

THE QUESTION OF THE JURASSIC – CRETACEOUS BOUNDARY IN MARGINAL ZONE OF THE EAST – EUROPEAN PLATFORM

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The Teisseyre-Tornquist tectonic zone (TTZ) represents a sharp boundary of strongly uplifted basement of craton of the East-European Platform and an area of downwarped basement of the Paleozoic Platform of western and central Europe. TTZ and uplifted Variscan foldbelt situated further to SW separate a paleogeographic depression characterized by marked inherited posthumous lability and responsible for origin of Danish-Polish furrow along the former. This depression was the site of sedimentation of the thickest sequences from the Zechstein till the Cretaceous, inclusively. The whole Kujawy region was situated within the part of the depression with the highest rate of subsidence and affected by both transgressions coming from SE, i.e. Tethyan Ocean, and marine influences from already opened Atlantic.

Wide, lagoonal Purbeck reservoirs brackish in character and similar to those from the German and Paris basins, originated in the Polish Lowlands at the turn of the Jurassic and Cretaceous. The reservoirs became the site of sedimentation of carbonate-detrital-marly and lumachelle rocks, reflecting their freshening, as well as sulfate ones. The strata are underlain by the Middle Volgian with *Virgatites pusillus* (Michalski) (10) and overlain by marine Riasanian with *Riasanites rjasanensis* (Wenetzky) Lahusen (22). Comparisons with Anglo-German basins suggest that the Purbeck facies began to predominate in Kujawy part of the basin (Figure) in times of sedimentation of passage beds between lower and middle parts of the Münders Formation, i. e. at the turn of the Portlandian and Purbeck sensu anglico (Table; see also 1, 6, 30).

The boundary between the *Beriasella* (*Beriasella*) *jacobi* and *Beriasella* (*Pseudosubplanites*) *grandis* zones, recommended as the Jurassic-Cretaceous boundary at the Lyon 1963 (1965) and Lyon-Neuchâtel 1973 (1975) meetings (19), passes within the strata developed in the Purbeck facies (18).

In the Jura Mts, some limnic-lagoonal intercalations with ostracods have been found in lower parts of the Berriasian, characterized by the record of ammonites *Beriasella lorioli* (Zittel), *Beriasella richteri* Oppel and *Beriasella privasensis* Pictet. This made possible general correlation of the Tithonian-Berriasian strata of SE France and time equivalents from the remaining limnic-lagoon basins of Europe.

On the basis of ostracods it is assumed that the stratotype Jurassic-Cretaceous boundary coincides with that from upper part of the Lower Purbeck in England and between middle and upper parts of the Münders Formation in the GDR and FRG (35, 16).

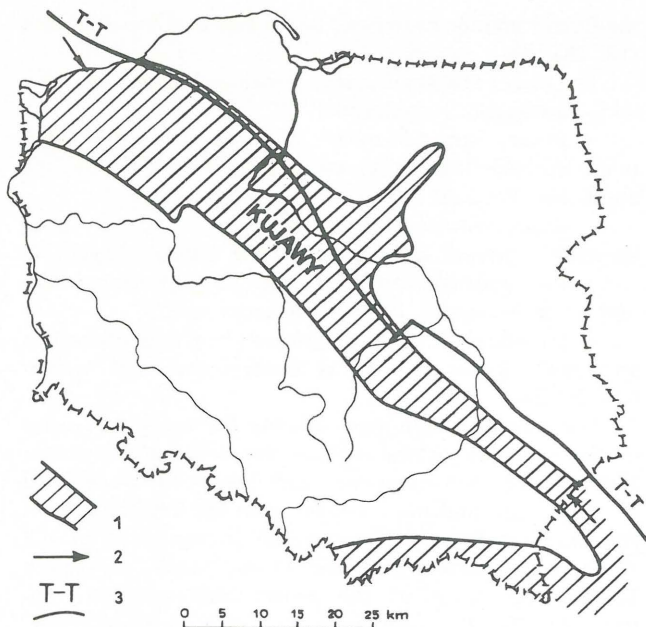
In the Kujawy region, central Poland, 6 ostracod zones have been differentiated in the Purbeck (from „F” to „A” – 2, 24, 1).

