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Biostratigraphic Zonation of the Upper Cretaceous in the East European Platform

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Abstract—Two biostratigraphic zonations, one based on macrofauna (primarily on inocerams and belemnites) and the other one based on microfossils, mostly on benthic foraminifers, are distinguished in the regional scale of the Upper Cretaceous of the East European platform. Both zonations are correlated to each other and with the Global Upper Cretaceous Scale (Olfer'ev and Alekseev, 2002).

Key words: Upper Cretaceous, zonation of macrofauna and benthic foraminifers, correlation, East European platform.

INTRODUCTION

In 2001, the Interdepartmental Stratigraphic Committee of Russia authorized the Regional Stratigraphic Scale of the Upper Cretaceous in the East European platform after its preliminary consideration at the regional conference held January 12, 2001. The scale has not been characterized so far in publications and cannot be properly used in practice of geological survey and relevant works. Accordingly, the main objective of this communication is to present in a brief manner the biostratigraphic zonations included in the scale. Characterization of superhorizons and horizons will be published elsewhere.

Ammonites are extremely rare in the Upper Cretaceous of the Russian plate, where concurrent planktonic foraminifers are of provincial character and rock sequences reveal stratigraphic ranges of calcareous nannoplankton index species, which differ from those in the Mediterranean region. Owing to these peculiarities, it is impossible to use directly the Global Upper Cretaceous Scale suggested recently (Olfer'ev and Alekseev, 2002) in practice of dating and correlation of regional stratigraphic subdivisions. That is why the regional biostratigraphic scheme appears to be necessary.

The first regional biozonation of the Upper Cretaceous in the East European platform was elaborated in 1954 (*Resheniya...*, 1955). To a considerable extent, it was based on macrofauna zonation established long ago by Arkhangel'skii (1912) in Upper Cretaceous sequences of the Volga River basin (Table 1). In the Cenomanian Stage, Arkhangel'skii distinguished the lower *Exogyra conica* and *Actinocamax primus* zones, and the *Lingula krausei* Beds above them. He correlated the *Inoceramus brongniarti* Zone with the lower Turonian Substage and attributed barren Cretaceous strata to the upper Turonian. The *Inoceramus involutus* Zone was regarded as corresponding to the Emscherian (Coniacian) Stage, whereas the Senonian interval was divided into the *Inoceramus pachti, Pteria tenuicostata, Belemnitella mucronata*, and *Belemnitella lanceolate* zones.

The scheme of 1954 was based on paleontological characterization of Upper Cretaceous sequences in eastern, western, and southern areas of the Russian plate. In addition to inocerams and belemnites, it accounted for distribution of ammonites found shortly before by Mikhailov (1951) in Campanian and Maastrichtian strata of the Donetsk basin and western Ukraine. The *Neohibolites ultimus, Pecten asper, Acanthoceras rhotomagense*, and *Actinocamax plenus* zones were established in the Cenomanian Stage. Distribution of inocerams was used to subdivide the Turonian–Coniacian–lower Santonian interval into the *Inoceramus labiatus, I. lamarcki, I. involutus*, and *I. cardissoides* zones (from the base upward). The *Oxytoma tenuicostata* Zone divided into the lower *Stensioeina exculpta–Anomalina stelligera* and upper *Ataxophragmium orbignynaeformis* foraminiferal subzones (?) was attributed to the upper Santonian. The lower Campanian Substage was divided into the *Gonioteuthis quadrata* and *G. mammillata* zones, and the upper one included the *Hoplitoplacenticeras coesfeldiense* and *Belemnitella mucronata* zones. The *Bostrychoceras polyplocum* and *Belemnitella langei* zones were distinguished in the lower Maastrichtian Substage, while the *Discoscaphites constrictus* corresponded to the upper Maastrichtian. The last zone was additionally divided into the *Acanthoscaphites tridens, Belemnitella lan-*

ceolate, Pachydiscus neubergicus, and *Belemnitella americana* subzones. Remarkable in the scheme was discrimination of foraminiferal subzones in the *Oxytoma tenuicostata* Zone (Table 1).

The scale of 1954 was modernized in 1959 (Naidin, 1960; *Resheniya...*, 1962), though its essence remained unchanged. In the renewed version, subdivision of Santonian, Campanian, and Maastrichtian stages was based on belemnites studied by Jeletzky (1948, 1951, 1955, 1958) and Naidin (1951, 1952, 1954, 1956). Versions of the scale published later on were supplemented with data on faunal assemblages from the Crimea, which turned out to be here more diverse within some intervals than in concurrent strata of the platform (Gerasimov *et al.*, 1962; Naidin, 1969).

At present, the former scales based on zonation of macrofauna find a limited application, because the main distribution area of Upper Cretaceous deposits is concealed, as drilling results showed, under younger sediments. Correlation and subdivision of borehole sections can be substantiated by microfossils only, and zonation of benthic foraminifers gained the prime importance for the situation we have now in the East European platform.

After insignificant corrections, biostratigraphic schemes elaborated by Naidin *et al.*, (1984a, 1984b, 1986) have been used in this work as a basis for the suggested regional zonal scale (Table 2).

GEOGRAPHIC LIMITATIONS

The zonal scale described below is applicable to southern areas of the Russian plate, where the widespread Upper Cretaceous deposits accumulated in a vast, relatively shallow basin, one in a system of sea basins, which represented the northern periphery of the Tethys. We mean primarily those areas, which lie inside the territory of the Russian Federation.

In terms of structural geology, the study region comprises a southern part of the Moscow syneclise, the Voronezh anteclise, the southwestern sector of the Volga–Ural anteclise with an internal Ul'yanovsk–Saratov depression, and the northwestern margin of the circum-Caspian depression (Fig. 1).

In terminology of Naidin *et al.*, (1986), the region under consideration represents a part of the European paleobiogeographic province (EPP) corresponding to southern and temperate (partially) latitudinal zones of Europe. In other words, it may be termed as a part of low- or sub-Boreal zone. Since the Late Cretaceous climate was warmer than now, environments in the concurrent sea basin of the East European platform corresponded to those of either the subtropical or, most likely, temperate zone.

On the east, the EPP southern boundary was situated to the south of the Crimea and northern Caucasus. Inside the EPP, there can be distinguished several subprovinces separated by sublatitudinal boundaries, which controlled distribution of belemnites, ammonites, and other invertebrates. For instance, Christensen (1990) distinguished the northerly Central Russian and southerly Central European subprovinces of the EPP. The analyzed region corresponded almost entirely to the northern part of the EPP, i.e., to the Central Russian subprovince. Marine biota that populated the region was of a rather monotonous composition in all the areas from the west to the east, and this situation is favorable for elaboration of a uniform biozonation. Despite its remoteness, the Kaliningrad area was also a part of the subprovince.

The Moscow syneclise is a particular case however, because benthic fauna from this structure is impoverished, mostly represented by inoceramids. Foraminifers and single ammonite and belemnite remains occur here at discrete levels, while radiolarians represent the main group of nannoplankton. Accordingly, our zonal scale is valid only for the Cenomanian, Turonian, and basal Coniacian intervals of the Upper Cretaceous sequence in the Moscow syneclise. It is clear that the Late Cretaceous biota of this syneclise included many taxa in common with biota of the Timan–Pechora province (Marinov *et al.*, 2002), where an independent biostratigraphic scheme should be elaborated.

ZONATION OF MACROFAUNA

According to Naidin *et al.* (1986, p. 14) "it is reasonable to distinguish chronozones in the European paleobiogeographic province, which can be based on ammonites and inocerams for the Cenomanian, on inocerams for the Turonian and Coniacian, on inocerams and belemnites for the Santonian, and on belemnites and ammonites for the Campanian and Maastrichtian." This alternation of guide fossil groups reflects their relative importance in separate intervals of the sequence that was controlled by the global biota evolution, on the one hand, and by changes in concrete paleogeographic environments, on the other. In other words, it is historical–geological in essence. Unfortunately, the Upper Cretaceous deposits of the Russian platform are almost lacking ammonites, single finds of which are only fragmentary described in publications. Thus, the ammonite scale proper cannot be used in the study region.

Cenomanian. The *Schloenbachia varians–Turrilites costatus* Zone corresponds in range to the lower–basal middle Cenomanian and is correlative with two lower Cenomanian zones of the western Kazakhstan (*Stratigraficheskie...*, 1996). *Turrilites costatus* Lam., the last of two ammonite index species, is unknown in the platform, whereas *Schloenbachia varians* (J. Sow.) occurs quite frequently in platform deposits (Arkhangel'skii, 1912, 1922, 1926; Milanovskii, 1940; Gerasimov *et al.*, 1962; Lavrova, 1971; Glazunova, 1972; Naidin, 1974). Exactly the distribution interval of *Schloenbachia varians* defines stratigraphic range of the zone, because this form appears simultaneously with *Mantelliceras man-*

Table 1. Correlated stratigraphic schemes of Upper Cretaceous deposits in central and southeastern areas of the East European platform and in some adjacent regions

Global Upper Cretaceous Scale (Olfer'ev and Alekseev, 2002)						Biozonation of the Upper Cretaceous in the Saratov and Penza areas of the Volga River basin (Arkhangel'skii, 1912)			Unified stratigraphic schemes of Upper Cretaceous deposits in the Russian platform of 1954 and 1958				Stratigraphic scheme of Upper Cretaceous deposits in the Russian platform (Naidin, 1960; Gerasimov *et al.*, 1962)				Upper Cretaceous biozonation in the Russian platform and Crimea (Najdin, 1969)		
System	Series	Stage	Substage	Zone or Subzone		Stage	Substage	Zone	Stage	Substage	Zone		Stage	Substage	Zone	Subzone	Stage	Substage	Zone or Subzone
Cretaceous	upper	Maastrichtian	upper	*Anapachydiscus terminus*		Senonian	upper	*Belemnitella americana*	Maastrichtian	upper	*Discoscaphites constrictus*	*Pachydiscus neubergicus Belemnitella americana B. arkhangelskii* [1958]	Maastrichtian	upper	*Belemnella arkhangelskii*	- - - -	Maastrichtian	upper (*Belemnella arkhangelskii* Beds)	
				Anapachydiscus fresvillensis												*Belemnitella nowaki*			
			lower	*Pachydiscus epiplectus*				*Belemnitella lanceolata*				*Acanthoscaphites tridens Belemnitella lanceolata*		lower	*Belemnella lanceolata*	*Belemnella sumensis*		lower (*Belemnitella lanceolate* Beds)	*Belemnella lanceolata*
				Pseudokossmaticeras tercense												- - - - *Belemnella licharewi*			*Belemnella licharewi*
		Campanian	upper	*Nostoceras hyatti*				Siliceous clay barren of fossils		?									
													Campanian	upper	*Belemnella langei*		Campanian	upper	*Belemnitella langei*
				Didymoceras donezianum						lower	*Bostrychoceras polyplocum Belemnitella langei*								
				Bostrychoceras polyplocum															
				Hoplitoplacenticeras marroti				*Belemnitella mucronata*	Campanian	upper	*Hoplitoplacenticeras coesfeldiense Belemnitella mucronata* [1954] *B. m. senior* [1958]				*Belemnitella mucronata senior*				*Belemnitella mucronata senior*
			lower	*Delawarella campaniensis*						lower	*Gonioteuthis quadrata Gonioteuthis mammillata* [1954]			lower	*Gonioteuthis quadrata* (S) *Belemnitella mucronata alpha* (N)			lower	*Gonioteuthis quadrata*
				Placenticeras bidorsatum				?	?							*Oxytoma tenuicostata*			*Oxytoma tenuicostata u Micraster schroederi*
			upper	*Placenticeras polyopsis*	*Placenticeras paraplanum*		lower	*Pteria tenuicostata*		upper	*Oxytoma tenuicostata*	*Ataxophragmium orbignynaeformis*							
												Stensioeina exsculpta [1954] *Anomalina stelligera*			*Gonioteuthis granulata* (S)		Santonian	upper (*Gonioteuthis granulata* Beds)	
			lower		*Texanites gallicus*			*Inoceramus pachti*		lower	*Inoceramus cardissoides*				*Inoceramus cardissoides*			lower (*Inoceramus cardissoides* Beds)	

