Correlation of the Campanian Stage in Kopetdag and Western Europe

Korrelation des Campan von Kopetdag mit West-Europa

ASHOT A. ATABEKJAN, Leningrad

with 7 tables

Atabekjan, A.A., 1979: Correlation of the Campanian Stage in Kopetdag and Western Europe. *Aspekte der Kreide Europas.* IUGS Series A, Nr. 6, pp. 511–526. Stuttgart.

Abstract: In Kopetdag, Campanian deposits outcrop in continuous sections. Transitions to the Santonian and Maastrichtian are gradual. The deposits of all these stages are represented by normal marine carbonate formations. The Campanian in Kopetdag comprises 4 zones – two in each substage: the Lower Campanian *Offaster pomeli* and *Eupachydiscus levyi* Zones; the Upper Campanian *Hoplitoplacenticeras coesfeldiense* and *Stegaster gillieroni* Zone, and the *Bostrychoceras polyplocum* Zone. The comparison of the Campanian faunal successions in Kopetdag, with the stratotypic region of this stage, and with other regions of Western Europe allows us to draw the following conclusions:

1. The lower boundary of the Campanian in Western Europe should not be drawn at the base of, but within the Upper Granulata Chalk.
2. The boundary of the Campanian substages should be drawn on the basis of the first appearance of the genus Hoplitoplacenticeras. In Western Europe the boundary determined on this basis should lie at the top of the overlap zone of *Gonioteuthis quadrata* Blainv, and *Belemnitella mucronata* Schloth., or, perhaps, somewhat below.
3. The upper boundary of the Campanian in different regions of the world is, apparently, drawn at various levels. The faunal assemblage of the *Hauericeras sulcatum* Zone of the Lower Maastrichtian in Kopetdag contains species found elsewhere within both Maastrichtian and Campanian deposits. The Maastrichtian species are found on the Cotentin peninsula in France (*Mesoscaphites grossouvrei* Atab., *Pachydiscus gollevillensis* (d'Orb.)), in the Alps (*Pseudokossmaticeras galicianum* (Favre)), and in Western Ukraine and Poland (*Hauericeras sulcatum* (Kner)). The Campanian species are present in Israel (*Mesoscaphites elatensis* (Lewy)) and in North America (*Didymoceras navarroense* (Shum.)). This is not caused by different ranges of these ammonites, but by the difference of view which geologists have regarding the duration of the Campanian.
4. The *Hauericeras sulcatum* Zone in Kopetdag is comparable to the upper part of the "R" Zone established by Arnaud (1877) in the stratotypic region; the lower part of the "R" Zone and the "Q" Zone are equivalent to the *Bostrychoceras polyplocum* Zone.

Kurzfassung: In Kopetdag ist das Campan in vollständigen Folgen aufgeschlossen. Die Übergänge zum Santon und zum Maastricht sind graduell. Die Sedimente dieser Stufen sind marine Karbonate. Das Campan von Kopetdag läßt sich in 4 Zonen gliedern, 2 in jeder Unterstufe: das Unter-Campan mit der *Offaster pomeli*- und der *Eupachydiscus levyi*-Zone; das Ober-Campan mit der *Hoplitoplacenticeras coesfeldiense* – *Stegaster gillieroni* – und der *Bostrychoceras polyplocum*-Zone. Der Vergleich der Faunenfolge des Campan von Kopetdag mit der des Stratotyps dieser Stufe und mit anderen Regionen in W-Europa erlaubt es, folgende Schlüsse zu ziehen:

1. Die Untergrenze des Campan sollte in W-Europa nicht an der Basis, sondern vielmehr innerhalb der oberen Granulaten-Kreide verlaufen.
2. Die Grenze der beiden Unterstufen des Campan sollte mit dem ersten Auftreten der Gattung *Hoplitoplacenticeras* zusammenfallen. In W-Europa sollte diese Grenze am Top der

Gonioteuthis quadrata- und *Belemnitella mucronata*-Zone oder möglicherweise etwas darunter verlaufen.

3. In verschiedenen Gegenden der Welt wird die Obergrenze des Campan auf unterschiedliche Weise gezogen. Die Faunenvergesellschaftung der *Hauericeras sulcatum*-Zone des Unter-Maastricht von Kopetdag enthält Arten, die anderswo in Sedimenten des Maastricht und des Campan gefunden werden. Arten des Maastricht werden auf der Halbinsel Cotentin in Frankreich (*Mesoscaphites grossouvrei* Atab., *Pachydiscus gollevillensis* (d'Orb.)), in den Alpen (*Pseudokossmaticeras galicianum* (Favre)) und in der W-Ukraine und Polen (*Hauericeras sulcatum* (Kner)) gefunden, während Arten des Campan in Israel (*Mesoscaphites elatensis* (Lewy)) und in N-Amerika (*Didymoceras navarroense* (Shum.)) vorkommen. Zu verstehen ist dies nicht durch eine unterschiedliche Lebensdauer dieser Ammoniten sondern durch unterschiedliche Auffassungen über die Dauer des Campan.

4. Die *Hauericeras sulcatum*-Zone in Kopetdag ist vergleichbar mit dem oberen Teil der Zone "R" Arnaud's (1877) aus der Gegend des Stratotyps, während der untere Teil der "R"-Zone und die "Q"-Zone mit der *Bostrychoceras polyplocum*-Zone zu vergleichen sind.

Résumé: Les dépôts campaniens affleurent partout au Kopetdag en coupes continues. Le passage au Santonien et au Maestrichtien se fait également sans interruption. Les dépôts de tous ces étages sont en général représentés par des formations carbonatées. Le Campanien du Kopetdag se divise en 4 zones: deux dans chaque sous-étage. Le Campanian inférieur comprend la zone d'*Offaster pomeli* et la zone d'*Eupachydiscus levyi*. Le Campanien supérieur contient la zone d'*Hoplitoplacenticeras coesfeldiense* et *Stegaster gillieroni* et la zone de *Bostrychoceras polyplocum*. La corrélation des successions faunistiques du Campanien du Kopetdag, de la région stratotypique de cet étage et d'autres régions de l'Europe occidentale permet de faire les conclusions suivantes:

1. Il est plus correct de tracer la limite inférieur du Campanien en Europe occidentale à l'intérieur de la Craie à Granulata supérieur qu'à sa base.

2. Il est plus correct de déterminer la limite entre les sous-étages selon la première apparition du genre *Hoplitoplacenticeras*. Définie selon ce critère, la limite passera en Europe occidentale au sommet de la zone de coexistence des espèces *Gonioteuthis quadrata* Blainv. et *Belemnitella mucronata* Schloth. ou, peutêtre, un peu au-dessous.

3. Dans les différentes régions du monde la limite supérieur du Campanien est tracée dans divers niveaux. L'ensemble faunistique de la zone d'*Hauericeras sulcatum* du Maestrichtien du Kopetdag comprend des espèces qui se rencontrent au Maestrichtien de la près qu'île Cotentin en France (*Mesoscaphites grossouvrei* (Atab.), *Pachydiscus gollevillensis* (d'Orb.), des Alpes (*Pseudokossmaticeras galicianum* (Favre)), de l'Ucraine occidentale et de la Pologne (*Hauericeras sulcatum* (Kner)), ainsi qu'au Campanien de l'Israel (*Mesoscaphites elatensis* (Lewy)) et de l'Amérique du Nord (*Didymoceras navarroensis* (Shum.)). Ceci s'explique plutot par la compréhension différente de l'extension du Campanien que par une plus large répartition stratigraphique des ammonites.

4. La zone d'*Hauericeras sulcatum* du Kopetdag est comparée avec le sommet de la zone "R" d'Arnaud (1877) de la région stratotypique, tandis que la partie inférieur de la zone "R" et la zone "Q" sont comparées avec la zone de *Bostrychoceras polyplocum*.

