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DEVELOPMENT OF BRYOZOAUS (BRYOZOA TYPE) ON THE BORDER OF DEVONIAN–CARBONIFEROUS IN WESTERN PART OF THE ALTAI-SAYANSKAYA FOLDED AREA

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The features of pearlside development in Late Devonian and Early Carboniferous time in western part of the Altai-Sayanskaya folded area have been revealed. The position of the lower border of carbon in the region is paleontologicaly proven by pearlsides taking into account the data on conodonts and brachiopods.

Introduction

Features of pearlside development in Late Devonian – Early Carboniferous time in western part of the Altai-Sayanskaya Folded Area (ASFA) are poorly studied. Bryozoa studying of such chronostratigraphic interval in 10^{th}–60^{th} of the XX^{th} century was carried out by famous paleontologists, such as: I.P. Tolmachyov, V.P. Nekhoroshev, I.P. Morozova, V.B. Trizna [1–5]. Owing to their works, the Early Carboniferous complex of pearlsides is fully characterized, but there is not enough data on Famennian associations to trace consecutive development of bryozoa near the border of Devonian-Carboniferous. Therefore, studying of Femennian pearlsides of the region has been continued by the author.

Fossilized pearlsides (Bryozoa type) are a benthos group of animals that lived on shallow and shelf sites of ancient sea basins. They were an integral part and one of the important components of sea ecosystem of Paleozoic. Presence in ontogenesis of the larval stage of development, allowing to be actively settled on significant distances, high adaptivness and small dependence on the substratum increase their stratigraphic. Findings of pearlside colonies in the region are dated to detritus limestones, aleurolites, lime sandstones, which allows to spend correlation of multifacies deposits. High degree of occurrence of this group of fossils in Devonian, Carboniferous deposits of western part of ASFA, original structure of complexes offers a special interest to them.

Position of the Lower Carboniferous border in the region

According to modern representations, the Famennian layer, crowning the Devonian system, includes three horizons (bottom-up) in western part of ASFA: Pescherkinskiy, Podoninskiy and Abyshevskiy in structure of Topkinskiy and Krutovskiy layers [6]. The Turneyskiy layer of the carboniferous system is presented by Taydonskiy and Fominskiy horizons. Position of the Early Carboniferous border in the region is still a debatable question. In 2005 at the working meeting of Devonian Section of Siberian Regional Interdepartmental Commission (SibRIC) the decision on drawing the Early Carboniferous border in western part of ASFA on the basis of Krutovskiy layers of the Abyshevskiy horizon was accepted. Such position of the border is the most close to global stratotype of the Carboniferous (cut La Serre, Southern France), where the border is drawn at first occurrence of the conodont zone *Siphonodella sulcata* [7]. A little lower the global biotic event Hangenberg is fixed (near the roof of the conodont zones *Siphonodella praesulcata*), dated to the beginning of transgression and connected with change of faunistic complexes [8.] the Hangenberg event became an original boundary between Middle- and Upper- Paleozoic faunae. Among different groups of fossils it is expressed unequivocally, for example, mass extinction of taxons is marked among ammonites. Among brachiopods, ostracodes, foraminifers, and there is a gradual updating specific and patrimonial structures.

Despite the paleontological substantiation of the bottom border position of Carboniferous in the basis of Krutovskiy layers of the Abyshevskiy horizon, there were no findings of the conodont complexes confirming Devonian age of Topkinskiy layers. Conodonts from the stratotype of the Abyshevskiy horizon have not studied at all. In summer of 2006, the employees of Research laboratory «Paleontology and paleogeography» of Kuzbass State Pedagogical Academy have organized an ex-

pedition to the right bank of the river Inya in order to liquidate this blank and to study a typical cut. Samples were taken and collection of pearlsides was collected from Topkinskiy limestones during field works for allocation of conodonts. At dissolution of stone material by acetic acid in Research laboratory «Paleontology and paleogeography» KuzGPA the Famennian conodonts were found in 5 samples. By of S.A. Rodygina's definition in structure of a complex there are kinds *Polygnathus inornatus* Branson et Mehl, *Icriodus costatus darbyensis* Klapper, *Mehlina strigosa* (Branson et Mehl), characteristic for late Famennian (conodont zones *expansa-praesulcata*). Thus, the bottom border of Carboniferous in the basis of Krutovskiy layers has received acknowledgement by conondants.