Upper Cretaceous biozonation in the East European platform (Naidin and Kopaevich, 1977)			Upper Cretaceous biozonation in the East European paleobiogeographic province (Naidin *et al.*, 1984b, 1986)			Boreal standard of the Upper Cretaceous (Zakharov *et al.*, 1987)	Regional stratigraphic scheme of western Kazakhstan, Santonian–Maastrichtian (*Stratigraficheskie…*, 1996); Stratigraphy of the Mangyshlak Mts., Cenomanian–Coniacian (Marcinowski *et al.*, 1996)			Regional stratigraphic scheme of Upper Cretaceous deposits in the Russian platform (approved by the ISC Bureau, February 2, 2001)		
Stage	Substage	Zone or Subzone	Stage	Substage	Zone or Subzone	Zone or Subzone	Stage	Substage	Zone or Subzone	Zone or Subzone	Substage	Stage
Maastrichtian	upper	*Neobelemnella kazimiroviensis*; (=*Belemnella arkhangelskii*) / *Belemnitella junior*	Maastrichtian	upper	*Neobelemnella kazimiroviensis*	*Neobelemnella kazimiroviensis*	Maastrichtian	upper	*Neobelemnella kazimiroviensis*	*Hoploscaphites constrictus*: *Belemnitella junior – Neobelemnella kazimiroviensis*	upper	Maastrichtian
Maastrichtian	lower	*Acanthoscaphites tridens*: *Belemnella sumensis*	Maastrichtian	lower	*Acanthoscaphites tridens*: *Belemnella sumensis*	*Acanthoscaphites tridens*: *Belemnella sumensis*	Maastrichtian	lower	*Belemnella sumensis*	*Hoploscaphites constrictus*, *Acanthoscaphites tridens*: *Belemnella sumensis*	lower	Maastrichtian
Maastrichtian	lower	*Acanthoscaphites tridens*: *Belemnella lanceolata*	Maastrichtian	lower	*Acanthoscaphites tridens*: *Belemnella lanceolata*	*Acanthoscaphites tridens*: *Belemnella lanceolata*	Maastrichtian	lower	*Belemnella lanceolata*	*Hoploscaphites constrictus*, *Acanthoscaphites tridens*: *Belemnella lanceolata*	lower	Maastrichtian
Maastrichtian	lower	*Acanthoscaphites tridens*: *Belemnella licharewi*	Maastrichtian	lower	*Acanthoscaphites tridens*: *Belemnella licharewi*	*Acanthoscaphites tridens*: *Belemnella licharewi*	Maastrichtian	lower	*Belemnella licharewi*	*Belemnella licharewi/Micraster grimmensis*	upper	Campanian
Campanian	upper	*Belemnitella langei*: *Belemnitella langei najdini*	Campanian	upper	*Belemnitella langei*: *Belemnitella langei najdini*	*Belemnitella langei*	Campanian	upper	*Belemnitella* ex gr. *langei*: *Belemnitella langei najdini*	Belemnitella langei: *Belemnitella langei najdini/Micraster grimmensis*	upper	Campanian
Campanian	upper	*Belemnitella langei*: *Belemnitella langei langei*	Campanian	upper	*Belemnitella langei*: *Belemnitella langei langei*	*Belemnitella langei*	Campanian	upper	*Belemnitella* ex gr. *langei*: *Belemnitella langei langei*	Belemnitella langei: *Belemnitella langei langei/Didymoceras donezianum*	upper	Campanian
Campanian	upper	*Belemnitella langei*: *Belemnitella langei minor*	Campanian	upper	*Belemnitella langei*: *Belemnitella langei minor*	*Belemnitella langei*	Campanian	upper	*Belemnitella* ex gr. *langei*: *Belemnitella langei minor*	Belemnitella langei: *Belemnitella langei minor/Bostrychoceras polyplocum*	upper	Campanian
Campanian	upper	*Hoplitoplacenticeras coesfeldiense*	Campanian	upper	*Belemnitella mucronata mucronata* and *Hoplitoplacenticeras coesfeldiense*	*Belemnitella mucronata*	Campanian	upper	*Hoplitoplacenticeras coesfeldiense* and *Belemnitella mucronata mucronata*	*Hoplitoplacenticeras coesfeldiense/Belemnitella mucronata mucronata*	upper	Campanian
Campanian	lower	*Gonioteuthis quadrata gracilis* and *Belemnellocomax mammilatus*	Campanian	lower	*Gonioteuthis quadrata gracilis* and *Belemnellocamax mammillatus*	*Gonioteuthis quadrata gracilis*	Campanian	lower	*Gonioteuthis quadrata gracilis* and *Belemnellocamax mammillatus*	*Belemnellocamax mammillatus*	lower	Campanian
Campanian	lower	*Gonioteuthis quadrata quadrata and Belemnitella mucronata alpha*	Campanian	lower	*Gonioteuthis quadrata quadrata* and *Belemnitella mucronata alpha*	*Gonioteuthis quadrata gracilis*	Campanian	lower	*Gonioteuthis quadrata quadrata* and *Belemnitella mucronata alpha*	*Belemnitella mucronata alpha*	lower	Campanian
Campanian	lower	*Actinocamax laevigatus* and *Belemnitella praecursor mucronatiformis*	Campanian	lower	*Actinocamax laevigatus* and *Belemnitella praecursor mucronatiformis*. *Pteria* Beds of the East European platform	*Gonioteuthis quadrata quadrata*; *Actinocamax laevigatus*	Campanian	lower	*Actinocamax laevigatus* and *Belemnitella praecursor mucronatiformis*	*Belemnitella praecursor mucronatiformis*	lower	Campanian
Santonian	upper	*Gonioteuthis granulata* and *Inoceramus patootensis*	Santonian	upper	Gonioteuthis granulata and Inoceramus patootensis	*Gonioteuthis granulata*	Santonian	upper	*Gonioteuthis granulata*	*Sphenoceramus patootensis/Belemnitella praecursor praepraecursor*	upper	Santonian
Santonian	lower	*Inoceramus cardissoides*	Santonian	lower	*Inoceramus cardissoides*; *Inoceramus undulatopicatus* at the base	*Sphenoceramus cardissoides*	Santonian	lower	*Inoceramus cardissoides* [Str.] *Sphenoceramus pachti Cladoceramus undulatoplicatus* [Mar.]	*Texanites texanus/Sphenoceramus cardissoides/Belemnitella propinqua propinqua*	lower	Santonian

Table 1. (Contd.)

Global Upper Cretaceous Scale (Olfer'ev and Alekseev, 2002)						Biozonation of the Upper Cretaceous in the Saratov and Penza areas of the Volga River basin (Arkhangel'skii, 1912)			Unified stratigraphic schemes of Upper Cretaceous deposits in the Russian platform of 1954 and 1958				Stratigraphic scheme of Upper Cretaceous deposits in the Russian platform (Naidin, 1960; Gerasimov *et al.*, 1962)				Upper Cretaceous biozonation in the Russian platform and Crimea (Najdin, 1969)		
System	Series	Stage	Substage	Zone or Subzone		Stage	Substage	Zone	Stage	Substage	Zone		Stage	Substage	Zone	Subzone	Stage	Substage	Zone or Subzone
Cretaceous	upper	Coniacian	upper	*Paratexanites serratomarginatus*		Emscherian		?	Coniacian	?			?				?		
			middle	*Gauthiericeras margae*				*Inoceramus involutus*		upper	*Inoceramus involutus*		Coniacian		*Inoceramus involutus*		Coniacian	upper (*Inoceramus involutus* Beds)	
				Peroniceras tridorsatum				Barren Cretaceous			? [1954]	*Inoceramus wandereri* [1958]			*Inoceramus wandereri*			lower (*Inoceramus wandereri* Beds)	
			lower	*Forresteria (Harleites) petrocoriensis*		Turonian				lower		Undetected index species	?				?		
		Turonian	upper	*Subprionocyclus neptuni*					?										
				Romaniceras deverianum	*Collignoniceras woollgari*														
			middle	*Romaniceras ornatissimum*				*Inoceramus brongniarti*	Turonian	upper	*Inoceramus lamarcki* (*Inoceramus falcatus*?) [1958]		Turonian	upper	*Inoceramus lamarcki*		Turonian	upper (*Inoceramus lamarcki* Beds)	
				Romaniceras kallesi															
				Kamerunoceras turoniense															
			lower	*Mammites nodosoides*						lower	*Inoceramus labiatus*			lower	*Inoceramus labiatus*			lower (*Inoceramus labiatus* Beds)	
				Watinoceras coloradoense															
				Pseudaspidoceras flexuosum															
				Watinoceras devonense					?				?						*Actinocamax plenus triangulus*

Upper Cretaceous biozonation in the East European platform (Naidin and Kopaevich, 1977)

Stage	Substage	Zone or Subzone
?		
Coniacian	upper	*Inoceramus involutus*
Coniacian	lower	*Inoceramus wandereri*
?		
Turonian	upper	*Inoceramus woodsi*
Turonian	upper	*Inoceramus lamarcki*
Turonian	lower	*Inoceramus labiatus*
Turonian	lower	*Preactinocamax plenus triangulus*

Upper Cretaceous biozonation in the East European paleobiogeographic province (Naidin *et al.*, 1984b, 1986)

Stage	Substage	Zone or Subzone
?		
Coniacian	upper	*Inoceramus involutus*
Coniacian	lower	*Inoceramus schloenbachi*
?		
Turonian	upper	*Inoceramus costellatus* and *Inoceramus striatoconcentricus*
Turonian	upper	*Inoceramus lamarcki*; *Inoceramus apicalis* at the base
Turonian	lower	*Inoceramus labiatus* and *Inoceramus hercynicus*
Turonian	lower	*Preactinocamax plenus triangulus*

Boreal standard of the Upper Cretaceous (Zakharov *et al.*, 1987)

Zone or Subzone
Volviceramus involutus
Inoceramus schloenbachi
Inoceramus costellatus
Mytiloides labiatus
?

Regional stratigraphic scheme of western Kazakhstan, Santonian–Maastrichtian (*Stratigraficheskie*.... 1996); Stratigraphy of the Mangyshlak Mts., Cenomanian–Coniacian (Marcinowski *et al.*, 1996)

Stage	Substage	Zone or Subzone
Coniacian	upper	*Magadiceramus subquadratus*
Coniacian	middle	*Volviceramus involutus/Volviceramus koeneni*
Coniacian	lower	*Cremnoceramus crassus/Cremnoceramus deformis*
Coniacian	lower	*Cremnoceramus brongniarti*
Coniacian	lower	*Cremnoceramus rotundatus*
Turonian	upper	*Mytiloides incertus*
Turonian	upper	*Inoceramus costellatus*
Turonian	middle	*Inoceramus lamarcki*
Turonian	middle	*Inoceramus apicalis*
Turonian	middle	*Mytiloides hercynicus*
Turonian	lower	*Mytiloides labiatus* *Mytiloides kossmati*
Turonian	lower	*Watinoceras amudariense/Mytiloides hattini*
?		

Regional stratigraphic scheme of Upper Cretaceous deposits in the Russian platform (approved by the ISC Bureau, February 2, 2001)

Zone or Subzone	Substage	Stage
Magadiceramus subquadratus	upper	Coniacian
Volviceramus involutus	middle	Coniacian
Volviceramus koeneni	middle	Coniacian
Cremnoceramus crassus–Cremnoceramus deformis	lower	Coniacian
Cremnoceramus brongniarti	lower	Coniacian
Cremnoceramus rotundatus	lower	Coniacian
Mytiloides scupini–Mytiloides incertus	upper	Turonian
Mytiloides striatoconcentricus	upper	Turonian
Inoceramus costellatus	upper	Turonian
Inoceramus lamarcki	middle	Turonian
Inoceramus apicalis	middle	Turonian
Mytiloides subhercynicus–Mytiloides hercynicus	middle	Turonian
Mytiloides labiatus – Mytiloides kossmati	lower	Turonian
Preactinocamax plenus triangulus	lower	Turonian

Table 1. (Contd.)

Global Upper Cretaceous Scale (Olfer'ev and Alekseev, 2002)						Biozonation of the Upper Cretaceous in the Saratov and Penza areas of the Volga River basin (Arkhangel'skii, 1912)			Unified stratigraphic schemes of Upper Cretaceous deposits in the Russian platform of 1954 and 1958			Stratigraphic scheme of Upper Cretaceous deposits in the Russian platform (Naidin, 1960; Gerasimov *et al.*, 1962)				Upper Cretaceous biozonation in the Russian platform and Crimea (Najdin, 1969)		
System	Series	Stage	Substage	Zone or Subzone		Stage	Substage	Zone	Stage	Substage	Zone	Stage	Substage	Zone	Subzone	Stage	Substage	Zone or Subzone
Cretaceous	upper	Cenomanian	upper	*Nigericeras scotti*		Cenomanian			?			?				?		
				Neocardioceras juddii					Cenomanian	upper	*Acanthoceras rhotomagense* *Scaphites aequalis* [1958] *Actinocamax plenus* [1954]	Cenomanian	upper	*Scaphites aequalis* (S) [1958]	*Actinocamax plenus*	Cenomanian	upper	*Scaphites aequalis*
				Metoicoceras geslinianum														
				Calycoceras guerangeri														
			middle	*Alternacanthoceras jukesbrownei*														
				Acanthoceras rhotomagense	*Turrilites acutus*													
					Turrilites costatus		lower	*Lingula krausei* Beds		lower	*Neohibolites ultimus* *Pecten asper* [1954] *Actinocamax plenus* [1958]		lower	*Exogyra conica*				
			lower	*Mantelliceras dixoni*											*Actinocamax primus*			- - - - - -
				Mantelliceras mantelli	*Mantelliceras saxbii*			- - - -										
					Sharpeiceras schlueteri			*Exogyra conica*									lower	
					Neostlingoceras carcitanense													

Note: (1) In the third column, years in square brackets after the taxon name mean one of two references given in the column heading. (2) Empty cells with question marks correspond to intervals undistinguished in corresponding schemes as individual stratigraphic subdivisions. Some of them have been implicitly regarded as continuations of adjacent zones.

telli (J. Sow.) and has its evolutionary termination in the *Turrilites costatus* Subzone.

The zone is an equivalent of *Neohibolites ultimus* and *Praeactinocamax primus primus* beds of the belemnite scale and corresponds in range to the lower Cenomanian Substage in the Upper Cretaceous stratigraphic scale for the Russian platform of 1958. The same correlation between the indicated subdivisions is established as well in northwestern Germany (Christensen *et al.*, 1992). Except for Ostreidae, belemnites represent fossils most widespread in Cenomanian deposits of the platform, which enable the stage identification. It should be mentioned, however, that *Neohibolites ultimus* (Orb.) has not been confidently detected in the platform, whereas in the Crimea Mountains it is characteristic of the terminal lower–middle Cenomanian strata (Naidin *et al.*, 1975; Alekseev, 1989). *Neohibolites* forms represent the belemnite group that is more thermophilic than *Belemnitella* species, the Cenomanian *Actinocamax* forms of the Central Russian subprovince included.