Authors' address: A. A. Atabekjan, VSEGEI, Sredny pr. 74, SSSR-199026 Leningrad. *- 19. 5. 1978.*

Introduction

This contribution is based essentially on published data on the stratigraphy and fauna of the Upper Cretaceous in Kopetdag, as well as on the analysis of a large volume of literature both on the stratotypic region of the Campanian and on the other major regions of Western Europe.

The sequence of faunal assemblages in Kopetdag has been established on the basis of ammonite zones, whereas in the stratotypic region of this stage and in some other regions

Western Europe, it has been established on the basis of correlation of separated sections. When comparing the zones of the Campanian in Kopetdag and Western Europe, we can outline some unsolved or disputable problems of the Campanian stratigraphy. These are, firstly, the lower boundary of the Campanian in Northern Europe, including this boundary in Southern England; secondly, the upper boundary of the Campanian within the Aquitanian basin and Kopetdag; and finally, the age position of the lower beds of baculite limestones on the Cotentin peninsula. In the present paper one of the possible ways of solving these problems is described.

History of study of the Campanian stage in Kopetdag

Detailed information concerning the history of study of the Campanian stage from the end of the nineteenth century to 1960 has already been presented (Atabekjan & Likhacheva 1961), when the zonal division of the stage in Central and Western Kopetdag and in Maly Balkhan was first established. Following this, the recognized zones were traced eastwards up to and including Gorny Badkhyz (Kalugin *et al.* 1964; Luppov 1966; Geology of the USSR, 1972). At present this scheme of zonal division is adopted as a unified one by the Interdepartmental Stratigraphic Committee of the USSR (Resolutions 1977).

The study of the rich fauna of this stage is not yet completed. Since 1960, only a small number of ammonite species (Atabekjan & Khakimov 1976, Maniya 1963), inoceramids (Arzumanova 1964, 1965), echinoids (Dzhabarov 1964), crinoids (Klikushin 1973, 1975) and brachiopods (Kats 1964; Vanchurov 1967; Titova 1977) has been described. Bryozoans have been more completely described (Voigt 1967).

The Campanian stage in Kopetdag

The Campanian deposits in Kopetdag are represented by normal marine carbonate formations composed of limestones, marls and more clayey varieties. As a result of the nature of their alternation, they form 6 lithological units, 3 in each substage. The 3 lower units can be traced from Maly Balkhan in the west up to Badkhyz in the east without any significant changes in lithology. The 3 upper units, however, become enriched in clayey and terrigenous material to the east of Gyaursdag. There are no visible traces of a break in sedimentation either within the Campanian or at its boundaries. Only locally, on the top of the uppermost unit, is there a weakly developed hard ground. General characteristics of the various units are outlined below (from the lowest unit upwards).

Unit I. Light grey to white, or occasionally red, marls. Along strike they sometimes pass into clayey marls. They differ from the underlying Upper Santonian marls in their lighter colour, which is caused by a relatively higher content of carbonate material. The thickness generally varies from 14 to 32 m, but in Gyaursdag reaches 99 m.

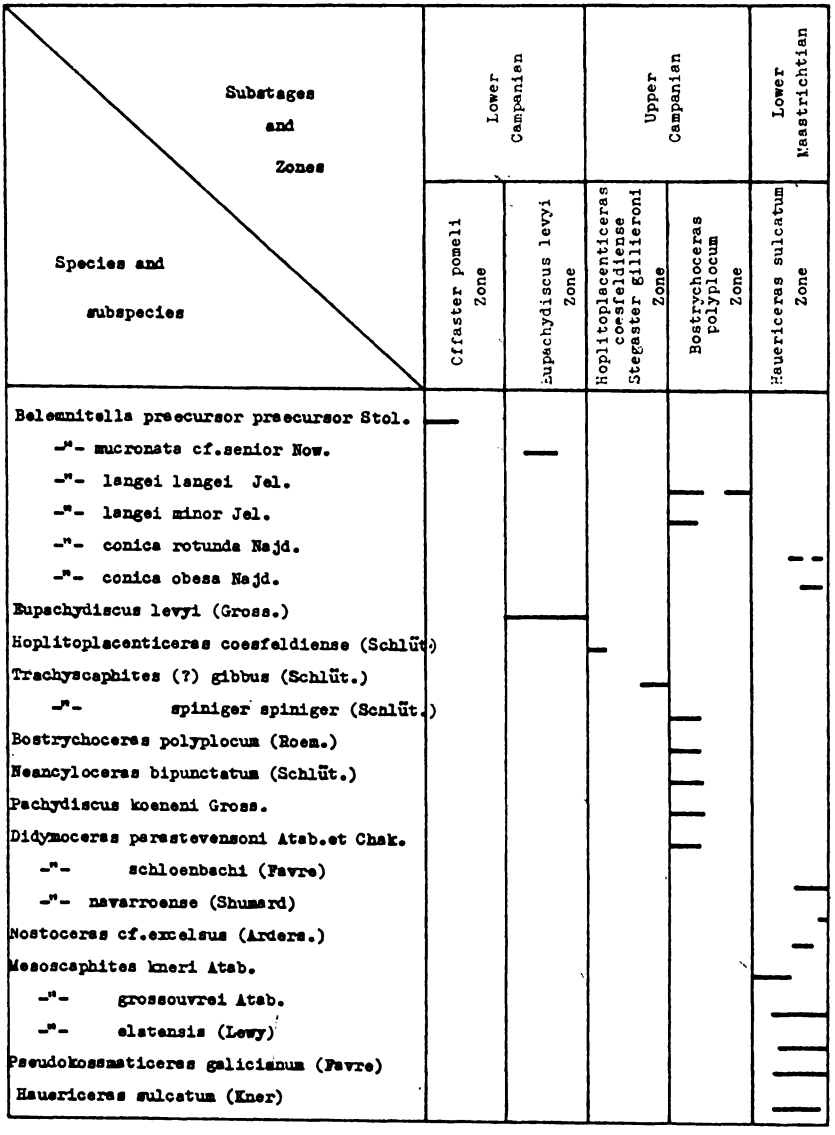
Unit II. White, fine-grained limestones with interbeds of greenish-grey clayey marls. In places (e.g. the southern part of Western Kopetdag, Central Kopetdag, Badkhyz), the content of clayey material in the limestones and the thickness of the marl interbeds increases considerably. The thickness of the unit is 24–60 m.

Unit III. Bluish-grey marls alternating with light grey clayey limestones in the west, and clays alternating with marls in Eastern Kopetdag and Badkhyz. The thickness varies from 8 to 48 m.

Unit IV. Greenish-grey and light grey marls in alternation. In places red marls are also intercalated. The thickness usually varies from 41 to 91 m, although in the southern part of Western Kopetdag it reaches 310 m.

