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## Journal of Natural History

Publication details, including instructions for authors and subscription information:

<http://www.tandfonline.com/loi/tnah20>

### Freshwater sponges of the West Indies: Discovery of Spongillidae (Haplosclerida, Spongillina) from Cuba with biogeographic notes and a checklist for the Caribbean area

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Published online: 21 Feb 2007.

To cite this article: R. Manconi & R. Pronzato (2005) Freshwater sponges of the West Indies: Discovery of Spongillidae (Haplosclerida, Spongillina) from Cuba with biogeographic notes and a checklist for the Caribbean area, *Journal of Natural History*, 39:36, 3235-3253, DOI: [10.1080/00222930500307327](https://doi.org/10.1080/00222930500307327)

To link to this article: <http://dx.doi.org/10.1080/00222930500307327>

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# Freshwater sponges of the West Indies: Discovery of Spongillidae (Haplosclerida, Spongillina) from Cuba with biogeographic notes and a checklist for the Caribbean area

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(Accepted 15 August 2005)

## Abstract

The paper reports the first finding of freshwater sponges from the Greater Antilles. Spongillidae belonging to four species of the genera *Ephydatia*, *Anheteromeyenia*, and *Radiospongilla* were found in a variety of freshwater habitats in western Cuba. *Anheteromeyenia cheguevarai* nov. sp. is described. Morphological traits of sponges from West Cuba were characterized by light microscopy and scanning electron microscopy and compared to the spongillofauna of the Nearctic and Neotropical regions and the pan-Caribbean area. The specific richness and the discovery of a new species suggest a high diversity of the Antillean freshwater sponges although the investigated area of Cuba is relatively small.

**Keywords:** *Anheteromeyenia cheguevarai* nov. sp., biodiversity, biogeography, *Ephydatia*, Greater Antilles, islands, Mesoamerica, *Radiospongilla*

## Introduction

Spongillidae (Spongillina, Haplosclerida) is the most speciose and widespread family of freshwater sponges and includes 21 genera and 134 species from a wide variety of habitats (Gee 1932; Penney and Racek 1968; Manconi and Pronzato 2002; Pronzato and Manconi 2002; also see references in Table I).

Freshwater sponges for long were considered absent from insular habitats of the Caribbean area (de Laubenfels 1936; Poirrier 1982). West Indies apparently harbours only *Ephydatia fluviatilis* (Linnaeus, 1759) in the Virgin Islands and *Radiospongilla crateriformis* (Potts, 1882) in temporary pools of Barbados and Nevis Islands (Smith 1994; Bass and Volkmer-Ribeiro 1998) although extensive surveys were recently performed. As for other Caribbean islands, *Corvoheteromeyenia heterosclera* Ezcurra de Drago, 1979 and *Spongilla alba* Carter, 1849 were recently found in the extremely hot and arid island of Curaçao (Debrot and van Soest 2001).

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Published 22 November 2005.

ISSN 0022-2933 print/ISSN 1464-5262 online © 2005 Taylor & Francis

DOI: 10.1080/00222930500307327

Table I. Checklist of freshwater sponges (Spongillidae, Metaniidae, and Potamolepidae) from the circum-Caribbean area.

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Florida (Potts 1885, 1887; Weltner 1895; Eshleman 1950; Penney and Racek 1968; Poirrier 1969, 1976; Harrison 1974, 1979; Volkmer-Ribeiro and Traveset 1987; Frost 1991; Slate and Stevenson 2000; Manconi and Pronzato 2002)

## Spongillidae

- Anheteromeyenia argyrosperma* (Potts, 1880)
- Dosilia palmeri* (Potts, 1885)
- D. radiospiculata* Mills, 1888
- Duosclera mackayi* (Carter, 1885)
- Ephydatia fluviatilis* (Linnaeus, 1759)
- E. mills* (Potts, 1888)
- E. subtilis* (Weltner, 1895)
- E. robusta* (Potts, 1887)
- Eunapius fragilis* (Leidy, 1851)
- E. igloviformis* (Potts, 1884)
- Heteromeyenia baileyi* (Bowerbank, 1863)
- Racekiela ryderi* (Potts, 1882)
- Radiospongilla crateriformis* (Potts, 1882)
- Spongilla alba* Carter, 1849
- S. aspinosa* Potts, 1880
- S. cenota* Penney and Racek, 1968
- S. lacustris* (Linnaeus, 1759)
- S. wagneri* Potts, 1889
- Stratospongilla penney* (Harrison, 1979)
- Trochospongilla leidii* (Bowerbank, 1863)

Louisiana (Moore 1951, 1953; Penney 1960; Poirrier 1969, 1977, 1978; Manconi and Pronzato 2002, 2004)

## Spongillidae

- Corvospongilla becki* (Poirrier, 1978)
- Dosilia palmeri* (Potts, 1885)
- Duosclera mackayi* (Carter, 1885)
- Racekiela ryderi* (Potts, 1882)
- Spongilla alba* Carter, 1849
- S. wagneri* Potts, 1889
- Trochospongilla pennsylvanica* (Potts, 1882)

Texas (Cheatum and Harris 1953; Penney 1960; Poirrier 1969, 1972; Frost 1991; Manconi and Pronzato 2002)

## Spongillidae

- Dosilia palmeri* (Potts, 1885)
- D. radiospiculata* (Mills, 1888)
- Radiospongilla cerebellata* (Bowerbank, 1863)
- R. crateriformis* (Potts, 1882)

