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A NOTE ON EXTENDED DISTRIBUTION RECORDS OF RADIOSPONGILLA CEREBELLATA (BOWERBANK, 1863) AND CORVOSPONGILLA ULTIMA (ANNANDALE, 1910) IN MAHARASHTRA, INDIA

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ABSTRACT

The study provides the records of extended distribution and taxonomic identification of freshwater sponges collected in Ahilyanagar (Formerly Ahmednagar) and the Pune district of Maharashtra, India. The sponge samples were collected and identified using the colony morphology and structural features of spicules and gemmules observed using Light Microscopy and Scanning Electron Microscopy (SEM). The identified sponge samples are *Radiospongilla cerebellata* (Bowerbank,1863) and *Corvospongilla ultima* (Annandale,1910). We provide descriptive notes on their colony morphology and SEM images of gemmules, gemmuloscleres, and spicules. There is a need for further research to obtain a more comprehensive understanding of freshwater sponge taxonomy.

INTRODUCTION

Approximately 8500 valid Porifera are enlisted in theWorld Porifera Database (WPD) catalogue, including both freshwater and marine habitats. Freshwater sponges belong to the Class Desmospongiae, order Spongillidae, constituting nearly 200–250 accepted species (WPD). A WPD search produced 257 accepted species, whereas only 219 are acknowledged (Manconi and Pronzato 2008), Thereare currently seven families, 47 genera, and 236 species of freshwater sponges distributed among six continents, however, these numbers are being continuously revised. However, taxonomic studies on Indian freshwater sponges were initially done by Carter (Carter 1849; 1882). It was Annandale (1911) who initially introduced a detailed account of the taxonomy and biology of freshwater sponges in India. Furthermore, Penney and Racek (1968) contributed more revised data on the worldwide collection of freshwatersponges. Yet, none of these studies included images of habitat nor the SEM observations on spicules or gemmules rather all the illustrations were schematic. In the Indian region, according to Soota's (1991) observation, the family of Spongillidae Gray consists of 30 species of freshwater sponges in 10 genera, while Manconi et al. (2013) declared 28 species in 10 genera in the same family.
Tonapi (1964) reported spongesof Poona (Now Pune). In 1976, Khera and Chaturvedi (1976) published a checklist of freshwater sponges. Among the few studies done, Jakhalekar and Ghate (2013) summarized all the studies on freshwater sponges in India. Jakhalekar and Ghate (2016) provided detailed distribution records of 10 species in Maharashtra and also recommended further investigation to understand the real picture of the diversity and distribution of freshwater sponges in Maharashtra. The study aims to provide further extended distribution records of freshwater sponges along with the details of colony morphology and taxonomically important structures of *Radiospongilla cerebellata* (Bowerbank, 1863) and *Corvospongilla ultima* (Annandale, 1910).

MATERIAL AND METHODS

Two sponge samples were collected from different localities in Maharashtra, India. First sponge colonies were observed at Kapurwadi lake situated on the outskirts of Ahilyanagar (formerly Ahmednagar), Maharashtra, India in the year 2013 during a bird survey. Later in the summer of 2022, sponge samples were collected from the same lake for identification and classification. It was given the code name of "KW". Kapurwadi Lakeis a man-made lake situated on the outskirts of Ahilyanagar city (19.1162° N, 74.7849° E), a well-known spot for bird watching. At the time of sample collection sponge body was found attached to the stem of a small bushy tree that was raisedabove the water level. The sponge was completely dried due tothe decreasing water levels in the summer. The sample was collected and stored at 4°C until further investigations. The second sponge sample was collected from the Wagheshwar temple situated at the backwater of the Pavana dam reservoir, Pune, Maharashtra (Fig.1- B). It is an old Shiva temple which seems to be built in Hemadpanthi architecture. This temple is visible only for four months in a year; the rest of the year, it is submerged under waters of Pavana Dam. Pavana Dam reservoir (18°40′30″N, 73°29′10″E) is situated on the Pavana River which is a man-made structure (Fig1- A). Samples were collected during the summer season when the temple was raised due reduced water level of the dam. The sponge was found extensively grown over the walls of the temple, both inner and outer wall. They were collected in live condition and given the code of "OT".