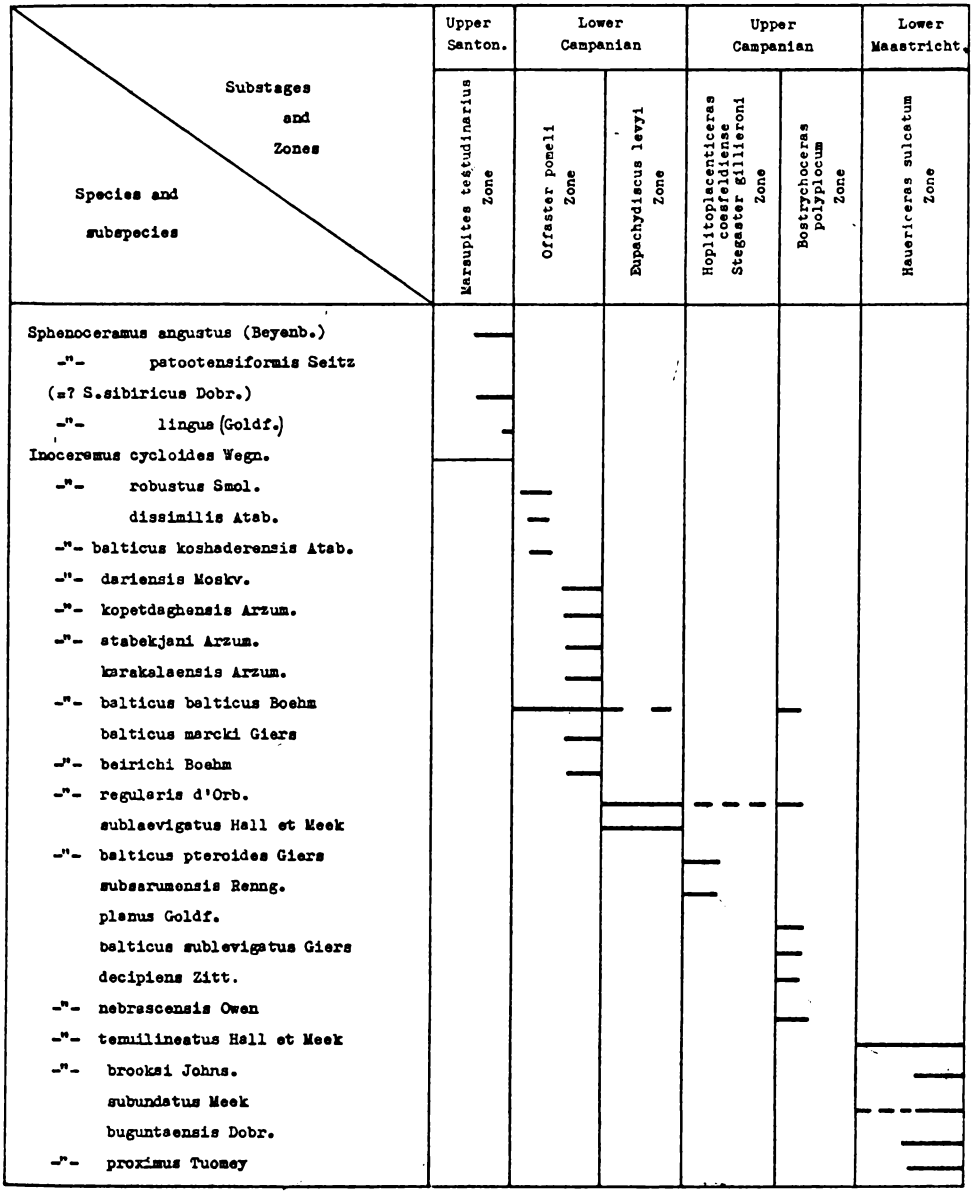
Unit V Rhythmical alternation of two types of members, both of which consist of intercalated limestones and marls. In one member, however, limestones are predominant, whereas in the other marls prevail. To the west of Gyaursdag lies the limestone-rich member, while to the east is the marl-rich member. The thickness varies from 24 to 51 m, although in Gyaursdag, it reaches 88 m.

Table 1. Distribution of Campanian and Lower Maastrichtian belemnites and ammonites in Kopetdag



Unit VI. Greenish-grey and light grey marls with rare limestone interbeds. On the whole, marls predominate in these strata, except in Maly Balkhan and the western part of Central Kopetdag where, by contrast, limestones prevail. In eastern Kopetdag and in Badkhyz, the lower horizon

Table 2. Distribution of Upper Santonian, Campanian and Lower Maastrichtian inoceramids in Kopetdag



of the Karatekin Formation is regarded as the age equivalent of these strata. This formation is represented by clays and marls with siltstone interbeds, and has a thickness up to 366 m. In western regions the thickness of the strata varies from 14 to 70 m, although in Gyaursdag it reaches 140 m.

Faunal composition. All the units contain a great abundance of echinoids, crinoids, inoceramids, brachiopods and bryozoans. Ammonites and especially belemnites are relatively rare. Foraminifers are represented both by benthonic and planktonic groups. The stratigraphic range of species from the main faunal groups is shown in Tables 1–4.

Division. In the Campanian deposits two substages are distinguished, each of which is subdivided into 2 zones. The *Offaster pomeli* Zone comprises lithological units I and II, the *Eupachydiscus levyi* Zone unit III, the *Hoplitoplacenticeras coesfeldiense* and *Stegaster gillieroni* Zones unit IV, and the *Bostrychoceras polyplocum* Zone units V and VI.

Position of the zonal boundaries. The lower boundary of the *O. pomeli* Zone, i.e. the Santonian/Campanian boundary, is drawn at the top of the beds containing *Marsupites testudinarius* Schloth., *Inoceramus cycloides* Wgn., *I. wegneri* Boehm., *Sphenoceramus angustus* Beyenb., and *S. patootensiformis* Seitz (*I. sibiricus* Cobr.), and at the base of the beds containing *Inoceramus balticus* Boehm., *I. dissimilis* Atab., *Offaster pomeli* Mun.-Chalm., *O. pilula* (Lam.), *Isomicraster stollei* Lamb., *Globotruncana arca* Cushm., *G. rugosa* Marie and *G. falsostuarti* Sig.

The lower boundary of the *E. levyi* Zone is drawn at the level of first appearance of the zonal species, together with *Inoceramus regularis* d'Orb., *I. sublaevigatus* Hall & Meek, *Echinocorys gibbus* Lamb., *E. marginatus* Goldf., *Isomicraster gibbus* Lam. and *Globotruncana morozovae Vass.*

The lower boundary of the *H. coesfeldiense* and *S. gillieroni* Zone, i.e. the boundary between the Campanian substages, is drawn on the basis of the first appearance of the zonal species, and *Inoceramus balticus pteroides* Giers and *Micraster glyphus* Schlüt.

The lower boundary of *B. polyplocum* Zone is drawn on the basis of the disappearance of *Micraster coravium* Posl., and the appearance of the zonal species *Belemnitella langei* Jel., together with *Trachyscaphites spiniger* (Schlüt.), *Neancyloceras bipunctatum* (Schlüt.), *Pachydiscus koeneni* Gross., *Inoveramus decipiens* Zitt., *Micraster brongniarti* Heb., *Carneithyris carnea* Sow., *Bolivinoides delicatulus* Cushm., *B. draco* Marss., *Bolivina incrassata incrassata* Reuss and *Globotruncana plicata* White.

The upper boundary of the Campanian is drawn between the *B. polyplocum* and *Hauericeras sulcatum* Zones. Kalugin *et al. (1964),* however, place this boundary lower, within the *B. polyplocum* Zone, along the base of unit VI.

The lower boundary of the *H. sulcatum* Zone, i.e. the lower boundary of the Maastrichtian stage in Kopetdag, is drawn on the basis of the disappearance of the species characteristic of *B. polyplocum* Zone, including *Belemnitella langei* Jel., and the disappearance of the zonal subspecies *Belemnitella conica rotunda* Najd., *B. conica obesa* Najd., and also of some ammonite species (Table 1), inoceramids (Table 2), brachiopods (Table 4), *Micraster grimmensis* Nietsch and *Bolivina incrassatta crassa* Vass. Beyond the limits of Kopetdag, however, analogous of the *H. sulcatum* Zone belong to the Lower Maastrichtian in some regions, but to the uppermost Campanian in others.

