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THE FIRST RECORD OF *Salamandrella* (CAUDATA: HYNOBIIDAE) FROM THE NEOGENE OF RUSSIA

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The record of the Siberian salamander, *Salamandrella*, is reported from the Miocene of the Tagay locality (Irkutsk oblast', Russia). *Salamandrella* sp. is described based on an almost complete trunk vertebra. The morphology of the vertebra generally corresponds to the modern species of *Salamandrella keyserlingii*, but differ from it in the shape of centrum, height of neural arch and deeper canal for arteria vertebralis. The described record is the first Neogene record of *Salamandrella* in Russia and the oldest record of this genus.

Keywords: Hynobiidae; Miocene; *Salamandrella*; Siberian salamander; Tagay.

INTRODUCTION

The Asiatic Salamanders, Hynobiidae, includes about 50 species and are one of the largest group within Caudata Fischer, 1813. Their recent distribution is restricted mainly to Asia. Based on fossil record, the hynobiids diverged from their sister group Cryptobranchidae not later than 161 Ma (Gao and Shubin, 2003). However, fossil hynobiids have been known only from the Late Miocene (Venczel, 1999a, 1999b). The fossil record of hynobiid is relatively poor: two species of *Parahynobius* were described from the Upper Miocene-Lower Pliocene of Hungary (MN 12 – 14), and, from Lower Pleistocene of Romania (MQ1) (Venczel, 1999a, b); *Ranodon* cf. *sibiricus* was reported from the Upper Pliocene (MN 16) of southern Kazakhstan (Averianov and Tjutkova, 1995); *Salamandrella keyserlingii* was reported from the Holocene of Siberia (Khozatski, 1982), and as a "fossil" frozen individuals from the permafrost in Siberia (Matveev, 1957); *Salamandrella* sp. was reported from several localities of Middle Pleistocene of European Russia (Ratnikov, 2002) and from the Upper Miocene of China (Vasilyan et al., 2012). The most commonly listed records belong to *Salamandrella*, the most widely distributed genus of Hynobiidae extending from Hokkaido in the east to the North-East of Europe in the west and from Chukchi Peninsula in the north to northern China in the south (Borkin et al., 1984). This genus is the one of the basal lineages of Hynobiidae (Poyarkov, 2010). According to molecular data, the estimated divergence time of *Salamandrella* from other hynobiids occurred in Eocene, at ca. 51 – 52 Ma (Zhang et al., 2006). Different data sets, however, indicate younger branching of the group: 13 – 14 Ma (cyt b) in the Early Miocene or 30.7 Ma (allozyme data) from the Oligocene to Early Miocene (Matsui et al., 2008). The aim of the present paper is to report of a new material on *Salamandrella* from the late(?) Early Miocene of Russia (Tagay locality, Irkutsk oblast'; Fig. 1).

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MATERIAL AND METHODS

The material described in this paper was collected in 2012 in the Tagay locality, Tagay Bay of the Olkhon Island, Irkutsk oblast', Russia. The sediments from the Tagay sections (Khalagay Formation) were examined for fossils using screen washing method (mesh size 0.7 and 1 mm). Eight fossil-bearing layers of the Tagay sections were investigated from which samples were taken for final treatment in the laboratory of Zoological Institute under a stereomicroscope. The remain of *Salamandrella* was found in the layer A (the uppermost layer about 2 m thick) of the Tagay section which comprises a sequence of clay and thick calcareous faces. The other fossil remains (including fish, amphibians, reptiles, birds, large and small mammals), which were also collected from the Tagay locality will be described separately. The age of the Tagay locality is under discussion. It is determined as belonging to the Early (Vislobokova, 1994,

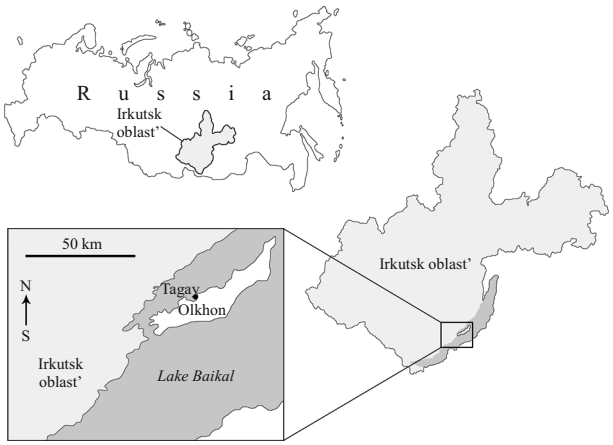

Fig. 1. The geographic position of the Tagay locality.