To identify the species of sponge, siliceousspicules needed to be separated from other tissues. This method was employed and published by Annandale in 1911 and Soota in 1991 with some modifications. To achieve this, sponge pieces were directly dissolved in concentrated nitric acid and were let to settle for some time. The solution was then repeatedly washed with distilled water. Treated sponge samples then were washed with twin 80 which reduced surface tension and removed debris from spicules. It was followed by multiple washings with double distilled water till all the foam from twin 80 disappeared. Later this solution was centrifuged to remove the supernatant. The obtained pellet was used to prepare a slide for morphological and structural observation of spicules and gemmules under the light microscope. Gemmules were observed under a stereomicroscope and were cut in half from the point of foramen to form identical sections. To determine the taxonomy of the sponge sample, SEM was employed. To prepare the sample for SEM, a small amount was dried first and then mounted on the microscope's stub usingdouble-sided carbon tape. The sample was then sputter-coated with gold in an ionic coater before being analyzed by the SEM (Nova NanoSEM NPEP303). The size, shape and microscopic structure of spicules and gemmules were determined by using the software linked with the SEM (Jakhalekar and Ghate 2016). The identification of freshwater sponges relies heavily on specific traits such as the skeletal framework, spicule shape and size and gemmular structure, which are all considered important diagnostic features (Manconi and Pronzato 2008). The primary method of identification was by comparing the species to the original descriptions and using the extensive research published (Annandale 1911; Penney and Racek 1968). The terminology employed adheres to the standards outlined by Boury-Esnault and Ru¨tzler (1997) and Manconi and Pronzato (2002). To taxonomically verify sponge identity, the keys of different publications - Annandale (1910; 1911), Soota (1991), Edmondson (1959) and Penney and Racek (1968) (page number 73, plate 5) were employed.

RESULT

The present study is on the taxonomic identification and morphological description of two sponge species. Diagnostic features are described in detail, along with scanning electron microscope (SEM) images of their gemmules and spicules, which were of prime importance in the taxonomic identification of the specimens. The study also includes information on the habitat where the sponges from were obtained.

Radiospongilla cerebellata (Bowerbank, 1863)

Radiospongilla is a freshwater sponge belonging to the family Spongillidae that is found in slow-moving or stagnant freshwater environments such as lakes, rivers, and ponds. They attach themselves to underwater substrates like rocks, logs, and water plants. Like other sponges, *Radiospongilla* species possess the trait of filter feeding by drawing water through a system of pores and channels to capture small particles like bacteria, plankton, and organic detritus. Species in *Radiospongilla* are small in size, ranging from a few millimetres to a few centimetres in diameter. The fragile body is translucent and often may have colors such as light brown, green, or yellowish depending upon symbiotic algae presence. The skeletal structure of *Radiospongilla* is formed by siliceous structures like megascleres and gemmuloscleres. Sponges belonging to this family have an ostia (pore) system on which the passage of water is dependent.

Diagnostic characters:

The colony of the sponge was found to be developed on an Acacia branch. The colony exhibited prominent lateral outward growth, and it was between 5 to 7 cm in length. The length of the colony on the branch was variable between 12 to 15 cm (Fig1- E). Gemmules were clustered in the lower portion of the lateral outward-growing component of the sponge (Fig1- F), whereas spicules were distributed in a non-uniform way throughout the outward growth. The sponge contained brown coloration. Lateral outward-growing regions exhibited a brittle nature, which contrasted with the layered morphology of the branch colony.

SEM study of the gemmules revealed them to be spherical to ovoid in shape measuring 528 ± 26 μm in diameter (Fig 2- A). The surface of the gemmules featured a foramen tubule (Fig 2- D). The gemmuloscleres (92.4 ± 3.5 × 7.2 ± 0.1 μm) are spined strongyles and were embedded on the surface non uniformly (Fig 2- C). The sponge species have megascleres smooth oxeas (383 ± 31 × 9.6 ± 0.3 μm) (Fig 2- F). There were no microscleres.