Table 3. Distribution of Upper Santonian, Campanian and Lower Maastrichtian echinoids and crinoids in Kopetdag

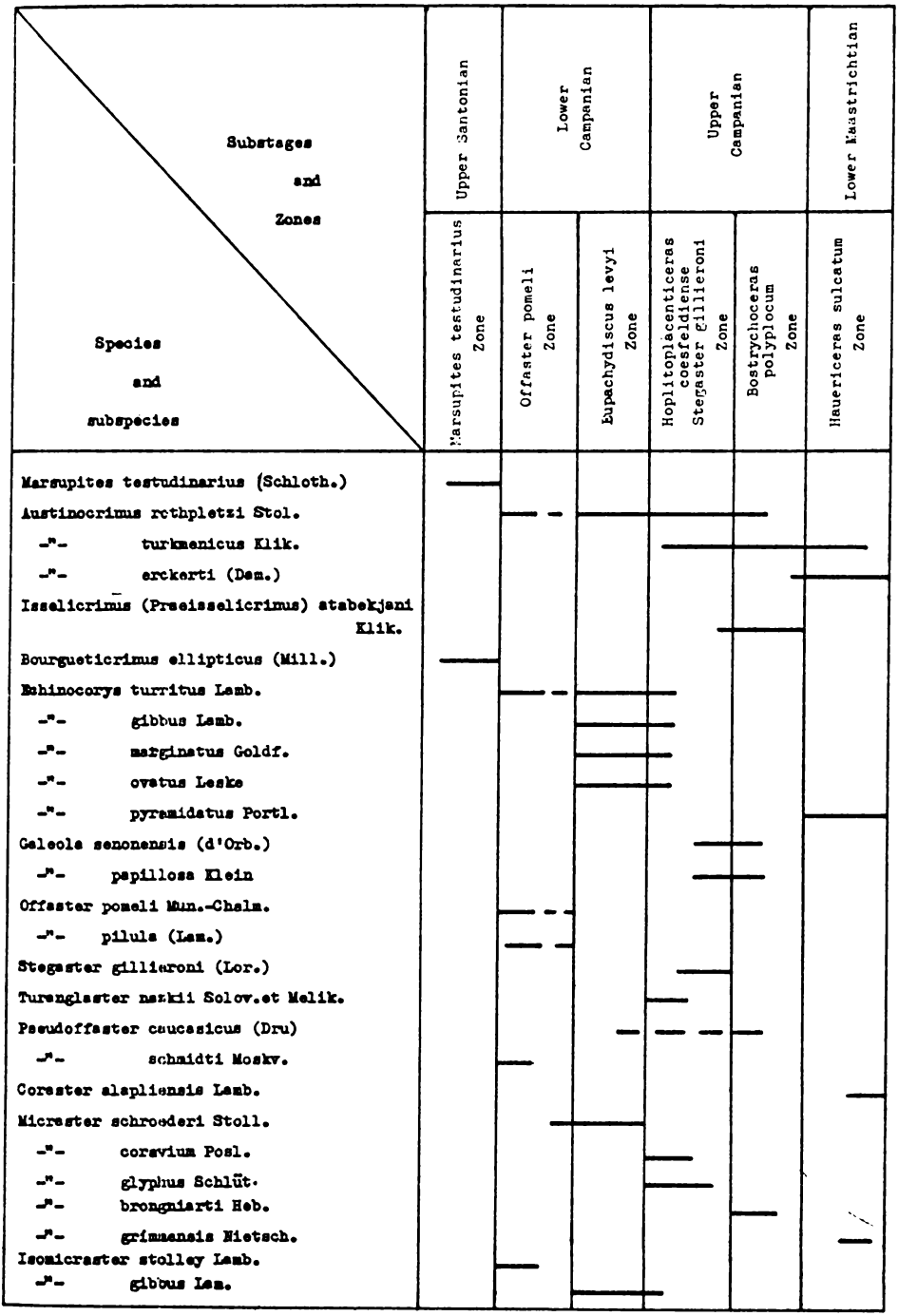


Table 4. Distribution of Campanian and Lower Maastrichtian brachiopods in Kopetdag

Species \ Substages and Zones	Lower Campanian		Upper Campanian		Lower Maastricht.
	Offaster pomeli Zone	Eupachydiscus levyi Zone	Hoplitoplacenticeras coesfeldiense Stegaster gilliéroni Zone	Bostrychoceras polyplocum Zone	Hauericeras sulcatum Zone
Basiliola campanensis Titova					
Kryumaria cretacea Nechr.					
Bisulcina chrysalis (Schloth.)					
Gyrosoria gracilis (Schloth.)					
Neoliothyrina obesa Sahni					
Carneithyris carnea Sow.					
Cretirhynchia limbata (Schloth.)					
-"- plicata Nechr.					
Parthirhynchia unguiseformis Titova					
Bolgarithyris bakalowi (Boncev)					
Magas pumilus Sow.					

Correlation of the Campanian zones in Kopetdag and Western Europe

Our knowledge of the succession of faunal assemblages of the Campanian in Kopetdag and Western Europe allows us to attempt their correlation, and also to offer a different solution to the problems connected with the boundaries of this stage. The results are shown in Tables 5, 6, 7.

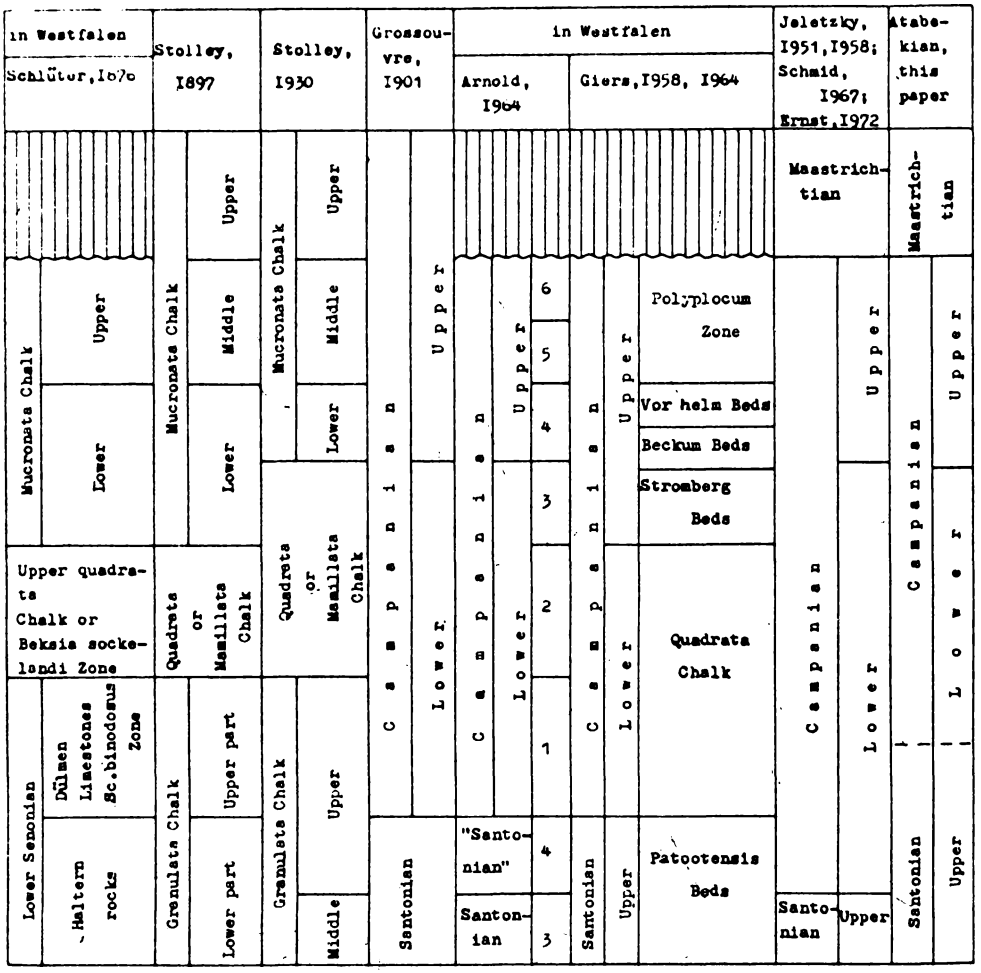
The lower boundary of the Campanian. Despite the fact that at present the majority of investigators in Western Europe draw the lower boundary of the Campanian at the base of the Upper Granulata Chalk (following Stolley), this cannot be regarded as a clear or, especially, a settled matter. The position of the lower boundary of the Campanian is generally determined by correlation with the stratotypic region or with the Westphalian basin. Judging from the faunal assemblage of the Upper Granulata Chalk (Stolley 1897), not only Dülmen limestones, but also some of the underlying Haltern sands (the upper horizons of which represent facies analogous to the Dülmen limestones) should be assigned to the Upper Granulata Chalk. This conclusion is drawn on the basis of the fact that among the ammonites characteristic of the Upper Granulata Chalk, two species, *Scaphites binodosus* Roem. and *Hauericeras* (*Gardeniceras*) *pseudogardeni*

