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# First evidence of an extant freshwater sponge fauna in Jackson Lake, Grand Teton National Park, Wyoming (USA)

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**ABSTRACT**

Skeletal remains of freshwater sponges are important microfossils that may be preserved in the sediments of inland waters, but much is still unknown about the sponge fauna of the Nearctic, which limits their use in paleoenvironmental reconstructions. Here, we report the first evidence of an extant freshwater sponge fauna in Jackson Lake, Grand Teton National Park, Wyoming (USA). Two sponge species were identified living in shallow littoral and shoreline environments: *Eunapius fragilis* (Leidy 1851) and *Ephydatia muelleri* (Lieberkühn 1856). The spicules of *Eunapius fragilis* present high morphological variability, in contrast to gemmuloscleres reported in specimens from lakes and rivers in southern South America and eastern North America. *Ephydatia muelleri* also exhibits morphological differences in comparison to published examples, chiefly related to the spines on megascleres. The megascleres of *Ephydatia muelleri* are straight or slightly curved, sharpening gradually toward the apices, with completely smooth surfaces (13%), surfaces with minimal spines (65%), or highly spined surfaces in the central area (22%). These morphological differences in the *Ephydatia muelleri* megascleres suggest the potential for ecophenotypic effects in Jackson Lake. Furthermore, the morphological and ecological variability of *Eunapius fragilis* and *Ephydatia muelleri* observed in Jackson Lake suggest the need for further studies of the Nearctic to understand if a species complex exists or if morphological dissimilarities are indicative of true taxonomic differences and therefore multiple new species. This study expands the biogeography of freshwater sponges and provides the first documentation of benthic sessile filter feeders in Jackson Lake, a key source of ecosystem services.

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## Introduction

Sponges are sessile benthic filter feeders whose fossils have been recorded in the geological record since the Precambrian (Li et al. 1998, Sperling et al. 2007). Freshwater sponges are metazoans often overlooked by aquatic scientists, yet they play a key role in ecosystem structure and function within inland aquatic settings (Skelton and Strand 2013, Pinheiro and Calheira 2020). Freshwater sponges (Porifera: Order Spongillida) are found in various aquatic and semi-aquatic habitats worldwide, from cold deserts in the high latitudes to tropical and equatorial rainforests (Manconi and Pronzato 2008). Sponges colonize virtually all inland aquatic environments, including groundwater springs, wetlands, freshwater lakes, thermal vents, saline–alkaline lakes, peat lands, and rivers. They have been documented in all zoogeographic regions except for Antarctica (e.g., De Santo and Fell 1996, Økland and Økland 1996, Barton and Addis 1997, Manconi and Pronzato 2008, Volkmer-Ribeiro and Machado 2009, Manconi et al. 2013, Rasbold et al. 2019). Moreover, sponges also colonize constructed reservoirs and artificial ponds in zoological–botanical gardens (Manconi and Pronzato 2008, Volkmer-Ribeiro et al. 2010, Jakhalekar and Ghate 2016).

Currently the world's freshwater sponge fauna consists of ∼268 species, (De Voogd et al. 2022). In the Nearctic biogeographic region, 32 species have been described thus far, of which 17 are endemic, belonging to 14 genera in 2 families (Manconi and Pronzato 2008, 2016). Because of their siliceous spicules, sponge remains are often well preserved in sediments. Yet, despite their abundance in sediments, sponge spicules are often underutilized as biological indicators in paleoenvironmental studies. In this context, some of the widest application has been in tropical floodplain settings because of the existence of well-documented taxonomic guides for low latitude riverine ecosystems (e.g., Harrison 1988, Frost 2002, McGlue et al. 2012, Tripathi et al. 2017, Guerreiro et al. 2018, Rasbold et al. 2019, Łukowiak 2020, Rasbold et al. 2021). By comparison, the application of sponge fossils for interpretations of

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ancient marine ecosystems is more widespread (e.g., Molina-Cruz 1991, Murchey and Jones 1992, Pratt 2002, Barron et al. 2009, Snelling et al. 2014).

Despite the high percentage of endemism in the Nearctic zoogeographic region (Molina-Cruz 1991, Murchey and Jones 1992, Pratt 2002, Barron et al. 2009, Snelling et al. 2014), laws or international conventions have yet to protect freshwater sponge species. This lack can perhaps be attributed to the scarcity of studies, even though the Porifera of North American inland waters have been reported since the late 1800s (e.g., Manconi and Pronzato 2016). The extant fauna in the Nearctic is composed of 3 families of the order Spongillida (Metaniidae, Spongillidae, and Potamolepidae; Copeland et al. 2015). In the geological record, the Potamolepidae family has also been documented in middle Eocene strata from northern Canada, which has provided insights on ancient biogeography and paleoclimate (Pisera et al. 2013). Apart from Pisera et al. (2013), other reports of sponge fossils as environmental or hydrological indicators in Nearctic continental settings are rather limited (e.g., Paduano and Fell 1997, Dunagan 1999).