A cross-section study of the gemmules revealed several features, one of them being the inner cavity where embryonic cells are housed (Fig 2- B). The foramen is approximately 120 μm in length and width of 28 μm. The embryonic cavity, focal to the gemmule, was isolated from the outer layers of gemmuloscleres. The tightly packed, spicule-filled layers were lined by inner, more permeable, pneumatic structures. The foramen was visible externally in the SEM image as a cone-like structure surrounded by gemmuloscleres.

Corvospongilla ultima (Annandale, 1910)

The genus is quite comparable to other freshwater sponges, but there is one trait that makes them stand out from other genera of the Spongillidae family: the morphology and organization of their spicules. These spicules are siliceous, that is, they are formed of silica, and are generally needle-like or elongated. These spicules form a dense network. The sponge body is generally irregular or cylindrical and gets fixed to various submerged surfaces such as rocks, logs, and aquatic plants. *Corvospongilla* species are generally a few millimetres to a few centimetres long depending on the environmental conditions. They vary from colourless to pale yellow or brown, and the spicules cause them to become cloudily pale. The sponges need a moderate to low-flow site as they flourish when the water is relatively immobile or gently circulating in a slack current, thereby allowing them to effectively filter-feed.

Diagnostic characters:

Sponge colonies were observed growing on both the exterior and interior walls of an ancient temple, forming extensive layers across the surfaces (Fig1- C and D). When collected, the colonies had a smooth surface measuring approximately 2-3 cm in thickness and lacked branching structures. There were numerous oscula, evenly spaced with diameters ranging from 20 to 30 mm, on the surface through which water passed through the colonies. Gemmules were embedded in the colony. The sponge colonies were structurally firm but soft, and the ones on the outer walls of the temple showed dark grey coloration. Colonies on inner walls were light-colored and featured distinct furrows on the surface, perhaps demonstrating microenvironmental differences in the temple structure. The boundaries of the colonies were smooth.

The gemmules showed an approximate diameter of 400 ± 12 μm and exhibited a smooth, non-angular surface spherical shape (Fig 3- A). The cross section of gemmule near foreman tubule reveal that the medulla was bulging out, forming a curve (Fig 3- B). Additionally, the surface of the gemmules was covered with gemmuloscleres, which appeared to be embedded into the external layer. Upon closer examination of the spicules, the megascleres were observed to be approximately 259 ± 17 µm in length and slightly pointed at the tips (Fig 3- E). These spicules had a smooth surface without any noticeable surface texture. Microscleres (27.5 ± 2.2 µm) were present with umbrella-shaped spines at both ends. Gemmuloscleres (40 ± 1.4 µm) were present with spines over the body with a higher density of spines near the end (Fig 3- D). The central region of the gemmule, identified as the medulla, was marked by a unique arrangement of cells and internal structures. Around this central cavity, pneumatic layers were visible, characterized by loosely packed cells, and the layer appeared largely free of gemmuloscleres. However, some gemmuloscleres were partially embedded in the outer layers, especially near the periphery of the gemmule. The foramen was marked as an elevated structure which is formed opposite to the broad base of the gemmule. It formed the characteristic square-shaped opening(18 × 20µm) at the pointed end (Fig 3- C).

DISCUSSION

This is a report on the occurrence of *Radiospongilla cerebellata* (Bowerbank,1863) and *Corvospongilla ultima* (Annandale,1910) from Ahilyanagar and Pune districts of Maharashtra, India. Further research is necessary to document the spread and variety of sponges in the area. Freshwater sponges could serve as an indicator of less polluted water since they thrive in unpolluted water with minimal human activities. The presence of sponges indicates that the environmentof Kapurwadi Lake and Pavana Dam is thriving and contributive to the survival of aquatic ecosystems. The ancient temple provides shallow water and protection from hailstorms and intense physical phenomenon in the water, creating an optimal habitat for sponge growth. Such ancient structures, which are submerged in backwater of dam or lake, might contribute to rich biodiversity in sponges; hence should be explored more.