Coquand, 1856–1858			Arnaud 1876–1877			Grossouvre, 1901			Haug, 1908		Seronie-Vivien, 1972			Platel, 1977			Atabekian, this paper		
Dordonian in: Grande Champagne	Dordonian in: Aubeterre		S	Upper	Dordonien	Pachydiscus neubergicus Zone	Upper Campanian		Pachydiscus neubergicus Zone	Maestrichtian							Didymoceras archiacianum Bed	Lower ?	Maastrichtian ?
			R_2	Middle										C_V	Unit 5				
	Dordonian	B	R_1																
Campanian	Campanian	G	Q	Lower		Bostrychoceras polyplocum Zone			Bostrychoceras polyplocum Zone		Orbitoides media Zone - 5	5c	Maestrichtian	C_V			Bostrychoceras polyplocum Zone	Upper Campanian	
		D										5b		C_V					
		E										5a		C_V	Unit 4				
		F												C_V					
		G										4d		C_{IVb}	Unit 3		Hoplitoplacenticeras vari Zone		
		H	P_3	Upper	Campanien	Hoplites vari Zone			Hoplites vari Zone			4c		C_{IVa}					
			P_2	Middle		Mortoniceras delawarense Zone	Lower Campanian		Mortoniceras delawarense Zone		Cibicides beaumontiana Zone - 4	4b	Campanian	C_{III}	Unit 2		Delawarella campaniensis Zone	Lower	
			P_1	Lower		Placenticeras bidorsatum Zone			Placenticeras bidorsatum Zone					C_{II}	Unit 1		Diplacmoceras canaliculatum Zone		
												4a		C_I					
Santonian			M	Upper	Santonian	Placenticeras syrtale and Pachydiscus (?) isculensis Zone	Upper Santonian		Placenticeras syrtale Zone	Santonian	Dorreina sp. Zone - 3	3	Santonian	Santonian			Eupachydiscus isculensis Zone	Upper Santonian	

Table 5.
Correlation of Zonal Divisions of the Campanian and Maastrichtian(?) in Northern Aquitania.

(Schlüt.), appear in the Haltern sands. However, only the ammonite species *Diplacmoceras canaliculatum* Hyatt and *Eupachydiscus duelmenensis* (Schlüt.) are common to both the Westphalian and the Aquitanian basins. Both species are present in the Dülmen limestones. There are no reliable data suggesting that these species are present in the lower beds of the Upper Granulata Chalk. On this basis, we can draw the conclusion that the lower boundary of the Campanian should not be drawn at the base of the Upper Granulata Chalk, but within it. In the Westphalian basin, it should be drawn within the Dülmen limestones (Table 6), because, in addition to the above-mentioned ammonite species, the Dülmen limestones contain: *Sphenoceramus angustus* (Beyenb.), and *S. patootensiformis* Seitz (=? *S. sibiricus* Dobr.). The latter throughout Kopetdag are found only in the Upper Santonian together with *Marsupites testudinarius* Schloth., but not above this limit. In the Dülmen limestones, the relation between these Santonian sphenoceramids and the Campanian ammonites has not yet been determined.

Table 6. Correlation of some Zonal Divisions of the Campanian in Northern Europe.



In the Harz foothill, the lower boundary of the Campanian Stage should probably not be drawn at the base of (Tröger & Haller 1966) but within the Blankenburg beds. The fact that the abovementioned *Sphenoceramus* species are confined only to the lower part of the Blankenburg beds can serve as a basis for this positioning. In the upper part of these beds, *Inoceramus balticus* Boehm (Riedel 1942) is found. Here, both the Blankenburg and the Heinburg beds belong to the Upper Granulata Chalk (Stolley 1897).

The position of the lower boundary of the Campanian in the English sections has not yet been determined (Table 7). The fact that the stages of the international scale are rarely used here is the reason for this. The *Offaster pilula* s.l. zone can be referred to the Upper Granulata Chalk (E. Stolley), since in this zone *Hauericeras* (*Gardeniceras*) *pseudogardeni* (Schlüt.), *Scaphites binodosus* Roem., and *S. inflatus* Roem. (Jukes-Browne 1912) are found. By analogy with other regions of Northern Europe, the lower boundary of the Campanian should also be drawn within the Upper Granulata Chalk. For this reason, it is proposed that the Santonian/Campanian boundary be drawn at the base of *Echinocorys scutatus cinctus* Subzone, or, amounting to the same, at the base of the horizon with abundant *Offaster pilula* Lam. (Table 7). This is somewhat higher than the boundary drawn by Grossouvre (1901) and his followers, but below that drawn by Spath (1926) and his successors. There is no doubt that some part of the *Gonioteuthis quadrata* Zone established by the previous authors should be refered to the Upper Santonian. This is based on the fact that the Santonian *Sphenoceramus pinniformis* (Will.), *S. tuberculatus* (Woods) and *S. patootensiformis* Seitz (=? *S. sibiricus* Dobr.) have been described (Woods 1912) from this zone, though a more precise stratigraphic position was not given.

The boundary between the Campanian substages. Grossouvre (1901) drew this boundary in the stratotypic region between zones P_2 und P_3 (Table 5) and, in the Westphalian basin, within the lower Mucronata Chalk (Schlüter 1876) (Table 6). The presence of representatives of *Hoplitoplacenticeras* genus and *Trachyscaphites* (?) *gibbus* (Schlüt.) served as basis for this. Later on, both in the Westphalian basin and throughout Northern Europe, many authors drew this boundary below the above-mentioned level, at the base of Mucronata Chalk (Riedel 1942, Schmid 1956, etc.). However, after 1958, drawing of the boundary at the level suggested by Grossouvre began again (Jeletzky 1958, Arnold 1964, Schmid 1967, etc.). Thus, there is no common opinion as to the age position of the lower part of the lower Mucronata Chalk. This lower part corresponds to the "Campanian 3" of Arnold (1964), to the Stromberg beds in Westphalia (Giers 1958), and to the *Gonioteuthis quadrata gracilis* beds throughout Northern Europe (Stolley 1930). This stratigraphic interval is also represented by the zone of overlap between *G. quadrata* and *Belemnitella mucronata*.

According to Giers (1964), the genus *Hoplitoplacenticeras* in the Westphalian basin appears lower than it was earlier supposed, namely at the base of the Beckum beds. In spite of this fact, Giers draws the lower boundary of the Upper Campanian even lower, along the base of the Stromberg beds (Table 6), for which there is no basis. The Beckum beds contain *B. mucronata senior* Now., *Hoplitoplacenticeras dolbergensis* (Schlüt.), *Patagiosites patagiosus* (Schlüt.), *Inoceramus balticus pteroides* Giers, and *I. balticus beckumensis* Giers. These data suggest that the Lower/Upper Campanian boundary should be drawn at the base of the Beckum beds (Table 6); this is, perhaps, slightly below the boundary drawn earlier.