Inoceramus crippsii Mant. is an inoceramid form characteristic of the zone in question, but this taxon is known only beyond limits of the region under consideration.

Acanthoceras rhotomagense–Inoceramus crippsii Zone. Extremely rare ammonite specimens have been found in the higher interval of the middle Cenomanian Substage. Single finds of *Acanthoceras rhotomagense* (Brgt.) from the Voronezh area (Semenov, 1986) imply that sedimentary sections of the Russian plate may include the synonymous zone established in western Europe. Tröger (1981) pointed out that *Inoceramus crippsii* Mant. still exists at this level. Stratigraphic range of this taxon extends up to the middle–upper Cenomanian boundary (Atabekyan, 1994).

Inoceramus pictus pictus–Praeactinocamax plenus longus Zone. Macrofossils are very rare in the upper

<table>
<tr><th colspan="3">Upper Cretaceous biozonation in the East European platform (Naidin and Kopaevich, 1977)</th><th colspan="4">Upper Cretaceous biozonation in the East European paleobiogeographic province (Naidin et al., 1984b, 1986)</th><th colspan="2">Boreal standard of the Upper Cretaceous (Zakharov et al., 1987)</th><th colspan="3">Regional stratigraphic scheme of western Kazakhstan, Santonian–Maastrichtian (Stratigraficheskie..., 1996); Stratigraphy of the Mangyshlak Mts., Cenomanian–Coniacian (Marcinowski et al., 1996)</th><th colspan="3">Regional stratigraphic scheme of Upper Cretaceous deposits in the Russian platform (approved by the ISC Bureau, February 2, 2001)</th></tr>
<tr><th>Stage</th><th>Substage</th><th>Zone or Subzone</th><th>Stage</th><th>Substage</th><th colspan="2">Zone or Subzone</th><th colspan="2">Zone or Subzone</th><th>Stage</th><th>Substage</th><th>Zone or Subzone</th><th>Zone or Subzone</th><th>Substage</th><th>Stage</th></tr>
<tr><td colspan="3">?</td><td colspan="4">?</td><td colspan="2"></td><td colspan="3"></td><td>Mytiloides hattini</td><td rowspan="4">upper</td><td rowspan="9">Cenomanian</td></tr>
<tr><td rowspan="8">Cenomanian</td><td rowspan="6">upper</td><td rowspan="6">Scaphites aequalis</td><td rowspan="8">Cenomanian</td><td rowspan="3">upper</td><td colspan="2" rowspan="2">Sciponoceras gracile; Inoceramus pictus bohemicus–Praeactinocamax plenus plenus Beds in Mangyshlak</td><td colspan="2">Praeactinocamax plenus triangulus</td><td rowspan="8">Cenomanian</td><td rowspan="3">upper</td><td>Neocardioceras juddii</td><td>Inoceramus pictus bohemicus</td></tr>
<tr><td colspan="2">Sciponoceras gracile</td><td rowspan="2">Actinocamax plenus</td><td rowspan="2">Inoceramus pictus pictus/Praeactinocamax plenus longus</td></tr>
<tr><td colspan="2">Eucalycoceras pentagonum</td><td colspan="2">Eucalycoceras pentagonum</td></tr>
<tr><td rowspan="3">middle</td><td rowspan="5">Inoceramus crippsii</td><td>Alternacanthoceras jukesbrownei</td><td colspan="2">Alternacanthoceras jukesbrownei</td><td rowspan="3">middle</td><td>Acanthoceras jukesbrownei</td><td rowspan="2">Acanthoceras rhotomagense/Inoceramus crippsii</td><td rowspan="3">middle</td></tr>
<tr><td>Turrilites acutus</td><td colspan="2">Turrilites acutus</td><td rowspan="2">Acanthoceras rhotomagense</td></tr>
<tr><td>Turrilites costatus</td><td>Turrilites costatus</td><td rowspan="3">Inoceramus crippsii</td><td rowspan="3">Turrilites costatus – Schloenbachia varians/Praeactinocamax primus primus – Neohibolites ultimus/Inoceramus crippsii</td></tr>
<tr><td rowspan="2">lower</td><td rowspan="2">Neohibolites ultimus / Parahibolites tourtiae</td><td rowspan="2">lower</td><td rowspan="2">Mantelliceras mantelli and Schloenbachia varians</td><td rowspan="2">Mantelliceras mantelli</td><td rowspan="2">lower</td><td>Mantelliceras dixoni</td><td rowspan="2">lower</td></tr>
<tr><td>Mantelliceras mantelli</td></tr>
</table>

Cenomanian Substage. Single specimens of *Praeactinocamax plenus longus* Najd. found in the East European platform imply that we may have here a subdivision analogous to the *Praeactinocamax plenus* Zone of western Kazakhstan and correlative with the *Inoceramus pictus* Zone distinguished by Wright *et al.* (1984) in western Europe. According to Marcinowski *et al.* (1996), the *plenus* Beds of Mangyshlak correspond to the *Calycoceras guerangeri* and *Metoicoceras geslinianum* zones of the ammonite scale. Consequently, the subdivision under consideration may be tentatively correlated with two lower zones of the upper Cenomanian accepted in the general scale. We should mention as well that *Praeactinocamax plenus* (Blainv.) has been found only in the *Metoicoceras geslinianum* Zone of western Europe. According to Marcinowski and his colleagues, the upper boundary of *Praeactinocamax plenus* Zone coincides with the first occurrence level of ammonites *Neocardioceras juddii* (Barr. et Guerne) in the Mangyshlak (Table 3).

Inoceramus pictus bohemicus Zone. This zone corresponds to the higher upper Cenomanian interval representing terminal portion of this substage (Tröger, 1981). In the regional scheme elaborated for the East European platform, we correlated this subdivision with the *Neocardioceras juddii* Zone of the general ammonite scale, although Naidin (*Stratigraficheskie...*, 1996) assumed that *Inoceramus pictus bohemicus* Leonhard represents subspecies characteristic of the entire upper Cenomanian of western Kazakhstan. Christensen *et al.* (1992) placed the lower boundary of the same inoceramid zone at the base of the *Metoicoceras geslinianum* Zones of the ammonite scale accepted in northwestern Germany.

Mytiloides hattini Zone. The regional scale of the Cenomanian Stage is crowned by the *Mytiloides hattini* Zone of inoceramids that has been established in the Pueblo section of the United States (Walaszczyk, 1992; Kennedy *et al.*, 2000), where it corresponds to the *Nigericeras scotti* Zone of the ammonite standard. The *Mytiloides hattini* interval zone comprises beds

Table 2. Stratigraphic scheme of Upper Cretaceous deposits in the East European platform

General stratigraphic scale: System	Series	Stage	Substage	Zone or subzone of ammonite scale	Zone of planktonic foraminifers	Nannoplankton zonation (Perch-Nielsen, 1985)	Regional stratigraphic subdivisions: Superhorizon, horizon		Molluscan and echinoderm regional zone or subzone		Zone of benthic foraminifers	Subzone or beds with benthic foraminifers
Cretaceous	upper	Maastrichtian	upper	*Anapachydiscus terminus*	*Abathomphalus mayaroensis*	CC26 *Nephrolithus frequens*	Severskii	Sudzha	*Hoploscaphites constrictus*	*Belemnitella junior–Neobelemnella kazimiroviensis*	*Brotzenella praeacuta–Hanzawaia ekblomi*	
				Anapachydiscus fresvillensis		CC25 *Arkhangelskiella cymbiformis* c, b						
			lower	*Pachydiscus epiplectus*	*Gansserina gansseri*	CC25 a; CC24 *Reinhardtites levis*; CC23 b			*Acanthoscaphites tridens*	*Belemnella sumensis*	*Brotzenella complanata*	*Bolivinoides draco draco*; *Brotzenella complanata*
				Pseudokossmaticeras tercense	*Globotruncana aegyptiaca*	CC23 *Tranolithus phacelosus* a				*Belemnella lanceolata*	*Neoflabellina reticulata*	
		Campanian	upper	*Nostoceras hyatti*	*Globotruncanella havanensis*			Tereshkino	*Belemnella licharewi/Micraster grimmensis*		*Angulogavelinella gracilis*	
									Belemnitella langei	*Belemnitella langei najdini/Micraster grimmensis*		*Brotzenella taylorensis*
				Didymoceras donezianum	*Globotruncanita calcarata*	CC22 *Quadrum trifidum*		Maslovo		*Belemnitella langei langei/Didymoceras donezianum*	*Globorotalites emdyensis*	*Bolivinoides draco miliaris*
				Bostrychoceras polyplocum	*Globotruncana ventricosa*	CC21 *Quadrum nitidum*; CC20 *Ceratolithoides aculeus*				*Belemnitella langei minor/Bostrychoceras polyplocum*		*Globorotalites emdyensis*
				Hoplitoplacenticeras marroti	*Globotruncanita elevata*	CC19 *Calculites ovalis*			*Hoplitoplacenticeras coesfeldiense/Belemnitella mucronata mucronata*		*Brotzenella monterelensis*	
			lower	*Delawarella campaniensis*		CC18 *Aspidolithus parcus*		Alekseevka	*Belemnellocamax mammillatus*		*Cibicidoides temirensis*	*Cibicidoides aktulagayensis*
									Belemnitella mucronata alpha			*Cibicidoides temirensis*
				Placenticeras bidorsatum		CC17 *Calculites obscurum*	Shilov	Dubenki	*Belemnitella praecursor mucronatiformis*		*Gavelinella clementiana clementiana*	
		Santonian	upper	*Placenticeras polyopsis*; *Placenticeras paraplanum*	*Dicarinella asymetrica*	CC16 *Lucianorhabdus cayeuxii*		Podgorenskii	*Sphenoceramus patootensis/Belemnitella praecursor praepraecursor*		*Gavelinella stelligera*	*Stensioeina pommerana* Beds
			lower	*Texanites gallicus*		CC15 *Reinhardtites anthophorus*		Terepsha	*Texanites texanus/Sphenoceramus cardissoides/Belemnitella propinqua propinqua*		*Gavelinella infrasantonica*	

Table 2. (Contd.)

General stratigraphic scale: System	Series	Stage	Substage	Zone or subzone of ammonite scale		Zone of planktonic foraminifers	Nannoplankton zonation (Perch-Nielsen, 1985)	Regional stratigraphic subdivisions: Superhorizon, horizon		Molluscan and echinoderm regional zone or subzone	Zone of benthic foraminifers	Subzone or beds with benthic foraminifers
Cretaceous	upper	Coniacian	upper	*Paratexanites serratomarginatus*		*Dicarinella concavata*	CC14 Micula staurophora	Gubkin	Vol'sk	*Magadiceramus subquadratus*	*Gavelinella thalmanni*	
			middle	*Gauthiericeras margae*						*Volviceramus involutus*		
				Peroniceras tridorsatum						*Volviceramus koeneni*		
			lower	*Forresteria (Harleites) petrocoriensis*			CC13 Marthasterites furcatus			*Cremnoceramus crassus – Cremnoceramus deformis*; *Cremnoceramus brongniarti*; *Cremnoceramus rotundatus*	*Gavelinella kelleri*	
		Turonian	upper	*Subprionocyclus neptuni*			CC12 Lucianorhabdus maleformis		Bannovo	*Mytiloides scupini – Mytiloides incertus*; *Mytiloides striatoconcentricus*; *Inoceramus costellatus*	*Gavelinella moniliformis*	
				Romaniceras deverianum	*Collignoniceras woollgari*							
			middle	*Romaniceras ornatissimum*		*Marginotruncana sigali*	CC11 Quadrum gartneti			*Inoceramus lamarcki*		
				Romaniceras kallesi						*Inoceramus apicalis*		
				Kamerunoceras turoniense		*Helvetoglobotruncana helvetica*				*Mytloides subhercynicus – Mytloides hercynicus*	*Gavelinella nana*	
			lower	*Mammites nodosoides*						*Mytloides labiatus – Mytloides kossmati*		
				Watinoceras coloradoense								
				Pseudaspidoceras flexuosum								
				Watinoceras devonense						*Praeactinocamax plenus triangulus*		
		Cenomanian	upper	*Nigericeras scotti*		*Whiteinella archaeocretacea*	CC10 Microrhabdulus decoratus	Bryansk	Dyat'kovo	*Mytiloides hattini*	*Lingulogavelinella globosa*	
				Neocardioceras juddii						*Inoceramus pictus bohemicus*		
				Metoicoceras geslinianum		*Rotalipora cushmani*				*Inoceramus pictus pictus/Praeactinocamax plenus longus*		
				Calycoceras guerangeri								
			middle	*Alternacanthoceras jukesbrownei*						*Acanthoceras rhotomagense/Inoceramus crippsii*		
				Acanthoceras rhotomagense	*Turrilites acutus*							
					Turrilites costatus	*Rotalipora reicheli*			Polpino	*Turrilites costatus – Schloenbachia varians/Praeactinocamax primus primus – Neohibolites ultimus/Inoceramus crippsii*	*Gavelinella cenomanica*	
			lower	*Mantelliceras dixoni*		*Rotalipora globotruncanoides*	CC9 Eiffellithus turriseiffelii					
				Mantelliceras mantelli	*Mantelliceras saxbii*							
					Sharpeiceras schlueteri							
					Neostlingoceras carcitanense							

