A new potamolepid freshwater sponge (Demospongiae) from the Miocene Nakamura Formation, central Japan

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Abstract. The freshwater sponge Oncosclera kaniensis sp. nov. of the demosponge family Potamolepidae is described from the Early Miocene Nakamura Formation (Mizunami Group) in Gifu Prefecture, central Japan. This is the first fossil record of the Potamolepidae in the world and also is the first documentation of fossil sponges from the Nakamura Formation. Paleoecology of Oncosclera kaniensis sp. nov. is briefly discussed.

Key words: freshwater sponge, Potamolepidae, Oncosclera, Early Miocene, Nakamura Formation

Introduction

A number of well preserved sponges assignable to a new species of the genus Oncosclera Volkmer-Ribeiro, 1970 of the family Potamolepidae (Demospongiae) were recovered from the Early Miocene Nakamura Formation, Mizunami Group in Gifu Prefecture, central Japan. This is the first fossil record of the genus Oncosclera as well as of the family Potamolepidae. The discovery dramatically extends the fossil record of the family Potamolepidae back to the Early Miocene. Recent species of potamolepid sponges are distributed in South America, Africa, and Asia, and have been considered as Gondwanian elements (Volkmer-Ribeiro and De Rosa-Barbosa, 1978). The discovery of a fossil potamolepid sponge from Japan is very important for future paleogeography and phylogenetic analysis. The purpose of this paper is to describe a new species and discuss its paleoecology.

Geologic setting

The fossil sponges were collected from tuffaceous sandstone exposed on a riverbed of the Kiso River, Dota area of the Minokamo basin, Kani City, Gifu Prefecture, central Japan (Figure 1). Distributed in this riverbed is the Mizunami Group, a stratotype of the Lower to Middle Miocene in Japan, that is composed of nonmarine sediments, while the group is composed of marine sediments in the neighboring Mizunami and Iwama basins.

A recent detailed lithostratigraphical study of the Mizunami Group along the Kiso River in the Minokamo basin by Shikano (1995) has shown that the group can be divided into three formations in ascending orders: the Hachiy a Formation, Nakamura Formation, and Hiramaki Formation.

The Nakamura Formation, from which the fossil sponges were recovered, is 130 m thick, of fluvial and lacustrine origin, and subdivided into the Lower Member, Middle Member, and Upper Member. The potamolepid sponges described here were recovered from a sandstone layer of the Upper Member, about 2 m below the contact with the Hiramaki Formation (Figure 2). The Upper Member is estimated to be 30 m thick and consists of tuffaceous mudstone, sandstone, conglomerate, and lignite. The basal layer of the Upper Member consists of massive tuff, and was dated as 21.7 ± 1.5 Ma by the fission track method (Shikano, 1995).

The sponge-bearing sandstone layer is ill-sorted and contains much granular material and organic debris. Other fossils associated in this sandstone layer are diatoms, macroplants, molluscs, fishes, and mammals. The fossil molluscs in this sandstone include an undescribed viviparid gastropod, Bellamyia sp. and undetermined unionid bivalves such as Anodonta sp. and "Unio" sp. The fossil fishes were identified as Cypris sp., Cyprinidae gen. et sp. indet., and Cultrinae gen. et sp. indet. (Yasuno, 1982; 1983). The fossil molluscs and cyprinids are all permanent freshwater dwellers. The fossil mammals from the sandstone layer are Plesiosorex sp., Amphialagus sp., Youngofiber sinensis, Anchitheriomys sp., Pseudootheridomy sp., and Aepomys (?) sp. (Tomida and Setoguchi, 1994; Tomida and Goda, 1995; Tomida et al., 1995).

Systematic description

Class Demospongiae Sollas, 1885
Order Hadromerida Topsent, 1894
Family Potamolepidae Brien, 1967
Genus Oncosclera Volkmer-Ribeiro, 1970
Type species: *Spongilla jemelli* Volkmer, by original designation.

**Diagnosis.** — Megascleres slightly curved, stout, occasionally microspined, amphioxea to amphistrongyla. Microscleres absent. Gemmoscleres short, stout, feebly curved, extremely variable, amphistrongyla or amphioxea, swollen at central portion, usually spined; spines more numerous at both ends.

