



Biodiversity assessment of the Lower Mekong Basin: A new species of *Corvospongilla* (Porifera: Spongillina: Spongillidae) from Thailand

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Abstract

Only six species (four genera, one family) of freshwater sponges are known until now from Thailand. A first record of the genus *Corvospongilla* Annandale, 1911 with the description of a new species is here reported from the Pong River in the Lower Mekong Basin. The taxonomic status of *Corvospongilla siamensis* **nov. sp.** is discussed in comparison to the 18 species assigned to the genus. The new species is characterised by *i*) alveolate, paucispicular skeletal network with scanty spongin, thick ascending tracts towards the sponge surface to support conules; *ii*) skeleton of stout microspined strongyles, and extremely rare, abruptly pointed oxeas usually with a few tubercles, plus micropseudobirotules with smooth shaft; *iii*) gemmules belonging to a single gemmular morph, typically sessile; *iv*) gemmular cage notably stout, of tangentially arranged strongyles of variable length from tubercled to spiny; *v*) gemmular theca with abundant laminar compact spongin, lacking pneumatic layer, armed by short, tubercled to spiny strongyles tangentially embedded; *vi*) larvae armed by spiny oxeas. *Corvospongilla siamensis* **nov. sp.** differs from all the other known species of the genus in its unique combination of diagnostic traits, particularly a) acanthostrongyles (megascleres), b) gemmuloscleres, both in the cage and in the theca, as strongyles showing the tendency towards ring-shape and button-like shape, and c) larval spiny oxeas.

Key words: Porifera, Freshwater sponges, *Corvospongilla siamensis* **nov. sp.**, Oriental Region, Pong River, Taxonomy, Biogeography, SEM

Introduction

The knowledge on taxonomic richness and geographic distribution of freshwater sponges (Haplosclerida: Spongillina: Spongillidae) in the Oriental Region is poor and scarcely reported in the literature (Potts, 1887; Weltner, 1895; Evans, 1901; Kirkpatrick, 1908; Annandale, 1908, 1910, 1911, 1918a, b; Gee, 1930a, b, 1932; Arndt, 1936; Suvatti, 1950; Penney & Racek, 1968; Khera & Chaturvedi, 1976; Rützler, 1978; Soota *et al.*, 1983; Manconi & Pronzato, 2002, 2007, 2009; Masuda, 2004; Sangpradub & Boonsoong, 2006). Freshwater Spongillina fauna of Thailand until now recorded belong exclusively to the family Spongillidae with four genera and six species, namely *E. carteri* (Bowerbank, 1863), *Eunapius potamolepis* (Annandale, 1918b), *Spongilla alba* Carter, 1849, *S. lacustris* (Linnaeus, 1759), *Stratospongilla indica* (Annandale, 1908), and *Umborotula bogorensis* (Weber, 1890). In the framework of a biodiversity assessment in the Lower Mekong Basin focused on mapping taxonomic richness and distribution of freshwater invertebrates we discovered rich assemblages of sponges. We report here on the discovery of a new species belonging to the genus *Corvospongilla* Annandale, 1911 from northeastern Thailand.

Materials & methods

Collection of sponges was carried out during visual census by wading, snorkelling and SCUBA diving in the Pong River (Mekong Hydrographic Basin, Khon Kaen Province, NE Thailand) (Fig. 1). The most representative speci-

mens were photographed and registered in a voucher collection. A set of macro- and micro-morphological characters (growth form, consistency, architecture of ectosomal and choanosomal skeleton, traits of skeletal megascleres and microscleres, gemmular architecture and gemmuloscleres morphology) was considered for diagnosis at the genus and species levels (Manconi & Pronzato, 2002). Representative fragments of sponges were dissected for Light Microscopy (LM) and/or Scanning Electron Microscopy (SEM). Spicules processed by dissolution of organic matter in boiling 65% nitric acid were suspended in ethanol and dropped onto slides and/or stubs (see Manconi & Pronzato, 2000). Dry body fragments, dissociated spicules, entire gemmules and their cross-sections were sputter-coated with gold and observed under SEM Leo 1450VP. Measurements were performed by LM on ca. 50 spicules of each diagnostic spicular type. Measurements on gemmular architecture were performed by SEM.

