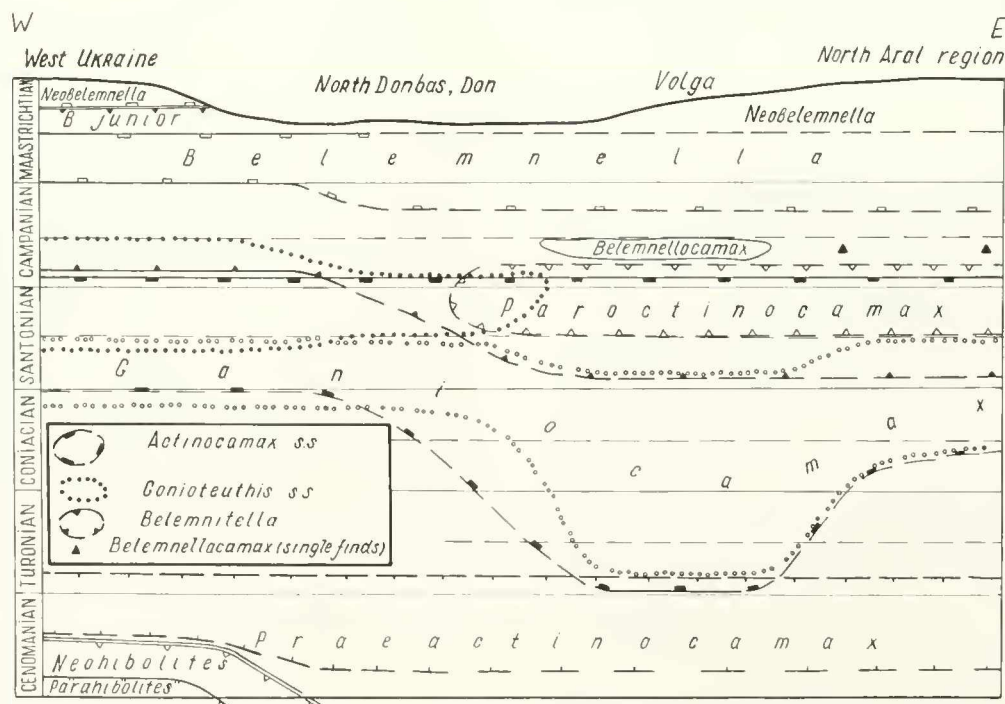


Fig. 1. Stratigraphical and geographical distribution of Late Cretaceous belemnites from eastern EPR, between Western Ukraine and northern Aral region (on latitude 50°, between 23° & 60° East of Greenwich).

The stratigraphy of the Santonian stage – its boundaries and subdivision – is the least-worked-on Upper Cretaceous interval in our territory. This is due to a row of circumstances of which the two principal are: the rarity of organic remains in this stratigraphic interval and bad outcrops on a significant part of EPR (Russian Platform, Crimea). In the well exposed outcrops of Mangyshlak the Santonian is also poor in fossils. However, in the section of Shakh-Bogota, the Upper Coniacian beds with *Inoceramus involutus* SOWERBY are directly overlain by beds containing remains of *Inoceramus indulato-*

■ - macrofauna is rare and poorly preserved

SW, NE = South-Western and North-Eastern parts of EPR within the Russian Platform