**Discussion.** — Brien (1967) proposed the new family Potamolepidae for the Ethiopian genera *Potamolepis* and *Potamophloios*. The family consists of six genera: *Oncosclera, Uruguaia, Sterrostrolepis, Potamolepis, Potamophloios*, and *Stratospongilla*, and the family is considered to have been derived from a certain marine group of the order Hadromerida (Volkmer-Ribeiro and De Rosa-Barbosa, 1978). Of the six genera above, *Oncosclera, Uruguaia and Sterrostrolepis* from South America have been thought in part to be relicts of the Gondwanian fauna (Volkmer-Ribeiro, 1981).

Figure 3. Oncosclera kaniensis sp. nov. 1. Sponge bodies encrust the postero-ventral area of the left valve of Anodonta sp., TMNH-02882 (paratype), ×1. 2. Enlargement of the sponge bodies of TMNH-02882, ×2.1. 3. Sponge bodies encrust the surface of Anodonta sp., vertical section, TMNH-02889a (paratype), ×1.2. 4. Sponge bodies encrust the surface of a cortex fragment (black color), TMNH-02881 (holotype), ×1.2. 5. Attached surface of sponge bodies, TMNH-02886 (paratype), showing the outline of the gemmules represented by ring spots, ×2.0. 6. Sponge bodies encrust the surface of a wood fragment, TMNH-02887, ×1.2.

Oncosclera kaniensis sp. nov.

Figures 3-5

Type locality.—Riverbed on the Kiso River, Dota, Kani City, Gifu Prefecture, Japan (Figure 1).

Etymology.—The species name is after Kani City, the municipality of the type locality.

Material studied.—Twenty-two specimens. Holotype: TMNH-02881 a-m, on 13 isolated blocks. Paratypes: TMNH-02885, 2883a, b, 02882, 02884 a, b, 02886. All deposited in the Toyohashi Museum of Natural History.

Diagnosis.—A species of Oncosclera characterized by
domination of amphistrongylous megascles, small amount of amphioxous megascles, amphistrongylous gemmoscles, and dense covering of spines at both ends.

**Description.** — Sponge encrusting shell surfaces of bivalve and wood fragments. Sponge surface even and generally less than 1 mm in thickness. Skeletal components consisting of megascles and gemmoscles. Gemmules with round spots, firmly adhering to basal part of sponge body, about 500 μm in diameter, but compressed subspherically. Megascles moderately small, almost straight, solid, amphistrongyla to amphioxea, covered with distinct spines at both ends, 100 to 179 μm in length and 7 to 15 μm in thickness. Majority of megascles stout and cylindrical amphistrongyla (Figure 4.1), occasionally with a few intermixed true amphioxea (Figure 4.2). Microscleses absent. Gemmoscles stout, variably curved, inflated at middle (Figure 4.3–4.5); amphistrongyla densely covered with distinct spines that are numerous at both ends; some of spines polyfurcate, and inner curved area smooth, 23 to 100 μm in length, 4 to 7 μm in thickness.

**Comparison.** — The present new species is assigned to the genus Oncosclera in its shape and surface ornamentation of megascles and gemmoscles. The new species is similar to the following Recent species from Argentina: *Oncosclera ponsi* (Bonetto and Ezcurra, 1968), *Oncosclera atrata* (Bonetto and Ezcurra, 1970), and *Oncosclera tonollii* (Bonetto and Ezcurra, 1968). Of the three species *O. kaniensis* sp. nov. is most similar to *Oncosclera ponsi* in spicular components, but it differs in having spinose amphioxous megascles. The present new species differs from *Oncosclera atrata* from the Parana River, Argentina in having amphistrongyla densely covered with distinct spines at both ends of the gemmoscles. It also differs from *Oncosclera tonollii* from the Uruguay River, Argentina (Bonetto and Ezcurra, 1967) in having a less spinose surface of gemmoscles and megascles. This new species has gemmoscles similar to the Recent species *Oncosclera jewelii* (Volkmer, 1963) known only from the Tainhas River of Brazil (Volkmer-Ribeiro, 1970) and *O. schubarti* (Bonetto and Ezcurra, 1967) from the Uruguay River, Argentina, but differs distinctly from the latter species in its spine amphistrongylous and amphioxous megascles.