Few records of living sponges are available from high elevation mountain lakes in the Nearctic, and as a result, the distribution in this region is not well understood. Smith (1921) recorded 4 freshwater sponge species from Colorado—*Ephydatia fluviatilis* (Linnaeus, 1759), *Eunapius fragilis* (Leidy 1851), *Ephydatia muelleri* (Lieberkühn 1856), and *Spongilla lacustris* (Linnaeus, 1759)—in habitats at altitudes ranging from 2470 to 3225 m a.s.l. More recently, a study by Barton and Addis (1997) documented 3 sponge species—*Ephydatia muelleri*, *Eunapius fragilis*, and *S. lacustris*—in lakes in western Montana between 884 and 2911 m a.s.l. High elevation mountain lakes are aquatic ecosystems that often exhibit considerable habitat isolation, affording the potential for speciation and the development of endemism. This isolation is particularly true for long-lived montane lakes formed through tectonic processes. For example, *Racekiela andina* Hernández and Barreat 2017 is the first freshwater sponge species reported for the Venezuelan Andes, and current research suggests it is endemic, but the genus *Racekiela* ranges from eastern North America to the British Isles, Faroe Islands, and Norway (Hernández and Barreat 2017, Manconi and Pronzato 2002). Another example is the endemic species *Balliviaspongia wirrmanni* Boury-Esnault and Volkmer-Ribeiro 1991 described from Lake Titicaca in Bolivia (Boury-Esnault and Volkmer-Ribeiro 1991). High elevation, long-lived lakes influenced by tectonism are less common in the Nearctic because many, if not most, lakes from this region formed during the last glaciation.

Studying sponges broadens our knowledge of biotic interactions in continental aquatic ecosystems and provides insights into water quality. In this study, we describe the first evidence of a sponge fauna in Jackson Lake, western Wyoming, USA (Fig. 1). Our discovery of these sponges is important for understanding the Jackson Lake benthic ecosystem as well as for expanding the biogeography of freshwater sponges in the Nearctic. Moreover, Jackson Lake sediments hold great promise for reconstructing the Quaternary climate and ecology of western Wyoming, an area sensitive to drought and prone to wildfires (Whitlock 1993, Hostetler et al. 2021). Therefore, knowledge of the environmental conditions associated with the extant fauna may improve paleoenvironmental reconstructions made using fossils.

## Material and methods

### *Study site*

Jackson Lake (2072 m a.s.l.) is the largest piedmont lake in Grand Teton National Park (GTNP) and one of the largest mountain lakes in the western United States, with a surface area of ~103.3 km$^2$ (White et al. 2009). Jackson Lake was partially excavated in the late Pleistocene (~15.5–14.4 ka) by glaciers, but its location adjacent to the seismically active Teton fault likely played a role in its evolution (Licciardi and Pierce 2018, Thigpen et al. 2021). The region is recognized as one of the highest seismic hazard areas in the continental United States (White et al. 2009, DuRoss et al. 2019, Larsen et al. 2019). A dam was placed over the lake outlet in the early 20th century to improve irrigation and court homesteaders to the Upper Snake River Valley (Stene 1993, Marston et al. 2005). Conversion to a reservoir led to a ~12 m rise in lake level elevation, and today at full pool Jackson Lake is ~140 m deep. This rise in lake level elevation led to flooding of the Snake River delta along the now-expanded northern axis of the lake (Fig. 1). Areas of deep water are localized along the western margin of the lake, whereas the eastern margins are considerably shallower with numerous islands dotting the nearshore area.

The Snake River and its tributaries drain the Teton Range, the Absaroka Mountains, and the Yellowstone Plateau. The regional bedrock consists chiefly of Precambrian metasediments and Cretaceous volcanoclastic rocks (Love et al. 1978). Nutrient loads of the Snake River north of Jackson Lake have low concentrations of nitrogen, phosphorus, and iron and a dominance of sodium and bicarbonate ions (Clark et al. 2004). Concentrations of calcium ranged from 14.2 to 25.1 mg/L