Mexico (Potts 1885, 1887; Old 1936; Martinez 1940; Rioja 1940a, 1940b, 1940c, 1942, 1953a, 1953b; Penney and Racek 1968; Bushnell 1971; Poirrier 1977, 1982; Frost 1991; Manconi and Pronzato 2002)

## Spongillidae

- Dosilia palmeri* (Potts, 1885)
- Eunapius fragilis* (Leidy, 1851)
- Ephydatia fluviatilis* (Linnaeus, 1759)
- E. robusta* (Potts, 1887)
- Heteromeyenia latitenta* (Potts, 1881)
- H. baileyi* (Bowerbank, 1863)
- Radiospongilla crateriformis* (Potts, 1882)
- Spongilla cenota* Penney and Racek, 1968

Belize (Poirrier 1977; Oakland and Oakland 1989; Manconi and Pronzato 2002)

## Spongillidae

- Racekiela ryderi* (Potts, 1882)
-

Table I. (Continued.)

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Guatemala (Meek 1905; Manconi and Pronzato 2002)
Spongillidae
<i>Eunapius fragilis</i> (Leidy, 1851)
El Salvador (Poirrier and Trabanino 1989; Manconi and Pronzato 2002)
Spongillidae
<i>Ephydatia fluviatilis</i> (Linnaeus, 1759)
<i>Spongilla alba</i> Carter, 1849
Costa Rica (Murillo and Mora 1995; Roush 1999; Manconi and Pronzato 2002)
Spongillidae
<i>Corvoheteromeyenia</i> sp.
<i>Dosilia</i> sp.
<i>Radiospongilla</i> sp.
<i>Spongilla cenota</i> Penney and Racek, 1968
<i>Trochospongilla</i> sp.
Panama (Jones and Rützler 1975; Poirrier 1990; Manconi and Pronzato 2002)
Spongillidae
<i>Eunapius carteri</i> (Bowerbank, 1863)
<i>Trochospongilla leidii</i> (Bowerbank, 1863)
<i>T. horrida</i> (Weltner, 1893)
Barbados (Bass and Volkmer-Ribeiro 1998)
Spongillidae
<i>Radiospongilla crateriformis</i> (Potts, 1882)
Virgin Islands (Smith 1994)
Spongillidae
<i>Ephydatia fluviatilis</i> (Linnaeus, 1759)
Venezuela (Bonetto and Ezcurra de Drago 1973; Rodriguez 1973; Mothes de Moraes 1983; Volkmer-Ribeiro and Pauls 1980, 2000)
Spongillidae
<i>Corvoheteromeyenia heterosclera</i> Ezcurra de Drago, 1979
<i>Dosilia browni</i> (Kirkpatrick, 1906)
<i>Spongilla alba</i> Carter, 1849
<i>S. spoliata</i> Volkmer-Ribeiro and Maciel, 1983
<i>Saturnospongilla carvalhoi</i> Volkmer-Ribeiro, 1976
<i>Trochospongilla gregaria</i> (Bowerbank, 1863)
<i>T. paulula</i> (Bowerbank, 1863)
<i>T. minuta</i> (Potts, 1881)
Metaniidae
<i>Acalle recurvata</i> (Bowerbank, 1863)
<i>Drulia browni</i> (Bowerbank, 1863)
<i>D. cristata</i> (Weltner, 1895)
<i>D. conifera</i> Bonetto and Ezcurra de Drago, 1973
<i>D. geayi</i> (Gravier, 1899)
<i>D. uruguayensis</i> Bonetto and Ezcurra de Drago, 1968
<i>Metania reticulata</i> (Bowerbank, 1863)
Potamolepidae
<i>Uruguayia corallioides</i> (Bowerbank, 1863)
<i>Oncosclera navicella</i> (Carter, 1881)
<i>Oncosclera spinifera</i> (Bonetto and Ezcurra de Drago, 1973)
<i>Oncosclera intermedia</i> (Bonetto and Ezcurra de Drago, 1973)
Curaçao (Debrot and van Soest 2001)
Spongillidae
<i>Corvoheteromeyenia heterosclera</i> Ezcurra de Drago, 1979
<i>Spongilla alba</i> Carter, 1849

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Table I. (Continued.)

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Surinam (Ezcurra de Drago 1975)
Spongillidae
<i>Radiospongilla crateriformis</i> (Potts, 1882)
<i>Trochospongilla paulula</i> (Bowerbank, 1863)
Metaniidae
<i>Drulia uruguayensis</i> Bonetto and Ezcurra de Drago, 1969
<i>Metania spinata</i> (Carter, 1881)
Guyana (Gee 1930, 1931)
Metaniidae
<i>Drulia browni</i> (Bowerbank, 1863)
Cuba (present paper)
Spongillidae
<i>Anheteromeyenia cheguevarai</i> sp. nov.
<i>Ephydatia facunda</i> Weltner, 1895
<i>Radiospongilla crateriformis</i> (Potts, 1882)
<i>Radiospongilla</i> sp.

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The discovery of freshwater sponges is here reported from the Great Antilles as a result of a first survey recently carried out in inland waters of western Cuba. An analysis of the pan-Caribbean spongioloфаuna is attempted at the alpha-biogeographic level on the basis of the taxonomic diversity in the Mesoamerican, Neotropical, and Nearctic regions.

