[Supplement to Newell, A. J. *et al*. 2010. Disruption of playa-lacustrine depositional systems at the Permo-Triassic boundary: evidence from Vyazniki and Gorokhovets on the Russian Platform. *Journal of the Geological Society*]

Report on ostracods from Zhukov Ravine

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The geological section in the Zhukov ravine is represented by two packets of rocks: a lower mudstone-siltstone packet and an upper sandstone packet

The lower mudstone-siltstone packet is represented in exposures 1 and 2. Ostracods from the bottom packet are selected from marls and limestones lying 2 – 3 m below the top. They include these species: *Suchonellina trapezoida* (Sharapova in Schneider,) 1948; *Wjatkellina ex gr. fragilina* Belousova, 1961; *W. cf vladimirinae* Belousova, 1961; *Darwinuloides svijazhicus* (Sharapova in Schneider), 1948; *Suchonella juv typica* Spizharskii, 1939; *S. circulata* Mischina, 1980; *Tatariella libera* Mischina, 1967; *T. ex gr subtilis* Mischina, … 1967;. This complex of species unequivocally defines the age as late Vyatkian. Such a combination of species, as *Suchonellina trapezoida, Wjatкellina vladimirinae, Suchonella typica* and *Darwinuloides svijazhicus*— is characteristic of the top half of the Vyatkian. They are widely represented in ections from the top part of the Vyatkian Gorizont everywhere on the Russian platform: in the basins of the rivers Sukhona and Dvina (Aristovo and Zabelino localities), the basis of the rivers Vyatka and Vetluga (numerous boreholes), in the basins of the rivers Sakmara and Ural (localities Vyazovka, Gryaznushka, Sambulak, Chesnokovka, etc.). The species *S. circulata* is related to the advanced Suchonellas, close to the *Suchonella typica* group. They have a bowl with convexities in the rear-belly part and almost triangular form from the posterior side. Such *Suchonella* existed in the second half of the Vyatkian Gorizont (Molostovskaya, 2000).

In the work of N.N. Strok and co-authors (Strok *et al*. 1984), according to M. Mishina, this part of the section yields a complex composed of "species of wide vertical distribution and individual specimens of the upper Tatarian *Darwinula parallela*" (Srok *et al*. 1984, p. 33). Thus it was noted, that "though lower Tatarian forms are not met, the complex is close to the above described mixed complex" (Strok *et al*. 1984, p. 34), i.e. corresponding to the bottom part of Severodvinian Gorizont. These conclusions reflected the level of understanding of ostracods at that time. This mistake, when the ostracod complex from the

top part of the Vyatkian Gorizont is defined as early Severodvinian, is also met in other works (Kuleva 1975; Ignatyev 1962), and was because they concluded that ostracod tests were present, similar in outline to lower Tatarian (Urzhumian) species under which name they established a complex. Later, after further work on the systematics of the ostracod suborder Darwinulocopina, it emerged that all phylogenetic attributes place these species in the other genus *Wjatkellina* which appeared in Vyatkian time (Molostovskaya 2000).

The upper sediment packet is assigned to exposures 1, 2 and 3.

Ostracods emerge from layers and lenses of clay in the exposures: they are represented by species of the genera *Darwinula* and *Gerdalia* which make the following complex: *Darwinula sima* Mischina, 1969; *D. acuta* Mischina, 1966; *D. cara* Mischina, 1969; *D. unzhica* Mischina, 1969; *D. media* Mischina, 1969; *D. regia* Mischina, 1969; *D. cf. prisca* Mischina, 1969; *D. ex gr accuminata* Belousova, 1961; *Gerdalia clara* Mischina, *G. ex gr variabilis* Mischina, 1966; *G. rixosa* Mischina, 1966; *G. dactyla* Belousova, 1961. All holotypes of E. M. Mishina's species come from the Vetlugian Series of the Lower Triassic of the Kostroma area (Mishina 1966, 1973). Z. D. Belousova's species are allocated from deposits of the Lower Triassic in the basin of the River Vyatka (Belousova 1961). This complex unequivocally defines the Early Triassic age of the beds of the upper sandstone packet. It is widely represented on the Russian plate in beds of the Lower Triassic. Our data confirm the results of research on ostracods from the sandstone packet of the Zhukov ravine, completed earlier by E. M. Mishina (Strok *et al*. 1984).

In connection with the new data on ostracods, the palaeomagnetic sequence of zones established by E. Molostovskiy in the Permian part of the Zhukov ravine section will be identified as follows: R2P3, N2P3 and R3P3.