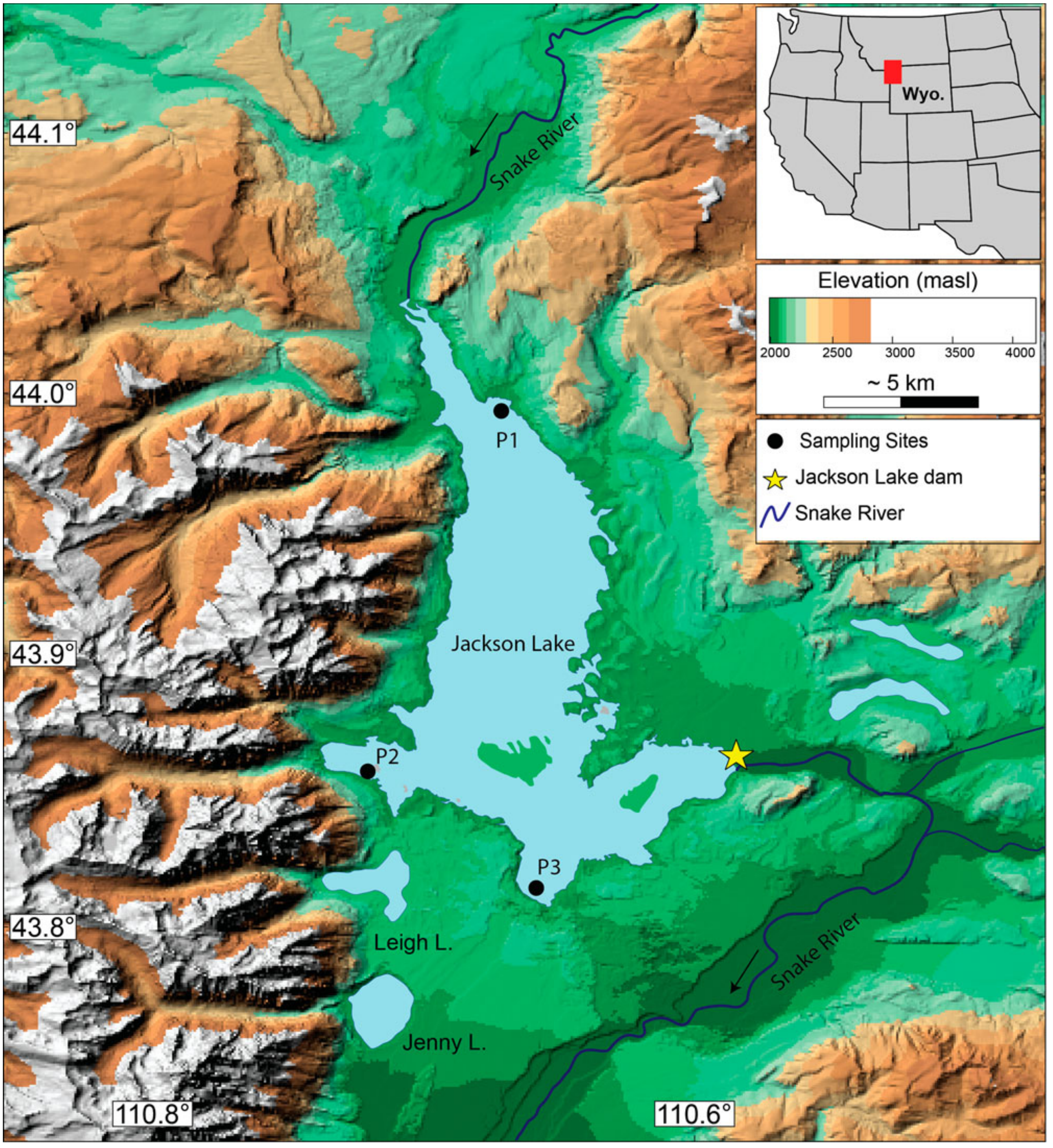


**Figure 1.** Jackson Lake, Grant Teton National Park, Wyoming, USA, and sampling sites of freshwater sponges in the lake shoreline.

in the Snake River just north (<10 km) of its delta in Jackson Lake (Clark et al. 2004).

The climate of the region is *Dsc* (dry-summer subarctic) according to the Köppen classification, with cold and snowy winters and warm and dry summers (Whitlock 1993). Regionally, annual precipitation ranges up to ~1500 mm in the Teton range adjacent to the lake, with lower amounts in the Jackson Hole valley (Despain 1987). The Snake River watershed is heavily vegetated, covered mostly with subarctic pines and grasses, and wildfires are common.

Extensive research into the limnology of Jackson Lake is lacking. The limited available data indicate that Jackson Lake is oligotrophic to mesotrophic, with Secchi depths ranging from 4.0 to 5.9 m and an effective photic zone down to ~14 m (Kilham et al. 1996, Wurtsbaugh 2014).

### *Taxonomic identification*

Sponges were discovered in Jackson Lake in summer 2019 during shoreline surveys and nearshore sediment sampling using a Ponar grab sampler. Specimens were collected at each site (Fig. 1), and sampling stations were registered using hand-held GPS (Table 1). After collection, specimens were dried and sampled for taxonomic analysis of spicules. Samples from each specimen were archived in the Porifera collection of the Federal University of Pernambuco (Brazil), preserved in 70% ethanol. To disarticulate the sponge skeleton and prepare the spicules for observation under the optical microscope (OM) and scanning electron microscope (SEM), a fragment of the sponge was placed in a centrifuge tube, immersed in nitric acid (5 mL), and heated over a lamp flame. Following digestion, the samples were centrifuged and the supernatant was siphoned off. The spicules were then washed with distilled water and ethanol. Repeated rinses and centrifugation continued until a neutral pH was achieved, after which the spicules were mounted on a microscope slide (Hajdu et al. 2011).

Taxonomic identification was performed through visual analysis of spicules and gemmules ($n = 500$) using light microscopy (LM) and photographed using SEM, according to the methods described by Hajdu et al. (2011). We measured the length and width ($n =$ 60, minimum-mean-maximum: mean underlined) of the spicules and the diameter of gemmules where possible. These morphometrics were compared with other *Eunapius* and *Ephydatia* species using publicly available data mined from the World Porifera Database (De Voogd et al. 2022).