In the Parisian basin, the uppermost strata of the M zone and N zone, according to Lambert (1878), correspond to the overlap zone of *Gonioteuthis* and *Belemnitella*. In England the boundary between the Campanian substages should, probably, be drawn a little above the base of *B. mucronata* Zone.

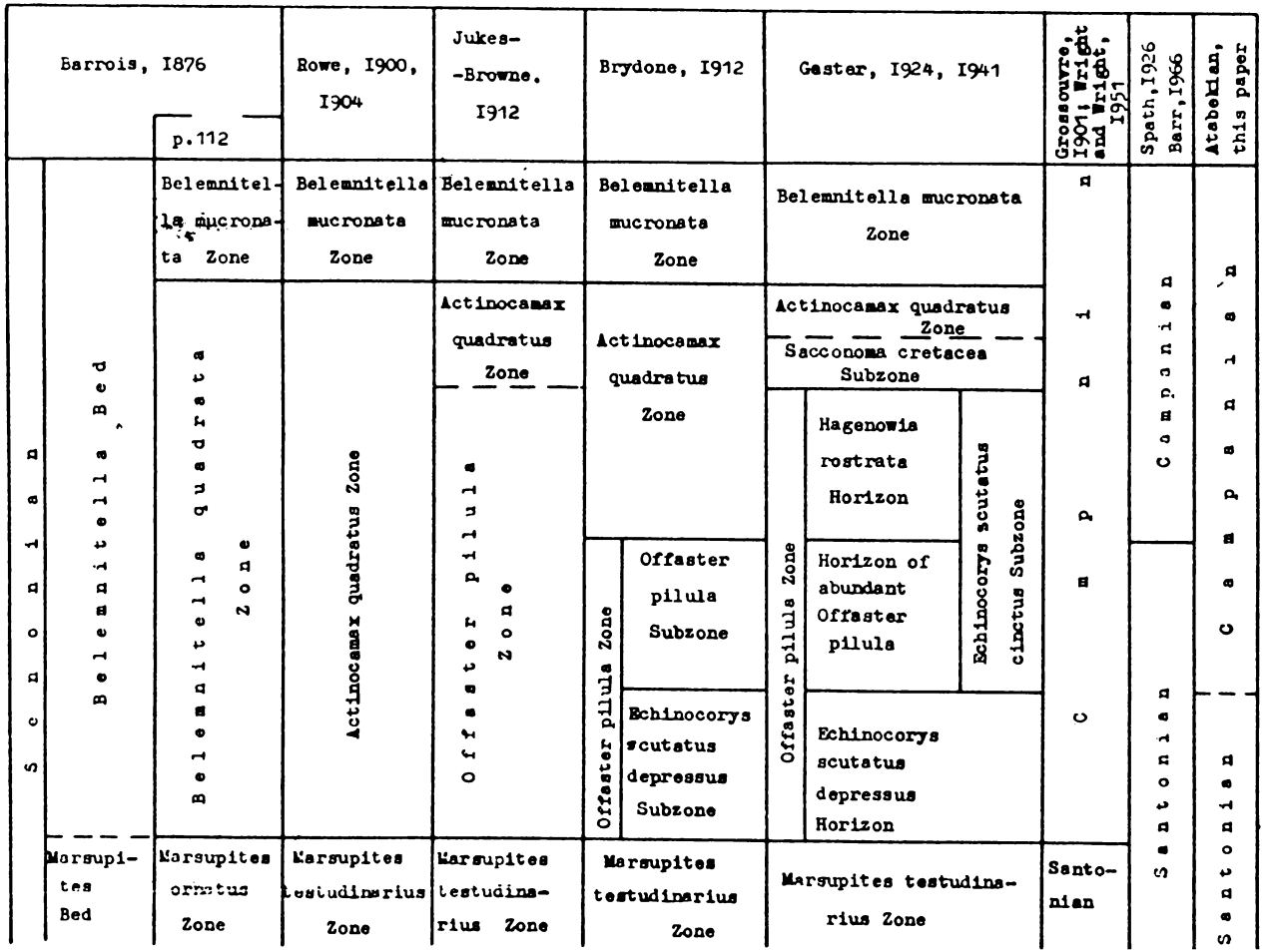


Table 7.
Correlation of Zonal Divisions of the Campanian in Southern England.

The upper boundary of the Campanian Stage. In Northern Europe the Campanian/Maastrichtian boundary is drawn between the *Belemnitella langei* Zone (= *Bostrychoceras polyplocum* Zone) and the *Belemnella lanceolata* Zone. The ammonite species typical of the *B. langei* Zone in Kopetdag are confined only to the lower strata of *B. polyplocum* Zone – to unit V (Table 1). The overlying unit VI also belongs to the *B. polyplocum* Zone, as confirmed by the occurrence of *B. langei langei* Jel. within this zone. The following ammonite species are considered characteristic of the *B. lanceolata* Zone: *Hoploscaphites constrictus* (Sow.), *Didymoceras schloenbachi* (Favre), *Pachydiscus gollevillensis gollevillensis* (d'Orb.) (= *P. gollevillensis nowaki* Mich.), *Pseudokossmaticeras galicianum* (Favre) (= *P. tercense* (Seun.)) and *Hauericeras sulcatum* (Kner). In the sections of Poland, which are more complete than those of Western Europe, these species are found only in the *B. lanceolata* Zone, and not in the Upper Campanian beds (Błaskiewicz 1966). On this basis, the age of the *Hauericeras sulcatum* Zone in Kopetdag has been determined as Lower Maastrichtian, in spite of the fact that *B. lanceolata* (Schloth.) has not yet been found there. In addition, a detailed study of the morphological features of all the specimens of "*Hoploscaphites constrictus* (Sow.)" described from this stratigraphic level in Europe shows that they differ from the holotype. In Kopetdag, such forms are found only in the *H. sulcatum* Zone, and typical *Hoploscaphites constrictus* (Sow.) is confined to the higher levels of the Maastrichtian. The difference from the holotype is so great that these forms (as well as one of the known species) have been determined as a new genus: *Mesoscaphites* Atabekjan, gen. nov. *Scaphites* (*Hoploscaphites*) *elatensis* Lewy was chosen as its type species. This genus comprises the following forms:

1. *M. grossouvrei* Atab. sp. nov. (= *Scaphites constrictus* in: Grossouvre 1894, pl. XXXI, fig. 1 (holotype), 2; *S. compressus* in: Kner 1848, pl. I, fig. 4; *S. constrictus* in: Favre 1869 pl. V, Fig. 4).
2. *M. kneri* Atab. sp.nov. (= *Scaphites constrictus* var. in: Kner 1852, Taf. I, Fig. 13 = holotype).

Thus, outside the Kopetdag area, *Mesoscaphites* gen. nov. is found in the Lower Maastrichtian of Western Ukraine and Poland (*M. kneri* Atab.), in the Maastrichtian on the Cotentin peninsula in France (*M. grossouvrei* Atab.), and in the "Upper Campanian" in Israel (*M. elatensis* (Lewy)). Among the other species characteristic of the *H. sulcatum* zone in Kopetdag (Table 1), *P. galicianum* (Favre) is described from the Lower Maastrichtian of Western Ukraine, the Causasus, Crimea, Bulgaria, Italy, as well as from the Lower Maastrichtian (?) in south-western France (Landes). Recently, this species has also been found in the Lower Maastrichtian of the Alps (Thiedig & Wiedmann 1976).