Acronyms: BMNH (The Natural History Museum, London, United Kingdom), DTRG (ex-IZUG, Dipartimento per lo studio del Territorio e delle sue Risorse, Dip.Te.Ris., Università di Genova, Italy), IM (ZEV) [Indian Museum including Zoological Survey of India, Calcutta, India], MCN (Museo de Ciências Naturais da Fundação Zoobotânica, Porto Alegre, RS, Brasil), MNHN (Muséum National d'Histoire Naturelle, Paris, France), MRAC (Musée Royal de l'Afrique Centrale de Tervuren KMMA, Belgium), MSNG (Museo civico di Storia Naturale 'G. Doria', Genova, Italy), ZMA (Zoölogisch Museum Universiteit van Amsterdam, Amsterdam, The Netherlands), ZMB (Zoologisches Museum für Naturkunde an der Universität Humboldt, Berlin, Germany).

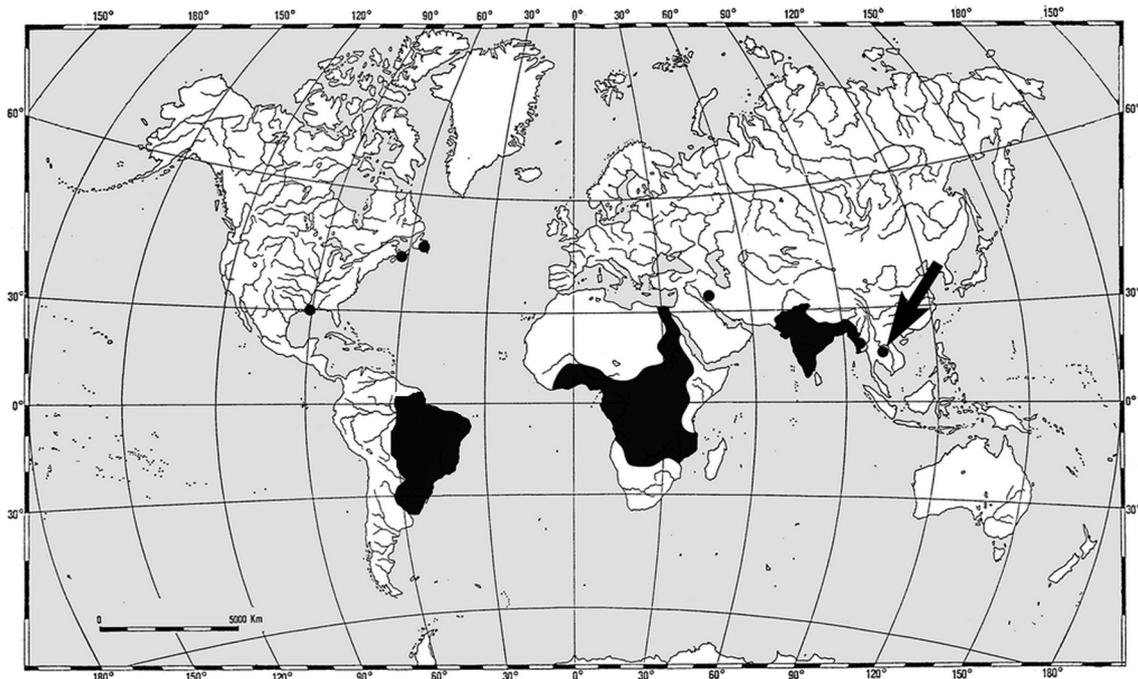


FIGURE 1. Biogeographic pattern of the genus *Corvospongilla* (modified from Manconi & Pronzato, 2002, 2004). The type locality of *Corvospongilla siamensis* at Ban Huai Sai (16°46'20.40"N, 102°42'48.22"E) (Pong River, Lower Mekong Basin, Thailand) is indicated by an arrow.

Taxonomic accounts

Class Demospongiae Sollas, 1888

Order Haplosclerida Topsent, 1928

Suborder Spongillina Manconi & Pronzato, 2002

Family Spongillidae Gray, 1867

Genus *Corvospongilla* Annandale, 1911

[Type species *Corvospongilla loricata* (Weltner, 1895)]

Diagnosis (emended after Manconi & Pronzato, 2002). Spongillidae with encrusting flat to massive, lobate growth form. Consistency extremely hard to delicate. Spongin scanty except for the well developed basal spongin plate and the gemmular theca. Skeletal network alveolar (isotropic) with polygonal meshes, and ascending pauci- to multi-spicular tracts toward surface supporting conules. Megascleres from smooth, granulated or spiny strongyles, to oxeas. Microscleres sometime rare, straight to slightly bent micropseudobiotules with smooth shaft. Gemmules of two types, sometime coexistent, single or grouped, free in the skeletal network or fixed (sessile) at the sponge base, with or without a variably stout spicular cage. Foramen ranging from apical to lateral with a short porus tube. Gemmular theca from tri-layered with a variably developed pneumatic layer to mono- or bi-layered of compact laminar spongin, according to the gemmular type. Gemmuloscleres, tangentially arranged in the theca, from elongated, variably bent to ring-shaped to oval, stout, spiny strongyles to oxeas. Spicules of larvae slender smooth to spiny oxeas.