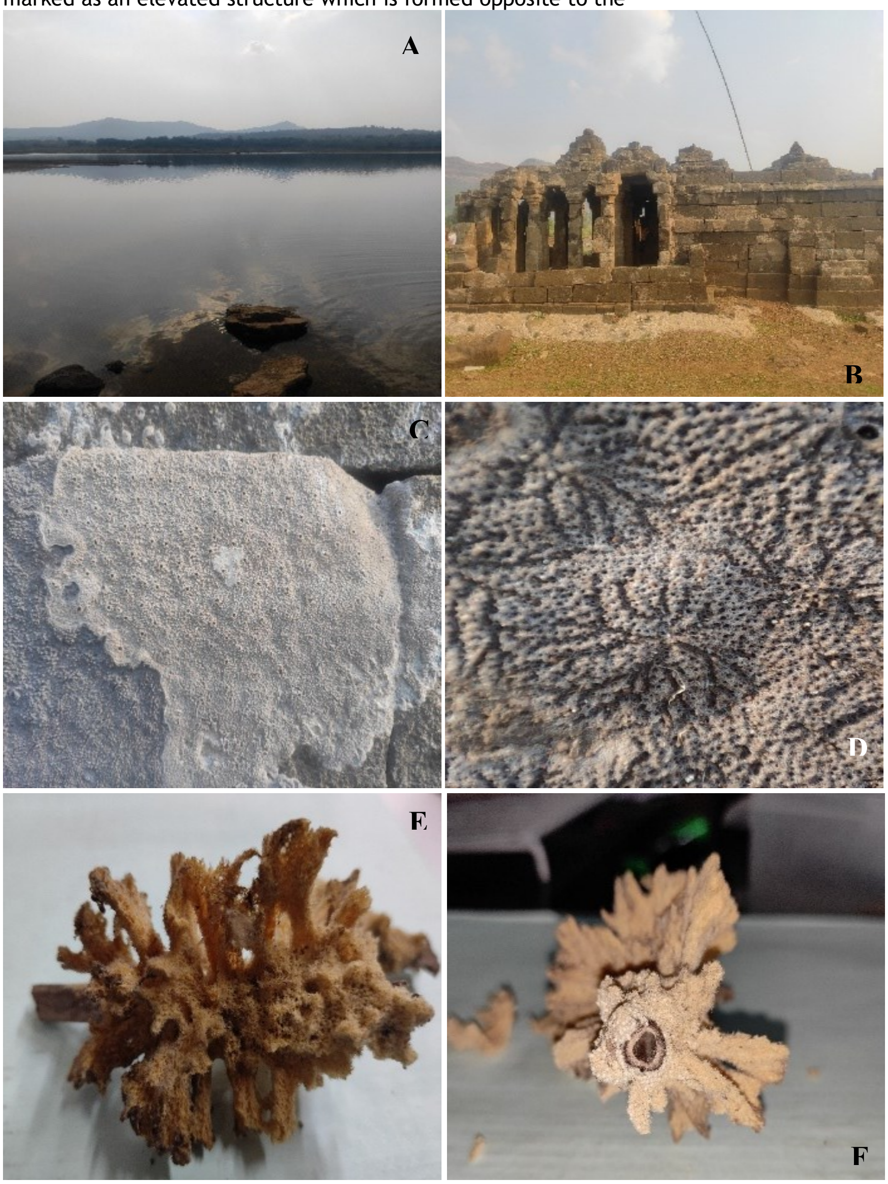

Fig 1: **A**-Pavana dam backwater, **B**-Ancient Mahadev temple from where samples have been collected **C-** Colony morphology of *Corvospongilla ultima* on the outer wall of the temple, **D-**Colony morphology of *Corvospongilla ultima* on the inner wall of the temple, **E-F-**Dry sample of *Radiospongilla cerebellata* collected from Kapurwadi lake