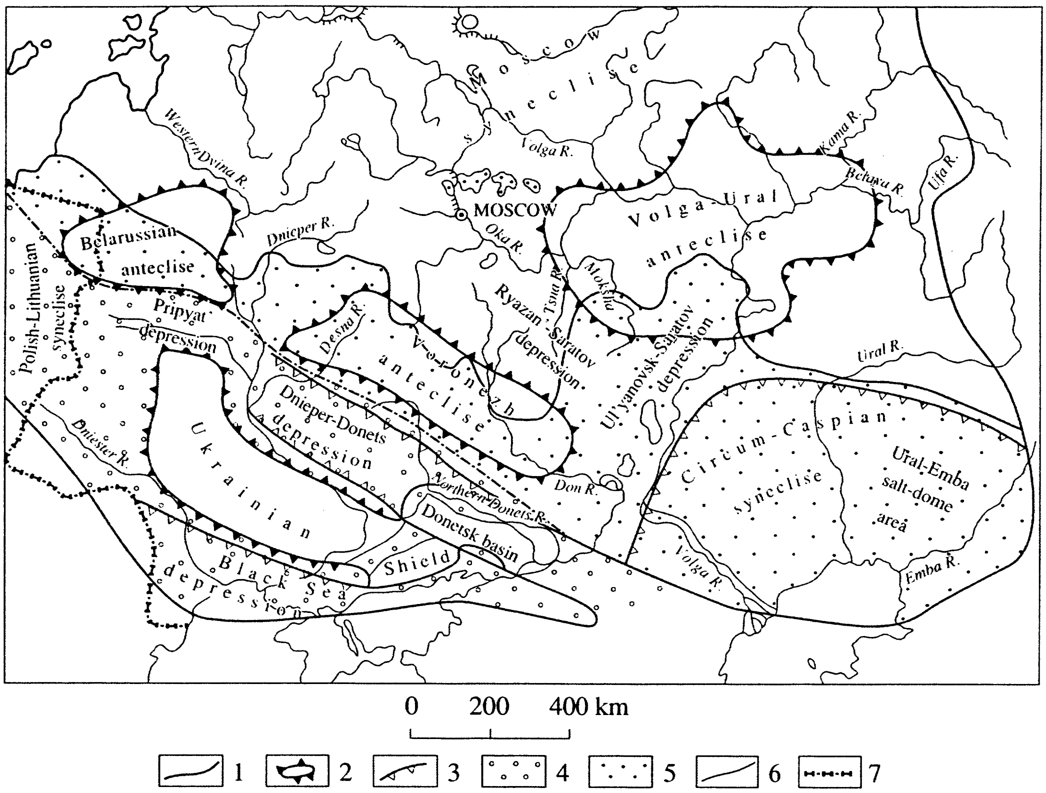

Fig. 1. Distribution areas of Upper Cretaceous deposits in different structures of the Russian platform (after Naidin *et al.*, 1986) and paleogeographic zoning of the Late Cretaceous time (after Christensen, 1990): (1) the Russian platform boundary; (2) shield or anteclise; (3) syneclise or depression; (4) Central European and (5) Central Russian paleobiogeographic subprovinces; (6) present-day distribution limits of Upper Cretaceous deposits; (7) state boundary of the former USSR.

between the first occurrence levels of *Mytiloides hattini* Elder and *Mytiloides puebloensis* Wal., the last of which marks the base of the overlying zone. Biozone of *Mytiloides hattini* Elder is actually much wider, because this species existed in Europe and America even during the Turonian time. This situation engendered the erroneous idea that the *Mytiloides hattini* Zone corresponds in Mangyshlak to the Turonian *Watinoceras coloradoense* Zone of the ammonite scale (Marcinowski *et al.*, 1996) or to the basal Turonian of Poland (Walaszczyk, 1992) (Table 3). Strictly speaking, this particular zone is most likely unrecorded over the greater part of the Russian plate, where hiatus between Cenomanian and Turonian stages is usually very distinct: various horizons of the lower and middle Cenomanian are overlain here by terminal lower or middle Turonian beds. We included this subdivision in our scheme in order to retain the necessary succession. Moreover, it seems to be recognizable in some sections. For instance, the middle–upper Cenomanian Melovatka Formation of the Saratov area yields nannoplankton of the 10 zone (unpublished data of M.N. Ovechkina), and Kopaevich detected planktonic foraminifers of the *Whiteinella archaeocretacea* Zone in upper beds of that formation.

Turonian Stage. Praeactinocamax plenus triangulus Zone. According to Naidin *et al.* (1986), the Turonian Stage begins in the platform with the *Praeactinocamax plenus triangulus* Zone. This taxon of belemnites is rather frequent near the Turonian base in the East European platform (Tuskar' Formation of the Voronezh anteclise, Oktyabr'sk and Bannovo formations of the Khoper monocline, Murom–Lomovka and Ul'yanovsk–Saratov depressions), but its stratigraphic range is imprecisely calibrated with the ammonite standard. According to stratigraphic position, the zone may correspond to the *Watinoceras devonense* Zone of the ammonite scale.

Mytiloides labiatus–Mytiloides kossmati Zone. In recent years, stratigraphic range of the *Mytiloides labiatus–Mytiloides kossmati* Zone that is terminal one in the lower Turonian Substage changed considerably. Naidin *et al.* (1984a, 1984b, 1986) regarded the upper part of the lower Turonian (provided that the stage is divided in two subunits) as corresponding to the wider *Mytiloides labiatus–Mytiloides subhercynicus–Mytiloides hercynicus* Zone. As is established at present, the *Mytiloides subhercynicus* and *M. hercynicus* zones correspond to the middle–upper Turonian *Collignoniceras woollgari* Zone of the ammonite standard (Kennedy *et al.*, 2000). Marcinowski *et al.* (1996) correlated the

Table 3. Correlation between principal stratigraphic schemes of Cenomanian–Turonian boundary deposits

General scale and regional stratigraphic subdivisions of the Russian platform (Olfer'ev and Alekseev, 2002)

Stage	Substage	Zones of general ammonite scale	Inoceramid and belemnite zones of the Russian platform
Turonian	middle (partially)	*Kamerunoceras turoniense/Collignoniceras woollgari*	*Mytiloides hercynicus–Mytiloides subhercynicus*
	lower	*Mammites nodosoides*	*Mytiloides labiatus – Mytiloides kossmati*
		Watinoceras coloradoense	
		Pseudoaspidoceras flexuosum	
		Watinoceras devonense	*Praeactinocamax plenus triangulus*
Cenomanian	upper	*Nigericeras scotti*	*Mytiloides hattini*
		Neocardioceras juddii	*Inoceramus pictus bohemicus*
		Metoicoceras geslinianum	*Inoceramus pictus pictus/Praeactinocamax plenus longus*
		Calycoceras guerangeri	

East European paleobiogeographic province (Naidin, 1986; Atabekyan *et al.*, 1986), Mangyshlak, and eastern circum-Caspian region (Naidin *et al.*, 1984a, 1984b)

Stage	Substage	Molluscan zonation
Turonian	lower	*Inoceramus hercynicus–Inoceramus subhercynicus–Inoceramus labiatus*
		Praeactinocamax triangulus
Cenomanian	upper	*Sciponoceras gracile Inoceramus pictus bohemicus Praeactinocamax plenus plenus*
		Eucalycoceras pentagonum

Central Poland (Walaszczyk, 1992)

Stage	Substage	Inoceramid zones
Turonian	middle (partially)	*Mytiloides hercynicus*
	lower	*Mytiloides labiatus*
		Mytiloides kossmati
		Mytiloides hattini

Mangyshlak (Marcinowski *et al.*, 1996)

Stage	Substage	Ammonite zones	Inoceramid and cephalopod zones
Turonian	middle (partially)	*Collignoniceras woollgari*	*Mytiloides hercynicus*
	lower	*Mammites nodosoides*	*Mytiloides labiatus Mytiloides kossmati*
		Watinoceras coloradoense	*Mytiloides hattini*
Cenomanian	upper	*Neocardioceras juddii*	*Neocardioceras juddii*
		Metoicoceras geslinianum	*Praeactinocamax plenus*
		Calycoceras guerangeri	

Colorado, United States (Kennedy *et al.*, 2000)

Stage	Substage	Ammonite zones	Inoceramid zones
Turonian	middle (partially)	*Collignoniceras woollgari*	*Mytiloides subhercynicus*
	lower	*Mammites nodosoides*	*Mytiloides mytiloides*
		Vascoceras birchbyi	*Mytiloides kossmati*
		Pseudoaspidoceras flexuosum	
		Watinoceras devonense	*Mytiloides puebloensis*
		Nigericeras scotti	*Mytiloides hattini*
		Neocardioceras juddii	*Inoceramus pictus*
		Sciponoceras gracile	

Stratigraphic ranges of inoceramids:

Mytiloides hattini Elder
Mytiloides puebloensis Wal.
Mytiloides kossmati (Heinz.)
Mytiloides mytiloides (Mant.)
Mytiloides labiatus (Schloth.)
Mytiloides subhercynicus (Seitz.)

Mytiloides kossmati and *M. labiatus* zones, which have been distinguished by Walaszczyk (1992) in the terminal lower Turonian, with upper strata of the *Watinoceras coloradoense* Zone coupled with *Mammites nodosoides* Zone of the general ammonite scale. As was established afterward (Kennedy *et al.*, 2000), the base of *Mytiloides kossmati* Zone is situated outside the *Watinoceras coloradoense* Zone and coincides with the base of underlying *Pseudaspidoceras flexuosum* Zone of the ammonite scale. Therefore, the *Mytiloides labiatus–Mytiloides kossmati* Zone of the East European platform is correlative with three upper ammonite zones of the lower Turonian in the general scale. This subdivision is established in Mordovia, Ul'yanovsk and Kuibyshev areas (Glazunova, 1972), in southwestern Lithuania and Belarus, in the southern periphery of the Donetsk basin, and in sections of the L'viv centrocline (Naidin and Morozov, 1986).

The inoceramid zonation established by Walaszczyk (1992) in central Poland and traceable in the Mangyshlak sections (Marcinowski *et al.*, 1996) has been used to determine regional zones of the middle and upper Turonian in our scale.

Mytiloides hercynicus–Mytiloides subhercynicus Zone. In the East European platform, the middle Turonian substage spans a succession of *Mytiloides hercynicus–Mytiloides subhercynicus, Inoceramus apicalis*, and *Inoceramus lamarcki* zones. Kennedy *et al.* (2000) established that the base of *Mytiloides subhercynicus* Zone corresponds in the Pueblo section of the United States to the first occurrence level of ammonite species *Collignoniceras woollgari* (Mant.) whose appearance is suggested to be an indicator of the middle Turonian base (Bengtson, 1996). The ammonite form *Collignoniceras woollgari* (Mant.) also known from Turonian deposits of the Russian plate (Ovechkina *et al.*, 2002) is extremely rare here, whereas zonal index species of inoceramids are more widespread. The latter have been encountered in sections of the L'viv centrocline and in eastern areas of the Dnieper–Donets depression (Naidin and Morozov, 1986).

Inoceramus apicalis Zone. This zone spans the middle interval of the middle Turonian. It has been established with confidence in the Volga River basin (Penza, Ul'yanovsk, and Saratov areas; Glazunova, 1972), where its thickness is insignificant. The zone has been also distinguished in sections of the L'viv centrocline and in the circum-Caspian depression (Naidin and Morozov, 1986) (Sobetskii *et al.*, 1982).

Inoceramus lamarcki Zone. This zone is terminal one in the middle Turonian Substage. Corresponding deposits are widespread and readily recognizable almost everywhere in the East European platform. Inoceramids characteristic of the zone, the index species included, have been listed by description of Turonian deposits in a series of explanatory notes to edited medium-scale geological maps.

Inoceramus costellatus Zone has been established in Germany (Ernst *et al.*, 1963), Poland (Walaszczyk, 1992), and western Kazakhstan (Marcinowski *et al.*, 1996). Its presence in the Russian plate has not been substantiated yet by paleontological data. In the East European paleobiogeographic province, Naidin *et al.* (1986) recognized the wider *Inoceramus costellatus–Inoceramus striatoconcentricus* Zone of the terminal Turonian interval.

Mytiloides striatoconcentricus Zone. In the East European platform, this subdivision is traceable in the Volgograd area and Ilovlya River basin (Glazunova, 1972), and also in the Saratov area and circum-Caspian depression (Sobetskii *et al.*, 1982).

Mytiloides scupini–Mytiloides incertus Zone crowns the upper Turonian. It is established in the Salzgitter-Salder section near Hannover in Germany above the *Mytiloides striatoconcentricus* Zone (Walaszczyk and Tröger, 1996; Kauffman *et al.*, 1996). The lower boundary of the Coniacian Stage is defined in the same section at the top of zone under consideration (Kauffman *et al.*, 1996). The *Mytiloides scupini–Mytiloides incertus* Zone has not been recognized yet in the Russian plate, but its presence is proved in adjacent western and eastern regions (Kauffman *et al.*, 1996; Walaszczyk, 1996; Marcinowski *et al.*, 1996; Walaszczyk, Wood, 1998).