***Corvospongilla siamensis* Manconi & Ruengsawang nov. sp.**

Figures 1–4

Material. Holotype MSNG 56533, Ban Huai Sai (16°46'20.40"N, 102°42'48.22"E) type locality, Pong River, Lower Mekong Basin, Thailand, leg. Nisit Ruengsawang, 12.II.2008. Paratype MSNG 56533a, Ban Huai Sai, leg. Nisit Ruengsawang, 12.II.2008.

Comparative materials. *Corvospongilla burmanica*, BMNH 82.3.22.1–3, box 6, dry, type, DTRG FW420 schizotype, Burma; *C. burmanica* (?), BMNH 86.10.29.1, DTRG FW 636, River Kuano, India; *C. caunteri*, BMNH 14.11.24.27 ex-ZEV 4776/7, paratype, DTRG FW637, schizotype, Lucknow, India; *C. lapidosa*, BMNH 08.2.11.1, paratype, DTRG FW638, schizotype, River Godavery Nasik, India; *Corvospongilla loricata*, ZMB 2093 SE325-SE37–41, type, fragment DTRG FW511 locality unknown, Africa; *C. mesopotamica* MSNG 51766, holotypes, DTRG FW574, schizotype, River Diyala, Iraq; *C. thysi*, MRAC 1311, type, DTRG FW472, schizotype, Lake Barombi-ma-Mbu, Cameroun, W-Africa; *C. ultima*, BMNH 14.11.24.29 ex-ZEV 4906/7, DTRG FW639, fragment, India; *C. ultima* var. *spinosa*, BMNH 14.11.24.30 ex-ZEV 5106/7, DTRG FW640, Satara District, India; *C. volkmeri*, BMNH 89.9.25.10, schizoparatype, ex-MCN 86, DTRG FW642, Lagoa Redonda, Sousa, Paraíba State, Brazil; *C. zambesiana*, BMNH 1906.2.28.2, 13IIC, DTRG FW623 R. Zambezi, SE-Africa.

Description. Holotype massive 14 x 11 cm in diameter, 0.5–5 cm in height with lobes up to 3–4 cm in height (Fig. 2A). **Growth form** from thin crusts to massive in flourishing specimens with body size dimensions up to 16 cm in diameter. **Colour** light brown, greenish to emerald green *in vivo* in the same specimen, light brown to brown in ethanol. **Consistency** rigid, hard with increasing hardness from surface to the basal portion, fragile *in vivo*, due to the low amount of spongin in the skeleton. Basal spongin plate notably developed, with sessile gemmules. **Surface** notably irregular and hispid, conulose, with conules supported by short ascending pauci- to multi-spicular tracts. **Conules** 1–2.5 mm in height, 1–1.5 mm apart. **Oscules** chimney-shaped (0.2–0.5 cm in diameter) apical and usually single at the tips of lobes (Fig. 2B). **Ectosomal skeleton** with no special architecture (triangular to polygonal paucispicular meshes) except for ascending pauci- to multi-spicular tracts supporting conules (Fig. 3A). **Choanosomal skeleton** as an alveolar (isotropic) network of megascleres with paucispicular (up to 6 spicules) polygonal meshes (89–213 µm in diameter), and ascending pauci- to multi-spicular tracts supporting conules (Fig. 3B). **Megascleres** strongyles (126–245 x 13–26 µm) frequently with slightly inflated tips, extremely abundant with scattered small tubercles (granules) except for tips or with shaft entirely covered of tubercles up to the tips (Figs 2C, 3C, D). Less frequent acanthostrongyles with few spines scattered up to the tips, among the small tubercles. Density of tubercles and spines notably variable. Rare smooth strongyles also present. Strongyles sometime x-shaped or with tips slightly inflated or rarely with swellings along the shaft as malformations. Rare stout, smooth oxeas (160–171 x 9–14 µm, n = 4) with tips abruptly pointed also present (Fig. 3C). **Microscleres** micropseudobiotules quite abundant, scattered in the choanosomal skeleton, typical of the genus, with smooth, variably bent shaft (19–51 x 2–2.5 µm) bearing distal smooth pseudobiotules (9–19 µm in diameter) with variably long, bent hooks (4–6) (Fig. 3E). **Gemmules** exclusively sessile, not abundant at the sponge basal portion, strictly adhering to the basal spongin plate singly or in small groups (2–5) sharing gemmular cages with fused walls (Fig. 4A). **Gemmular cage** hemispherical (865–1160 µm in diameter) with thick wall (107–113 µm in thickness) of

