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Early Triassic Conchostracans (Crustacea: Branchiopoda) from the terrestrial Permian–Triassic boundary sections in the Moscow syncline

Frank Scholze [a,d,*], Valeriy K. Golubev [b,d], Grzegorz Niedźwiedzki [c], Andrey G. Sennikov [b,d], Jörg W. Schneider [a,d], Vladimir V. Silantiev [d]

[a] Geological Institute, Technische Universität Bergakademie Freiberg, Bernhard-von-Cotta-Str. 2, 09599 Freiberg, Germany
[b] Borissiak Paleontological Institute, Russian Academy of Sciences, Profsoyuznaya str. 123, Moscow, 117997 Russia
[c] Department of Organismal Biology, Uppsala University, Norbyvägen 18A, 752 36 Uppsala, Sweden
[d] Kazan Federal University, Kremlyovskaya str. 18, 420008 Kazan, Russia

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ABSTRACT

The Permian–Triassic boundary marks the greatest mass extinction in Earth's history. In order to understand the real causes of this severe extinction event, multidisciplinary investigations around the globe are required. Here, the terrestrial Permian–Triassic boundary sections in the Vladimir region, Central Russia, were sampled bed-by-bed for conchostracan study. In the Early Triassic intervals the following taxa were recognized for the first time: *Cornia germari* (Beyrich, 1857), *Euestheria gutta* (Lutkevitch, 1937), *Magniestheria mangaliensis* (Jones, 1862), *Palaeolimnadiopsis vilujensis* Varentsov, 1955, and *Rossolimnadiopsis* Novozhilov, 1958. The wide distribution of *C. germari* demonstrates their high value for biostratigraphy, since this species was also reported from the Lower Buntsandstein Subgroup in the Germanic Basin as well as from Early Triassic deposits in Hungary, Greenland and Siberia. The assumption of an Early Triassic age of the studied sections is also supported by associated *Tupilakosaurus* bone fragments, which point to the *Tupilakosaurus wetlugensis* Zone in the earliest Triassic.

1. Introduction

The Permian–Triassic boundary (PTB) marks the greatest mass extinction in Earth's history. The strongest effects of the end-Permian mass extinction on the biosphere are visible in the marine realm, where over 90% of species died out (e.g., Erwin, 1994). The interval of the extinction is less than 200,000 years (Shen et al., 2011) and debates about the cause include oceanic anoxia (e.g., Wignall and Twichett, 1996), volcanism (e.g., Reichow et al., 2002), asteroidal or cometary impact (e.g., Becker et al., 2001), global cooling (e.g., Roscher et al., 2011), global warming (e.g., Sun et al., 2012), and various combinations of these processes (e.g., Benton and Twichett, 2003). The terrestrial system suffered as well, but the extinction was not as severe as in the oceans (e.g., Erwin, 2006). The investigation of extinction pattern in terrestrial environments is primarily hampered by the inadequate determination of the PTB in nonmarine environments. The lack of volcanic ash beds for isotopic age determination of the critical interval in several of the best investigated terrestrial PTB sections such as in the European part of Russia is challenging the search of alternative time markers like prominent peaks in carbon isotopic values (e.g., Aref'ev et al., 2015), magnetostratigraphic reversals (e.g., Taylor et al., 2009), and abrupt facies changes in the depositional system (e.g., Newell et al., 2010).

The sedimentary successions of the Moscow syncline in the vicinity of the towns of Vyazniki and Gorokhovets, Vladimir region, Central Russia (Fig. 1A), provide a rare chance to study a nonmarine ecosystem of Late Permian to Early Triassic age. Conchostracans represent one of the most abundant faunal elements among a diverse assemblage of nonmarine fossils consisting of tetrapods, fishes, insects, ostracods, bivalves, and plant remains (e.g., Golubev, 2000; Golubev et al., 2012a, b; Krassilov and Karasev, 2008, 2009; Kukhtinov et al., 2008; Owocki et al., 2012; Sennikov and Golubev, 2005, 2006, 2010a,b, 2012, 2013a, b). They form a paraphyletic group of Branchiopoda, now divided into the monophyletic Laevicaudata, Spinicaudata and Cladoceromorpha (Richter et al., 2007). Here we deal with Spinicaudata, but use for convenience the term Conchostraca.

The first conchostracans from Vyazniki were determined to be *Rossolimnadiopsis marlierei* by Novozhilov (1958). Further finds of *Pseudestheria suchonensis*, *Pseudestheria* sp., *Loxomicroglypta* sp. and *Concherisma* sp. were reported by Sennikov and Golubev (2005, 2006). Although conchostracans generally show high value for biostratigraphy in nonmarine sedimentary environments (e.g., Schneider et al.,

* Corresponding author at: TU Bergakademie Freiberg Geological Institute, Department Palaeontology/Stratigraphy Bernhard-von-Cotta-Str. 2 09599 Freiberg Germany. Tel.: 0049 3731 393812.
E-mail addresses: Frank.Scholze@geo.tu-freiberg.de (F. Scholze), vg@paleo.ru (V.K. Golubev), grzegorz.niedzwiedzki@ebc.uu.se (G. Niedźwiedzki), sennikov@paleo.ru (A.G. Sennikov), Joerg.Schneider@geo.tu-freiberg.de (J.W. Schneider), Vladimir.Silantiev@kpfu.ru (V.V. Silantiev).

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