Coniacian Stage. Like in the case of Turonian deposits, we used the inoceramid zonation to outline biostratigraphy of the Coniacian Stage in the Russian plate. In distinction from the scheme suggested by Naidin *et al.* (1986), we managed to considerably detail the stage zonation, using new data from a series of works (Walaszczyk, 1992; Marcinowski *et al.*, 1996; Kauffman *et al.*, 1996; Walaszczyk and Wood, 1998), and to verify stratigraphic range of the stage. According to the former concept, the Coniacian Stage base coincided "with the base of the *Inoceramus schloenbachi (=Inoceramus deformis)* Zone" (Naidin *et al.*, 1986, p. 15). Recent data (Kauffman *et al.*, 1994, 1996) showed, however, that biozone of aforementioned species corresponds in the North American Interior basin to the lower part of the *Volviceramus koeneni* Zone, thus being located at the base of the middle Coniacian Substage.

As the International Working Group recommended to authorize the first occurrence level of bivalve mollusk *Cremnoceramus rotundatus* (sensu Tröger) for the lower boundary of the Coniacian Stage, we discriminated near the stage base the synonymous zone that was originally distinguished in Germany (Ernst *et al.*, 1983; Wood *et al.*, 1984).

The *Cremnoceramus rotundatus* Zone has been established in the Salzgitter-Salder section (Kauffman *et al.*, 1996). In the East European platform, it is known in the Bryansk area of the Desna River basin and further eastward in the Mangyshlak (Marcinowski *et al.*, 1996). Recent reexamination of classical Coniacian sequences in the Lower Saxony, central Poland, and the Western Interior basin (Walaszczyk, Wood, 1998; Walaszczyk, Cobban, 2000) showed that the species *Cremnoceramus rotundatus* (sensu Tröger non Fiege) is a junior synonym of North American *Cremnoceramus erectus* (Meek). Accordingly, it was suggested to regard this taxon as a subspecies of the *Cremnoceramus deformis* (Meek) phylogenetic lineage and to rename the *Cremnoceramus rotundatus* Zone as the *Cremnoceramus deformis erectus* Zone.

The *Cremnoceramus brongniarti* Zone established by Walaszczyk (Walaszczyk, 1992; Marcinowski *et al.*, 1996) approximately corresponds in range to the former *Cremnoceramus erectus* Zone (Ernst *et al.*, 1983; Wood *et al.*, 1984). According to recent data (Walaszczyk and Wood, 1998), it can be divided into the *Cremnoceramus waltersdorfensis hannovrensis* and *Cremnoceramus inconstans* zones. The unit under consideration has been recognized in the Desna River basin, southern Donetsk basin (Kotsyubinskii *et al.*, 1974), and Ural–Emba region (Marcinowski *et al.*, 1996).

The *Cremnoceramus crassus–Cremnoceramus deformis* Zone is terminal one in the lower Coniacian Substage. It is known in sections of the L'viv centrocline, southern Donetsk basin, and also in the west of the Voronezh anteclise, in the east of the Dnieper–Donets depression (Naidin and Morozov, 1986), and in the Mangyshlak (Marcinowski *et al.*, 1996). In opinion of Walaszczyk and Cobban (2000), the zone is an equivalent of the *Cremnoceramus crassus crassus* Zone of the terminal lower Coniacian in the United States. Walaszczyk (2000) also assumed that *Cremnoceramus* Beds do not crown the lower Coniacian Substage. After revision of fossils collected by Olfer'ev in the Bryansk area, Walaszczyk concluded that the terminal lower Coniacian subdivision corresponds to the *Inoceramus gibbosus* Zone.

After recommendations of the International Working Group, the lower–middle Coniacian boundary is defined at the appearance level of inoceramid form *Volviceramus koeneni* (Möll.) representing the index species of lower zone in the middle Coniacian Substage. The last zone completely corresponds in range to the *Peroniceras tridorsatum* Zone of the general ammonite scale (Kauffman *et al.*, 1994, 1996).

The *Volviceramus koeneni* Zone is recognizable above the appearance level of its index species and subspecies *Cremnoceramus schloenbachi schloenbachi* (Böhm) (Kauffman *et al.*, 1994). In the Russian plate, this zone is known only the L'viv centrocline (Naidin and Morozov, 1986).

The *Volviceramus involutus* Zone was widely acknowledged some time ago under the name "*Inoceramus involutus* Zone," because this index species with distinctive morphological features is easily recognizable. This subdivision was regarded formerly as corresponding in stratigraphic range either to the entire Coniacian Stage, or to its upper half, if the stage is divided in two substages (Table 1). With its new, much narrower range approximately corresponding to the *Cremnoceramus wandereri* (Andert) Biozone (Kauffman *et al.*, 1994), the zone crowns the Coniacian Stage and can be traced in many areas of the East European platform. Hardenbol *et al.* (1998) correlated this subdivision with the *Gauthiericeras margae* Zone of the ammonite scale.

Magadiceramus subquadratus Zone. In accord with the same recommendations of the International Working Group (Kauffman *et al.*, 1996), the middle–upper Coniacian boundary is defined at the first occurrence level of inoceramid forms *Magadiceramus subquadratus* (Schlüter) representing index species of the indicated zone. In two well-known stratigraphic schemes (Marcinowski *et al.*, 1996; Hardenbol *et al.*, 1998), the *Magadiceramus subquadratus* Zone is correlated with the upper Coniacian *Paratexanites serratomarginatus* Zone of the ammonite scale. In the Russian plate, the zone under consideration has been established in western Ukraine and in the Bryansk area.

Santonian Stage. The International Working Group on Santonian Stage recommended to accept the first occurrence level of inoceramid form *Cladoceramus undulatoplicatus* (Roem.) for the Coniacian–Santonian boundary. This form is however unknown in the East European platform, where we have instead the abundant inoceramids of *cardissoides* group, such as *Sphenoceramus pachti* (Arkh.) and *S. cardissoides* (Goldf.), which are, in opinion of Arkhangel'skii (1912, 1922), indicators of the Santonian base. As we already mentioned considering general biozonation of the Santonian Stage (Olfer'ev and Alekseev, 2002), the coincidence of basal levels of the *Cladoceramus undulatoplicatus* and *Sphenoceramus cardissoides* zones is doubtful. Recent investigations in northwestern Germany (Kaplan and Kennedy, 2000) and Austria (Lamolda and Hancock, 1996) showed that *cardissoides* forms appear earlier than *Cladoceramus undulatoplicatus* (Roemer). The inversed order of occurrence levels is recorded, however, in southern England (Bailey *et al.*, 1983) and in France, on the opposite side of the English Channel (Amedro and Robaszynski, 2000), and Naidin noted the same situation in western Kazakhstan (*Stratigraficheskie...*, 1996). In the Western Interior basin of North America (Kauffman *et al.*, 1994) and also in the Boreal province (Dhondt, 1992; Lopez *et al.*, 1992), Caucasus and Central Asia (Atabekyan, 1986; Moskvin, 1986), both taxa have concurrent ranges.

Sphenoceramus cardissoides–Texanites texanus–Belemnitella propinqua propinqua Zone. Following Arkhangel'skii (1912), Naidin (*Stratigraficheskie...*, 1996), Hardenbol *et al.* (1998), Tröger and Summesberger (1994), Walaszczyk (1992), and Marcinowski *et al.* (1996), we discriminate a basal Santonian interval that yields *Sphenoceramus cardissoides* (Goldf.). Other characteristic taxa occurring in this interval are *Texanites texanus* (Roemer) known from the Terepsha Formation of the Voronezh anteclise and more widespread *Belemnitella propinqua propinqua* (Mob.) (Naidin and Kopaevich, 1977; Christensen, 1990). Exactly this triad of fossils defines stratigraphic range of the lower Santonian Substage in the East European platform.

Sphenoceramus patootensis–Belemnitella preacursor praepraecursor Zone. Naidin *et al.* (1986) regarded the complex *Sphenoceramus patootensis–Gonioteuthis granulata* Zone as an equivalent of the upper Santonian. We accept the first taxon for the index species of the substage, although the concurrent interval in inoceramid zonations (Tröger, 1989; Walaszczyk, 1992) is termed as the *Sphenoceramus patootensiformis* Zone or the unit 29 in nomenclature of Tröger. The fact is that the last form has stratigraphic range spanning the coupled upper Santonian and lower Campanian interval and is therefore inappropriate index species for the upper Santonian proper.

As for the second index species included by Naidin and his colleagues in the complex zone name, it seems to be inappropriate as well. Belemnites of the genus *Gonioteuthis* are characteristic of southern areas of the Central European subprovince distinguished by Christensen (1990), being extremely rare in northern areas of the Russian plate, where they have been found in single sections located on the southern slope of the Voronezh anteclise. Findings of subspecies *Gonioteuthis granulata granulata* (Blainv.) are unknown so far from the study region of the Central Russian subprovince, where the Santonian–Campanian sequences yield instead the abundant representatives of the genus Belemnitella. According to Naidin (1964), subspecies *Belemnitella praecursor praepraecursor* Najd. is most characteristic of the upper Santonian, and we used it to designate the second index taxon of the corresponding zone.

Campanian Stage. Belemnitella praecursor mucronatiformis Zone. Naidin *et al.* (1986) who distinguished the *Actinocamax laevigatus–Belemnitella praecursor mucronatiformis* Zone of the East European paleobiogeographic province as the lower one in the Campanian Stage regarded it as a stratigraphic equivalent of the *Gonioteuthis granulataquadrata–Placenticeras bidorsatum* Zone in Germany (Naidin, 1979). In the name of this belemnite zone, we left only the last taxon, because *Actinocamax laevigatus* Arkh. is widespread, as established now, not only in the so-called "*Pteria* Beds" of a disputable Campanian age, but also in the underlying upper Santonian deposits of the Voronezh anteclise, their basal strata included. We do not exclude as well that the zone under discussion includes the topmost portion of the upper Santonian (*marsupites* Beds).

Belemnitella mucronata alpha Zone. Naidin *et al.* (1986) attributed to this zone the beds with *Gonioteuthis quadrata quadrata* Blainv. and *Belemnitella mucronata alpha* Schatsky. In the zone name, we retain only the second taxon, because the first one is extremely rare and has been established in the *Pteria* Beds of the Boguchar and Belaya Gorka localities (Naidin *et al.*, 1980, p. 34), where they belong to underlying zones of the lower Campanian and upper Santonian that is incompatible with the currently authorized stratigraphic range of *Gonioteuthis quadrata quadrata* Blainv.

Belemnellocamax mammillatus Zone. Because of the same reasons, we excluded subspecies *Gonioteuthis quadrata gracilis* (Stoll.) from the former name of the terminal lower Campanian zone and left only the index species *Belemnellocamax mammillatus* (Nilss.) whose subspecies *B. mammillatus mammillatus* (Nilss.) and especially *B. mammillatus volgensis* Najd. are widespread in eastern areas of the Russian plate. Subspecies *Gonioteuthis quadrata gracilis* (Stoll.) typical of the uppermost lower Campanian in northwestern Europe (Christensen, 1990) is known in the study region from the *Pteria* beds of the Boguchar and Belaya Gorka sections (Naidin *et al.*, 1980), i.e., from the lower level of the *Belemnitella praecursor mucronatiformis* Zone.

Hoplitoplacenticeras coesfeldiense–Belemnitella mucronata mucronata Zone. For the lower zone of the upper Campanian, we accepted the name *Hoplitoplacenticeras coesfeldiense–Belemnitella mucronata mucronata* Zone suggested by Naidin *et al.* (1986), although these ammonite taxa were formerly detected only southward of the study region, in the L'viv centrocline, southern Donetsk basin, and western Kazakhstan (Naidin and Morozov, 1986; *Stratigraficheskie skhemy,* 1996). Recently, V.B. Sel'tser discovered the ammonite assemblage of *Hoplitoplacenticeras coesfeldiense coesfeldiense* (Schlöt.), *H. coesfeldiense costulosum* (Schlöt.), *H.* cf. *vari* (Schlöt.), and *Trachyscaphites gibbus* (Schlöt.) in the Mezino-Lapshinovka section located to the northwest of Saratov. Belemnite rostra of *Belemnitella mucronata mucronata* (Schlöt.) are known from the basal upper Campanian almost everywhere in the Russian plate. The indicated zone corresponds to the lower zone of the general upper Campanian ammonite zonation.

The *Belemnitella langei* Zone originally distinguished by Naidin *et al.* (1986) represents the overlying zone of the upper Campanian Substage. Its deposits are widespread in the Voronezh anteclise and Volga River basin. The unit base is defined at the first occurrence level of its index species. According to changes in phylogenetic lineage of the late Campanian *Belemnitella langei* Schatsky, Naidin distinguished the succession (from the base upward) of *Belemnitella langei minor, Belemnitella langei langei,* and *Belemnitella langei najdini* subzones. It was also stated that "stratigraphic ranges of subzones represent epiboles of corresponding subspecies" (Naidin and Kopaevich, 1977, p. 98).

Characteristic late Campanian ammonite taxa included in the nomenclature of above subzones enable correlation between these and concurrent West European biostratigraphic subdivisions. In general, the upper Campanian *Belemnitella langei* Zone of the Russian plate is subdivided (from the base upward) into the *Belemnitella langei minor–Bostrychoceras polyplocum*, *Belemnitella langei langei–Didymoceras donezianum*, and *Belemnitella langei najdini–Micraster grimmensis* subzones. The last index species represents the echinoderm assemblage of the Vol'sk section.

The *Belemnitella langei najdini–Micraster grimmensis* Subzone yields foraminifers of the *Brotzenella taylorensis* Zone (*Prakticheskoe...*, 1991) that is correlative with the *Osangularia navarroana* Zone of northwestern Germany. Consequently, the aforementioned regional subdivision of macrofauna corresponds to the lower part of the upper Campanian *Micraster grimmensis* Zone in that country (Schönfeld and Burnett, 1991; Christensen, 1993; Beniamovskii and Kopaevich, 1998).