2004) or to the Middle-Late Miocene (Pokatilov, 2012; Daxner-Höck et al., 2013). Here we preliminary consider it as late(?) Early Miocene based on the dataset from small (A. Tesakov and A. Lopatin, personal communication) and large mammals (Vislobokova, 2004). For comparisons, we used the following specimens of Recent Hynobiidae: *Ranodon sibiricus* (ZMMU No. 2992) and *Hynobius* sp. (ZIN PH No. 455/0), as well as published data on recent and fossil *Salamandrella* (Hilton, 1948; Teege, 1957; Zhang, 1985; Antipenkova, 1994; Ratnikov, 2002, 2010; Ratnikov and Litvinchuk, 2007) and other hynobiids (Averianov and Tjutkova, 1995; Venczel, 1999a, 1999b). The terminology used in this paper follows Estes (1981, 1988). The described specimen of *Salamandrella* is housed in the Paleoherpetological collection of the Zoological Institute of the Russian Academy of Sciences.

Institutional abbreviations: ZIN PH, Zoological Institute, Russian Academy of Sciences, St. Petersburg, Russia; ZMMU, Zoological Museum of Moscow State University, Moscow, Russia.

SYSTEMATICS

Class Amphibia Linnaeus, 1758
Order Caudata Oppel, 1811
Family Hynobiidae Cope, 1859
Genus *Salamandrella* Dybowski, 1870
***Salamandrella* sp.**

Material. The almost complete trunk vertebra (ZIN PH 1/181, Fig. 2); Tagay locality, Olkhon Island, Irkutsk oblast', Russia; Khalagay Formation, late(?) Early Miocene, Neogene.

DESCRIPTION

The specimen represents an almost complete trunk vertebra, damaged in both distal parts of rib-bearers. The centrum length is 2.1 mm. This value generally corresponds to those of other *Salamandrella* which usually range between 2.0 and 3.2 mm. The centrum is amphicoelous that match the morphology of the Hynobiidae. The anterior and posterior articular surfaces (= cotyles) are circular and of about the same height, whereas in *S. keyserlingii* the anterior surface is more dorso-ventrally compressed as compared to the posterior one. In dorsal or ventral views, the centrum is longer than wide. Its ventral surface is distinctly concave in its middle part, and straight in the anterior and posterior parts (i.e., hourglass shaped). The concavity of the centrum seems of same depth as in *S. keyserlingii*. Laterally, the anterior cotyle is concave and oblique, whereas the posterior cotyle is straight. In *S. keyserlingii* the anterior cotyle is straight, whereas the posterior cotyle is concave and oblique. The alar processes (= laminae) are small and poorly visible. The subcentral foramen is absent as in other *Salamandrella*. The rib-bearers (= transverse processes) are represented only by its medial parts. They are bicipital, extend posterolaterally and clearly fused in their medial parts suggesting a fusion along their entire lengths. The base of the rib-bearers is perforated anteriorly and posteriorly by a deep canal for arteria vertebralis. In *S. keyserlingii*, this canal looks more shallow. The neural arch is relatively broad and high in anterior and posterior views, whereas in *S. keyserlingii* it is high posteriorly and depressed anteriorly. The anterior margin of neural arch are slightly concave and reach the level of the middle part of prezygapophyseal articular facets. The posterior margin of neural arch is almost straight and reach the middle part of postzygapophyseal articular facets. This morphology is usually characteristic for the anterior trunk vertebrae of *Salamandrella*. In lateral view, there is no trace of intravertebral foramen. The neural spine is reduced to a low keel. The zygapophyses are oval in shape and directed antero-posteriorly. The prezygapophyseal articular surfaces are elongate oval in outline, face dorsally and slightly sloping (in anterior view, its lateral borders is slightly higher than medial ones). The postzygapophyseal articular surfaces looks more rounded in outline, face ventrally and slightly sloping (in posterior view, its lateral borders are slightly lower than the medial ones).