Discussion

In western part of ASFA the Hangenberg event is expressed as the Cheremshanskiy bioevent (Mountainous Altai), connected with origin of a new epicontinental coast-shelf basin [9]. It is dated for the beginning of the Abyshevskiy transgression in the region and coincides with the basis of the Abyshevskiy horizon. A cardinal change of associations is observed among brachiopods, pearlsides, phoraminifers, ostracods and other groups of fossils. The majority of Devonian forms dies out or enters a stage of degradation; new taxons appear reaching blossoming during Carboniferous time.

Findings of pearlsides of the Upper Famennian in the region are dated to the basins of the rivers Inya, Tykhty, Bolshaya Kamyshnaya (Kuzbass), and the rivers Pykhtovka, Serzhikha (territory of Kazakhstan). According to modern systematization they are presented by the following groups: Cystoporida, Trepostomida, Rhabdomesida, Tubuliporida, Cryptostomida, Fenestellida [10]. Extensive transgression restores the lost in the Middle Famennian communications between neighboring sea basins. To the beginning of Topkinskiy time the complex of bryozoa kinds of the western part of ASFA includes 52 kinds of 29 sorts [2, 3, 5, 11]. Among them, the predominating position is taken by trepostomides (17 kinds of 10 sorts, including 4 new sorts) (Fig. 1). By the end of this time they are replaced by phenestellides (11 sorts), to the most representative group of carbon. High rates of speciation in existing sorts (20 kinds) and intensive species-formation (7 new sorts) are characteristic for phenestellides. A small percent in pearlside associations of the Late Riphean time is a share of cystoporids (7 % from patrimonial structure) and rhabdomesid (14 %). But the families Nikiforovella and Ipmorella, reaching blossoming during the Carboniferous time, appear among the latter. There are individual representatives of the groups Cryptostomida and Tubuliporida. Thus, the border of Topkinskiy layers of the Abyshevskiy horizon is well expressed and recognized by change of bryozoa communities. At the same time, a share of Devonian sorts and kinds continues to remain rather high (60 %). The analysis of the pearlside complex of the Abyshevskiy horizon shows its individuality, which can be possible to use for regional correlations. Presence of the known kinds of other regions (East Transbaikalia, Central Kazakhstan) (table) allows to assume close paleographic relations between them during the Abyshevskiy time. Characteristic kinds of Topkinskiy complex are *Fistulipora foliacea* Tr., *Monotrypella carbonica* (Tschich.), *Nikiforovella bytchokensis* Trizna, *Laxifenestella juxtaserratula* (Tr.), *Ipmorella irregularis* (Nekh.).

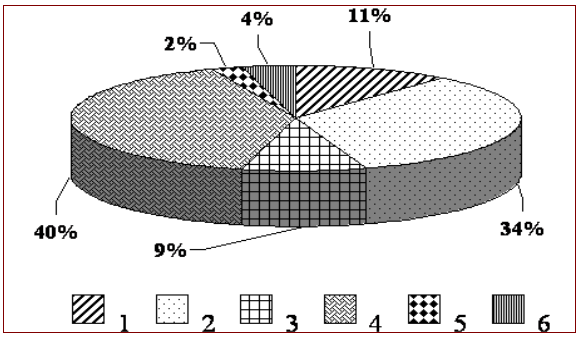

Fig. 1. *The percentage parity of pearlside kinds from the total amount during the Topinskiy time. Representatives of group: 1) Cyclostomida, 2) Trepostomida, 3) Rhabdomesida, 4) Fenestellida, 5) Cryptostomida, 6) Tubuliporida*