The *Belemnella licharewi–Micraster grimmensis* Zone is terminal one in the upper Campanian Substage. Jeletzky (1948) originally attributed the *Belemnella licharewi* Zone to the basal lower Maastrichtian, but he denied his initial opinion later on (Jeletzky, 1958). Nevertheless, the Maastrichtian age of *licharewi* Beds was argued for since the 1950s in a series of works (Naidin, 1960, 1996; Naidin *et al.*, 1984a,1984b, 1986; Kopaevich *et al.*, 1987). According to additional data, the *Belemnella licharewi* Zone bears foraminifers of the *Angulogavelinella gracilis* Zone (Kopaevich *et al.*, 1987) that is an analogue of the West European *Bolivinoides peterssoni* Zone (Beniamovskii and Kopaevich, 1998). Consequently, the *Belemnella licharewi* Zone should be correlated with the upper part of the *Micraster grimmensis* Zone of Germany (Schönfeld and Burnett, 1991). With due account for all these data, we discriminated the described zone under the double name in our scheme.

Maastrichtian Stage. Acanthoscaphites tridens Zone. The regional scale of the Upper Cretaceous of the East European platform includes two zones attributed to the Maastrichtian Stage, which correspond, according to Naidin (1978), to the *Hoploscaphites constrictus* (J. Sow.) Biozone. The lower *Acanthoscaphites tridens* Zone is divided into the lower *Belemnella lanceolate* and upper *Belemnella sumensis* subzones. The base of the former coincides with the base of synonymous belemnite zone of northwestern Europe and Balto-Scandia (Christensen, 1990). Simultaneously, it approximately corresponds to the lower boundary of the ammonoid *Pseudokossmaticeras tersense* Zone and lies inside the subzone CC23a of the nannoplankton scale (Hancock *et al.*, 1993).

The *Belemnella sumensis* Subzone is an equivalent of the West European *Belemnella occidentalis* Zone (Kopaevich *et al.*, 1987). Its base is situated in the upper portion of the nannoplankton subzone CC23b (Schönfeld and Burnett, 1991; Jagt and Felder, 1999), thus being approximately at the level of lower boundary of the *Pachydiscus epiplectus* Zone of the general ammonite scale (Hancock *et al.*, 1993).

The *Belemnitella junior–Neobelemnella kazimiroviensis* Zone terminates the Maastrichtian Stage of the Russian plate and corresponds to synonymous zone in the stage stratotype (Jagt, 1999). It is not easy to divide this zone in two parts, as it is evident from a thorough stratigraphic analysis by Kopaevich *et al.* (1987). The zone base approximately corresponds to the lower boundary of the nannoplankton zone NC22 or subzone CC25b (McLaughlin *et al.*, 1995) and to the base of *Anapachydiscus fresvillensis* Zone in the ammonite scale, which is believed to be the boundary between the lower and upper Maastrichtian.

ZONATION OF BENTHIC FORAMINIFERS

Benthic foraminifers are widely used in practice of subdivision of Upper Cretaceous deposits in the East European platform. Scientists who contributed much to development of the regional foraminiferal scale are V.S. Akimets, V.T. Balakhmatova, V.I. Baryshnikova, V.P. Vasilenko, A.M. Voloshina, A.A. Grigyalis, L.G. Dain, E.L. Lipnik, and E.V. Myatlyuk. The first zonal scheme for Upper Cretaceous benthic foraminifers from the Russian plate has been suggested by Grigyalis *et al.*, (1974, 1980). In fact, it was a modification of scheme elaborated by Vasilenko (1961) for the Mangyshlak. In recent years, the scheme was considerably refined by Kopaevich and Beniamovskii. The regional zonation of benthic foraminifers presented in this work was approved at the workshops in Kiev (1988) and Kamenets-Podol'skii (1989). With minor corrections, it was included afterward in "Practical Guide to Microfauna of the USSR, vol. 5: Mesozoic Foraminifers" published in 1991. In 2000, Bureau of the Regional Interdepartmental Stratigraphic Commission on Central and Southern Russian Platform organized a special Working Group that somewhat amended the scheme. We took account of these corrections in our scheme though with some modifications, bearing in mind new data on distribution ranges of index species, which have been obtained in the last two years of comprehensive study on the Upper Cretaceous biostratigraphy in the Russian plate.

Cenomanian Stage. The lower *Gavelinella cenomanica* Zone of the stage that has been originally distinguished by Vasilenko (1961) corresponds to the *Schloenbachia varians–Turrilites costatus* Zone of macrofauna. In addition to index species, its foraminiferal assemblage includes *Hagenowella chapmani* (Cushm.), *Tritaxia cenomana* Gorb., *Arenobulimina conoidea* (Pern.), *Eggerellina cenomana* Akim., *Marssonella gomelina* Akim., *Marginulina jonesi* (Reuss), *Gavelinella baltica* Brotz., *G. mirtchinki* (Akim.), *G. minutissima* (Akim.), *Lingulogavelinella formosa* (Brotz.), *L. orbiculata* (Kusn.), *L. ornatissima* (Lipn.), *Cibicidoides gorbenkoi* (Akim.), and *Guembelitria* *cenomana* (Kell.). The appearance level of these benthic foraminifers defines the base of subdivision.

The *Lingulogavelinella globosa* Zone of the upper Cenomanian has been distinguished by Akimets (1970). Its lower boundary corresponds to the appearance level of index species *Lingulogavelinella globosa* (Brotz.) in association with *Spiroplectammina cuneata* Vass., *Gaudryina arenosa* Akim., *G. angustata angustata* Akim., *G. folium* Akim., *Gyroidinoides conica* (Vass.), *G. nitidus* (Reuss), *Gavelinella vesca* (N. Byk.), *G. loevi* (Akim.), *Brotzenella belorussica* (Akim.), *B. berthelini* (Kell.), *Cibicides polyrraphes polyrraphes* (Reuss), *C. minusculus* Akim., and *Bolivina spectabilis* (Akim.). Concurrent planktonic foraminifers are represented by *Hedbergella caspia* (Vass.), *H. delrioensis* (Carsey), *Whiteinella archeocretacea* (Pess.), *W. brittonensis* (Loebl. et Tapp.), and *W. paradubia* (Sigal.). This zone spans the middle and upper Cenomanian substages, except for the *Turrlites costatus* Subzone of the general scale.

Turonian Stage. The *Gavelinella nana* Zone was distinguished by Akimets *et al.*, (1991) at the appearance level of benthic foraminifers *Arenobulimina presli* (Reuss), *Globorotalites hangensis* Vass., *G. turonicus* Kaev., *Eponides turonicus* Lipn., *Gavelinella nana* (Akim.), *G. ammonoides* (Reuss), *G. kelleri dorsoconvexa* Akim., and *Reussella turonica* Akim. It is correlated with three lower Turonian zones of molluscan fauna (*Praeactinocamax plenus triangulus, Mytiloides labiatus–Mytiloides kossmati*, and *Mytiloides hercynicus–Mytiloides subhercynicus*). Northward of Moscow, the aforementioned assemblage is known from the Chernevo Formation that yields ammonite species *Collignoniceras woollgari* (Mant.) identified by Atabekyan and nannoplankton characteristic of the zone CC11 (Ovechkina *et al.*, 2002). In the southeast of the East European platform (Bragina *et al.*, 1999), larger forms of *Hedbergella* group, such as *Hedbergella holzli* (Hagn et Zeil.), *Whiteinella paradubia* (Sigal), and *W. bornholmensis* (Dougl.) prevail among foraminifers of the zone.

The *Gavelinella moniliformis* Zone has been originally established by Akimets (1974) as corresponding to that part of the upper Turonian of the Russian plate, which begins with the molluscan *Inoceramus apicalis* Zone. The index species first appearing in the unit is associated with *Spiroplectammina praelonga* (Reuss), *Verneuilina muensteri* Reuss, *Gaudryina laevigata* Franke, *G. variabilis* Mjatl., *Arenobulimina minima* Vass., *Globorotalites multiseptus* Brotz., *Stensioeina praeexsculpta* Kell., *S. laevigata* Akim., *Eponides concinnus* Brotz., *Osangularia whitei praeceps* (Brotz.), *Gavelinella ammonoides* (Reuss), *Reussella carinata* Vass., and *R. kelleri* Vass. *Gavelinella praeinfrasantonica* (Mjatl.) and *Ataxophragmium nautiloids* Brotz. appear in terminal strata of the zone. The listed benthic taxa may occur in association with keeled planktonic foraminifers *Marginotruncana lapparenti* (Brotz.), *M. marginata* (Reuss), *M. pseudolinneiana* Pess., and *M. renzi* (Gand.). The indicated stratigraphic interval yields nannoplankton of the zone CC12.

Coniacian Stage. The *Gavelinella kelleri* Zone in original nomenclature of Grigyalis *et al.*, (1974) corresponds to epiboles of species *Ataxophragmium nautiloids* Brotz., *Gavelinella kelleri* Mjatl., and *G. praeinfrasantonica* Mjatl. Characteristic of this zone are first appearing *Gaudryina coniacica* Akim., *Ataxophragmium compactum* Brotz., *Valvulineria praebiconvexa* Lipn., *Stensioeina emscherica* Baryshn. [the known in Russia is subspecies *S. granulata granulata* (Orb.)], *Eponides biconvexus* Marie, *Gavelinella giedroyci* Grig., and *Cibicidoides praeeriksdalensis* (Vass.). Other taxa typical of the zone are *Heterostomella carinata* (Franke), *Marssonella oxycone* Reuss, *Globorotalites multiseptus* Brotz., *Osangularia whitei whitei* (Brotz.), and *Gavelinella moniliformis* (Reuss). Rather abundant *Hedbergella agalarovae* (Vass.), *Whiteinella brittonensis* (Loeb. et Tapp.), *Marginotruncana marginata* (Reuss), *M. renzi* (Gand.), *M. coronata* (Bolli), and *Heterohelix moremani* (Cushm.) represent planktonic foraminifers of the unit. The assemblage under consideration also includes *Spiroplectammina praelonga* (Reuss), *Stensioeina praeexsculpta praeexsculpta Kell., Gavelinella ammonoides (Reuss), and Cibicides polyrraphes polyrraphes* (Reuss), which disappear in the overlying zone. The *Gavelinella kelleri* Zone is correlative with three lower inoceramid zones of the Coniacian Stage and correspond to the lower substage of the latter. The concurrent nannoplankton characteristic of zone CC13 suggests the same stratigraphic level.

The *Gavelinella thalmanni* Zone has been adopted at the workshop aimed to elaborate the Upper Cretaceous foraminiferal scale for the East European platform and held in Kamenets-Podol'skii (1989). The zone is named after the index species *Gavelinella thalmanni* (Brotz.) in distinction from the former *Gavelinella costulata* Zone accepted in the Practical Guide to Microfauna of the USSR (*Prakticheskoe…*, 1991). The last name appears to be inappropriate because of two reasons. First, species *Gavelinella costulata* described by Myatlyuk considerably differs from *Gavelinella costulata* (Marie) described much earlier (Marie, 1941) as a form appearing in the Campanian Stage. As a result, one can meet in publications two synonymous taxa—*Gavelinella costulata* (Mjatl. non Marie) and *G. costulata* (Marie non Mjatl.), stratigraphic ranges of which are different. Second, *Gavelinella costulata* (Mjatl. non Marie) appears, in distinction from *Gavelinella thalmanni* (Brotz.), already in the lower *Gavelinella kelleri* Zone. Characteristic benthic foraminifers appearing in the *Gavelinella thalmanni* Zone in association with its index species are *Spiroplectammina embaensis* Mjatl., *Gavelinella infrasantonica* (Balakhm.) [*G. vombensis* (Brotz.) in nomenclature of West European paleontologists], *Cibicidoides eriksdalensis* (Brotz.), and *Bolivinitella eleyi*

(Cushm.). *Gaudryina laevigata* Franke, *Ataxophragmium compactum* Brotz., *Stensioeina emscherica* Baryschn., "*Gavelinella costulata* (Mjatl.)," *Cibicidoides praeeriksdalensis* (Vass.), and *Reussella kelleri* Vass. continue their existence at this level, while evolution of *Gavelinella kelleri* (Mjatl.) and *Gavelinella moniliformis* (Reuss) is terminated here. The zone under consideration corresponds to three upper inoceramid zones of the Coniacian Stage, i.e., to the middle and upper substages of the latter. Coexisting nannoplankton of zone CC14 is another evidence in favor of this conclusion.