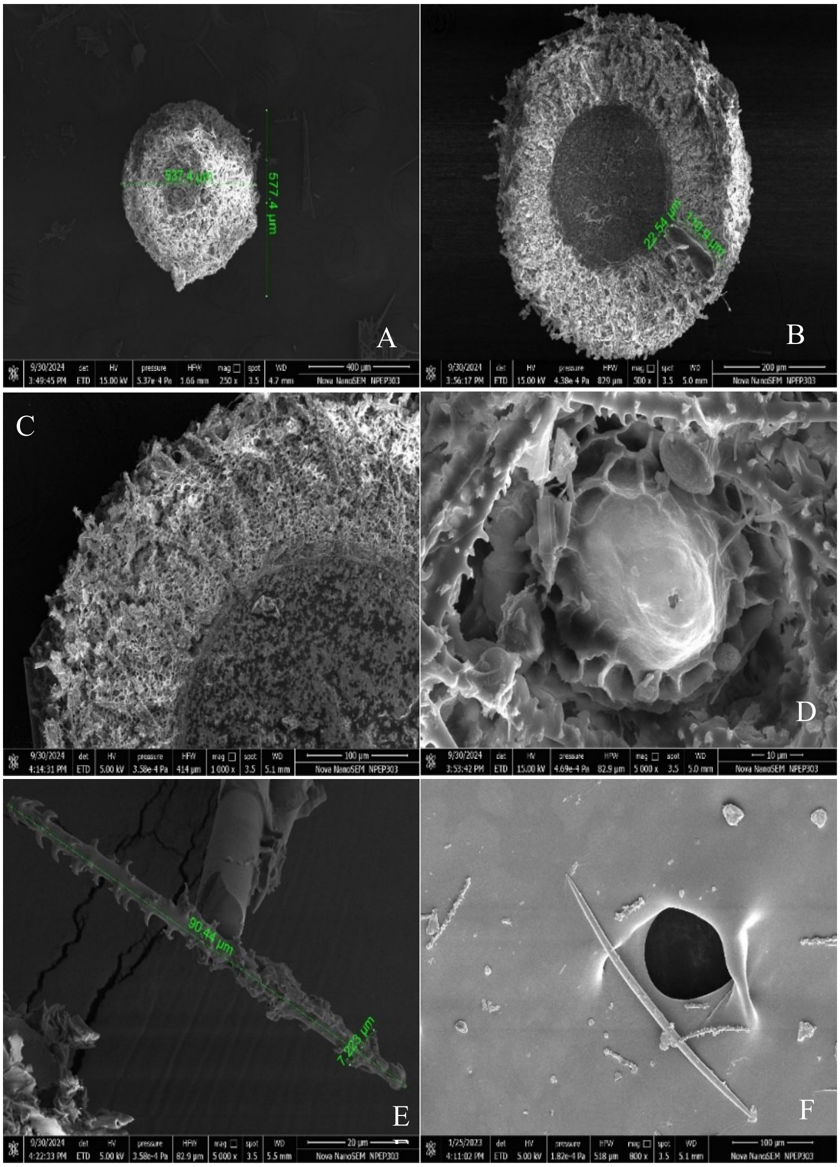

Fig 2: SEM images of *Radiospongilla cerebellata* **A**-Gemmule, **B**-Cross section of gemmule showing foramen tubule, **C**-Spatial arrangement of gemmuloscleres along with pneumatic layer, **D**-Elevated foramen tubule from external surface, **E**-Gemmuloscleres, **F**-Megascleres