### Study area

A survey focusing on the presence of sponges in inland waters was carried out in the western territory of Cuba during winter 2000. The study area was selected in accordance with its old geological and natural history, and its ancient fauna and flora with high levels of diversity and endemism.

Different environmental typologies were surveyed such as small streams, rivers, lakes, man-made basins, pools, and subterranean watercourses. Samplings were performed at 12 sites, namely the subterranean Rio Viñales in the Cueva de los Indios (two sites), the hydrographic basin of Rio San Juan of the Reserva de la Biosfera of the Sierra del Rosario (three sites), the Embalses El Jibaro and El Salto near Piñar del Rio (two sites), two small embalses (two sites) between Guanajay and Rosa Marina along the southern side of the Pinar–La Habana road, a small pond of the Giardino Botanico Nacional of La Habana (one site), the Rio Ariguanabo near San Antonio de los Baños (one site), the Laguna del Tesoro (one site) of the Gran Parque Natural de Montemar along the Ciénaga de Zapata (Figure 1).

Cuban inland waters range from perennial to ephemeral with notable water level fluctuations in May to June and September to November. The dry season occurs in wintertime (ca 25°C), and the wet season (ca 30°C) from May to October. Rainfall ranges from ca 3000 to 1000 mm per year, respectively, in northern and southern Cuba according to the tropical climate (Walter et al. 1967). Several water bodies are partially subterranean, according to the karstic nature of the island, as in the case of the presently considered Rio Ariguanabo and the Rio de la Cueva de los Indios.

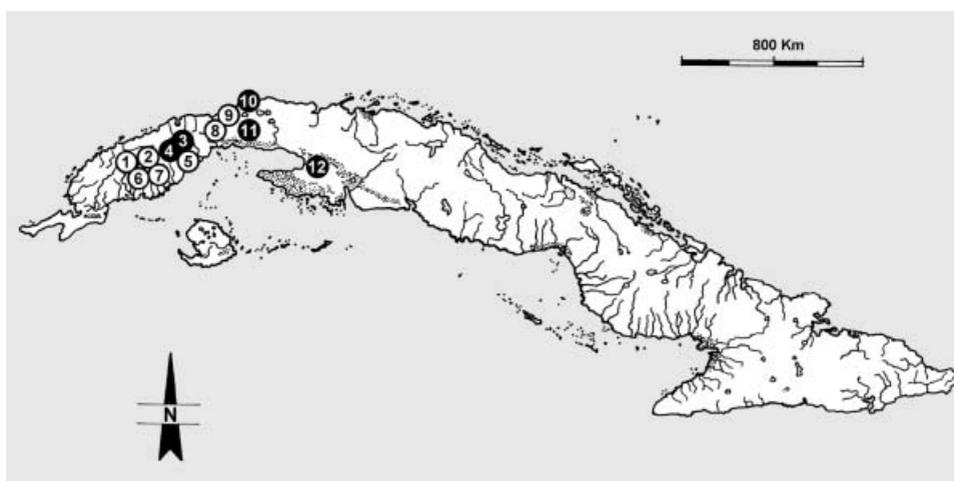


Figure 1. Study area of freshwater sponges in western Cuba with sites of sampling (circles) and findings (black dots with numbers). Cueva de los Indios (1: 22°40'N, 83°43'W; 2: 22°40'N, 83°43'W), Embalse San Juan (3), Rio San Juan (4), rapids in Rio San Juan (5), Embalse El Jibaro (6: 22°31'N, 83°41'W), Embalse El Salto (7: 22°37'N, 83°41'W), two small embalses along the Pinar–La Habana road (8: 22°58'N, 82°39'W; 9: 23°01'N, 82°31'W), Giardino Botanico Nacional of La Habana (10: 22°58'N, 82°23'W), Rio Ariguanabo near San Antonio de los Baños (11: 22°55'N, 82°28'W), Laguna del Tesor (12: 22°24'N, 81°08'W).

The checklist of freshwater sponges (Table I) refers to the pan-Caribbean area including the Nearctic and Neotropical regions in their, respectively, southern and northern areas.

### Materials and methods

Submerged substrata were examined in shallow waters of both lentic and lotic habitats. Sponge bodies were scraped with care from substrata with a knife to collect also gemmules generally produced at the sponge base. Collected specimens were preserved by drying and deposited in the freshwater sponge collection of the authors at the Dipartimento per lo studio del Territorio e delle sue Risorse (Università di Genova) with registered numbers DTRGFW599, DTRGFW600, DTRGFW601, DTRGFW602, and DTRGFW603. Type material is registered in the Museo Civico di Storia Naturale “G. Doria” di Genova. Observations on macroscopic traits and dissection of sponge body were performed under a stereomicroscope. Spicules and gemmules were prepared for both light microscopy (LM) and scanning electron microscopy (SEM) following standard methods (Manconi and Pronzato 2000, 2002; Pronzato and Manconi 2002). Measurements were carried out for each spicular type ( $n = 30\text{--}60$ ) and for gemmules ( $n = 10$ ).

### Results

Sponges were found in five sites (Figure 1). Sponge density was low and a small size of sponge body with an encrusting growth form was recorded in all the environmental typologies. Four species of three genera of spongillids were determined.