Santonian Stage. The *Gavelinella infrasantonica* Zone Vasilenko (1961) who originally distinguished this zone used a lame index species to term the unit despite the mass abundance of *Gavelinella infrasantonica* (Balakhm.) in the corresponding interval, because this form is known in the East European platform and northwestern Germany (Schönfeld, 1990) beginning from the middle Coniacian Substage. Other diagnostic taxa of the zone are the appearing here *Spiroplectammina rosula* (Ehr.), *Arenobulimina courta* (Marie), *Martinottiella communis* (Orb.), *Ataxophragmium crassum* (Orb.), *Neoflabellina rugosa* (Orb.), *Valvulineria laevis* Brotz., *V. marie* Vass., *Stensioeina exsculpta exsculpta* (Reuss), *Eponides concinnus planus* Vass., *Osangularia whitei crassa* Vass., *O. w. polycamerata* Vass., *Cibicides ribbingi* Brotz., *Praebulimina ventricosa* (Brotz.), and *Cuneus buliminoides* (Brotz.). The zonal foraminiferal assemblage also includes *Gaudryina laevigata* Franke, *Globorotalites multiseptus* Brotz., *Osangularia whitei whitei* (Brotz.), *Cibicides excavatus* Brotz., *Cibicidoides eriksdalensis* (Brotz.), and *Bolivinitella eleyi* (Cushm.), all known from underlying strata as well. Taxa terminating their evolution in the zone are *Spiroplectammina embaensis* Mjatl., *Arenobulimina orbignyi* (Reuss), *Gavelinella costulata* (Mjatl. non Marie), *G. giedroyci* Grig., and *G. thalmanni* (Brotz.). The *Gavelinella infrasantonica* Zone is identical in range to the *Texanites texanus–Sphenoceramus cardissoides–Belemnitella propinqua propinqua* Zone of molluscan fauna.

The *Gavelinella stelligera* Zone is included in our scale in the range suggested by Akimets *et al.*, (1979). This upper zone of the Santonian Stage reveals predominance of first appearing species *Gaudryina rugosa* Orb., *Arenobulimina senonica* Mjatl., *Ataxophragmium orbignynaeformis* Mjatl., *Orbignyina variabilis* (Orb.), *Stensioeina granulata incondite* Koch, *S. granulata perfecta* Koch, *S. mursataiensis* Vass., *Gavelinella stelligera* (Marie), *G. santonica* Akim., and *Sitella carseyae* (Plumm.). This assemblage is well correlative with those characterizing the terminal middle (beginning from the *Stensioeina granulata incondite* Zone after Schönfeld, 1990) and upper Santonian of northwestern Germany (Table 4).

Foraminifers from the upper part of *Gavelinella stelligera* Zone represent an assemblage transitional in composition to the Campanian one. All characteristic taxa listed above coexist at this level with newcomers *Heterostomella praefoveolata* Mjatl., *Arenobulimina vialovi* Wolosch., *A. obliqua* (Orb.), *Egerrellina brevis* (Orb.), *E. ovoidea* Marie, *Orbignyina convexocamerata* Wolosch., *O. inflata* (Reuss), *O. irreperta* Wolosch., *Voloschinovella aequisgranensis* (Beis.), *Valvulineria biconvexa* Lipn., *Stensioeina pommerana* Brotz., *Eponides* aff. *grodnoensis* Akim., *Osangularia cordieriana* (Orb.), *Gavelinella bistellata* (Gorb.), *G. dainae* (Mjatl.), *G. costulata* (Marie), *Brotzenella insignis* (Lipn.), *Pullenia dampelae* Dain, *Cuneus triangulus* (Cushm. et Park.), *Bolivina funalis* Wolosch., and *Bolivinoides strigillatus* (Chapm.). Concurrent planktonic forms are *Rugoglobigerina ordinata* (Subb.) and *R. kelleri* (Subb.). Owing to abundance of *Stensioeina pommerana* (Brotz.) and absence of *Gavelinella clementiana clementiana* (Orb.), we defined the interval of indicated assemblage as the *Stensioeina pommerana* Beds, which are correlative with the synonymous subzone of the European paleobiogeographic province (Beniamovskii and Kopaevich, 1998) or with the *Stensioeina pommerana–Eponides frankei* Zone of northwestern Germany (Schönfeld, 1990). The last subdivision corresponds to the upper *marsupites* Beds of the terminal Santonian in Germany. In areas framing the Donetsk basin on the north, the distribution interval of the assemblage under consideration was defined as the *Gavelinella dainae–Orbignyina inflata* Beds of the lower Campanian (Naidin *et al.*, 1980), which were erroneously placed above the *Gavelinella clementiana clementiana* Beds. Correlation between various zonal schemes of the Santonian Stage in the European paleobiogeographic province is illustrated in Table 4. The *Gavelinella stelligera* Zone of benthic foraminifers corresponds to the *Sphenoceramus patootensis–Belemnitella praecursor praepraecursor* Zone of molluscan fauna.

Campanian Stage. The *Gavelinella clementiana clemetiana* Zone distinguished by Akimets (1980) can be established by appearance of its index species and is traceable throughout the territory of the European paleobiogeographic province, although its deposits are preserved after erosion in a limited number of localities. It corresponds to the molluscan *Belemnitella praecursor mucronatiformis* Zone of the East European platform, and its assemblage is also known from the lower Campanian *Placenticeras bidorsatum* Zone of Germany.

The *Cibicidoides temirensis* Zone was established for the first time by Vasilenko (1961). This upper zone of the lower Campanian is divided in two subzones. The lower *Cibicidoides temirensis* Subzone corresponds to the interval, where its index species show mass abundance. Index species of the upper *Cibicidoides aktulagayensis* Zone coexist with concurrently appearing *Neoflabellina rugosa leptodisca* (Wedek.), *Gavelinella clementiana laevigata* Marie, *Cibicidoides beaumontianus* (Orb.), *Bolivinoides decoratus* (Jones), and *B. laevigatus* Marie. These subzones are equiva-

Table 4. Correlated Santonian zonations of benthic foraminifers in the European paleobiogeographic province (EPP)

Zonation of benthic foraminifers suggested in this work

Stage	Substage	Zone	
Campanian	lower (partially)	*Cibicidoides temirensis*	
		Gavelinella clementiana clementiana	
Santonian	upper	*Gavelinella stelligera*	*Stensioeina pommerana* Beds
	lower	*Gavelinella infrasantonica*	
Coniacian	middle–upper	*Gavelinella thalmanni*	
	lower	*Gavelinella kelleri*	

Western Kazakhstan (Akimets *et al.*, 1991)

Stage	Substage	Zone	
Campanian	lower (partially)	*Cibicidoides temirensis*	
		Bolivinoides decoratus decoratus	
		Gavelinella clementiana clementiana	
Santonian	upper	Gavelinella stelligera	Bolivinoides strigillatus
			Osangularia
	lower	*Stensioeina granulata perfecta*	
		Stensioeina exsculpta exsculpta	
Coniacian	upper	*Stensioeina granulata granulata*	

Zonation of benthic foraminifers in the EPP (Beniamovskii and Kopaevich, 1998)

Stage	Substage	Zone	
Campanian	lower (partially)	*Bolivinoides decoratus decoratus*	*Cibicidoides temirensis/Gavelinella clementiana usakensis*
			Bolivinoides decoratus
		Gavelinella clementiana clementiana	
Santonian	upper	*Bolivinoides strigillatus*	*Stensioeina pommerana*
			Gavelinella stelligera
		Stensioeina granulata perfecta	

Northwestern Germany

Stage	Substage	(Schönfeld, 1990)	(Koch, 1977)
Campanian	lower (partially)	*Bolivinoides granulatus*	*Bolivinoides decoratus decoratus*
		Neoflabellina wedekindi	
		Gavelinella clementiana	
		Eponides concinna	
Santonian	upper	*Stensioeina pommerana/Eponides frankei*	*Bolivinoides strigillatus*
		Bolivinoides strigillatus	
		Stensioeina granulata perfecta	*Stensioeina granulata perfecta*
	middle	*Stensioeina granulata incondita*	*Stensioeina granulata polonica*
		Gaudryina jonesiana	
	lower	*Cicicidoides eriksdalensis/Gavelinella vombensis (=infrasantonica)*	
Coniacian	middle–upper		*Stensioeina exsculpta exsculpta*
	lower	*Praebulimina evolutum*	*Stensioeina granulata granulata*

Southern England (Baily *et al.*, 1983)

Bolivinoides culverensis	*Pullenia quaternaria*
	Eouvigerina galeata
	Gavelinella usakensis
	Gavelinella cristata
Bolivinoides strigillatus	*Gavelinella cristata/Globigerinelloides rowei*
Stensioeina granulata perfecta	
Stensioeina granulata polonica	*Cibicides ex gr. beaumontianus*
	Loxostomum eleyi
Stensioeina exsculpta exsculpta	

lents of two upper subzones of the *Bolivinoides decoratus decoratus* Zone that has been originally established in western Germany (Koch, 1977) and is recognizable in the European paleobiogeographic province (Beniamovskii and Kopaevich, 1998). It is impossible to trace in the Russian plate the lower *Bolivinoides decoratus decoratus* Subzone s. str. (*Prakticheskoe...*, 1991) or *Bolivinoides decoratus decoratus–Bolivinoides granulatus* Subzone (Beniamovskii and Kopaevich, 1998) originally recognized in western Kazakhstan (Naidin *et al.*, 1984; *Prakticheskoe...*, 1991; *Stratigraficheskie...*, 1996). This situation can be explained either by a cryptic hiatus, or by ecological factors, which controlled provincialism of faunal assemblages. The *Cibicidoides temirensis* Subzone corresponds to the *Belemnitella mucronata alpha* Zone of cephalopods, whereas the *Cibicidoides aktulagayensis* Subzone is correlative with the *Belemnellocamax mammillatus* Zone.

Brotzenella monterelensis Zone. The upper Campanian Substage is divided into three zones of benthic foraminifers. The lower *Brotzenella monterelensis* was initially established by Dolitskaya (1961) in the interval, where its index species appears in association with *Arenobulimina puschi* (Reuss), *Orbignyina simplex* (Reuss), *Eponides grodnoensis* Akim., *Brotzenella menneri* (Kell.), *Cibicidoides voltzianus* (Orb.), *Sitella laevis* (Beiss.), *Eouvigerina campanica* Dain, and *Pseudouvigerina cretacea* Cushm. Taxa terminating their evolution in that interval are *Spiroplectammina lingua* Akim., *Brotzenella insignis* Lipn., and *Praebulimina ventricosa* (Brotz.). In its stratigraphic range, the *Brotzenella monterelensis* Zone corresponds to the *Hoplitoplacenticeras coesfeldiense–Belemnitella mucronata mucronata* of cephalopods and to the lower ammonite zone of the upper Campanian in the general scale.

The *Globorotalites emdyensis* Zone was recognized by Akimets (1974) and named after the index species described by Vasilenko in 1961 that is indistinguishable from simultaneously described *Globorotalites hiltermanni* Kaever, 1961. The zone is divided (Fig. 2) into the *Globorotalites emdyensis* s. str., *Bolivinoides draco miliaris*, and *Brotzenella taylorensis* subzones, which correspond to zones BF5, BF6, and BF7 in the scheme of Beniamovskii and Kopaevich, (1998). The lower zonal boundary is defined at the first occurrence level of the index species in association with *Heterostomella foveolata* (Marss.) and *Orbignyina pinguis* Wolosch. The base of *Bolivinoides draco miliaris* Subzone corresponds to the appearance level of this subspecies and associated taxa *Eponides frankei* Brotz., *Bolivina incrassata incrassata* (Reuss), and *B. kalinini* Vass. Indicative forms of the upper subzone are *Neoflabellina praereticulata* Hilt., *Osangularia navarroana* (Cushm.), *Stensioeina gracilis stellaria* Vass., *Brotzenella taylorensis* (Carsey), *Bolivinoides decoratus giganteus* Hilt. et Koch, and *Silicosigmoilina volganica* (Kuzn.).

The *Globorotalites emdyensis* Subzone corresponds to the *Belemnitella langei minor–Bostrychoceras polyplocum* Subzone of cephalopods. Equivalents of *Bolivinoides draco miliaris* and *Brotzenella taylorensis* subzones are the *Belemnitella langei langei–Didymoceras donezianum* Subzone and lower strata of the *Belemnitella langei najdini–Micraster grimmensis* Subzone, respectively.

The *Angulogavelinella gracilis* Zone initially recognized by Beniamovskii *et al.*, (1973) is terminal one in the Campanian Stage of the East European platform, though earlier (Naidin *et al.*, 1984a, 1984b; Beniamovskii *et al.*, 1988) its range was believed to be wider, spanning in addition the *Neoflabellina reticulata* Zone distinguished afterward (Beniamovskii and Kopaevich, 1998) and attributed to the lower Maastrichtian. In our zonation, the *Angulogavelinella gracilis* Zone is accepted as subdivision signifying appearance of its index species in association with *Spiroplectammina suturalis* Kalin., *Cuneus minutus* (Marss.), *Bolivinoides delicatulus* Cushm., and *B. peterssoni* Brotz. Its assemblage also includes *Silicosigmoilina volganica* (Kuzn.) and *S. epigona* (Rzeh.)

The *Angulogavelinella gracilis* Zone is confidently correlated (Beniamovskii and Kopaevich, 1998) with the *Bolivinoides peterssoni–Globorotalites hiltermanni* Zone of northwestern Germany (Schönfeld, 1990), where the latter is attributed to the terminal part of the *Micraster grimmensis–Cardiaster granulosus* Zone that is the uppermost one in the Campanian Stage of western Europe. In the Russian plate, the *Angulogavelinella gracilis* Zone corresponds to the upper portion of the *Belemnitella langei najdini–Micraster grimmensis* Subzone and to the *Belemnella licharewi–Micraster grimmensis* Zone (*Prakticheskoe...*, 1991).