extremely scanty compact spongin in small laminae joining abundant strongyles arranged in a notably dense mosaic-like multilayer. Strongyles of the cage belong to different categories, from stout, large, granulate (tubercled) strongyles (107–190 x 15–27 μm , n = 25) very similar to skeletal megascleres, to bent and tubercled strongyles (27–49 x 7–14 μm , n = 15), to bent acanthostrongyles (29–49 x 6–9 μm , n = 5) up to boomerang-shaped, or ring-like (17 μm in diameter, n = 2) and flat button-like (16–27 μm in diameter, n = 4), armed by acute spines sometimes grouped (Fig. 4B). **Gemmular theca** enveloped by the cage but not joined to it (cage and theca are easily detachable from each other), subspherical (589 x 650 μm in diameter) to suboval (424 x 814 μm in diameter) (Fig. 4C, D) of almost compact spongin with sublayers (up to 5) supported by small gemmuloscleres tangentially embedded (Fig. 4E, G, H). Pneumatic layer absent; only rare, small areas of spongin chambers are present, scattered within the sublayers of laminar spongin. Foramen single, apical or lateral with a short simple collar surrounded by slightly chambered spongin (Fig. 4F). **Gemmuloscleres** short acanthostrongyles (32–50 x 7–14 μm , n = 25) from straight to boomerang-shaped, ring-shaped to flat (button-like) with ornamentations ranging from tubercles scattered along the shaft to large acute spines mostly at the tips (Fig. 3F); also smooth spherules rarely present. **Brooded larvae** present. **Larval acanthoxeas** (128–139 x 5 μm , n = 3) fusiform, slender, straight, with scattered small, acute spines more dense towards the tips.

Etymology. The specific epithet is derived from the ancient name of Thailand, formerly known as Siam.

Geographic distribution. Known until now exclusively from the type locality (Fig. 1).

Habitat. Sponges in dense populations along the river bank at 0.5–2.0 m of depth in quite transparent waters, generally in shaded areas. Associated organisms: diatoms, insects, molluscs, bryozoans.

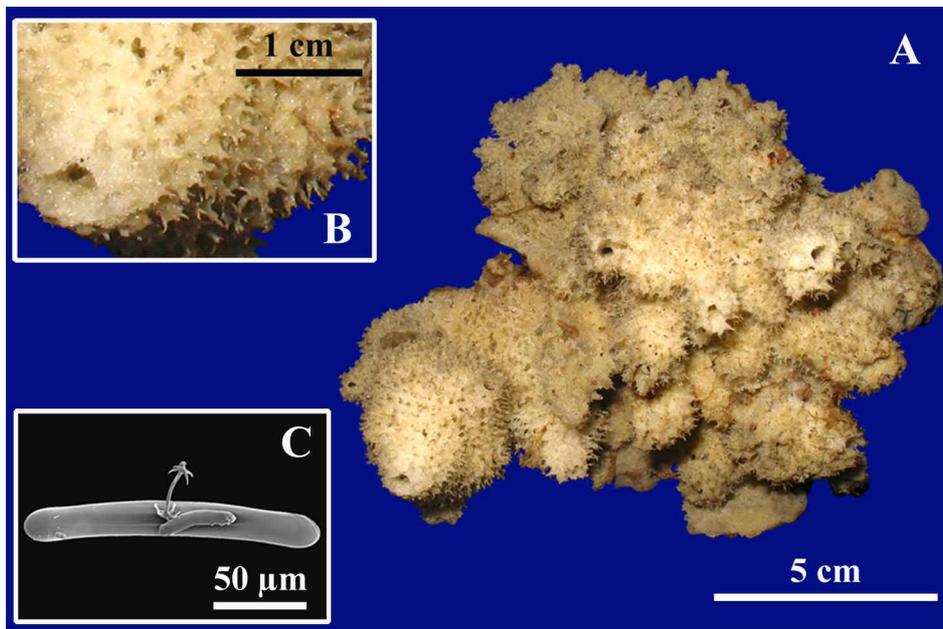


FIGURE 2. *Corvospongilla siamensis*. A, Holotype MSNG 56533 from the Pong River (Lower Mekong Basin, Thailand). B, Detail of a chimney-like lobe with apical oscule and conulose surface. C, Spicular complement. Strongyle and micropseudobiotule from the skeletal network, and strongyle from the gemmular theca.

