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Endemic Lake Baikal sponges from deep water. 1: Potential cryptic speciation and discovery of living species known only from fossils

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Abstract

We revealed new deep-water species and cryptic speciation within freshwater sponges of the endemic family Lubomirskiidae (Porifera; Demospongiae; Spongillina) based on molecular and spicule morphology analyses of ITS and CO1 mtDNA. Lubomirskiidae contains a group of closely related species which are a dominant component of the benthos in Lake Baikal, the world's deepest and most ancient lake. Spicule morphology was similar between two Recent samples and species only known previously from fossils in Late Pliocene (3.2–2.8 mya) sediments. Despite the morphological similarity with the cosmopolitan family Spongillidae, molecular analysis of ITS sequences has reliably assigned these species to Lubomirskiidae. This not only indicates that species identification of freshwater fossil sponge spicules should be made with caution, but also suggests that the structure of megascleres may not be a reliable character for interpretations of paleoclimatic reconstructions for the Baikal region. Our results do not support the current classification of Lubomirskiidae into its morphologically defined genera and species, suggesting a strong discrepancy between molecular and morphological variation in Baikalian sponges. This present contribution is the first part of a study on the phylogenetic relationships of the Lake Baikal deep water sponge fauna.

Key words: freshwater sponges, Porifera, Lake Baikal, molecular phylogeny, deep-water species

Introduction

Lake Baikal is the oldest and deepest lake in the world. The age of the basin is estimated as 25–30 million years and its maximum depth is measured at 1,637 m (Timoshkin 1995). Its water circulation allows oxygenation down to deepest points of the lake. This facilitates the habitation of Lake Baikal at all depths including the "abyssal" area (defined as below the dimictic layer at 250m, see Martin *et al.* 2005) in contrast with other deep ancient lakes of the world, which are thermally stratified and often anoxic at depth. Due to Lake Baikal's age and variety of ecological niches a unique fauna and flora has evolved, with an estimated number of 40% endemic species (Timoshkin 1995). Many representatives of the Baikalian fauna are regarded as true sister species and this rich fauna provides particularly favorable opportunities for studying patterns of speciation (Fryer 1996; Sherbakov 1999).

Sponges (Porifera) comprise the oldest extant and most primitive metazoan phylum with origins in pre-Cambrian times (Bergquist 2001). There are about 8,500 described species of Porifera that are considered valid, with a total of at least 17,000 species estimated to be living worldwide in fresh and marine water bodies (Van Soest *et al.* 2012). Sponges are sessile filter-feeding organisms, which have colonized most aquatic habitats from polar seas to tropical waters and contribute in some places to up to 80% of benthic biomass (Bergquist 2001). Deep-water sponge grounds constitute main components of deep marine ecosystems and create habitats for a wide range of other species (Longo *et al.* 2005; Roberts *et al.* 2000; Van Soest *et al.* 2007; Van Soest & Lavaleye 2005). Sponges are among the most prolific sources of bioactive natural products, some of which have been isolated exclusively from deep-water species (Na *et al.* 2010; Plaza *et al.* 2010; Newman & Cragg 2012).

Deep-water sponge grounds are shown to be reservoirs of rare and undescribed species and many biodiversity

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