## Taxonomic accounts

**Class Demospongiae**  
**Order HAPLOSCLERIDA** Topsent, 1928  
**Suborder SPONGILLINA** Manconi and Pronzato, 2002  
**Family SPONGILLIDAE** Gray, 1867  
*Anheteromeyenia* Schröder, 1927  
*Anheteromeyenia cheguevarai* nov. sp.  
(Figures 1, 2)

### *Material examined*

Type material MSNG-52156. Three small encrusting sponges from a patch of gemmules on the same boulder, from the Embalse San Juan, locality Las Terrazas in the neighbourhood of the village, Biosfera de la Sierra del Rosario, west Cuba, 13 December 2000, R. Manconi leg. Schizotypes as small fragments, slides and stubs labelled as DTRGFW601 are preserved in the author's collection.

### *Diagnosis*

*Anheteromeyenia* with a pneumatic layer shaped as a network of spongin fibres in the gemmular theca supported by radially arranged gemmuloscleres pseudobiotules of one-dimensional class.

### *Description*

Encrusting irregular sponges (2–5 cm in diameter, 1–2 mm thick). Colour pearl grey. Surface apparently smooth and velvet in living specimens. Oscules not conspicuous. Ectosomal skeleton as more or less tangential spicules with tips slightly emerging from the dermal membrane. Choanosomal skeleton irregularly reticulated isotropic, paucispicular. Megascleres oxeas (105–315 × 5–15 μm) straight to slightly bent, from covered by short spines except at the sharply pointed tips, to rarely smooth or flexuous (Figure 2G). Oxeas sometimes with bifid, bent, or rounded tips. Microscleres absent. Gemmules brilliant grey at the sponge basis in a single compact layer strictly adherent to the well-developed basal spongin plate. Gemmules subspherical to oval (330–360 μm in diameter) (Figure 2A). Foramen with a developed tube at the middle of a depressed area supported by dense gemmuloscleres (Figure 2B, E). Gemmular theca trilayered (35–60 μm thickness) with gemmuloscleres arranged in a radial manner (Figure 2D). Outer layer thick pierced by gemmulosclere shaft with emerging distal pseudorotules (Figure 2C). Pneumatic layer as a thick network of spongin fibres with irregular rounded meshes (Figure 2F). Inner layer of sublayered compact spongin (Figure 2D). Gemmuloscleres pseudobiotules (50–84 μm in length) (Figure 2H) with a shaft 3.6–4.5 μm thick from smooth to ornate by 7–15 long acute spines mainly towards the distal part of shafts (Figure 2I); pseudorotules (4.5–14 μm in diameter) with a conspicuous umbone bearing 6–11 smooth curved hooks (Figure 2I).

### *Etymology*

The species is named for Ernesto “Che” Guevara, the popular hero of Latino-America.