The Permo-Triassic boundary in Zhukov ravine section is designated precisely enough using ostracods. The large rectangular and roughly triangular shells of the Permian *Suchonellina* and *Suchonella* are replaced by the finer extended low shells of *Darwinula* and *Gerdalia*. The change of complexes coincides with an erosive contact in exposure 2 and with the change in lithological type of clays in exposure 1. Triassic ostracods from clays under sandstones are not very safe, and they define the Triassic age of the beds with some reservations. Sections where the change from Permian to Triassic ostracod complexes has been observed within a clay unit, but without visible erosive contact, deserve further study.

Report on fish remains from Vyazniki, Zhukov ravine, and nearby localities

A. V. and M. G. Minikh

In B.P. Vyushkov's collections from the **Vyazniki** location (neither number nor repository are known), selachian fin spine fragments and some actinopterygians have been determined. Judging from ichthyodorulites, sharks of various sizes occurred there: from 1 m to 3-4 m long. The smallest spine belongs to *Hybodus sp*. This genus came into being, most probably, in the very end of the Permian and evolved during the Mesozoic; the last of its representatives lived up to the Late Cretaceous. In Russia, apart from two locations, Blyumental-3 and Vyazniki, the genus is known from Mesozoic beds. A fairly large spine belongs to the shark *Xenosynechodus* Glukman. The genus was first established by L.S. Glikman in 1980 from teeth found together with the skull, jaws and ichthyodorulites in the Isheyevo location close to the boundary of the Middle Permian Urzhumian stage and the Severodvinian stage of the Upper Permian Tatarian series. Its remains are known within European Russia from the Severodvinian beds from the Sukhona basin and in some locations in the South Cis-Urals and in the Vyatkian stage from the Obshchiy Syrt. No xenosynechodoses [reworked specimens] have been encountered in the Triassic, yet.

Large spine fragments, probably of large sharks, from Vyazniki belong to other shark genera: three of these - of the ctenacanth type, probably close to *Sphenacanthus* are known (Zangerl, 1981) from the Burdichouse Limestone, Edinburgh, Scotland and other Scottish locations and from the Russian Carboniferous and probably Permian beds. The remaining ichthyodorulites from B.P. Vyushkov's collections belong to sharks of obscure systematic affiliation.

In addition, from Vyushkov's collections from the same place, a fin spine of an actinopterygian *Mutovinia sennikovi* A. Minich and a jaw fragment of *Saurichthys* sp. have been determined. The species *Mutovinia sennikovi* in Russia is known from the terminal Permian and probably from the Triassic basal layers (Zhukov Ravine). *Saurichthys* is known worldwide from the Triassic, and it is only in Russia that they have been encountered in the terminal Permian from the Klyazma basin and in Armenia – also in Permian-Triassic boundary layers.

In a layer of grey bayou-lake clays at the **Sokovka** locality, fairly large fragments of investing bones and scales of *Mutovinia sennikovi* A. Minich occur, rare teeth of *Isadia*

aristoviensis A. Minich and scales of some new, yet unknown actinopterygian taxa. The following remains have been discovered from the overlying sand sequence of the same location: an operculum of a very large specimen of *Mutovinia sennikovi* A. Minich, up to 130 mm long, and other investing bones of the same species, scales of *Strelnia* sp., *Isadia aristoviensis* and bones and scale of some other unknown fishes. Among the latter ones, a side scale of the Triassic genus (?)*Evenkia* has been tentatively determined.

In a gully 500 m east of the Sokovka location, on the southern slope of the Klyazma valley (the **Metallist** location), only some scales of *Mutovinia sennikovi* A. Minich and *Mutovinia* sp. have been determined.

Numerous fish bones and scales have been found in the **Bykovka** locality recently discovered by A.G. Sennikov. Scales of *Toyemia blumentalis* A. Minich, *Toyemia* sp., *Strelnia* sp., and *Isadia* sp. have been determined there, as well as actinopterygian scales close to *Evenkia* (?) sp. Among the teeth of actinopterygians unspecified more closely, teeth of *Saurichthys* (?) sp. have been revealed. Among the relatively large fish fragments, a distal segment of the dorsal fin dermal armour and an investing bone of a new fish species of the genus *Geryonochthys* have been revealed.

In the head of a gully 1.3 km west of the village of Bykovka, scale fragments of actinopterygians close to *Varialepis stanislavi* A. Minich occur; these are presently known from the Upper Permian Severodvinian beds from the Sukhona basin, from the Monastyrskiy gully on the right bank of the Volga (Tatarstan) and from some other locations of Severodvinian age in the Orenburg Region.