Discussion

Eighteen species are currently recorded as valid for the genus *Corvospongilla* in the World Porifera Database (Van Soest & Manconi, 2011): *C. boehmii* (Hilgendorf, 1883), *C. novaeterrae* (Potts, 1886), *C. loricata* (Weltner, 1895), *C. zambesiana* (Kirkpatrick, 1906), *C. burmanica* (Kirkpatrick, 1908), *C. lapidosa* (Annandale, 1908), *C. ultima* (Annandale, 1910), *C. caunteri* Annandale, 1911, *C. micramphidiscoides* Weltner, 1913, *C. scabriscipulis* Annandale, 1913, *C. victoriae* Annandale, 1914, *C. seckti* Bonetto & Ezcurra de Drago, 1966, *C. thysi* (Brien, 1968), *C. sodenia* Brien, 1969, *C. becki* Poirrier, 1978, *C. bhavnagarensis* Soota, Pattanayak & Saxena, 1983, *C. volkmeri* de Rosa Barbosa, 1988 and *C. mesopotamica* Manconi & Pronzato, 2004. The description of the new species from Thailand increases the species number for the genus to 19 species.

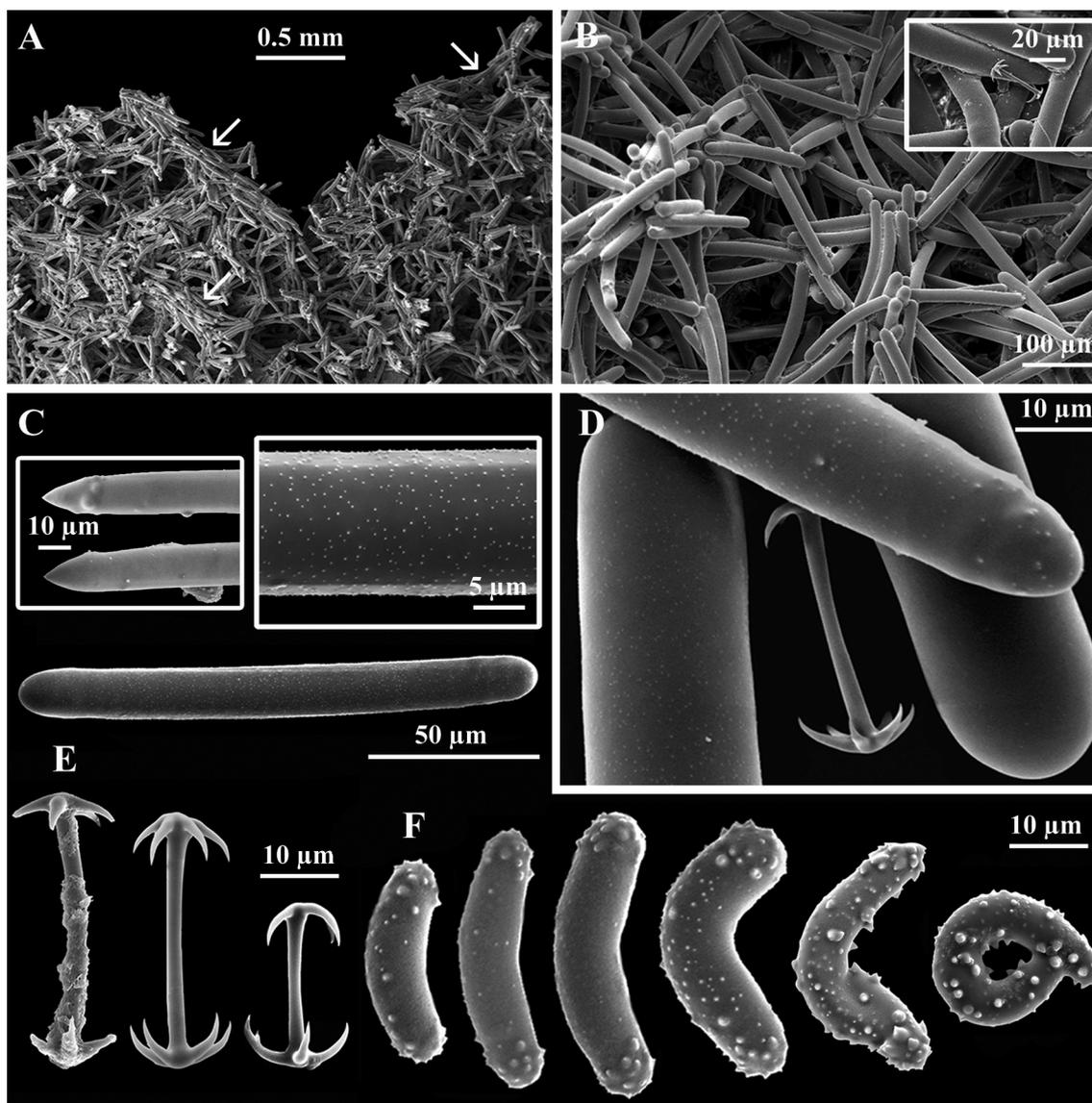


FIGURE 3. *Corvospongilla siamensis*. Holotype MSNG 56533 from the Pong River (Lower Mekong Basin, Thailand). Micrographs (SEM) of the spicular complement. A, Skeletal alveolate network with ascending plurispicular tracts (arrows) to support conules at the surface (lateral view); B, Detail of alveolate skeleton of strongyles and micropseudobiotules (inset); C, Skeletal megascleres, as strongyle with microspined surface (inset, right), and tips of the rare tubercled oxeas (inset, left); D, Apices variably shaped of strongyles and a microsclere; E, micropseudobiotules entirely smooth with pseudobiotules armoured by recurved hooks; F, strongyles, with tubercles and spines, shared by gemmular theca and gemmular cage.

Morphological data and analyses of diagnostic traits by LM and SEM revealed that *C. siamensis* from the Pong River diverges from all the other species assigned to the genus. From a biogeographic point of view the new species seems to be strictly allied with Oriental, Afrotropical and Palaearctic species of the genus.