Finally, *Didymoceras navarroense* (Shum.), though confined to the uppermost beds of the *H. sulcatum* Zone, is known outside the Kopetdag area from the uppermost part of the Mishash Formation in the "Upper Campanian" of Israel, and from the *Baculites cuneatus* and *B. reesidei* Zones, as well as from beds containing *Nostoceras hyatti* Steph., *N. helicinum* (Shum.), *B. undatus* Steph., *Solenoceras texanum* (Shum.) and *S. reesidei* Steph. in the Western Interior of the United States. Some authors define the beds containing these forms as Upper Campanian, while others define them as Lower Maastrichtian (Obradovich & Cobban 1975).

Thus, the majority of the species from the *H. sulcatum* Zone in Kopetdag confirm the Lower Maastrichtian age of this zone. If this point of view becomes universally accepted, then it will be necessary to recognize that *Hoploscaphites* (Sow.) does not appear at the

Micraster grimmensis Zone in the Northern Caucasus, and the beds containing this species in the regions of Northern Europe and England, are Maastrichtian in age; 3. to revise the Campanian age of the above mentioned beds in Israel, in the USA, and in other regions of the world; 4. to acknowledge the fact that in the Tajik depression (USSR), the upper boundary of the Campanian is drawn higher than in Kopetdag, since in the Tajik area the uppermost beds of the "Campanian" contain species common with those found in the "Upper Campanian" of Israel and of the USA, e.g. *Nostoceras* cf. *hyatti* Steph. and *N.* cf. *draconis* Steph. (Atabekjan & Khakimov 1976).

The *H. sulcatum* Zone in Kopetdag is correlatable with the upper part of R zone of Arnaud (1877), since it contains *Didymoceras archiacianum* (d'Orb.) species which are present in the *H. sulcatum* Zone in Tuarkyr. The presence of *Sphenodiscus ubaghsi* Gross. and *S. rutoti* Gross. also speaks in favour of the Maastrichtian age of these beds. The reprensentatives of this genus in Europe are found only in the Maastrichtian, though in other regions they appear in the Campanian. The Maastrichtian age of these boundary beds is also suggested by their stratigraphic position, since the Q zone contains species characteristic of *B. polyplocum* Zone (Grossouvre 1901; Jeletzky 1951). For these reasons, we cannot agree with the conclusions drawn by Platel (1977), according to whom the Upper Cretaceous sections in the Aquitanian basins are topped by the Campanian Stage (Table 5).

Conclusions

For definition of the Campanian, it is considered advisable to use the three lower zones proposed by Grossouvre (using the index species taxonomy outlined here), as well as the *Bostrychoceras polyplocum* Zone proposed by Schlüter for the Westphalian basin. The range of these zones is equivalent to that of the Campanian in Kopetdag (Table 5).

The proposed raising of the lower boundary of the Campanian within Northern Europe should not be regarded as the final solution of this problem, but as one of the possible versions which should be considered further in the future.

The upper boundary of the Campanian in Kopetdag is drawn at the top of the *B. polyplocum* Zone. However, in some regions of the world this boundary is drawn higher, at the top of the *Hauericeras sulcatum* Zone, which in Kopetdag is ascribed to the Lower Maastrichtian.

The question of whether the level of appearence of the genus *Hoplitoplacenticeras* in Northern Europe coincides everywhere with the end of the overlap zone of *Goniateuthis* and *Belemnitella* genera, or whether this takes place somewhat earlier, has not yet been solved.

References

Arnaud, H. (1876): Profils géologiques des falaises crétacées de la Gironde. *Actes Soc. Linnéenne Bordeaux, 30, 3,* 10: 555–574; *4,* 1: 168–201, Bordeaux.

– (1877): Mémoire sur le terrain crétacé du sud-ouest de la France. *Mém. Soc. géol. Fr., (2), 10,* N 4, 110 p., 11 pl., Paris.

Arnold, H. (1964): Die Erforschung der westfälischen Kreide und zur Definition der Oberkreidestufen und -zonen. *Fortschr. Geol. Rheinld. Westf., 7:* 1–14, 1 Abb., 1 Tab., Krefeld.

Arzumanova, A.E. (1964): Some representatives of the Inoceramidae family in the Upper Cretaceous deposits of Western Kopetdag. *Izv. Acad. Sci. Turkm. SSR, 3:* 102–103, 2 pls.; Ashkhabad [Russ.].

- (1965): New representatives of the Inoceramidae family in the Lower Campanian deposits of Eastern Kopetdag. – *Izv. Acad. Sci. Turkm. SSR, 1:* 100–110; Ashkhabad [Russ.].

Atabekjan, A.A. & Khakimov, F.K. (1976): Campanian and Maastrichtian ammonites in Central Asia, 118 p., 13 pls.; Dushanbe [Russ.].

Atabekjan, A.A. & Likhacheva, A.A. (1961): Upper Cretaceous deposits of Western Kopetdag. *Trudy* VSEGEI, *n.s. 62,* 242 p.; Leningrad [Russ.].

Barr, F.T. (1966): The Foraminiferal genus *Bolivinoides* from the Upper Cretaceous of the British Isles. *Palaeontology, 9,* 2: 220–243, pls. 34–38, London.

Barrois, C. (1876): Recherches sur le Terrain Crétacé supérieur de l'Angleterre et de l'Irlande. *Mém. Soc. géol. Nord,* 234 p., Lille.

Błaszkiewicz, A. (1966): Uwagi o stratygrafii Kampanu i Mastrychtu doliny srodkowej Wisley. *Kwart. Geol., 10,* 4: 1060–1071, 1 Tab., Warszawa.

Brydone, R.M. (1912): The Stratigraphy of the Chalk of Hants. 116 p., 3 pls., Col. Map, London (Dulau & Co.).

Coquand, H. (1856): Notice sur la formation crétacée du département de la Charente. *Bull. Soc. géol. Fr., (2) 14: 55–98, Paris.*

- (1858): Description physique, géologique, paléontologique et minéralogique du département de la Charente. I. 538 p., 80 Fig., Basançon.

Dzhabarov, G.N. (1964): Upper Cretaceous echinoids in Central Kopetdag. 71 p., 20 pls., Ashkhabad (Turkmenizdat) [Russ.].

Ernst, G. (1972): Grundfragen der Stammesgeschichte bei irregulären Echiniden der nordwesteuropäischen Oberkreide. *Geol. Jb. A4:* 63 – 175, 26 Abb., 7 Taf., Hannover.

Favre, E. (1869): Description des Mollusques fossiles de la craie des environs de Lemberg en Galicie. 187 p., 13 pls., Genève.

Gaster, C.T.A. (1924): The Chalk of the Worthing District, Sussex. *Proc. Geologists' Assoc., 35:* 89–110, London.

- (1941): The Chalk Zones of *Offaster pilula* and *Actinocamax quadratus. Proc. Geologists' Assoc. 52:* 210–215, London.

Geology of the USSR (1972): 22, The Turkmenian SSR, Geological description. 768 p., 90 figs., 18 tables, Moscow. [Russ.].

Giers, R. (1958): Die Mukronatenkreide im östlichen Münsterland. Fazies, Stratigraphie und Lagerung. *Beih. Geol. Jb., 34,* 148 S., 4 Taf., 12 Abb., 39 Profile, Hannover.

- (1964): Die Großfauna der Mukronatenkreide (unteres Obercampan) im östlichen Münsterland. *Fortschr. Geol. Rheinld. Westf., 7:* 213–294, 8 Taf., 10 Abb., 3 Tab., Krefeld.

Grossouvre, A. de (1894): Récherches sur la craie supérieure. II – Paléontologie, Ammonites de la craie supérieure. *Mém. Carte géol. France,* 264 p., 39 pls., Paris.