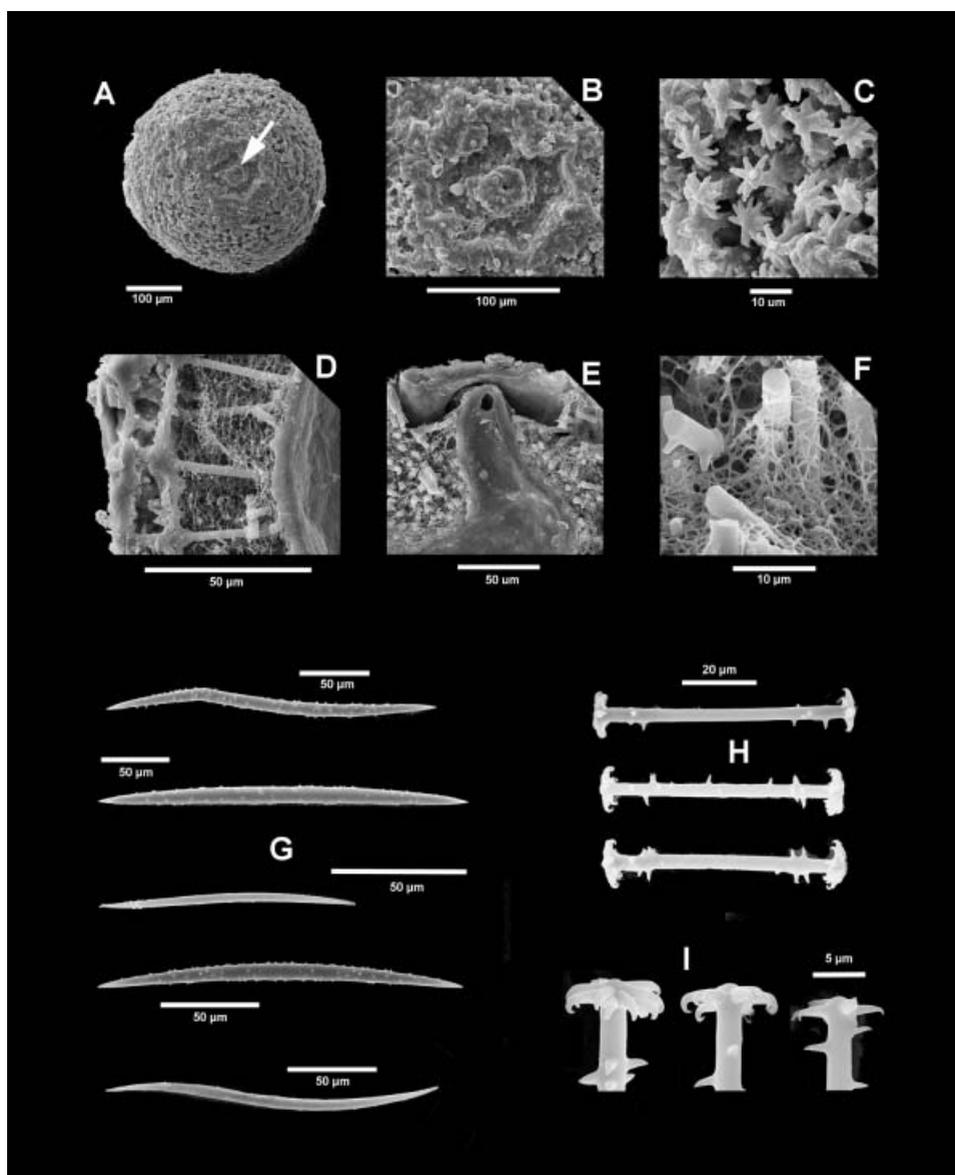


Figure 2. *Anheteromeyenia cheguevarai* nov. sp. from Cuba. Holotype MSNG52156 (Museum of Natural History, Genoa) and DTRGF601 (author's collection). SEM photomicrographs of resistant bodies and spicular complement. (A) Gemmule with foramen (arrow); (B) foramen in a depressed area; (C) free distal pseudorotules of gemmuloscleres at the gemmular surface; (D) cross-section of the trilayered gemmular theca with radial gemmuloscleres pseudobiotules; (E) detail of the foramen with a developed tube and a thick foraminal membrane at the top (cross-section); (F) network of spongin fibres in the pneumatic layer; (G) megascleres spiny oxeas, rarely smooth, from straight to flexuous; (H) gemmuloscleres pseudobiotules with spiny shaft; (I) details of pseudorotules with umbone and bent smooth hooks.

### Remarks

Only two other species are ascribed to the genus *Anheteromeyenia*, namely *A. argirosperma* (Potts, 1880) (type species), and *A. ornata* (Bonetto and Ezcurra de Drago, 1970).

Manconi and Pronzato (2002) erroneously listed in the genus *Anheteromeyenia* also *A. pictovensis* (Potts, 1885) and *A. biceps* (Lindenschmidt, 1950), sharing diagnostic traits with the genus *Racekiela*. The specimen DTRGFW601 matches the genus *Anheteromeyenia* for megascleres acanthoxeas, short oxeas sometimes sigmoid, absence of microscleres, and gemmulosclere pseudobiotules radially arranged as redefined by Volkmer-Ribeiro (1996) and Manconi and Pronzato (2002). The comparison of morphological traits highlighted however that *Anheteromeyenia cheguevarai* nov. sp. diverges from the other two species of the genus in some main diagnostic traits: (1) “megascleres acanthoxeas gradually pointed” versus “acanthoxeas abruptly pointed”; (2) “gemmuloscleres pseudobiotules of a single dimensional class” versus “gemmuloscleres pseudobiotules of two dimensional classes”; (3) “pneumatic layer as a well developed network of spongin fibres” versus “pneumatic layer of irregularly chambered spongin”. The analysis of the gemmular material by SEM of the trait “chambered pneumatic layer” versus “fibrous pneumatic layer” in the family Spongillidae strongly suggests its taxonomic value (Manconi and Pronzato 2002).

### Habitat

Specimens of *Anheteromeyenia cheguevarai* nov. sp. were found in a small lentic habitat (embalse) under boulders near the shoreline in shallow shaded quite brown waters at a depth of ca 40–60 cm.

### Geographic distribution

The finding of *Anheteromeyenia* in Cuba matches the Nearctic and Neotropical geographic range of the genus with *A. argyrosperma* from Canada to Florida, and the Neotropical *A. ornata* from Brazil and Argentina (Penney and Racek 1968; Bonetto and Ezcurra de Drago 1970; Frost 1991; Ricciardi and Reisswig 1993; Volkmer-Ribeiro 1996; Manconi and Pronzato 2002) (Tables I, II).

Table II. Distribution of 15 genera of Spongillidae in the Nearctic, Neotropical, Mesoamerican regions, Cuba, and the other Caribbean islands.

	Nearctic	Neotropical	Meso- america	Cuba	Florida	Caribbean islands
<i>Anheteromeyenia</i> Schröder, 1927	+	+		+	+	
<i>Corvoheteromeyenia</i> Ezcurra de Drago, 1979		+				+
<i>Corvospongilla</i> Annandale, 1911	+	+				
<i>Dosilia</i> Gray, 1867	+	+	+		+	
<i>Duosclera</i> Reisswig and Ricciardi, 1993	+	+			+	
<i>Ephydatia</i> Lamouroux, 1816	+	+	+	+	+	+
<i>Eunapius</i> Gray, 1867	+	+	+		+	
<i>Heteromeyenia</i> Potts, 1881	+				+	
<i>Heterorotula</i> Penney and Racek, 1968		+				
<i>Spongilla</i> Lamarck, 1816	+	+	+		+	+
<i>Racekiela</i> Bass and Volkmer-Ribeiro, 1998	+	+	+		+	
<i>Radiospongilla</i> Penney and Racek, 1968	+	+	+	+	+	+
<i>Saturnospongilla</i> Volkmer-Ribeiro, 1976		+				
<i>Trochospongilla</i> Vejdovsky, 1883	+	+	+		+	
<i>Uruguayella</i> Bonetto and Ezcurra de Drago, 1969		+				

*Ephydatia* Lamouroux, 1816  
*Ephydatia facunda* Weltner, 1895

(Figures 1, 3)

*Ephydatia facunda* Weltner 1895, p140; Manconi and Pronzato 2002, p938; see synonymies in Pinheiro et al. 2004, p2.