Corvospongilla siamensis is characterised by *i*) alveolate, paucispicular skeletal network with sparse spongin, bearing thick ascending tracts exclusively towards the sponge surface to support conules; *ii*) skeleton of stout microspined strongyles, and extremely rare, abruptly pointed oxeas usually with few tubercles, plus micropseudobiotules with smooth shaft; *iii*) gemmules belonging to a single gemmular morph typically sessile; *iv*) gemmular cage notably stout, of tangentially arranged strongyles of variable length from tubercled to spiny, *v*) gemmular theca armed by short, tubercled to spiny strongyles tangentially embedded in abundant laminar spongin (pneumatic layer absent); *vi*) larvae armed by spiny oxeas. *C. siamensis* differs from all the other known species of the genus in its unique combination of diagnostic traits, particularly a) acanthostrongyles (megascleres), b) gemmuloscleres, both in the cage and in the theca, as strongyles showing the tendency towards ring-shape and button-like shape, and c) larval spiny oxeas.

The skeletal architecture and spicular complement of *C. siamensis* differs from *C. caunteri* (India) and *C. ultima* (India) among Oriental species which have smooth oxeas in mono- to pauci-spicular tracts, and from *C. novaeterrae* (Nearctic) which oxeas ranging from smooth to those with few large spines.

Corvospongilla siamensis with strongyles bearing small tubercles/spines also differs from *C. victoriae* (E-Africa) which has strongyles with large spines in a paucispicular skeletal network. Manconi & Pronzato (2004) erroneously reported smooth oxeas (p. 174) for *C. victoriae* although they illustrated strongyles amongst its spicular complement (Fig. 16, p. 178).