## Results

We identified 2 sponge species in Jackson Lake, *Eunapius fragilis* (Leidy 1851) and *Ephydatia muelleri* (Lieberkühn 1856). For *Ephydatia muelleri* we observed considerable morphological variability in the megascleres relative to published examples. Three types of megasclere were identified for *Ephydatia muelleri*: (1) spicules with completely smooth surfaces, (2) spicules with a few spines, and (3) spicules with densely spined surfaces in the central axis (e.g., Ezcurra de Drago 1976).

**Table 1.** Sample sites for freshwater sponges in Jackson Lake, Grant Teton National Park, Wyoming, USA.

| Site | Species | Latitude (DD) | Longitude (DD) | Substrate | Depth (m) |
|---|---|---|---|---|---|
| P1 | *Eunapius fragilis* | 44.002 | −110.686 | Trunk | 0.5 |
| P2 | *Eunapius fragilis* | 43.857 | −110.748 | Trunk | 0.3 |
| P3 | *Ephydatia muelleri* | 43.808 | −110.673 | Trunk | 0.5 |

Phylum Porifera Grant, 1836
Class Demospongiae Sollas, 1885
Order Spongillida Manconi and Pronzato 2002
Family Spongillidae Gray 1867
Genus *Eunapius* Gray 1867
*Eunapius fragilis* (Leidy 1851)
Synonymy: *Spongilla fragilis* Leidy 1851

*Eunapius fragilis*: Penney and Racek (1968), Ricciardi and Reiswig (1993), Pronzato and Manconi (2001), Manconi and Pronzato (2002, 2007), Frost et al. (2010)

**Diagnosis.** Species of *Eunapius fragilis* characterized by the presence of oxea megascleres with one category of gemmuloscleres strongyles with abundant spines.

**Description.** Growth form encrusting tree trunks and pebbles, 5–10 mm in thickness, consistency soft, gelatinous in vivo, fragile in the dry condition. Color bright brown in vivo and creamy white when dry (Fig. 2a, c). Megascleres oxeas (145.2–<u>252.9</u>–337.7 / 6.6–<u>11</u>–15.7 μm for length/width [Table 2]) straight or slightly curved, sharpening gradually toward the apices (Fig. 3a). Gemmuloscleres strongyles usually curved and straight (59.3–<u>84.9</u>–133.1/5.6–<u>8.0</u>–11 μm) covered with abundant spines (Fig. 3d). Gemmules (diameter: 194.6–<u>313.7</u>–505.5 μm) are enclosed in a common brown coat, forming a pavement layer cemented to the substrate (Fig. 2b).

**Ecology.** Specimen found encrusted on submerged pebbles from littoral zone (6.1 m depth) and shoreline-proximal submerged tree trunks (0.5 m depth).

**Type locality.** Jackson Lake, Grant Teton National Park, Wyoming, USA.

Phylum Porifera Grant, 1836
Class Demospongiae Sollas, 1885
Order Spongillida Manconi and Pronzato 2002
Family Spongillidae Gray 1867
Genus *Ephydatia* Lamouroux, 1816
*Ephydatia muelleri* (Lieberkühn 1856)
Synonymy. *Spongilla mülleri* Lieberkühn 1856

*Ephydatia muelleri*: Smith (1921), Penney and Racek (1968), Ezcurra de Drago (1975, 1976), Manconi and Pronzato (2002, 2007), Pronzato and Manconi (2001), Frost et al. (2010).