- (1901): Récherches sur la craie supérieure. I.-Stratigraphie générale. *Mém. Carte géol. France,* 1013 p., 39 tabl., 3 pls., 33 fig., Paris.

Haug, E. (1908): Traité de géologie, *2,* 2: 929–1396, 19 pls., 109 figs., Paris.

Jeletzky, J.A. (1951): Die Stratigraphie und Belemnitenfauna des Obercampan und Maastricht Westfalens, Nordwestdeutschlands und Dänemarks, sowie einige allgemeine Gliederungs-Probleme der jüngeren borealen Oberkreide Eurasiens. *Beih. Geol. Jb., 1,* 142 S., 7 Taf., 3 Tab., Hannover.

- (1958): Die jüngere Oberkreide (Oberconiac bis Maastricht) Südwestrusslands und ihr Vergleich mit der Nordwest- und Westeuropas. I. Dnjepr-Donez-Senke und Nordwestrand des Donezbeckens sowie einige Vergleichs- und Gliederungs-Probleme der russischen borealen Oberkreide. *Beih. Geol. Jb., 33,* 157 S., 11 Abb., 1 Tab., Hannover.

Jukes-Browne, A.J. (1912): On the Recognition of Two Stages in the Upper Chalk. – *Geol. Mag., N.S., 5., 9:* 304–313, 360–372, London.

Kalugin, P.I., Dmitriev, A.V. & Kozhevnikova, G.E. (1964): Stratigraphy of the Upper Cretaceous and Paleocene deposits of Kopetdag and Badkhyz. 342 p., Ashkhabad (Turkmenizdat) [Russ.].

Kats, Y.I. (1964): New species of the Upper Cretaceous brachiopods in Central Asia. *Vestn. Kharkov. Univ., (2, Geogr.) 1:* 158–160; Kharkov [Russ.].

Klikushin, V.G. (1973): Late Cretaceous Isocrinidae (Crinoidea) of Maly Balkhan. *Nautch. Trudy Leningr. Gorn. Inst., 5:* 51–56, 2 figs., Leningrad [Russ.].

- (1975): *Austinocrinus* in the Soviet Union. *Palaeont. Jh. 1975, 3:* 94–100, 2 figs., Moscow [Russ.].

Kner, R. (1848): Versteinerungen des Kreidemergels von Lemberg und seiner Umgebung. *Haidingers naturwiss. Abh., 3,* 2, 42 S., 5 Taf., Wien.

– (1852): Neue Beiträge zur Kenntnis der Kreideversteinerungen von Ost-Galizien. *Denkschr. Akad. Wiss., 3,* 42 S., 3 Taf., Wien.
Lambert, J. (1878): Notice stratigraphique sur l'étage Sénonien aux environs de Sens. *Bull. Soc. Sci. hist. nat. l'Yonne, 32:* 129–192, Paris.
Luppov, N.P. (Ed.) (1966): Excursion-Guide to the Cretaceous deposits of Central Asia (April-May, 1966), 78 p., Ashkhabad (Turkmenistan) [Russ.].
Maniya, A.A. (1963): On the occurrence of *Discoscaphites gibbus* (Schlüter) in the Campanian deposits of Gorny Badkhyz. *Izv. Ac. Sci. Turkm. SSR, 5:* 122–124, 1 fig., Ashkhabad [Russ.].
Obradovich, J.D. & Cobban, W.A. (1975): A Time-scale for the Late Cretaceous of the Western Interior of North America. *Geol. Assoc. Canada, Spec. Paper, 13:* 31–54, 1 Tab., Toronto.
Platel, J.-P. (1977): Le Campanien stratotypique dans le synclinal de Saintes (Charentes): Lithostratigraphie, géomorphologie et biozonation. *Bull. B.R.G. M., (2) 1, 4:* 261–276, 3 fig., Paris.
Resolutions of the Interdepartmental stratigraphic meeting on the Mesozoic in Central Asia (Samarkand, 1971) (1977): Interdepartmental Stratigraphic Committee, 47 p., 14 pls., Leningrad (VSEGEI) [Russ.]
Riedel, L. (1942): Obere Kreide. *Schr. wirtschaftswiss. Ges. Stud. Niedersachs., N.F., 2:* Das Mesozoikum, 52 S., 4 Abb., Oldenburg.
Rowe, A.W. (1900): The Zones of the White Chalk of the English Coast. *Proc. Geologists' Assoc., 16:* 289–368, 3 pls., London.
– (1904): The Zones of the White Chalk of the English Coast. *Proc. Geologists' Assoc., 18:* 1–51, 193–296, London.
Schlüter, C. (1876): Die Cephalopoden der oberen deutschen Kreide. *Palaeontographica, 24:* 121–264, 19 Taf., Stuttgart.
Schmid, F. (1956): Jetziger Stand der Oberkreide-Biostratigraphie in Nordwestdeutschland: Cephalopoden. *Paläont. Z., Sonderh., 30:* 7–10, Stuttgart.
– (1967): Die Oberkreide-Stufen Campan und Maastricht in Limburg (Südniederlande, Nordostbelgien), bei Aachen und in Nordwestdeutschland. *Ber. dt. Ges. geol. Wiss., A. Geol. Paläont., 12,* 5: 471–478, 1 Abb., Berlin.
Sèronie-Vivien, M. (1972): Contribution a l'étude du sénonien en Aquitaine septentrionale. Ses stratotypes: Coniacien, Santonien, Campanien. *Les Stratotypes françaises, 2,* Paris (S.N.R.S.).
Spath, L.F. (1926): On New Ammonites from the English Chalk. *Geol. Mag., 63:* 77–83, London.
Stolley, E. (1897): Über die Gliederung des norddeutschen und baltischen Senons, sowie die dasselbe charakterisierenden Belemniten. *Arch. Antropol. Geol. Schlesw.-Holst., 2,* 2: 216–302, 3 Taf., Kiel & Leipzig.
(1930): Einige Bemerkungen über die Kreide Südscandinaviens. *Geol. Fören. Förhandl., 52,* 2: 157–190, Stockholm.
Thiedig, F. & Wiedmann, J. (1976): Ammoniten und Alter der höheren Kreide (Gosau) des Krappfeldes in Kärnten (Österreich). *Mitt. geol.-paläont. Inst. Univ. Hamburg, 45:* 9–27, 2 Taf., 2 Textabb., Hamburg.
Titova, M.V. (1977): Late Cretaceous Cancellothyrididae (Brachiopoda) in Turkmenia. *Palaeont. Zh. 1977,* 4: 73–85, 2 pls., 8 figs., Moscow [Russ.].
Tröger, K.-A. & Haller, W. (1966): Biostratigraphie der Inoceramen und einiger ausgewählter Ammoniten, Belemniten und Echinodermaten des Unter-Coniac bis Unter-Campan in der DDR. *Abh. zentr. geol. Inst., 5:* 84–91, 4 Anl.-Tab., Berlin.
Vanchurov, I.A. (1967): Late Cretaceous Crania in Kopetdag. *Izv. Ac. Sci. Turkm. SSR, 1:* 95–101, 1 pl., Ashkhabad [Russ.].
Voigt, E. (1967): Oberkreide-Bryozoen aus den asiatischen Gebieten der UdSSR. *Mitt. geol. Staatsinst. Hamburg, 36:* 5–95, Taf. 1–34, Hamburg.
Wodds, H. (1912): The Cretaceous Lamellibranchia. *Mon. Palaeontogr. Soc., 65:* 285–340, pls. 51–54, London.
Wright, C.W. & Wright, E.V. (1951): A Survey of the Fossil Cephalopoda of the Chalk of Great Britain. *Mon. Palaeontogr. Soc.,* 40 p., London.