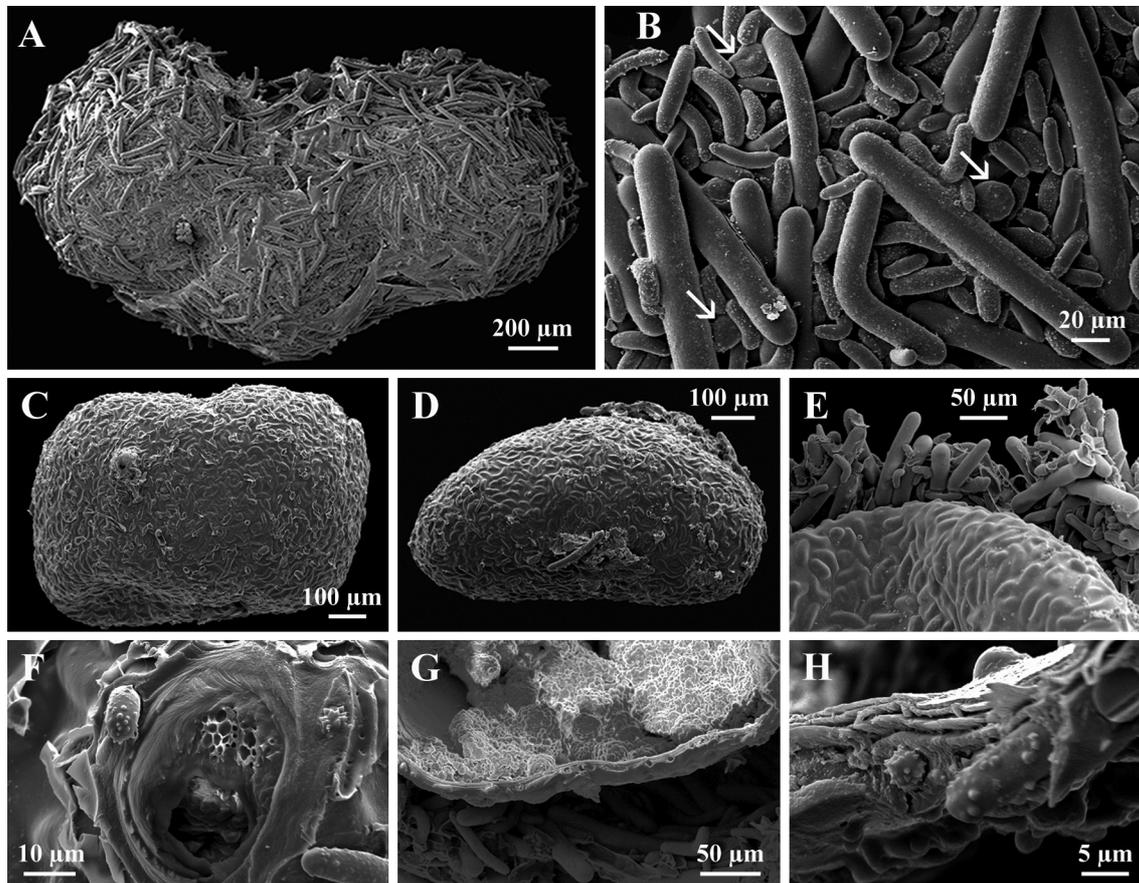


FIGURE 4. *Corvospongilla siamensis*. Holotype MSNG 56533 from the Pong River (Lower Mekong Basin, Thailand). Micrographs (SEM) of gemmules. A, Gemmules of the sessile morph in a cluster sharing the gemmular cage strictly adhering to the basal spongin plate. Each hemispherical cage envelopes one gemmular theca; B, Strongyles variably shaped at the outer surface of the gemmular cage, typical button-like gemmuloscleres are indicated by arrows; C, D, Gemmular theca variably shaped, bearing tangentially gemmuloscleres embedded in compact spongin; E, Gemmular theca surrounded by the not adhering stout spicular cage (cross section); F, Foramen with compact and chambered spongin armed by a few gemmuloscleres; G, Gemmular theca (cross section) of sublayered compact spongin protecting the mass of totipotent cells; H, Detail of the gemmular theca (cross section) of compact sublayered spongin armed by gemmuloscleres as tangential strongyles with spiny tips.

The new species shares the trait ‘stout strongyles’ as main skeletal megascleres with the Oriental *C. bhavnagarensis*, *C. burmanica* and *C. lapidosa*, the Afrotropical *C. boehmii*, *C. micramphidiscoides*, *C. scabriscipulis*, *C. thysi*, *C. victoriae* and *C. zambesiana*, the Palaearctic *C. loricata* and *C. mesopotamica*, and the Neotropical *C. becki*, *C. seckti* and *C. volkmeri*.

Among corvospongillans recorded from the Indochinese Region *C. siamensis* with ornamentation of microspines and microtubercles on the strongyles differs from *C. burmanica* with exclusively smooth strongyles. In this respect, ‘ornamented strongyles’ in *C. siamensis* is shared with the African lineage comprising *C. boehmii*, *C. loricata*, *C. micramphidiscoides*, *C. scabriscipulis* and *C. victoriae* and the Neotropical-Nearctic lineage containing *C. becki*, *C. seckti* and *C. volkmeri*.