	BEDS WITH FORAMINIFERA (WEST KAZAKHSTAN)	FORAMINIFERAL ZONATION	
		V. P. VASSILENKO (Mangyshlak)	W. KOCH (GFR)
m ¹ m ₁	<i>Angulogavelinella gracilis</i> : <i>An. gracilis</i> , <i>Cibicidoides bembix</i> , <i>Neoflabellina reticulata</i> , <i>Osangularia navarroana</i>	<i>Grammostomum incrassatum</i> <i>incrassatum</i>	<i>Neoflabellina reticulata</i>
cp ³⁻⁴ cp ₂	<i>Brotzenella taylorensis</i> : <i>Br. taylorensis</i> , <i>Bolivina incrassata</i> <i>incrassata</i> , <i>Neoflabellina praereticulata</i> ----- <i>Bolivina kalinini</i> : <i>B. kalinini</i> , <i>Bolivinoidea draco miliaris</i> , <i>Gemmeloides orcinus</i>	<i>Cibicides voltzianus</i> : <i>Cb. voltzianus</i> , <i>Grammostomum kalinini</i> , <i>Anomalina cayei</i> , <i>Cibicides orcinus</i> , <i>Bolivinoidea draco miliaris</i>	<i>Bolivinoidea draco miliaris</i> : <i>Bl. draco miliaris</i> , <i>Bolivina incrassata</i> <i>incrassata</i> , <i>Neoflabellina praereticulata</i>
cp ² cp ₂	<i>Cibicidoides voltzianus</i> : <i>Orbignyna inflata</i> , <i>Cb. voltzianus</i> , <i>Gavelinella clementiana</i> <i>laevigata</i> , <i>Globorotalites emdyensis</i>	-----	-----
cp ¹ cp ₂	<i>Brotzenella monterelensis</i> : <i>Orbignyna ovata</i> , <i>Or. sacheri</i> , <i>Br. monterelensis</i> , <i>Br. menneri</i>	<i>Cibicides</i> <i>aktulagayensis</i> : <i>Cb. aktulagayensis</i> , <i>An. monterelensis</i> , <i>Or. sacheri</i>	<i>Neoflabellina numismalis</i> : <i>N. numismalis</i> , <i>Bolivinoidea laevigatus</i>
cp ²⁻³ cp ₁	<i>Cibicidoides aktulagayensis</i> : <i>Cb. aktulagayensis</i> <i>Cibicidoides temirensis</i> : <i>Cb. temirensis</i> ----- <i>Bolivinoidea decoratus</i> : <i>Ataxophragmium compactum</i> <i>caspium</i> , <i>Bl. decoratus</i> , <i>Bl. granulatus</i> , <i>Osangularia cordieriana</i>	<i>Cibicides temirensis</i> : <i>Cb. temirensis</i> , <i>Cb. aktulagayensis</i> (above), <i>Stensioeina pommerana</i>	<i>Bolivinoidea decoratus</i> : <i>Bl. decoratus</i> , <i>Bl. granulatus</i> , <i>Neoflabellina rugosa</i>
cp ¹ cp ₁	<i>Gavelinella clementiana clementiana</i> : <i>G. clementiana clementiana</i> , <i>Gavelinella dainae</i> , <i>Stensioeina pommerana</i> , <i>Neoflabellina rugosa</i>	<i>Anomalina stelligera</i> : <i>Anomalina stelligera</i> , <i>A. costulata</i> , above: <i>Anomalina clementiana clementiana</i> , <i>Bolivinoidea strigillatus</i>	<i>Bolivinoidea strigillatus</i> : <i>Stensioeina granulata</i> <i>granulata</i> , <i>St. granulata perfecta</i> : above: <i>Gavelinella clementiana</i> , <i>Stensioeina pommerana</i> , <i>Bolivinoidea strigillatus</i>
st ² st ₂	<i>Gavelinella stelligera</i> : <i>Ataxophragmium orbignyanaeformis</i> , <i>G. stelligera</i> , <i>Bolivinoidea strigillatus</i> ----- <i>Osangularia</i>	-----	-----

plicatus ROEMER, a species characteristic for the Lower Santonian Zone of Western Europe. The upper Santonian boundary in Mangyshlak we consider to be very clearly expressed. It consist of a double macropalaeontological horizon of only a few metres; the lower part contains remains of *Uintacrinus socialis* GRINNELL, the upper part plates, arms and even complete thecae of another crinoid, *Marsupites testudinarius* (SCHLOTHEIM). This horizon we place in the Upper Santonian of the three-membered subdivision of the stage used in Western Europe; so far, we cannot divide the lower Santonian deposits in the lower and middle members of that same subdivision. In the section without hiatus of Shakh-Bogota we consider the Santonian to begin with the beds of *I. undulatopectatus* and at the top are the first appearance of *Uintacrinus*; thus we define the Lower Santonian. We have written previously (AKIMETZ et al., 1979; NAIDIN & IVANNIKOV, 1980) that in Mangyshlak it is advisable to put the boundary between the Santonian and the Campanian at the top of the *Marsupites* beds. This placement would be in accordance with the understanding of the larger part of the researchers working on lithologically, palaeontologically and biostratigraphically well documented sections in the Santonian and Campanian of the GFR. We consider that the sections in GFR are fulfilling those requirements. Substantiation of such a placement of the Santonian/Campanian boundary can be found in the paper by PAPULOV & NAIDIN (1979, pp. 7-23). Clearly, indeed the placement of the Santonian/Campanian boundary at the top of *Marsupites* beds, based solely on macropalaeontological data, has a real possibility of becoming one of the accepted Upper Cretaceous boundaries. The outcrops at the stratotypes, as shown in the article of AKIMETZ et al. (1979: 119) do not help to solve the question of this boundary.

Not long ago, WOOD (1981) after studying the sections from North England (Yorkshire, Lincolnshire, Norfolk) and Northern Ireland also put the Santonian/Campanian boundary at the top of the *Marsupites* beds.