**Diagnosis.** Species of *Ephydatia muelleri* characterized by the presence of categories of megascleres, and

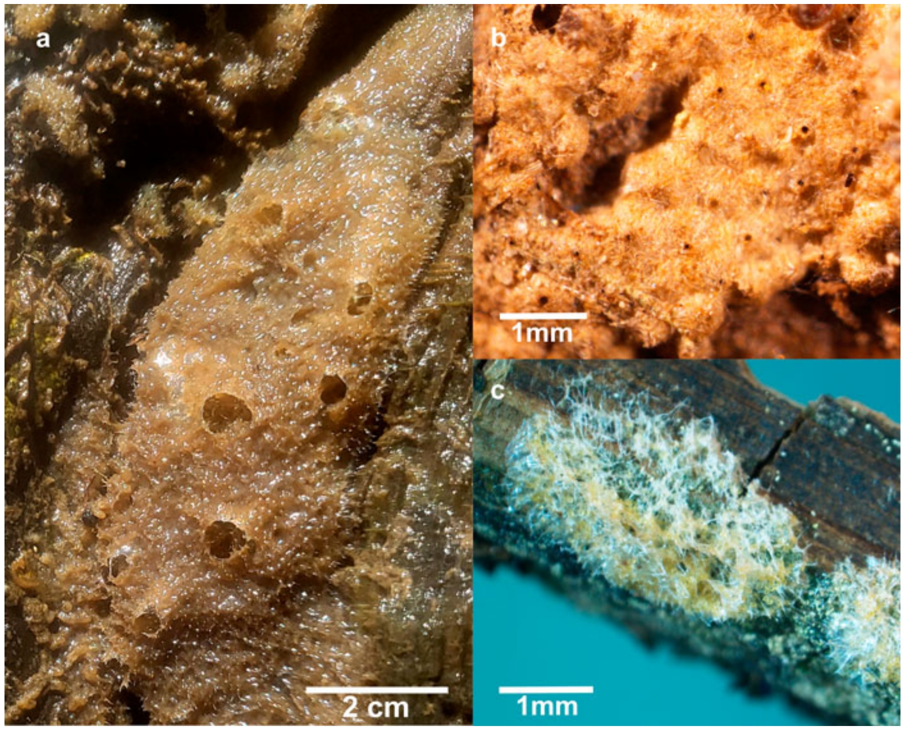


**Figure 2.** *Eunapius fragilis* (Leidy 1851). (a) Specimen in vivo; (b) dry specimen and detail of the gemmules; (c) dry specimen.

one category of gemmuloscleres birotules, with a short, thick, smooth shaft, and rotules with indented margins.

**Description.** Growth from thinly encrusting tree trunks to slightly massive, 5–10 mm in thickness. Consistency soft and gelatinous in vivo, fragile in the dry condition. Color bright brown in vivo and creamy white when dry (Fig. 4a, c). Megascleres oxeas straight or slightly curved, sharpening gradually toward the apices, with completely smooth surface (13%), with a few spines (65%), and highly spined surface in the central area (22%). In total, 87% of megascleres presented spines (Fig. 5a, 6, and Table 3).

Gemmuloscleres birotules, with a short, thick, smooth shaft, and rotules with indented margins (Fig. 5d–e and Table 3). Gemmules (285.0-353.5-407.5 μm) subspherical, relatively abundant, and scattered singly in the choanosomal skeleton or clusters at the sponge base (Fig. 4c and 5b)

**Ecology.** Specimen found encrusted on submerged tree trunks (0.5 m depth).

**Type locality.** Jackson Lake, Grant Teton Nation Park, Wyoming, USA.

**Table 2.** Spicule micrometrics of *Eunapius fragilis*. Measurements are shown as minimum-mean-maximum. Values before and after the dash (/) are length and width, respectively.

| Reference | Locality | Megasclere oxea (μm) | Gemmulosclere strongyles (μm) | Gemmule (μm) |
|---|---|---|---|---|
| UFPEPOR2726 | Site 1, Jackson Lake, Wyoming, USA | 200-253.1-283/8-10.8-12 | 59-81.3-126/6-8.2-10 | 194-322.4-442 |
| UFPEPOR2727 | Site 1, Jackson Lake, Wyoming, USA | 145-226.5-298/6-10.2-16 | 63-83.2-111/5-8.1-11 | — |
| UFPEPOR2728 | Site 2, Jackson Lake, Wyoming, USA | 200-264.9-338/8-11.1-14 | 64-84.4-133/6-7.8-11 | 231-305.1-505 |
| Potts (1887)* | Delaware and Schuylkill Rivers, USA | 205.7 | 68.6 | — |
| Barton and Addis (1997) | Western Montana, USA | 90-275-392/2-9.5-14 | 30-79-148/3.5-6.0-8.0 | 250-500 |
| Ricciardi and Reiswing (1993) | Eastern Canada | 165-189-261/4-10-14 | 32-57-121/3-5-8 | — |
| Manconi et al. (2008) | Mudzi River, South-Eastern Africa | 319-426/9-13 | 84-132/3-6 | — |
| Oscoz et al. (2009) | Zadorra River, Spain | 174-204-224 | 62-87-150 | — |
| Oscoz et al. (2009) | Ebro River, Spain | 195-218-232 | 70-83-132 | — |
| Ezcurra de Drago (1974) | Panguipulli Lake, Chile | 200-325/8-17 | 110-140/6-8 | — |
| Ezcurra de Drago (1974) | Calle-Calle River, Chile | 200-325/8-17 | 70-120/6–9 | — |
| Bonetto and Ezcurra de Drago (1964) | Setúbal and Don Pancho lakes, Argentina | 260-375/12-21 | 140-210/5–7 | — |
| Penney and Racek (1968) | Europe, North America, Africa, Australia | 180-270/5-12 | 75-140/2-7 | — |
| Tavares et al. (2003) | Rio Grande do Sul State, Brazil | 170-237-290/7.5-11.95-17.5 | 90-130.2-175/5-9-12.5 | — |

*Measurements performed in type during species redescription.