Carbonate rocks of the zone „F”, within which the Middle-Upper Volgian boundary has been delineated (10), yield brachiopods as well as euryhaline ostracods *Mantelliana purbeckensis* (Forbes) and first oligohaline ones of the genera *Klieana* and *Rhinocypris*.

Lower part of the zone „E” displays complete extinction of foraminifers. In the Kujawy region (central part of the sedimentary furrow), this zone is characterized by sulfate rocks with intercalations of limestones and marls with ostracods *Fabanella ansata* (Jones), *Mantelliana purbeckensis* (Forbes) and *Klieana alata* Martin. This ostracod assemblage is characteristic of the lowermost Purbeck in southern England and middle part of the Münders Formation.

The zones „F” and „E” correspond to the uppermost part of the Middle Volgian and lowermost Upper Volgian (10), whereas „D”, „C” and „B” – presumably represent equivalents of the Upper Volgian.

The zone „D” reflects continuing predominance of the sulfate-carbonate facies. The recorded ostracods in-



Marine basin in the Riasanian.

1 – original extent of sediments, 2 – directions of transgression, 3 – SW margin of the East-European Platform – the Teisseyre-Tornquist tectonic zone.

Basen morski w riazaniu.

1 – pierwotny zasięg osadów, 2 – kierunki transgresji, 3 – SW krawędź platformy wschodnioeuropejskiej – strefa tektoniczna Teisseyre'a-Tornquista.

clude *Cypridea dunkeri* Jones and *Cypridea* aff. *granulosa* (Sowerby) in Oertli, characteristic of upper part of the Lower Purbeck in England and lower member of upper part of the Munder Formation – Katzberg Member (30, 6).

The overlaying brackish-freshwater zones „C” and „B” are represented by marls and marly shales with intercalations of *Cyrena lumachelles*. The recorded ostracod assemblage comprises the species *Cypridea binodosa* Martin, *C. cf. alta* Wolburg and *C. aff. propunctata* Sylwester-Bradley and *Klieana kujaviana* Bielecka et Szejn, which make possible correlation of the two zones with lower part of the Middle Purbeck in England and German serpulite (2, 1).

The uppermost ostracod zone „A”, confined to central parts of the Kujawy furrow, is brackish-marine in character and developed as marly mudstones and sandy limestones with *Cyrena lumachelles*. Besides *Cypridea posticalis* Jones, here were recorded marine ostracods *Pachycytheridae compacta* (Wolburg) and agglutinate foraminifers *Ammobaculites kcyeniensis* Szejn, *Ammobaculites cf. eocretaceous* Bartenstein et Brand. This zone reflects onset of Riasanian marine transgression in the Polish Lowlands and the strata gradually pass into marine ones with *Riasanites riasanensis* (Wenetzky) Lahusen. The zone is correlable with upper part of the German serpulite and Mid-Purbeck Cinder layer which reflects Early Cretaceous marine ingression in southern England basin (4).

To sum up, the ostracod zones „D”, „C”, „B” and „A” correspond to upper part of Lower and Middle Purbeck in England and the Katzberg and Serpulite members, upper parts of the Munder Formation. The latter are regarded as a member transitional between that formation and the Bückenberg Formation of the Weald (11, 16, 25, 26).

Palynological data (19, 21) generally give support to the above outlined stratigraphic position of strata of the Purbeck facies. This time interval was characterized by marked predominance of plants of the family Cheirolapi-