*Material examined*

Six specimens, labelled DTRGFW600, Rio Ariguanabo, Las Yagrumas near San Antonio de Los Baños, west Cuba, 11 December 2000, R. Manconi leg.; 10 small specimens, labelled DTRGFW602, Rio San Juan, Los Baños, Sierra del Rosario, west Cuba, 14 December 2000, Luca Pronzato leg.

*Description*

Encrusting sponges of irregular shape, from 0.4 to 3 cm in diameter, 2–4 mm thick. Colour whitish-greenish to light brown. Surface hispidation is evident in dry specimens. Oscules not conspicuous. Ectosomal skeleton as spicules emerging from the dermal membrane. Choanosomal skeleton irregularly reticulated, isotropic, paucispicular.

Megascleres oxeas (DTRGFW600: 232–316 × 7–14 μm; DTRGFW602: 205–363 × 7–9 μm) straight to bent, from entirely smooth to spiny except at the sharply pointed tips (Figure 3I). Rare oxeas are densely spined. Microscleres absent. Gemmules whitish, subspherical (DTRGFW600: 185–280 μm; DTRGFW602: 200–278 μm in diameter) (Figure 3A–C) at the sponge basis not adhering at the thin basal spongin plate. Foramen simple without collar, not surpassing the outer layer. Gemmular theca trilayered (DTRGFW600: 31–35 μm; DTRGFW602: 25–44 μm in thickness) (Figure 3D, E) with gemmuloscleres in a single radial layer from densely to sparsely arranged (Figure 3D, E), and bearing distal rotules from entirely to partially embedded in the outer layer of spongin (Figure 3F–H). Outer layer well developed. Pneumatic layer with rounded chambers in both studied specimens (Figure 3D, E). Inner layer of compact multilayered spongin. Gemmuloscleres birotules (DTRGFW600 and DTRGFW602: 23–51 × 4–7 μm), with smooth shaft or bearing one or two acute long spines (Figure 3J). Rotules are plates and of constant size (DTRGFW600 and DTRGFW602: 19–25 μm) with a granulated outer surface, a conspicuous central umbone, and margins deeply indented with 15–20 rays (Figure 3K).

*Remarks*

These Cuban sponges clearly differ from *E. millsii* (Potts, 1888) for the shape of gemmular birotules and size of megascleres. As for *E. subtilis*, recorded as a new species but not described by Weltner (1895), Harrison (1979) reports that its “taxonomic status remains undetermined” because despite extensive collecting in the type locality (Lake Kissimee, Florida) the species was not found. The examined material from Cuba shares with *E. facunda* the general morphology, size of skeletal and gemmular elements, and the variable trait “outer layer with embedded or free distal rotules in the gemmular theca”; it differs however for the size of megascleres when compared to the recent description by Pinheiro et al. (2004). *E. facunda* was considered a synonym of *E. fluviatilis ramsayi* by Ezcurra de Drago (1975), and re-evaluated as a valid species by De Rosa Barbosa (1979) and Pinheiro