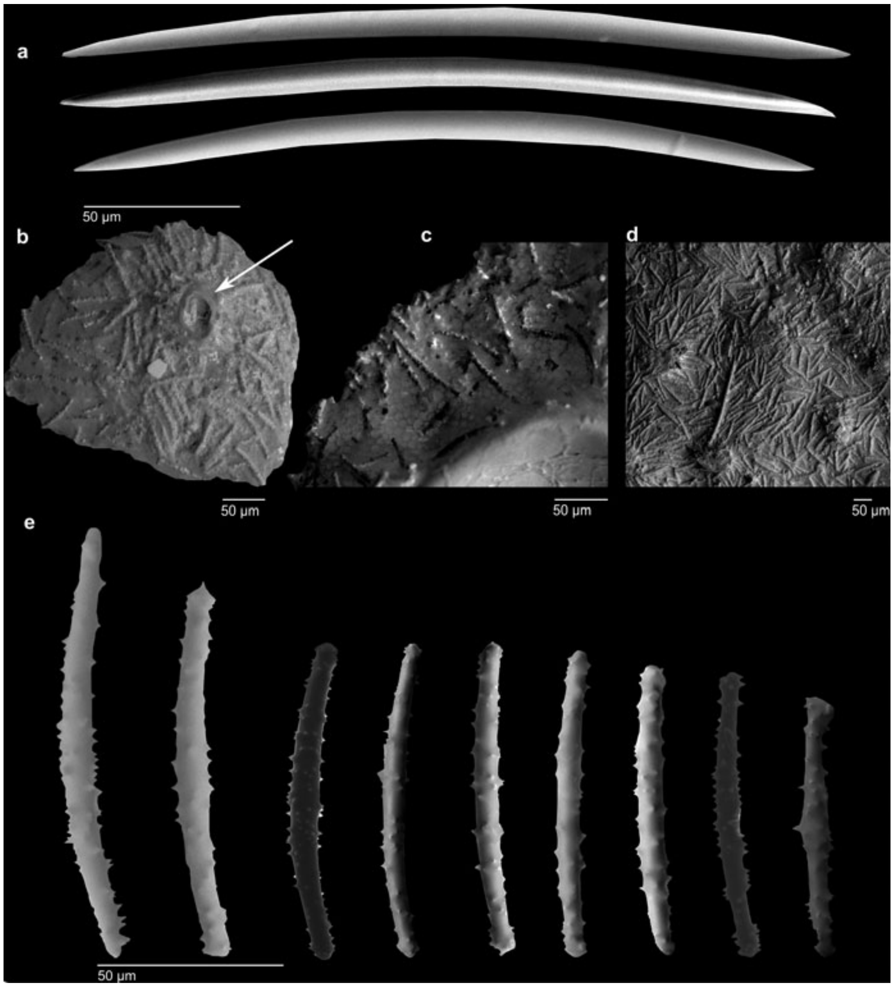


**Figure 3.** Scanning electron microscope (SEM) images of spicules of *Eunapius fragilis* (Leidy 1851). (a) Megascleres: oxeas; (b–d) detail of gemmule surface with gemmuloscleres embedded; (e) Gemmuloscleres: strongyles with abundant spines.

## Discussion

Ricciardi and Reiswig (1993) reported the occurrence of *Eunapius fragilis* widely distributed in calcium-rich soda lake habitats across eastern Canada. In waters with high calcium, *Eunapius fragilis* forms thin and uniform encrustations, for example in near-shore areas of Lake Michigan (Jewell 1939, Lauer et al. 2001). In the lakes of Louisiana (USA), *Eunapius fragilis* has been found living in lentic environments with pH ranging from 6.5–8.7 and temperatures from 23 to 34 °C (Poirrier 1969). In Norway, Økland and Økland (1996) found *Eunapius fragilis* in calm, low-altitude (3–341 m a.s.l.) lakes with alkaline waters with pH values up to 9.6. In Montana, *Eunapius fragilis* and *Ephydatia mullieri* occurred in lakes with calcium and magnesium concentrations of 2.0–39.4 and 0.0–12.8 mg/L, respectively (Barton and Addis 1997). These ranges are broadly in-line with our findings,

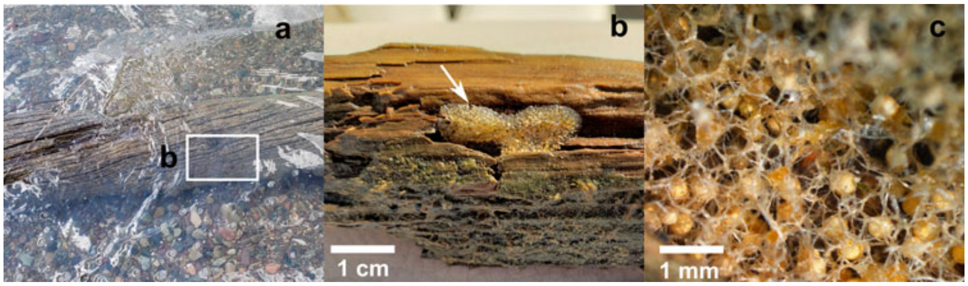


**Figure 4.** *Ephydatia muelleri* (Lieberkühn 1856); (a–b) specimen in vivo; (c) dry specimen and detail of the gemmules.