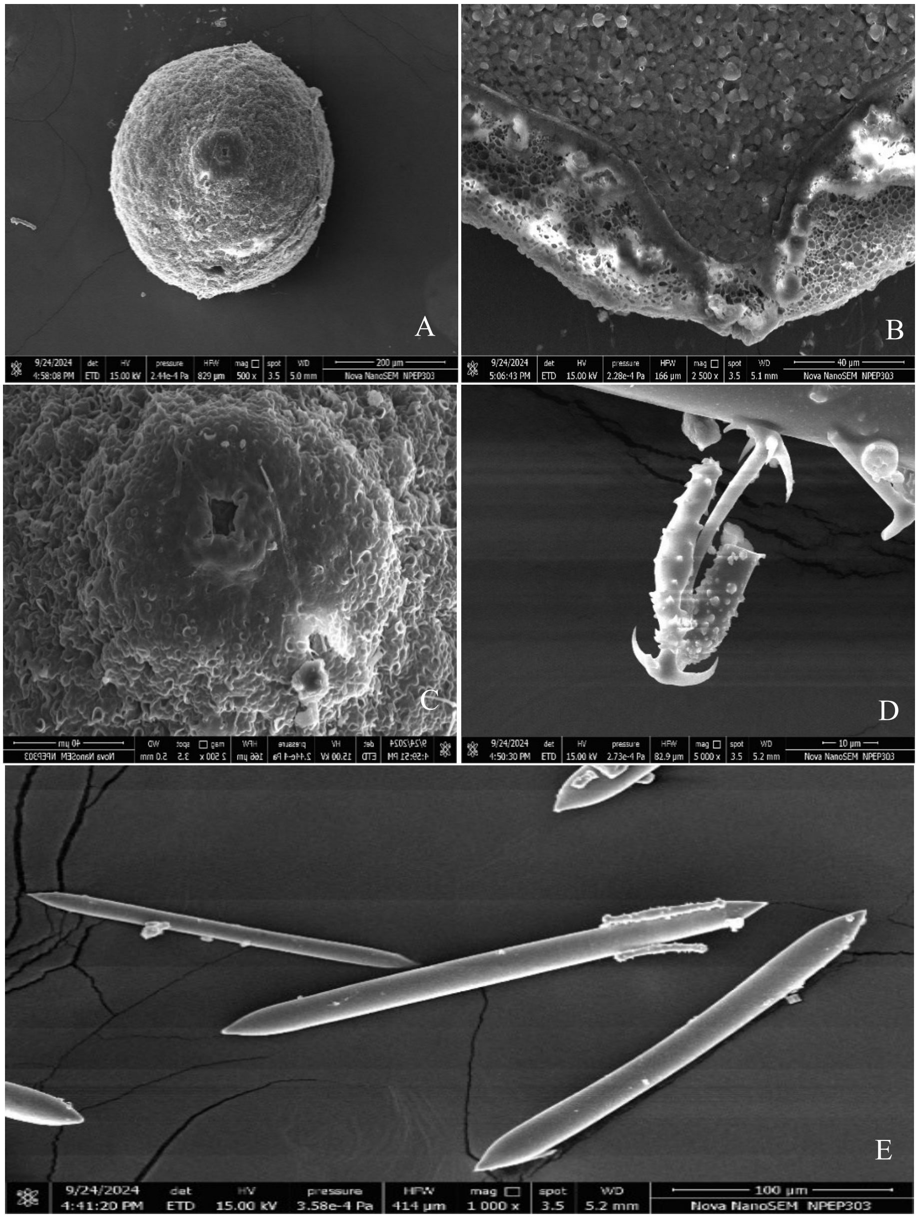

Fig 3: SEM images of *Corvospongilla ultima* **A**-Gemmule, B-Cross section of gemmule showing foramen tubule, **C**-Elevated foramen tubule from external surface, **D**- Gemmuloscleres with Microscleres, **E**-Megascleres

CONCLUSION

This study confirms the presence of *Radiospongilla cerebellata* and *Corvospongilla ultima* in Ahilyanagar and Pune districts, indicating healthy, unpolluted aquatic ecosystems at Kapurwadi Lake and Pavana Dam respectively. Ancient submerged structures like old temples may enhance sponge biodiversity, but further research is needed to fully understand their distribution and taxonomy.

Competing Interest

All authors declare no competing interests.

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