Maastrichtian Stage. The *Neoflabellina reticulata* Zone established by Koch (1977) is the lowermost one in the Maastrichtian Stage. It is defined by appearance of index species in association with *Heterostomella bullata* Akim., *Cibicidoides bembix* (Marss.), *Bolivina decurrens* (Ehr.), and *Pseudouvigerina cristata* (Marss.). Other characteristic forms of zonal assemblage are *Spiroplectammina suturalis* Kal., *Orbignyina pinguis* Wolosch., *O. sacheri* (Reuss), *O. inflata* (Reuss), *Stensioeina pommerana* Brotz., *Eponides frankei* Brotz., *Osangularia navarroana* (Cushm.), *Brotzenella menneri* (Kell.), *Cibicidoides beaumontianus* (Orb.), *C. aktulagayensis* (Vass.), *C. voltzianus* (Orb.), *Cuneus minutus* (Marss.), *Sitella laevis* (Vass.), *Bolivina incrassata incrassata* Reuss, *Bolivina kalinini* (Vass.), and *Bolivinoides delicatulus* Cushm. Taxa terminating their evolution at this level are *Globorotalites emdyensis* Vass., *Gavelinella clementiana laevigata* (Marie), and *Gemellides orcinus* (Vass.). The described zone corresponds to the lower part of the *Belemnella lanceolata* Subzone and is correlative with the subzone CC23a of calcareous nannoplankton.

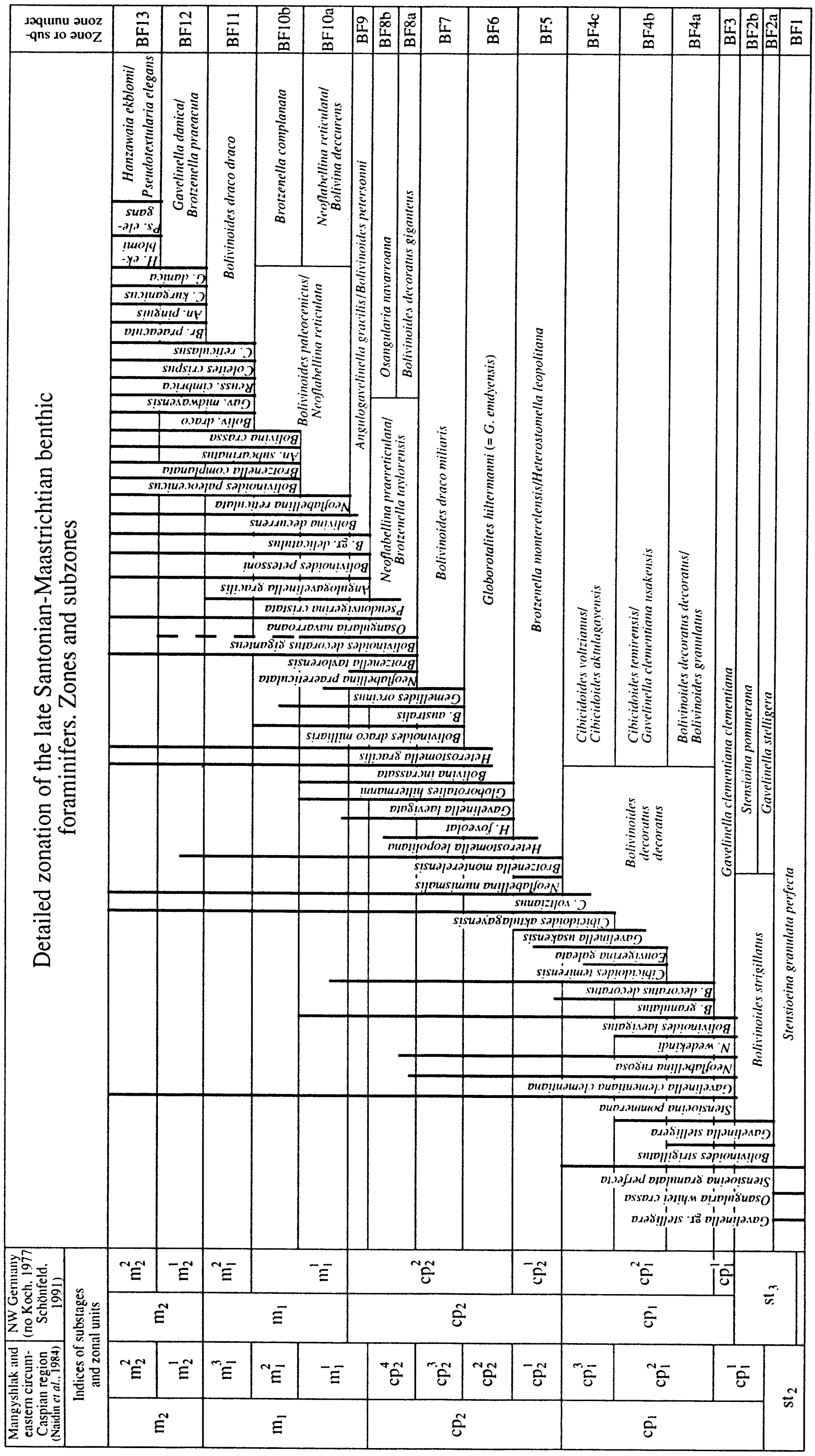

Fig. 2. Detailed zonation of the late Santonian–Maastrichtian benthic foraminifers (after Beniamovskii and Kopaevich, 1988, with modifications).

Table 5. Foraminiferal biozonations in the Mangyshlak–eastern circum-Caspian region (after Beniamovskii and Kopaevich, 1998, with modifications) and northwestern Germany correlated with the scheme suggested for the Russian platform

Mangyshlak and eastern circum-Caspian region		Northwestern Germany		Zonation of benthic foraminifers in the European paleobiogeographic province (Beniamovskii and Kopaevich, 1998)			Regional zones of benthic foraminifers: East European paleobiogeographic province (Naidin *et al.*, 1984a, 1984b; Akimets *et al.*, 1991)		West European paleobiogeographic province (Koch, 1977)	West European paleobiogeographic province (Schönfeld, 1990)	Zonation of benthic foraminifers in the Russian platform as suggested in this work: Zones	Subzones and beds
Substages and their subordinate subdivisions												
m_2		m_2	m_2^2	*Hanzawaia ekblomi/Pseudotextularia elegans*		BF13	*Pseudotextularia elegans*	XXVI	*Pseudotextularia elegans*	*Pseudotextularia elegans* – I. Zone	*Brotzenella praeacuta – Hanzawaia ekblomi*	
			m_2^1	*Gavelinella danica/Brotzenella praeacuta*		BF12	*Brotzenella praeacuta*	XXV	*Gavelinella danica*			
m_1	m_1^3	m_1	m_1^2	*Bolivinoides draco draco*		BF11	*Bolivinoides draco draco*	XXIV	*Bolivinoides draco draco*	*paleocenicus/reticulata* P.R. Zone	*Brotzenella complanata*	*Bolivinoides draco draco*
	m_1^2			*Bolivinoides paleocenicus/Neoflabellina reticulata*	*Brotzenella complanata*	BF10b	*Brotzenella complanata*	XXII	*Neoftabellina reticulata*			*Brotzenella complanata*
	m_1^1		m_1^1		*Neoflabellina reticulata/Bolivina decurres*	BF10a	*Angulogavelinella gracilis*	XXII		*decurrens* – I. Zone	*Neoftabellina reticulata*	
		cp_2	cp_2^2	*Angulogavelinella gracilis/ Bolivinoides peterssoni*		BF9			*Bolivinoides draco miliaris*	*peterssoni/hiltermanni* – C.R. Zone	*Angulogavelinella gracilis*	
cp_2	cp_2^4			*Neoflabellina praereticulata/Brotzenella taylorensis*	*Osangularia navarroana*	BF8b	*Brotzenella taylorensis*	XXI		*navarroana/cristata* – P.R. Zone	*Globorotalites emdyensis*	*Brotzenella taylorensis*
	cp_2^3				*Bolivinoides decoratus giganteus*	BF8a				*miliaris/incrassata* – P.R. Zone		*Bolivinoides draco miliaris*
				Bolivinoides draco miliaris		BF7	*Bolivinoides draco miliaris*	XX		*gracilis* – P.R. Zone		*Globorotalites emdyensis*
	cp_2^2			*Globorotalites hiltermanni* (= *G. emdyensis*)		BF6	*Cibicidoides voltzianus*	XIX	*Neoflabellina numismalis*	*leopolitana* – P.R. Zone		
	cp_2^1		cp_2^1	*Brotzenella monterelensis/Heterostomella leopolitana*		BF5	*Brotzenella monterelensis*	XVIII		*laevigatus* – P.R. Zone	*Brotzenella monterelensis*	
cp_1	cp_1^3	cp_1	cp_1^2	*Bolivinoides decoratus decoratus*	*Cibicidoides aktulagyensis/C. voltzianus*	BF4c	*Cibicidoides aktulagayensis*	XVII	*Bolivinoides decoratus decoratus*	*voltzaianus* – P.R. Zone	*Cibicidoides temirensis*	*Cibicidoides aktulagayensis*
	cp_1^2				*Cibicidoides temirensis/Gavelinella clementiana usakensis*	BF4b	*Cibicidoides temirensis*	XVI		*granulatus* – P.R. Zone		*Cibicidoides temirensis*
					Bolivinoides decoratus decoratus/B. granulatus	BF4a	*Bolivinoides decoratus decoratus*	XV		*wedekindi* – P.R. Zone	?	
	cp_1^1		cp_1^1	*Gavelinella clementiana clementiana*		BF3	*Gavelinella clementiana clementiana*	XVI	*Bolivinoides strigillatus*	*clementiana* – P.R. Zone *concinna* – I Zone	*Gavelinella clementiana clementiana*	
		st_3		*Bolivinoides strigillatus*	*Stensioeina pommerana*	BF2b	*Bolivinoides strigillatus*	XIII		*pommerana/frankei* P.R. Zone	*Gavelinella stelligera*	*Stensioeina pommerana*
st_2					*Gavelinella stelligera*	BF2a				*strigillatus* – P.R. Zone		*Gavelinella stelligera*
				Stensioeina granulata perfecta		BF1	*Stensioeina granulata perfecta*	XII	*Stensioeina granulata perfecta*	*perfecta* – P.R. Zone		

The *Brotzenella complanata* Zone was originally recognized by Grigyalis *et al.*, (1974), and its stratigraphic range was somewhat refined afterward (Akimets *et al.*, 1983). It includes the *Brotzenella complanata* s. str. and *Bolivinoides draco draco* subzones. Foraminiferal assemblage of the former is similar in general to that of the underlying zone, but newcomers *Brotzenella complanata* (Reuss) and *Bolivina incrassata crassa* Vass. represent its distinctive taxa. The lower subzone corresponds to the upper part of *Belemnella lanceolate* Subzone or to the subzone CC23b of calcareous nannoplankton. The upper subzone is established above the extinction level of subspecies *Bolivinoides draco miliaris* Hilt. et Koch that is replaced by subspecies *Bolivinoides draco draco* (Marss.) associated with *Gavelinella midwayensis* (Plum.). This subzone corresponds to the *Belemnella sumensis* Subzone and bears nannoplankton of the zone CC24.

The *Brotzenella praeacuta–Hanzawaia ekblomi* Zone it terminal one in the Maastrichtian Stage. In sections of northwestern Germany (Koch, 1977) and western Kazakhstan (Naidin *et al.*, 1984a, 1984b), there were distinguished, though under different names, two subzones of the unit (Table 5): the lower *Gavelinella danica* or *Brotzenella praeacuta* subzones and the upper *Pseudotextularia elegans* or *Hanzawaia ekblomi* subzones (in western or eastern regions, respectively). It is likely that in the eastern Russian plate (Ul'yanovsk and Saratov areas), the *Brotzenella praeacuta* and *Hanzawaia ekblomi* subzones can be recognized as separate subdivisions (Beniamovskii *et al.*, 1988; Dmitrienko *et al.*, 1988; Alekseev *et al.*, 1999), but they cannot be discriminated in the west so far.

The following taxa of benthic foraminifers are characteristic of the *Brotzenella praeacuta–Hanzawaia ekblomi* Zone: *Spiroplectammina suturalis* Kal., *S. kelleri* Dain, *S. kasanzevi* Dain, *Neoflabellina reticulata* (Reuss), *Stensioeina pommerana* Brotz., *S. caucasica* (Subb.), *Osangularia navarroana* (Cushm.), *Gavelinella affinis* (Hant.), *G. danica* (Brotz.), *G. midwayensis* (Plum.), *G. pertusa* (Marss.), *G. welleri* (Plum.), *Brotzenella complanata* (Reuss), *B. praeacuta* (Vass.), *Hanzawaia ekblomi* (Brotz.), *Cibicidoides beaumontianus* (Orb.), *C. bembix* (Marss.), *C. spiropunctatus* (Gall. et Marss.), *Anomalidoides pinguis* (Jenn.), *A. ukrainicus* (Wolosch.), *Karreria fallax* Rzeh., *Cuneus minutus* (Marss.), *Bulimina quadrata* Plum., *B. inflata* Seg., *Bolivina decurrens* Ehr., *B. plaita* Carsey, *Bolivinoides draco draco* (Marss.), *B. decoratus giganteus* Hilt. et Koch, *B. incrassata incrassata* Reuss, and *B. peterssoni* Brotz. It is remarkable that among concurrent planktonic forms there are present *Abathomphalus mayaroensis* (Bolli) and *Globotruncanita stuarti* (Lappar.), both identified by T.E. Ulanovskaya in the Maastrichtian sequence of the Pervomaiskaya–Chir monocline, the Rostov region. The described zone yields fossils characteristic of nannoplankton zones CC25 and CC26 (Alekseev *et al.*, 1999) and corresponds to the *Belemnitella junior–Neobelemnella kazimiroviensis* Zone of cephalopods.

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