The trait ‘micropseudobiotules as microscleres’ of *C. siamensis*, characterised by straight to bent shafts, entirely smooth, with few hooks (4–6), is similar to all the other species, although morphometrics show that *C. bhavnagarensis*, *C. seckti* and *C. volkmeri* bear the smallest micropseudobiotules.

Corvospongilla siamensis shares the trait ‘exclusively sessile gemmular morph with a protective cage of specialized spicules’ with lineages from Nearctic, Afrotropical, Palaearctic Africa (lower Nile), and the Indian Subregion. The trait ‘exclusively free gemmular morph scattered in the skeletal network’ was indeed recorded only for *C. caunteri*. Gemmules were not recorded until now in the Afrotropical *C. sodenia* and *C. zambesiana*. The coexistence of two gemmular morphs (sessile and free) in *Corvospongilla* spp. is shared by 8 out of 17 species (47%), namely *C. burmanica*, *C. loricata*, *C. mesopotamica*, *C. micramphidiscoides*, *C. novaeterrae*, *C. seckti*, *C. ultima* and *C. volkmeri*. Eight out of 17 species (47%) are known to produce only sessile gemmules, namely *C. bhavnagarensis*, *C. becki*, *C. boehmii*, *C. lapidosa*, *C. scabrispiculis*, *C. siamensis*, *C. thysi* and *C. victoriae*. In synthesis, the genus *Corvospongilla* is characterized by the presence of fixed gemmules in 16 out of 17 species (94%) (Hilgendorf, 1883; Potts, 1886; Weltner, 1895, 1913; Kirkpatrick, 1906, 1908; Annandale, 1908, 1910, 1911, 1914; Bonetto & Ezcurra de Drago, 1966; Brien, 1968, 1969; Penney & Racek, 1968; Carvalho, 1969; Volkmer-Ribeiro *et al.*, 1975; Poirrier, 1978; Soota *et al.*, 1983; De Rosa-Barbosa, 1988; Manconi & Pronzato, 2002, 2004, 2009).

As for gemmuloscleres, *C. siamensis* bears almost exclusively strongyles with tubercles and spines both in the gemmular cage and in the gemmular theca. This trait in the new species differs from *C. bhavnagarensis* and *C. novaeterrae*, which bear exclusively spiny oxeas as gemmuloscleres. The presence of both oxeas and strongyles in the gemmules is displayed only by *C. boehmii*, *C. caunteri*, *C. seckti*, *C. thysi* and *C. volkmeri*. It is possible that short spiny oxeas rarely reported in the genus as skeletal microscleres could belong to free gemmules. This could be the reason why Manconi & Pronzato (2004) reported free gemmules for *C. victoriae*, but later the same authors reported only the sessile gemmule (Manconi & Pronzato, 2009, Fig. 148).

The circumtropical/subtropical biogeographic pattern of the genus *Corvospongilla* is notably disjunct with scattered enclaves in the Nearctic (Newfoundland and Nova Scotia), the Palaearctic (lower Nile in Egypt, Mesopotamia in Iraq), across the Afrotropical-Indian Region (Manconi & Pronzato, 2004, 2009) and the eastern Neotropical Region (Muricy *et al.*, 2011). *Corvospongilla boehmii*, *C. loricata*, *C. micramphidiscoides*, *C. scabrispiculis*, *C. sodenia*, *C. thysi*, *C. victoriae* and *C. zambesiana* are all endemic to restricted areas of the Afrotropical Region (Manconi & Pronzato, 2009).

The new record in northeastern Thailand extends the easternmost range of the genus in the Indochinese Region. A more comprehensive biodiversity assessment along the Pong River and the Lower Mekong Basin in the future may reveal if *C. siamensis* also has a restricted geographic range.

The last syntheses of taxonomic richness report the presence in the Oriental Region of 38 species of freshwater sponges (endemicity 24%) belonging to 11 genera of Spongillina ascribed to two families, namely Spongillidae (10 genera, 35 species) and Metaniidae (one genus, three species) (Penney & Racek, 1968; Manconi & Pronzato, 2002, 2007, 2008). Although the Indochinese Region is considered a hot spot of biodiversity in Asia (Médail & Quézel, 1999; Myers *et al.*, 2000), the taxonomic richness and endemicity level of Spongillina, and in general of several other freshwater taxa, seem to be highly underestimated in the entire Oriental Region and particularly in the Mekong Basin.

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