BIOSTRATYGRAFIA POGRANICZA JURY I KREDY

TETYDA		PROWINCJA				BOREALNA				TETYDA											
SE Francja		NE Anglia		S Anglia	RFN i NRD		Niz Polski (Kujawy)	Platforma wschodnioeuropejska	N Syberia, Urat	S Europa											
Kw ₁	pertransiens	Kw ₁	Paratolia		Kw ₁	Tolypeceras marcosianum	Neocomites + Platylenticeras	Kw ₁	Pseudogarreria undulato-plicatilis	Neotilia klimovskensis	pertransiens	Kw ₁									
B e r l i a s	górný	boissieri	callisto	Peregrinoceras abidum	P u r b e e k	Cinder	Bückeberg (Osterwed) górný	W e i l d	R i a z a ñ	R i a z a ñ	Surites tzikwinianus - spasskensis	Bojarkia mieszezhnikowi	B e r l i a s								
			picteti	Surites (Bojarkia) stenomphalus										Surites (Lynnina) icenii	Euthymiceras	Euthymiceras, Surites	Surites analogus				
			paramimo-unum	Hectoroceras kochi														Riasanites + Malbosciceras	Euthymiceras, Extremiceras, Hectoroceras kochi	Hectoroceras kochi	occitanica
		dólný	dalmasi	Runtonia runctoni										Serpulit	A	Cypridea posticalis, Ammobaculites kcyeniensis	Riasanites riasanensis	Garniericeras subcypereforme	Chetaites sibiricus	Chetaites sibiricus	grandis
			occitanica	Subcraspedites (Volgodiscus) lamplughi																	
	privasensis	Subcraspedites prepicomphalus	D	Cypridea aff. granulosa, C. dunkeri	Graspedites subditus	Kachpurites fulgens	Craspedites okensis	transitorius													
	subalpina	Subcraspedites (Swinertonia) primitivus							E	Fabanello ansata, Manteliana purbeckensis	Epivirgatites nikitini	Epivirgatites variabilis									
	górný	jacobi	Paracraspedites	Paracraspedites opressus	F	Virgatites pusillus	Virgatites virgatus	Tajmyrosphinctes excentricus													
			transitorius	Titanites giganteus					Craspedites okensis												
			Crendonites gorei																		
Tyton		W o t t e n	Paracraspedites	Portland Stone	Formacja Munder górný	Fabanello ansata															

daceae whereas the shares of conifers of the families Taxodiaceae—Taxaceae—Cupressaceae were subordinate, and those of the families Pinnaceae—Podocarpaceae— even somewhat lower. The share of ferns Filicales of the family Gleicheniaceae appears negligible. The data indicate dry and fairly warm climatic conditions.

Marine Riasanian sediments, occurring in sedimentary continuity with those of the zone „A”, are assigned to the beds with *Riasanites* and *Malbosiceras*. They are represented by sandy mudstones, sandstones and sandy limestones with fauna: *Riasanites rjasanensis* (Wenezky) Lahusen, *Riasanites* sp. sp., *Praetolia* cf. *maynci* Spath, *Subcraspedites* (*Pronjaites*) sp., *Malbosiceras* cf. *malbosi* (Pictet), *Retowskiceras* cf. *andrussovi* (Retowski), *Beriasella* (*Picticeras*) cf. *pictetii* (Jacob), *Beriasella* (P.) aff. *picteti* (Jacob) and *Beriasella* (P.) cf. *jauberti* (Mazenot).

In the Polish Lowlands, the overlaying strata of upper marine Riasanian — beds with *Euthymiceras* and *Surites* — are generally represented by claystones and mudstones with *Surites* cf. *spasskensis* (Nikitin), *Surites* cf. *subtzikwinianus* (Bogoslowski), *Surites* sp., *Externiceras* sp., *Subcraspedites* (*Borealites*) sp., *Riasanites* sp. div., *Neocosmoceras* cf. *sayni* (Simionescu), *Neocosmoceras* cf. *flabelliforme* (Hegerat), *Neocosmoceras* cf. *platycostatum* (Sayn), *Euthymiceras* cf. *euthymi* (Pictet) and *Beriasella* (*Fauriella*) sp. (cf. *boissieri* Pictet), *Beriasella* sp. div.

The Riasanian strata also yield bivalves, mainly of the species *Exogyra sinuata* (Sowerby), and foraminifer and ostracod microfauna (33, 34). The foraminifer assemblages mainly comprise representatives of species with calcareous tests: *Lenticulina*, *Eoguttulina*, *Vaginulinopsis*, *Reinholdella*, *Trocholina*, *Citharina* and *Epistomina*, whereas of those with agglutinated tests are less common: *Marssonella*, *Lagenammia*, *Verneulinoides*, *Trochamminoides*, *Haplophragmoides*, *Trochammina* and *Reophax*. Ostracods are here represented by the genera *Protocythere*, *Schuleridea* and *Cytherella*.

Microfloristic studies (19, 20, 21) showed sudden extinction of plants Cheirolepidaceae and vivid development of conifers of the families Taxodiaceae—Taxaceae—Cupressaceae and Pinnaceae—Podocarpaceae at the boundary of strata developed in the Purbeck facies and marine Riasanian. These phenomena were accompanied by marked development of Filicales plants, especially those of the family Gleicheniaceae, whereas the share of horsetails Equisetales and club-moss Lycopodiales was subordinate. The vegetation indicates marked increase in humidity of climate in relation to the Late Volgian (Purbeck).

