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Aquatic tardigrades in the Great Smoky Mountains National Park, North Carolina and Tennessee, U.S.A., with the description of a new species of *Thulinus* (Tardigrada, Isohypsibiidae)

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Abstract

As part of the All Taxa Biodiversity Inventory (<http://www.dlia.org>), an extensive survey of tardigrades has been conducted in the Great Smoky Mountains National Park (GSMNP) in Tennessee and North Carolina, U.S.A., by Bartels and Nelson. Freshwater tardigrades include three species in the aquatic genus *Thulinus* (Eutardigrada, Isohypsibiidae). A new species, *Thulinus romanoi*, described from stream sediment, is distinguished from all other congeners by having a sculptured cuticle. In addition, the presence of *Thulinus augusti* (Murray, 1907) was verified by combined morphological and molecular analysis, and nine specimens of a third species, *Thulinus* cf. *saltursus*, were also found. *Thulinus augusti* is a new record for the United States. *Thulinus saltursus* (Schuster, Toftner & Grigarick, 1978) was previously recorded in California and Ohio, but our specimens vary slightly in morphology. The list of tardigrades from streams in the GSMNP was updated to a total of 44 species, 22 of which were predominantly or exclusively aquatic.

Key words: biodiversity, biological inventory, Eutardigrada, freshwater meiofauna, Southern Appalachians, *Thulinus romanoi* sp. nov.

Introduction

A large scale, multihabitat inventory of tardigrades (Phylum Tardigrada) in the Great Smoky Mountains National Park (GSMNP), U.S.A. was initiated in 2001 as part of the park's All Taxa Biodiversity Inventory (see www.dlia.org) (Bartels & Nelson 2006; Nelson & Bartels 2007). Tardigrades were collected from aquatic and numerous terrestrial sites, and in 13 freshwater streams, 12 genera were reported, some of which were considered to be "accidentals" while others were predominantly or exclusively aquatic. New material has been collected since those earlier publications, and other specimens in the aquatic samples warranted further taxonomic analysis. Here we update the list of aquatic tardigrades and report on a careful analysis of the genus *Thulinus* in the GSMNP collection. In the genus *Thulinus*, three species were previously listed (Bartels & Nelson 2006; Nelson & Bartels 2007): *Thulinus augusti* (Murray, 1907), *Thulinus stephaniae* (Pilato, 1974), and *Thulinus ruffoi* (Bertolani, 1982). We no longer believe that *T. stephaniae* and *T. ruffoi* exist in our GSMNP collection. One of the currently recognized species, *Thulinus romanoi* sp. nov., is new to science and is described in this paper. Scottish type material of *T. augusti*, another species present in our samples, had previously been studied by Bertolani & Nelson (see: Bertolani *et al.* 1999). In this paper we compare our park samples of *T. augusti* with information on the type material of the species and discuss the species current distribution. *Thulinus* cf. *saltursus* is also compared with its type species description and reported distribution.

small, compared to the more “terrestrial” habitats (e.g. mosses, lichens, leaf litter) (Nelson *et al.* 2010). Our data on GSMNP confirm this generalization, even though the data increase the number of taxa described for that area and for freshwater in general. The relatively low numbers of reported freshwater tardigrade taxa may be explained by the relatively low number of studies related to this environment, but more probably by the ability of terrestrial tardigrades to enter anhydrobiosis. Anhydrobiosis (the ability to cope with desiccation) is advantageous in terrestrial habitats subject to repeated drying because it greatly reduces the number of habitat competitors, predators, and parasites since most animals are unable to carry out this phenomenon. Anhydrobiosis also allows organisms to escape in time from habitat conditions hostile to active life (Guidetti *et al.* 2011). In freshwater habitats anhydrobiosis is not necessary (or possible) and therefore there is more competition to colonize this environment.

This study also shows that a multihabitat research approach can actually discover the rich biodiversity (81 species, 44 of them aquatic species in an area of 2114 km²) of an often neglected group of organisms such as tardigrades. The molecular approach is just beginning for the GSMNP, but it represents a good premise for taxa identification and for further biogeographical studies, especially when combined with thorough morphological analyses. Together with ecological analysis, these multiple approaches will allow us to determine the species diversity of an area and the factors that contribute to biodiversity in general.

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