**Paleoecology.** — Potamolepids commonly have highly silicified skeletons and lack spongion fibers. Many species of the genus *Oncosclera* encrust stable bottom surfaces in streams. *Oncosclera atrata* inhabits a curved bank of a tributary of the Parana River in the Misiones Province, Argentina, where it encrusts surfaces of partially submerged rocks (Bonetto and Ezcurra, 1970). *Oncosclera jewelii* and *O. tonollii* encrust rocky bottoms in rapid and turbulent waters in the Uruguay River (Bonetto and Ezcurra, 1968). Both species grow in the upper and lower surfaces of the rocks, and the sponges encrusting the lower surfaces are disposed to grow exuberantly. *Oncosclera jewelii* in the Tainhas River of Brazil also encrusts exclusively stable bottom surfaces in fast streams close to rapids and/or falls. *Oncosclera navicella* in the Amazon River of Brazil and Iguazu Fall of Argentina, on the other hand, encrusts ligaments and valves of the living freshwater bivalve *Anodontites trapesialis forbesianus* and *Paxyodon symmatophorus* (Volkmer-Ribeiro, 1970; Tavares and Volkmer-Ribeiro, 1997).

*Oncosclera kaniensis* sp. nov. is represented entirely by fossilized sponge bodies and encrusts two types of substrates: shell surface of the unionid bivalve *Anodonta* sp. (Figure 3.1–3.3) and surface of wood fragments (Figure 3.4–3.6). The sponge bodies on the unionid bivalve encrust the ventral and posterior parts of almost horizontally embedded articulated valves that are preserved as composite moulds (Figure 6.1). They also encrust the outer surfaces of isolated valves that are diagnostically compacted and embedded with the convex side up (Figure 6.2). The sponge bodies also encrust strongly compacted woods almost entirely (Figure 6.3) and encrust partly the wood fragments that remain in possession of annual rings (Figure 6.4). The shells and wood fragments may have provided hard substrates for colonization of the fossil sponges in the soft bottom environment. The gemmules of *O. kaniensis* sp. nov. can be seen by naked eye as ring spots. The gemmules of the fossils are located at the basal portion of the sponge as in *O. jewelii* and *O. navicella* (Figure 3.5). These facts strongly suggest that *O. kaniensis* sp. nov. dwelled in a river like the Recent *Oncosclera* species and had a habitat preference to the upper and lower surfaces of hard substrates (Figure 6.5–6.8). The unusual preservation of the megascles and gemmoscles of *O. kaniensis* sp. nov. may have resulted from its comparatively stout skeleton, strong attachment to the substrates and rapid burial after death.

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Figure 5. SEM micrographs of *Oncosclera kaniensis* sp. nov. 1. Gemmule, vertical section, scale bar=100 µm. 2. Amphistrongylos mesascleres, scale bar=50 µm. 3. End parts of amphistrongylos mesascleres, scale bar=10 µm. 4. End parts of amphioxeos mesascleres, scale bar=5 µm. 5. Gemmoscleres, scale bar=10 µm. 6. Gemmoscleres, scale bar=10 µm. 7. End parts of gemmoscleres, scale bar=5 µm.
Figure 6. Mode of occurrences of *Oncosclera kaniensis* sp. nov. 1-4. Four types of encrustation. 1. Sponge bodies encrust an articulated valve of the unionid bivalve *Anodonta* sp. The bivalve is embedded with its comissure plane almost horizontal and is preserved as a composite mould. 2. Sponge bodies encrust the outer surface of an isolated valve of the unionid bivalve *Anodonta* sp. The valve is compacted diagenetically. 3. Sponge bodies encrust a strongly compacted wood fragment almost entirely. 4. Sponge bodies encrust a wood fragment that retains its annual rings. 5-8. Reconstruction of the four types of encrustation for 1 to 4, respectively.

References