DISCUSSION

The described vertebra is assigned to Hynobiidae based on the combination of the following characters: amphicoelous centrum; circular articular surfaces; low

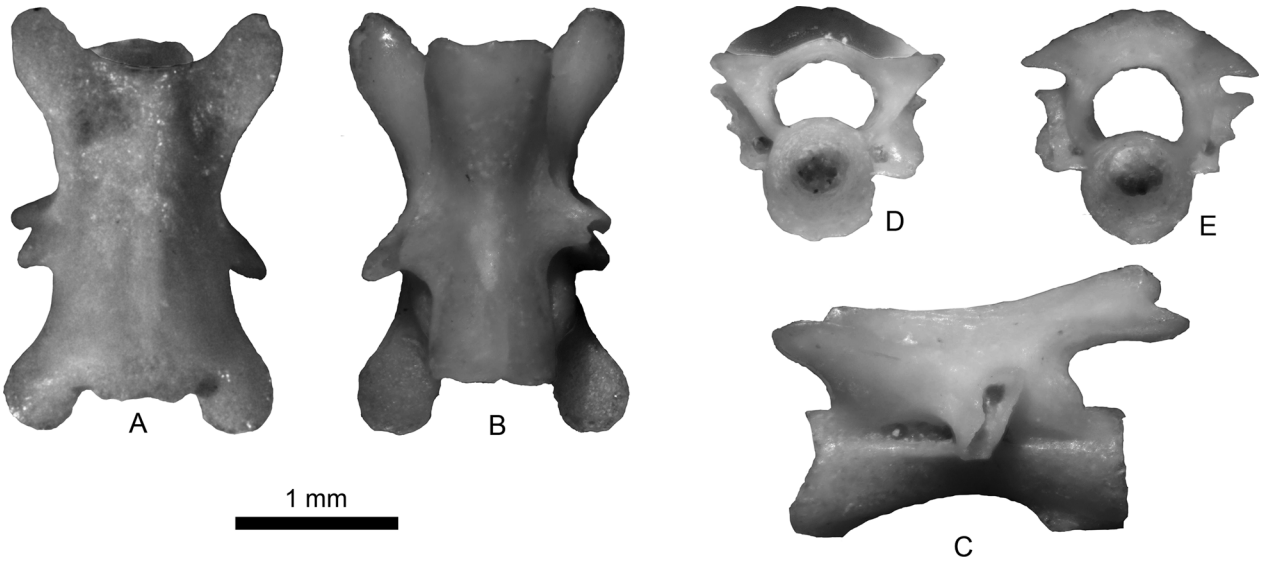

Fig. 2. The trunk vertebra of *Salamandrella* sp., ZIN PH 1/181; Tagay locality, Olkhon Island, Irkutsk oblast', Russia; Khalagay Formation, late(?) Early Miocene: *A*, dorsal view; *B*, ventral view; *C*, lateral view; *D*, anterior view; *E*, posterior view.

neural spine; lacking notch on the posterior margin of neural arch; fused rib-bearers. It is assigned to *Salamandrella* based on the following characters: absence of the subcentral foramen; concave anterior margin of neural arch which reaches the middle part of prezygapophyseal articular facets. The attribution of Tagay specimen to any known species is uncertain. The morphology of the vertebra generally corresponds to recent species *Salamandrella keyserlingii*. However, it seems that the same vertebral morphology is present in the recently described cryptic species of *Salamandrella schrenckii* (Strauch, 1870) (Berman et al., 2005; Ratnikov, 2010). At the same time, the specimen from the Tagay shows some differences from the recent *S. keyserlingii* in the shape of centrum, height of neural arch and in having deeper canal for arteria vertebralis. These differences may reflect the individual variation of vertebrae along the axial column. But more likely, the Tagay specimen represents a separate form, ancestral to recent *Salamandrella*. The available data on DNA and allozymes suggest, that the divergence time of *S. keyserlingii* and *S. schrenckii* occurred at about 6 – 8 Ma in the Late Miocene to Early Pliocene (Matsui et al., 2008). However, the absence of detailed comparative studies of vertebrae of *Salamandrella* and of other hynobiid salamanders precludes erection of a new species name based on a single vertebra. For this reason, until more information is available, we consider this record as *Salamandrella* sp.

The described record extends a geological distribution of the genus. Fossil *Salamandrella* was previously known only from the Holocene and Pleistocene of Russia (Ratnikov, 2010) and as a single undescribed specimen from the Late Miocene of China (Vasilyan et al., 2012). Thus, the Tagay *Salamandrella* is the first Neogene record of *Salamandrella* in Russia and the oldest record of this genus. Climatic conditions under which Tagay specimen occurred are estimated as subtropical, that might have been unfavorable for Recent *Salamandrella* adapted to cool climate. Possibly, The Tagay form was adapted to warm-humid or semi-arid climatic conditions, as reconstructed for the Early-Middle Miocene of the peri-Baikal area (Filippov et al., 2000). This may indirectly indicate a separate species status for the Tagay form that might represent an ancestral form of a *Salamandrella* lineage prior to its striking adaptation to the cold climate of Pleistocene.

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