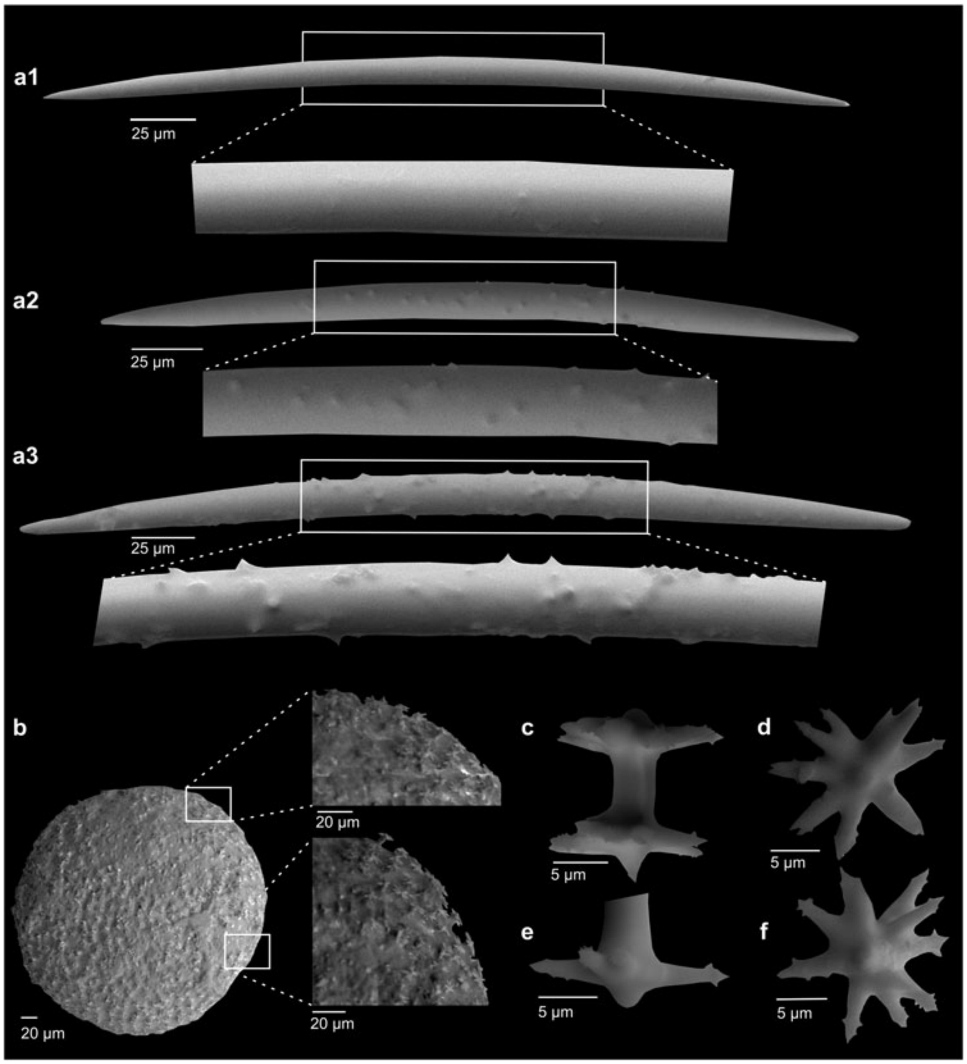


**Figure 5.** Scanning electron microscope (SEM) images of spicules of *Ephydatia muelleri* (Lieberkühn 1856) from Jackson Lake. (a) Three types of megascleres: (a1) megasclere with smooth surface; (a2) megasclere with a few spines; (a3) megasclere with densely spined surfaces in the central axis. (b) Detail of gemmule surface with gemmuloscleres embedded. (c–f) Gemmuloscleres: birotules, with short, thick, smooth shaft, and rotules with indented margins.

given the concentrations of 9.00-25.1 mg/L calcium and 1.56–4.66 mg/L magnesium in the Snake River waters north of its delta in Jackson Lake (Clark et al. 2004). Yet other studies suggest the species may be more cosmopolitan. In the lowlands of Argentina, Bonetto and Ezcurra de Drago (1964) found *Eunapius fragilis* living in the Paraná River, with morphological and skeletal ornamentation adapted to flowing water and channel substrates. In Brazil, *Eunapius fragilis* has been found in rivers and lakes in Rio Grande do Sul, typically with a preference for rocky substrates (Tavares et al. 2003).

*Eunapius fragilis* presents a wide geographic distribution, including the Nearctic, Palearctic, Afrotropical, Neotropical, Oriental, and Australian regions. In this sense, *Eunapius fragilis* can be described as a cosmopolitan species or a species complex because of its high morphological variability (Harrison 1974, Manconi and Pronzato 2016). In our study, this variability is evident in spicule morphology (Table 2). In Jackson Lake, *Eunapius fragilis* was collected from submerged tree trunks and pebbles (up to ~6 m water depth); all specimens had relatively small dimensions and exhibited a high production of gemmules. When compared with other studies, the specimens in Jackson Lake have similar dimensions to those found in rivers from Spain (Manconi et al. 2008, Oscoz et al. 2009), Chile (Ezcurra de Drago 1974), and in parts of North America, Africa, and Australia (Penney and Racek 1968, Barton and Addis 1997). Conversely, this species has been identified with much smaller gemmuloscleres in the lakes of eastern Canada (Ricciardi and Reiswig 1993) and in rivers of the eastern United States (Potts 1887). Specimens with larger gemmuloscleres have been identified in lakes of