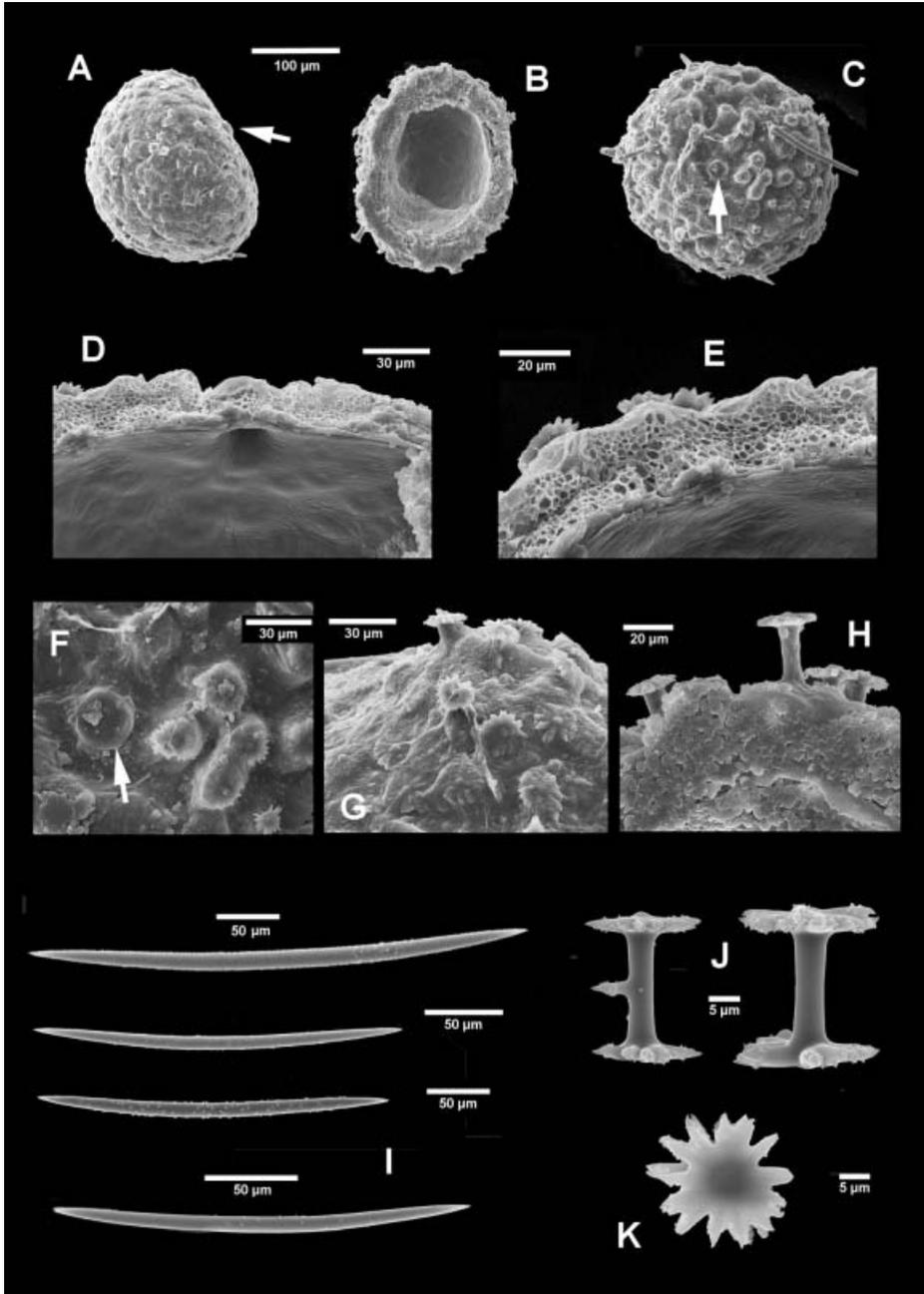


Figure 3. *Ephydatia facunda* from Cuba (DTRGFW600, DTRGFW602). SEM photomicrographs of resistant bodies and spicular complement. (A) Gemmule lateral view with foramen on the right (arrow); (B) cross-section of the gemmular theca; (C) top view of a gemmule with foramen in the centre (arrow); (D) gemmular theca at the foraminal level (cross-section); (E) trilayered gemmular theca with compact spongin in the outer and inner layer, and chambered spongin in the pneumatic layer (cross-section); (F) foramen (arrow) surrounded by distal rotules of gemmuloscleres; (G, H) outer layer with emerging distal rotules of gemmuloscleres [(G) top view; (H) cross-section]; (I) megascleres acanthoxeas; (J) gemmuloscleres birotules; (K) spiny rotules bearing indented margins.

et al. (2004). As for the freshwater sponges ascribed to *Ephydatia fluviatilis* from the Island of St John (Virgin Islands), it clearly appears from SEM micrographs by Smith (1994) that gemmules are characterized by the trait “pneumatic layer as a network of spongin fibres” deeply diverging from the typical gemmular architecture of *E. fluviatilis* characterized by a “pneumatic layer of chambered spongin”. A comparative analysis of distant populations of *E. fluviatilis* is at present in progress by morphological and molecular approaches to clarify its problematic cosmopolitanism with a disjunct geographic range.

### *Habitat*

In the Rio Ariguanabo under boulders near the embarcadero in shaded shallow brownish-yellowish waters with a high content of minerals, ca 20–40 cm of depth. The Rio Ariguanabo in this karstic area runs, with a wide wet bed (10–15 m wide), under tunnel-shaped vegetation and becomes subterranean below this site. In the Rio San Juan of the Sierra del Rosario sponges were settled under boulders and pebbles in running clear shallow waters with high mineral content, ca 10–20 cm of depth, in a habitat shaded by a tunnel vegetation. Sponges were associated with statoblasts of an unidentified bryozoan.

### *Geographic distribution*

The presence of *E. facunda* in western Cuba fits well the distribution of the cosmopolitan genus *Ephydatia* in the pan-Caribbean area with *E. fluviatilis* (Linnaeus, 1759) recorded in Florida, Mexico, El Salvador, and the Virgin Islands, and *E. millsii* and *E. subtilis* in Florida (Tables I, II). *Ephydatia facunda* is endemic to the Neotropical region and recorded till now exclusively from Brazil (Pinheiro et al. 2004). The present record extends the geographic range of the species to the Caribbean area.

***Radiospongilla* Penney and Racek, 1968**

***Radiospongilla crateriformis* (Potts, 1882)**

(Figures 1, 4)

*Meyenia crateriformis* Potts 1882, p 12; 1887 p.228; *Radiospongilla crateriformis* see synonymies in Penney and Racek 1968, p 66; Ezcurra de Drago 1975, p 180; Bass and Volkmer-Ribeiro 1998, p 124; Manconi and Pronzato 2002, p 956.

### *Material examined*

Ten very small specimens labelled DTRGFW603, Orto Botanico Nacional, La Habana, west Cuba, 16 December 2000, R. Manconi leg.

