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New data on Silurian vertebrates of southern Siberia

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Abstract

This paper presents revised data on Silurian conodonts, graptolites and vertebrates of southern Siberia. We define patterns of facies associations of agnathans and fishes from Silurian basins of the Tuva region in southern Siberia based on original and published data. The agnathans display a mosaic distribution: *Tuvaspis margaritae* Obruchev plus *Tannuaspis levenkoi* Obruchev, *Helenolepis navicularis* Karatajute-Talimaa, and *Helenolepis obruchevi* Karatajute-Talimaa plus *Loganellia scotica* (Traquair) occur in littoral, sublittoral and distal uplifted sublittoral environments, respectively. *Elegestolepis grossi* Karatajute-Talimaa fish taxa occur in both littoral and sublittoral environments, whereas those of *Tuvalepis schultzei* Zigaite and Karatajute-Talimaa are more typical of distal uplifted environment. Our obtained data contribute to the understanding of the Silurian biostratigraphy and litho- and biofacies of the whole region.

Keywords: Tuva; Biostratigraphy; Agnathans; Fishes; Taxa; Environment

1. Introduction

Silurian vertebrates from eastern (Asian) Russia were first reported by Obruchev (1956, 1958, 1960). Recently, vertebrates have been also discovered in the Russian Arctic, e.g., in Severnaya Zemlya, and in the Transbaikalia region (Table 1).

Three Silurian vertebrate assemblages were recognized in the Siberian Platform (Žigaite, 2013). The first assemblage includes *Tesakoviaspis concentrica* Karatajute-Talimaa and Smith, *Elegestolepis conica* Karatajute-Talimaa and *Loganellia asiatica* Karatajute-Talimaa from the Moyero and Khaastyr horizons or regional stages of the Rhuddanian–Aeronian age. The second assemblage includes *Talimaalepis rimae* and was derived from the Agidyi Horizon and it is correlated with the Telychian Stage of the International Stratigraphic Scale (ISS). The third assemblage includes *Loganellia* cf. *asiatica* and *Udalepis* sp. of the Khakom Horizon and can be correlated with the Wenlock Series of the ISS.

However, many patterns of the early evolution of vertebrates, for example, the taxonomic diversity of agnathans and fishes, the restriction of vertebrate facies to this or that paleobasin, the endemism of vertebrate assemblages of opened and half-isolated basins, have remained debatable. The paper presents new data on the Silurian biostratigraphy and litho- and biofacies of the Tuva region in southern Siberia, which will certainly contribute to the solution of those challenging questions.

2. Geological setting

Siberia is a huge region of Russia consisting of the Siberian Platform and its framing orogenic belts, all parts of the Central Asian Orogenic Belt (CAOB), which is formed by multiple stages of oceanic subduction-accretion and subsequent collisions of the East European, Siberian, North China and Tarim cratons during the last 800 Ma (e.g., Dobretsov, 2003; Kovalenko et al., 2004; Windley et al., 2007; Safonova et al., 2011). The Altai-Sayan folded area (ASFA), which includes the Tuva region under study, is situated in the western CAOB, and consists of several Paleozoic (including Silurian) terranes of different tectonic origin, e.g., Precambrian Tuva-Mongolian microcontinent, Early Paleozoic Kuznetsky Alatau, Gorny Altai, and West Sayan

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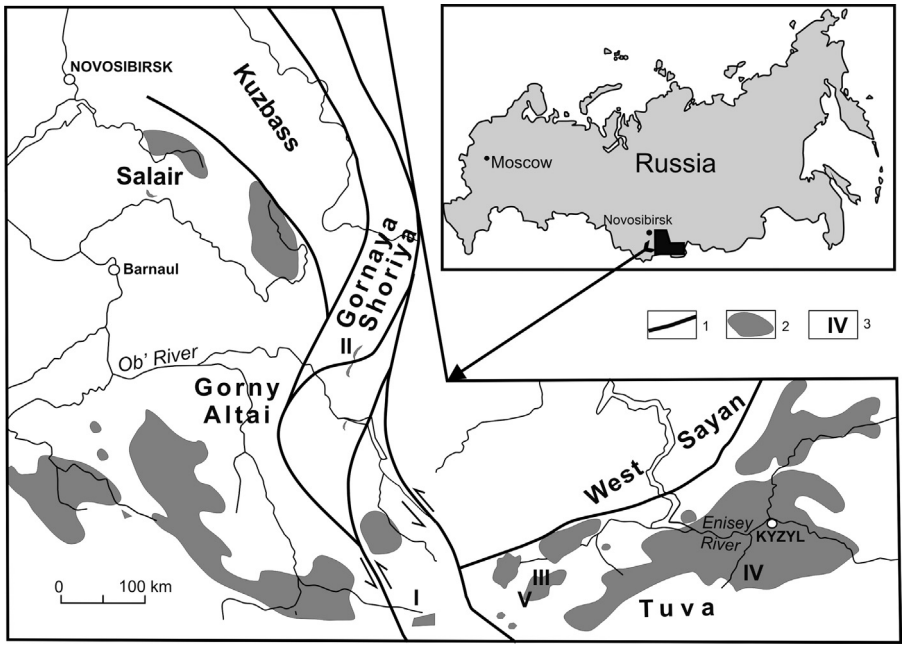