**Table 3.** Spicule morphometrics of *Ephydatia muelleri* Lieberkühn 1856. Measurements are shown as minimum-mean-maximum (mean underlined) or minimum-maximum. First set of values is length and (where measured) a slash (/) separates following values of width and a double slash (//) separates following values of diameter.

| Reference | Locality | Megasclere oxea (µm) | Gemmulosclere birotule (µm) | Gemmule (µm) |
|---|---|---|---|---|
| UFPEPOR2725 | Site 3, Jackson Lake, Wyoming, USA | 241.6-304.6-350.4/10.5-14.1-18.1 | 12.0-15.0-17.2/3.0-4.4-5.5//14.3-16.0-19.3 | 285.0-353.5-407.5 |
| Penney and Racek (1968) | Europe, North America, Asia | 200-350/9-20 | 12-20/4-6//20-25 | 350–450 |
| Ezcurra de Drago (1976) | Salisbury, Rhodesia, Africa | 170-320/12-15 | 11-23/4//17-22 | — |
| Ricciardi and Reiswig (1993) | Eastern Canada | 171-245-311/5-11-23 | 8-17-28/1-4-9//8-15-27 | — |
| Barton and Addis (1997) | Western Montana, USA | 150-269-391/3.0-10.5-18.0 | 9.5-14.5-25.0/1.5-4.0-7.5//9.5-17.5-27.5 | 350-450 |

southern Brazil (Tavares et al. 2003), Chile (Ezcurra de Drago 1974), and Argentina (Bonetto and Ezcurra de Drago 1964; however, the megascleres of the specimens from Jackson Lake are larger than other records from localities in North and South America (Table 2).

The morphological and ecological variability of *Eunapius fragilis* suggests that more study, including molecular analyses, are needed to ascertain if a species complex exists or if those dissimilarities are indicative of true taxonomic differences. Molecular analyses conducted by Pinheiro and Calheira (2020) noted that South America has >90% of the endemism within the freshwater sponges, with *Eunapius fragilis* ranking among the exceptions given its widespread distribution. Pinheiro (2007) observed that the 3 cosmopolitan sponge species found in South American have a paucity of distinguishing taxonomic characteristics; *Eunapius fragilis* is one such example, because it possesses only megascleres and gemmuloscleres, and microscleres are absent. *Ephydatia muelleri* also has a wide geographic distribution and has been described for the Nearctic and Palearctic regions (Manconi and Pronzato 2016). This species presents broad morphological variations, suggesting the potential for a species complex (Manconi and Pronzato 2016). According to Ezcurra de Drago (1976), the megascleres of *Ephydatia muelleri* have extensive morphological variability. The biggest differences usually concern the presence of spines: (1) specimens collected in the Ticino River (Italy) present spinose megascleres (83% and 84% in 2 individuals); (2) specimens collected in Lake Maggiore (Italy) present a higher number of smooth spicules (no spines; 10–30%), similar to those found in the Mwenje River (Zimbabwe; 6–24%); (3) specimens observed in Magadino Pond (Switzerland) present smooth spicules and spines in the same proportion. Barton and Addis (1997) also reported that smooth and spined megascleres were frequently present in the same specimens from their study of Wyoming.

*Ephydatia muelleri* has an apparently high environmental resilience because of its presence in waters with diverse physical and chemical characteristics, but the available data do not allow correlations among variability in skeletal morphology to environmental characteristics (Ezcurra de Drago 1976). The *Ephydatia muelleri* megascleres found in Jackson Lake present high variability in the proportion of spines (Fig. 5). Approximately 87% of the megascleres counted have spines; this number is similar for the specimens collected in the Ticino River (Ezcurra de Drago 1976). In Jackson Lake, however, *Ephydatia muelleri* megascleres more commonly exhibit a low number of spines (65%), whereas in the Ticino River, spicules with a very spiny surface around the central axis (58–69%) are most common.

## Conclusions

In this study, we identify 2 sponge species extant in Jackson Lake, Grand Teton National Park (Wyoming), *Eunapis fragilis* and *Ephydatia muelleri.* These species were found during an initial limnogeological survey, and our findings do not preclude the possibility of more species living in the lake. Additional research in Jackson Lake should intensify the search for other sponge species.

*Eunapis fragilis* and *Ephydatia muelleri* could be considered part of a species complex with preferences for lowlands worldwide, but our study shows these sponges can likewise colonize in a high-altitude, oligotrophic–mesotrophic lake environment. Both species present morphological differences compared with other populations. *Eunapius fragilis* presents differences in the length of gemmuloscleres in contrast with specimens reported for southern Brazil, Argentina, Chile, and eastern North America, and *Ephydatia muelleri* presents differences related to the spines on megascleres relative to other specimens reported in the literature. A morphological revision of type material and molecular studies of samples is necessary to understand the real status of these widespread populations and to determine if morphologies are intraspecific (ecophenotypic) or interspecific variations.

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## Disclosure statement

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