According to foraminiferal data this boundary lies within the deposits of the *Anomalina stelligera* zone s. l. (VASSILENKO, 1961; TRIFONOV & VASSILENKO, 1963) and within the *Bolivinoidea strigillatus* zone (KOCH, 1977). A more detailed subdivision into three members has been published recently (AKIMETZ et al, 1979) and has been followed in the present work (Table 3). According to this subdivision the boundary falls within the *Gavelinella stelligera* beds.

On the Russian Platform the position of the Santonian/Campanian boundary has been usually related to the position of the "Pteria beds" (the beds containing *Oxytoma* (*Pteria*) *tenuicostata* (ROEMER)). This is one of the basic problems of the Upper Cretaceous stratigraphy of the Platform. Remains of pteriids have a wide and massive distribution and can even be seen in borehole cores. In this way the *Pteria* beds have acquired the significance of an important stratigraphic marker. Some new data on the problem of the *Pteria* beds have recently been published (AKIMETZ et al., 1978, 1979; PAPULOV & NAIDIN, 1979; NAIDIN & IVANNIKOV, 1980). Those data prove that the *Pteria* beds belong to the beginning of the Campanian; they prove that the correlation used by a series of authors of those beds with the *Marsupites* beds cannot be upheld. The *Marsupites* beds, as has been shown above, forms the top of the Santonian, and consequently they are stratigraphically lower than the *Pteria* beds of the platform.

Our data on the distribution of benthonic foraminifera allow a more precise correlation between the *Marsupites* beds of Mangyshlak and the *Pteria* beds of the Precaspian region.

The interval of the section called "Pteria beds" of the Russian Platform is equivalent to the *Gavelinella clementiana clementiana* beds (upper part of the *Anomalina stelligera* zone), resting directly on the *Gavelinella stelligera* beds (Table 3).

In Mangyshlak full sections between the *Marsupites* beds and the *Gavelinella clementiana clementiana* beds a 2–4 m thick sequence (the topmost part of the *Gavelinella stelligera* beds) is recognisable. Very probably this sequence corresponds with that recognised in Southern England immediately above the deposits with the last *Marsupites* – the beds with *Uintacrinus anglicus* (BRYDONE) RASMUSSEN (RASMUSSEN, 1961; MORTIMORE, 1981). According to MORTIMORE (1981: 12) their thickness is about 2–3 m.

KOCH (1977) places the lower boundary of the Campanian stage within the deposits of the *Bolivinoidea strigillatus* zone, slightly lower than the first appearance of *Gavelinella clementiana* and *Stensioeina pommerana*, which in our understanding correlate with the lower boundary of the *Gavelinella clementiana clementiana* beds.

In Mangyshlak the Campanian is represented mainly by chalks, chalky marls and marls (thickness 70–200 m). Hard-ground surfaces are common.

In the Eastern Precaspian region the deposits of this stage are specific marls, often pyritised; their thickness is 150–250 m.

The Campanian deposits in Mangyshlak and in the Eastern Precaspian region contain rare belemnite guards and ammonites. Using those the Campanian of both regions can be biostratigraphically subdivided; the resulting subdivision

can be compared with that used in GFR, in Western Ukraine, in the Dnieper-Donetz basin and in the Volga region (Table 1).

A very important part of the Campanian fauna of Mangyshlak are the echinoderms. Remains of asteroids, ophiuroids are not rare, in places crinoids are common, but especially abundant are the echinoids. However only a few representatives of the echinoids and crinoids have significance for the subdivision of the sections and for their correlation with other regions.

The lower Upper Campanian (cp₂) contains few macrofossils; therefore, the boundary between the substage is based on foraminifera. It lies at the beginning of the *Brotzenella monterelensis* beds. If we apply different micropalaeontological subdivisions, the boundary is situated at the beginning of *Cibicidoides aktualagayensis* zone (VASSILENKO, 1961; TRIFONOV & VASSILENKO, 1963) or at the *Neoflabellina numismalis* Zone (KOCH, 1977).

The uppermost Upper Campanian can be subdivided in subzones using subspecies of *Belemnella langei* which correlates with foraminiferal beds (Tables 2, 3). The upper boundary of the Campanian in the eastern part of EPR is strongly expressed: from massive finds of *Belemnella* species of the group *langei* there is a sudden (in the sections there is no hiatus visible) turnover into *Belemnella* species (Table 2). Applied to foraminifera this means that this turnover point lies within the *Angulogavelinella gracilis* beds. In the VASSILENKO scheme 1961 the boundary is placed in the lower part of the *Grammostonium incrassatum incrassatum* zone; KOCH (1977) places it at the beginning of the *Neoflabellina reticulata* zone.

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