A similar situation is observed among brachiopods, ostracods and other groups of fossils. Brachiopods of Topkinskiy layers are presented by the following kinds: *Aulacella interlineata* (Sow.), *Schuchertella valentinae* Sok., *Rugosochonetes injensis* Sok., *Mesoplica abyschevensis* Sar., *Rugauris inica* (Sar.), *Camarotoechia injensis* Sok., *Cyrtospirifer ivanovae* Basn., *Tenticospirifer tychtensis* Besn., *Sphenospira julii* (Dehee), *Imbrexia topkensis* Besn., *Iniathyris tykhtensis* Besn., *Athyris pseudoconcentrica* Besn. [12]. In the resulted complex the majority of kinds continue the Devonian tendency of development. At a patrimonial level there is only one taxon Imbrexia, the blossoming period of which falls on Carboniferous. This circumstance always guarded researchers who unanimously marked the «devonian shape» of brachiopods of Topkinskiy layers. Findings of spore complexes of the *Hymenozonotriletes lepidophytum* zone [12] in the east suburb of Kuzbass (basins of the rivers Taydon, Nizhnaya Ters, Gryaznaya an Zalomnaya) confirm Late Famennian age of Topkinskiy layers.

Overwhelming majority of paleontologists correlate Topkinskiy layers of the Abyshevskiy horizon by the remains of fossils with Etren layers [12–16], marking thus a break in sedimentation between Topkinskiy and Krutovskiy layers of the Abyshevskiy horizon [12, 17]. A geological event connected with transgression of sea basin takes at the base of Topkinskiy layers (change of red-color rocks of the Podoninskiy horizon by dark grey hydrosulphuric limestones of Topkinskiy layers). Change of sedimentation modes is sharp, but without appreciable discrepancies. The following large bioevent coincides with the basis of Krutovskiy layers of the Abyshevskiy horizon. Tuffites and dust tufs, connected with sharp splash in volcanic activity, are deposited in the basis of Krutovskiy layers. Possibly, the volcanic material is brought from the southeast part of Mountainous Altai [18].

Table. *The correlation scheme of Upper Devonian – Early Carboniferous deposits of the western part of ASFA, Kazakhstan, East Transbaikalia [2, 3, 5, 12, 14, 19, 20], conodonts are defined by S.A. Rodygin)*

System	Layer	Horizon (layers)	Western part of ASFA			Horizon	Kazakhstan	Horizon	East Transbaikalia
			Pearlsides	Brachiopods	Conodonts		Pearlsides		Pearlsides
Carboniferous	Turneyskiy	Taydonskiy	*Rectifenestella rudis (Ulr.), Rectifenestella serratula (Ulr.), Fistulipora tubulosa Nikif., Polypora biseriataformis Nekh., Polypora spininodata Ulr., Klaucena firma Tr., Sulcoretepora tomiensis (Tolm.), Triznotrypa tenuilignata (Tri.), Flexifenestella taidonica Nekh.*	*Pustula altaica Tolm., Spirifer baiani Nal., Unispirifer taidonensis (Tolm.), Plicochonetes poljenowi (Tolm.), Avonia minima (Tolm.), Spirifer taigensis Besn.*	Unknown	Simorinskiy	*Rectifenestella serratula (Ulr.), Klaucena firma Trizna, Semicoscinium glabrum Troiz. Rectifenestella triserialis Ulr., Intrapora acatalecta Troiz.*	Pavlovskiy	*Lioclema tubulosa Nekh., Polypora bukhtarmensis Nekh., Triznotrypa tenuilignata (Trizna), Flexifenestella taidonica (Nekh.), Reteporidra iovalifenestra Nekh., Arborocladia argolensis Popeco*
		Abyshevskiy (Krutovskiy)	Unknown	Unknown	Unknown				
Devonian	Famennian	Abyshevskiy (Topkinskiy)	*Fistulipora foliacea Trizna, Monotrypella carbonica (Tschich.), Nikiforovella bytchokensis Trizna, Fenestella abyschevoensis Trizna, Fenestella tarkhanca Nekh., Arborocladia tarkhanca Nekh., Reteporina altaica Nekh., Stictoporina bifurcata Nekh., Neotrematopora podunskensis (Trizna), Cyclotrypa arboracea Nekh., Cyclotrypa gigantea Nekh., Laxifenestella juxtaserratula (Triz.), Lioclema ramosum Nekh.*	*Athyris pseudoconcentrica Besn., Schuchertella valentinae Sok., Sphenospira julii (Dehee), Steinhagella kuzbassica Sar.*	*Polygnathus inornatus Branson et Mehl, Icriodus costatus darbyensis Klap., Mehlina strigosa (Branson et Mehl)*	Sultsiferoviy	*Cyclotrypa gigantea Nekh., Cyclotrypa arboracea Nekh., Petalotrypa kazakhstanensis Troiz., Leptotrypella tenisica Troiz., Pseudocampylus tarbagataicus Troiz., Rhombopora famenensis Nekh., Intrapora lanceolata Nekh., Lioclema ramosum Nekh.*	Kotikhinskiy	*Cyclotrypa arboracea Nekh., Neotrematopora podunskensis (Trizna), Monotrypella carbonica (Tschich.), Pseudobatostomella longipora (Nekh.), Imporella irregularum (Nekh.), Nikiforovella bytchokensis Trizna, Stictoporina bifurcata Nekh., Laxifenestella juxtaserratula (Trizna)*