Fig. 1. Studied localities in South-Siberia with Silurian sediments productive of vertebrates. Dashed polygon showing regions studied in the western part of the Altai-Sayan Folded Area — Gorny Altai, Gornaya Shoriya, and Tuva. 1 – large-scale tectonic fault zones; 2 – Silurian strata outcrops; 3 – sections producing vertebrates: I – Tarkhata Section; II – Lebed'-Sadra Section; III – Bazhin-Alaak Section; IV – Elegest Section; V – Ulug-Khondergei Section.

Table 1
Main localities of Silurian vertebrates in Russia.

Region	References
Siberian Platform	Moskalenko (1968), Karatajute-Talimaa and Predtechenskyi (1995) and Žigaite (2013)
Tuva	Karatajute-Talimaa (1973), Vladimirskaya et al. (1977, 1986), Karatajute-Talimaa (1978), Kulkov et al. (1985), Karatajute-Talimaa and Ratanov (2002), Karatajute-Talimaa and Smith (2003, 2004), Žigaite (2004, 2013), Žigaite and Blieck (2006) and Žigaite and Karatajute-Talimaa (2008)
Severnaya Zemlya	Matukhin and Menner (1999), Karatajute-Talimaa and Märss (2002) and Märss and Karatajute-Talimaa (2002)
Trans-Baikal	Vladimirskaya et al. (1986), Rodina et al. (2002) and Karatajute-Talimaa and Smith (2003)

foldbelts of subduction-accretionary nature, the Middle Paleozoic Anui-Chuya marginal sea trough, the Late Paleozoic–Early Mesozoic Kuznetsk Basin, which is a Hercynian continental intermountain depression, and the Zaisan collisional belt (Dobretsov, 2003; Sennikov et al., 2008; Vladimirov et al., 2008). The complicated structure of the ASFA is formed by gradual northward accretion of Late Neoproterozoic–Paleozoic oceanic, island-arc and active margin terranes and Precambrian microcontinents to the Siberian continental margin (Dobretsov et al., 1995; Dobretsov, 2003; Windley et al., 2007; Safonova et al., 2011). The early and late Paleozoic periods of the geological evolution of the ASFA, which were related to oceanic subduction and closure, have been studied by many scientists, however, the Middle Paleozoic stage, which separated the Caledonian and Hercinian periods of Pacific-type orogeny (Sennikov et al., 2008; Safonova and Maruyama, 2014), have remained understudied. In addition, the Silurian sequences of the Tuva-Mongolian microcontinent and Kuznetsk-Alatau foldbelt have been studied to a lesser extent compared to other Early Paleozoic sedimentary basins of the ASFA, especially in terms of litho- and biostratigraphy and composition of fauna paleoassemblages.

3. Materials and methods

Vertebrates were obtained from the samples from the Gorny Altai, Gornaya Shoriya (southern Kuznetsky Alatau accretionary-folded zone), and Tuva (Tuva microcontinent) (Fig. 1), supplemented by material from the rock samples from Gorny Altai sequences that were provided by Dr. Ya. Gutak. Information on vertebrates from the many sequences in these areas has been presented in various short papers (Rodina, 2002, 2009; Rodina et al., 2002; Gutak et al., 2005, 2009). The principal focus of the present investigation is to present identifications of vertebrates within the Silurian chronostratigraphic framework of Tuva based on stratigraphic ranges of conodonts and graptolites from the reference sections. These data have provided the biostratigraphic ranges of vertebrate taxa, from which we have established a new sequence of vertebrate assemblages.

We are responsible for all descriptions and allocation of taxa to stratigraphic sections. Sampling for microfossils (conodonts and vertebrates) was made from carbonate rocks and from calcareous intervals within siliceous packages. Collections of vertebrate remains (agnathan and fish scales) were obtained by acid-leaching of limestones, limy mudstones, limy siltstones, and limy sandstones in dilute acidic acid. Published data on ranges of the Silurian vertebrates in Tuva sequences used for this summary include those of Karatajute-Talimaa