The marine Riasanian of the Polish Lowlands appears well correlable with the Upper Riasanian of the Russian Platform (22, 32, 28, 29, 31). Recent studies on lower members of the *Riasanites rjasanensis* zone in areas of the Pechora River and Oka River in the Moscow Basin have shown presence of two species of the genus *Garniericeras* and *Hectoroceras kochi* Spath, highly important form the point of view of stratigraphy. Correlation of the Oka River sections and those from the Mangyshlak region indicates that lower members of the Riasanian stage correspond to the *grandis* zone (31). In the marine Riasanian of the Kujawy furrow, equivalents of the lowermost members of the Riasanian stage with the fauna of *Garniericeras subdypeiforme*, *Hectoroceras kochi* Spath and *Riasanites* sp. div. are lacking. In Poland, the members are at least partly replaced by strata of Purbeck brackish-marine ostracod zone „A”.

Correlation of marine Riasanian sections of the Polish Lowlands and those of the southern province shows that

the former mainly correspond to the *Fauriella boissieri* zone (17, 18, 14).

The above analysis made it possible to draw the following stratigraphic conclusions:

— lower ostracod zones „F” and „E”, developed in the Purbeck facies, represent passage beds of the Middle and Upper Volgian;

— upper ostracod zones „D”, „C” and „B” presumably represent equivalents of the Upper Volgian;

— the uppermost ostracod zone „A” represents initial part of transgression of the Riasanian sea;

— the marine Riasanian comprises beds with *Riasanites* and *Malbosiceras* as well as *Euthymiceras* and *Surites* (25, 26, 23, 27).

The recorded ammonites, mainly belonging to species of the southern genera such as *Fauriella*, *Malbosiceras*, *Euthymiceras*, *Neocosmoceras*, *Picticeras*, *Beriasella* and *Retowskiceras*, and those known from the Central Russia, *Riasanites*, indicate that the initial transgression of the Riasanian sea came to Poland from south-east, i. e. western Tethys. Ammonites of the genera *Subcraspedites*, *Externiceras* and *Praetolina* indicate influences from north-west, i. e. from the northern Atlantic via the North Sea (22, 3, 7). A direct connection across East-German area presumably did not exist at that time as Wealdian strata known from north-eastern Mecklenburgia do not display marine influences (12).

In the Boreal-Subboreal province, it is widely accepted that the Jurassic-Cretaceous boundary passes between the Volgian and Riasanian, i. e. between the *Subcraspedites* (*Volgodiscus*) *lamplughii* and *Runctonia runctoni* zones in England, *Chetaites chetae* and *Chetaites sibiricus* zones in Siberia, and *Craspedites nodiger* and *Riasanites rjasanensis* zones in Russian part of the East-European Platform. A large part of Soviet researchers think that the Volgian-Riasanian boundary roughly corresponds to the stratotype boundary of the Tithonian and Beriasian, delineated between the *jacobi* and *grandis* zones (31, 15). According to other researchers, the Volgian-Riasanian boundary corresponds to a boundary within the Beriasian in the Tethyan province, passing at the base of the *boissieri* zone (36, 32), within the *occitanica* zone or at the base of the latter (15).

The above outlined differences in interpretations reflect remarkable difficulties in establishment of the Jurassic-Cretaceous boundary which could be treated as valid for both the Tethyan and Boreal provinces. An unequivocal determination of stratigraphic position of the Riasanian stage in the East-European Platform, where there are recorded ammonites of both southern and northern provinces, may be of decisive importance for solving these questions. In the Polish Lowlands, any accurate definition of stratigraphic position of the Riasanian is impeded by the development of its lower members and the Upper Volgian in the Purbeck facies.

The analysis of results of stratigraphic studies on the Jurassic-Cretaceous passage beds implicates that transgression of the Riasanian sea in the Kujawy furrow began before the onset of sedimentation of strata of the *boissieri* zone, in the *occitanica* zone. Strata of the marine-brackish ostracod zone „A” originated at that time and marine conditions began to predominate finally in the *boissieri* zone.