Fish bone concentrations have been revealed in the **Gorokhovets** location. Excavations have produced teeth, a jaw fragment and other bones and scales of *Isadia aristoviensis* A. Minich, skull investing bones and scales of *Toyemia blumentalis* A. Minich, fin spines and dermal plates of *Geryonichthys (?) longus* A. Minich, *Geryonichthys burchardi* A. Minich, scales and skull-cap bones of *Mutovinia sennikovi* A. Minich, *Mutovinia Stella* Minich, scales of *Strelnia* sp., scales of *Varialepis vitalii* A. Minich, numerous teeth and one scale of the *Saurichthys* sp. chondrostean and scales of more closely undetermined actinopterygians. Judging from the sizes of individual scales and bones of the *Toyemia* and *Isadia* genera, some specimens were up to 70-80 cm long.

In the **Shchyokino** location, in the conglomerates from the upper part of the left wall of the gully and from the spring channel, A.G. Sennikov and M. Benton have found a large jaw fragment of probably discordichthyiform fish *Geryonichthys* sp. (the sample is in the stage of preparation).

Some interesting fish materials were collected in 2003 by A.G. Sennikov, V.K. Golubev and V.V. Bulanov in the well-known (Molostovskiy, 1983) location of **Zhukov Ravine** in the synonymous gully close to the village of Arefino. In the uppermost part of the section, at the top of a sand member, competent rust-brown conglomerates occur, impregnated with numerous fragments of fish bones and scales, less frequently with intact scales and teeth and flora remains, very rarely – with terrestrials vertebrate bones. A. V. Minikh and M.G. Minikh have determined some teeth of large specimens of *Isadia aristoviensis* A. Minich, a dental plate fragment of a *Gnathorhiza* sp. dipnoan, investing-bone fragments of *Mutovinia sennikovi* A. Minich, scales of *Strelnia* sp., an actinopterygian fish tooth, vaguely resembling typical teeth of the genus *Saurichthys,* numerous scales close to *Evenkia* (?) sp. Morphologically close *Evenkia* scales were found by M.G. and A.V. Minikh in 1968 in the Kudanga Triassic location that had been discovered by V.R. Lozovskiy on the right bank of the Kudanga in the south of the Volgograd region. Fishes of the genus *Evenkia* have been found in some Triassic locations in European Russian and in Siberia.

We believe that joint occurrence of the remains of three fish genera: typically Triassic genus *Saurichthys*, the dipnoan genus *Gnathorhiza*, close to the typical Triassic form *Gnathorhiza otschevi* Minich, and the Triassic genus *Evenkia* (?) developed and common in the Triassic of European Russia - in the section of the Zhukov Ravine location may testify to the Triassic age of the hosting conglomerates.

SUMMARY AND CONCLUSIONS

We deal with transitional deposits from the Vyatkian stage of the Permian Tatarian series to the Lower Triassic Induan stage (Minikh, A. Minikh, 2006). Alongside characteristic Late Permian fish taxa (*Isadia aristoviensis, Toyemian blumentalis, Geryonichthys longus, Geryonichthys burchardi, Mutovinia stella, Varialepis vitalii*), for the first time scales and teeth of the typical Triassic genus *Saurichthys* (of the Chondrostei superorder) occur there at various levels; these are common worldwide in the Triassic; the species *Mutovinia sennikovi* first appears in those beds, as well.

Conglomerates from the Zhukov Ravine may definitely be referred to the early Triassic: several forms of typically Triassic fishes occur there.

The final decision on the position of the Permian-Triassic boundary in the sections represented by continental facies should be based on complex examination of several groups of fossil organic remains.

The research was financially supported by the Russian Foundation for Fundamental Research: project №07-05-00624.

Molostovskiy E.A. 1983. Paleomagnetic stratigraphy of the Upper Permian and the Triassic from the east of the USSR European part / Ed.: Prof. A. N. Khramov – Saratov: SGU Publ., 166 pp.

Hand-drawn section of Zhukov Ravine by IIM

Title is: ‘Contact of Permian and Triassic deposits in Zhukov Ravine, near Arefino village. The sketch map at bottom right shows the Klyaz’ma river and Arefino village to the north, and the branching Zhukov Ravine, with locations of sections 1, 2, and 3. The larger diagram is a sketch, against topographic height, of the walls of the ravine, showing the three logs, and lists of ostracods from immediately below and above the PTB. The upper margin represents the level of fields, and the lower boundary, the tallweg of the ravine.