Extinction of 31 kinds of 10 sorts of pearlsides (Fig. 2) is marked on this border. On a share Trepostomides 14 kinds of 4 sorts are a share of trepostomides. There are fewer units among other groups of disappearing taxonomatic units. Because the thickness of tuffites of the Krutovskiy horizon is deprived of fossils, it is not obviously possible to track the development of bryozoa in a continuous cut. Duration of the Krutovskiy event, most likely, was short, and during the Taydonskoe time the formation of carboniferous deposits of the Taydonskiy horizon has renewed.

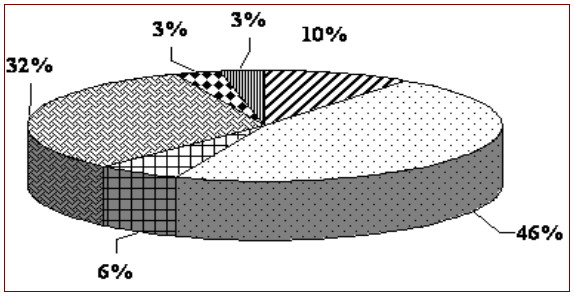

Fig. 2. *The scheme of extinction of pearlside kinds at the beginning of the Krutovskiy time. Conventional signs are presented on Fig. 1*

Pearlside associations of the Taydonskiy horizon according to researchers [3, 5] are characterized by prevalence of phenestellides (Fig. 3). There are 62 kinds of 26 sorts, from which 8 sorts are new, known to be of the Taydonskiy horizon. Existing at the same time taxons have extended on greater distances, which allows using them for inter-regional correlations. Distinctive kinds of the complex are *Fistulipora tubulosa* Nikif., *Flexifenestella taidonica* Nekh., *Rectifenestella serratula* Ulrich, *Triznotrypa tenuilignata* (Trizna). The overwhelming majority of Devonian sorts disappear on the bottom border of the Taydonskiy horizon. Updating is appreciable both on specific, and at higher levels (down to class). All this points to rather high rank of changes near the Krutovskiy events.

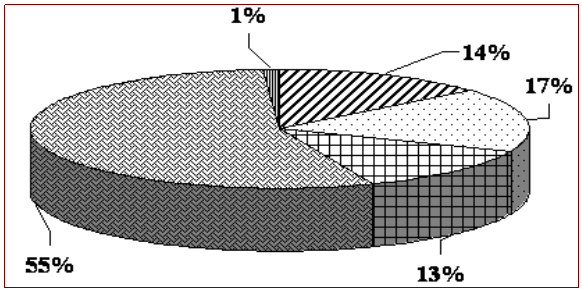

Fig. 3. *The scheme of distribution of pearlside kinds during the Taydonskiy time. Conventional signs are presented on Fig. 1*

Conclusion

It has been shown, that a cardinal change of taxonomatic variety takes place among pearlsides on the border of Devonian-Carboniferous in western part of ASFA. During Late Riphean time the Devonian forms prevail, but new taxons appear, expanding wide during the Carboniferous ime (sort *Nikiforovella, Ipmorella*). At the be-

ginning of the Taydonskiy тайдонского time the majority of Devonian forms disappears and the kinds of coal shape begin to develop. The border of Devonian and Carboniferous systems is offered to be drawn in the basis of Krutovskiy layers of the Abyshevskiy horizon (by time of regional bioevent). It is most comprehensible, easily recognized and proves to be true by paleontological data (pearlsides, conodonts, brachiopods, plants).

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