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STRESZCZENIE

Granica jura—kreda, odpowiadająca w prowincji tetydzkiej granicy tyton—berias ustalonej w spągu poziomu grandis, przypada wewnątrz utworów facji purbekkiej w limniczno-lagunowych basenach Europy Zachodniej.

W bruzdzie kujawskiej Niżu Polskiego w utworach facji purbekkiej wyróżniono 6 poziomów małżoraczkowych.

Węglanowe utwory poziomu „F”, w obrębie których przebiega granica między wołgiem środkowym i górnym, zawierają obok ramienionogów euryhalinowe małżoraczki z rodzajów *Mantelliana purbekensis* (Forbes) i pierwsze oligohalinowe małżoraczki z rodzajów *Klieana* i *Rhinocypris*.

W poziomie „E”, w którego dolnej części wygasają otwornice, występują utwory siarczanowe z wkładkami wapieni i margli z gatunkami *Fabanella ansata* (Jones), *Mantelliana purbekensis* (Forbes) i *Klieana alata* Martin.

Poziomy małżoraczkowe „F” i „E” odpowiadają najwyższej części wołgu środkowego i najniższej wołgu górnego.

Poziomy małżoraczkowe „D”, „C” i „B” mają charakter brakiczno-słodkowodny i są zapewne odpowiednikami wiekowymi wołgu górnego. Najwyższy poziom małżoraczkowy „A” ma już charakter brakiczno-morski. W poziomie tym występują, obok *Cypridea posticalis* Jones, morskie małżoraczki *Pachycytheridea compacta* (Wolburg) oraz zlepieńcowate otwornice *Ammobaculites kcygniensis* Szejn, A. cf. *eocretaceous* Bartenstein et Brand. Poziom małżoraczkowy „A” znamionuje początek transgresji morza riazańskigo.

Riazań morski reprezentują warstwy z *Riasanites* i *Malboliceras* oraz *Surites* i *Euthymiceras*, korelujące się w zasadzie z poziomem boissieri. Można wnioskować, że pierwsze ingresje morza riazańskigo nastąpiły przed poziomem boissieri w poziomie occitanica. Niestety profil riazania Niżu Polskiego, reprezentowanego w dolnej części przez utwory facji purbekkiej, nie pozwala na jednoznaczne określenie jego pozycji stratygraficznej i ścisłą korelację z innymi profilami prowincji borealnej i tetydzkiej.

РЕЗЮМЕ

Граница юра—мел, которой в тетиской провинции соответствует граница титон—берриас, определённая в подошве горизонта грандис, находится внутри отложений пурбекской фации в лимнически-лагунных бассейнах западной Европы.

В кувявской борозде Польской низменности в отложениях пурбекской фации выделены 6 остракодовых горизонта. Карбонатные отложения горизонта „Ф”, в пределах которых проходит граница между средним и верхним волгом содержат, кроме плеченогих, эвригалиновые остракоды *Mantelliana purbekensis* (Forbes) и первые олигогалиновые остракоды родов *Klieana* и *Rhinocypris*. В горизонте „Е”, в нижней части которого исчезают фораминиферы, находятся сульфатные отложения с прослойками известняков и мергелей содержащих роды *Fabanella ansata* (Jones), *Mantelliana purbekensis* (Forbes), *Klieana alata* Martin.

Остракодовые горизонты „Ф” и „Е” соответствуют самой верхней части среднего волга и самой нижней части верхнего волга.

Остракодовые горизонты „Д”, „Ц” и „Б” отличаются солоноватопресноводным характером и вероятно по возрасту соответствуют верхнему волгу.

Самый верхний остракодовый горизонт „А” имеет уже солоноватоморской характер. В этом горизонте кроме *Cypridea posticalis* находятся морские остракоды *Pachycytheridea compacta* (Wolburg) а также конгломератовые фораминиферы.

Остракодовый горизонт „А” указывает на начало трансгрессии рязанского моря. Морской рязань представлен пластинами с *Riasanites* и *Malboliceras* а также *Surites* и *Euthymiceras*, которые коррелируются с горизонтом боиссьери. Можно предполагать, что первые ингрессии рязанского моря имели место перед горизонтом боиссьери, в горизонте оцитаника.

К сожалению разрез рязаня Польской низменности, представленного в нижней части отложениями пурбекской фации, не позволяет на однозначное определение его стратиграфической позиции и на точную корреляцию с другими разрезами boreальной и тетиской провинции.