### *Description*

Encrusting irregular sponges 2 cm in diameter, 2–3 mm thick. Colour whitish. Oscules not conspicuous. Surface hispid. Ectosomal skeleton as spicule tufts emerging from the dermal membrane. Choanosomal skeleton irregularly reticulated isotropic, paucispicular. Megascleres oxeas (209–321 × 8–10 μm) straight to slightly bent, smooth in the middle and with small spines at the sharply pointed tips (Figure 4E, J). Microscleres spiny strongyles to oxeas (75–85 × 2.5–5 μm) (Figure 4F, G, K). Gemmules abundant and grouped at the sponge basal area, not adhering at the basal spongin plate. Gemmular shape

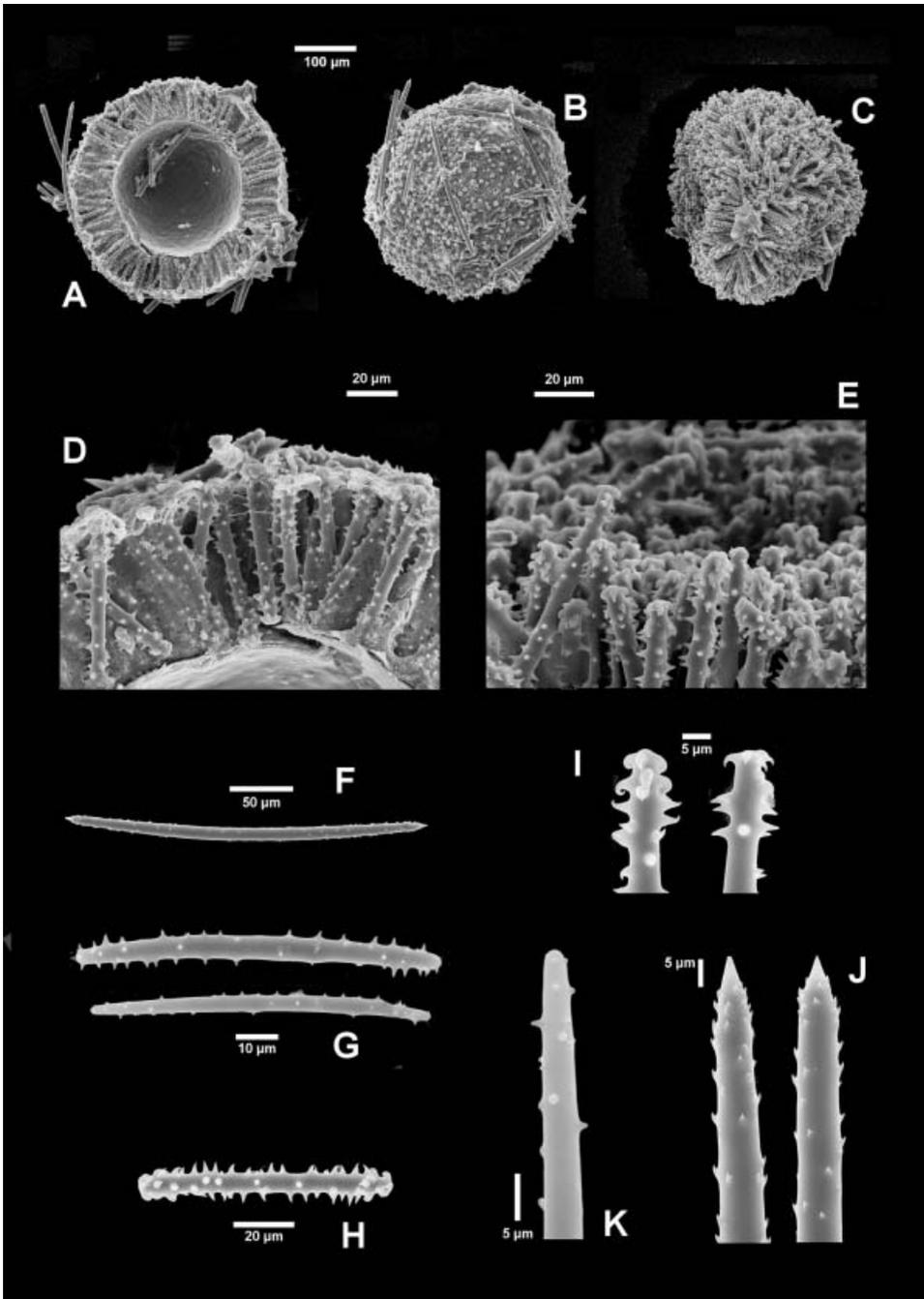


Figure 4. *Radiospongilla crateriformis* from Cuba (DTRGFW603). SEM photomicrographs of resistant bodies and spicular complement. (A) Gemmule (cross-section); (B) gemmule with the outer layer pierced by distal rotules of radial gemmuloscleres; (C) gemmule without outer layer; (D) gemmular theca (cross-section) with radial gemmuloscleres adhering to the inner layer by the proximal rotules. Pneumatic layer as thin scattered spongin fibres; (E) gemmular theca with free distal rotules; (F) megasclere oxea with small spines; (G) microscleres spiny strongyloxeas; (H) gemmulosclere pseudobirotole with spiny shaft and bent long spines at the apices; (I) apices of gemmuloscleres; (J) apices of megascleres oxeas; (K) apex of microsclere strongyloxea.

from subspherical (400  $\mu\text{m}$ ) to oval (320  $\times$  400  $\mu\text{m}$ ) (Figure 4A, B). Colour of gemmules white to dark grey according to the absence/presence of the outer layer in the theca (Figure 4B). Foramen tubular without collar but at the middle of a crater-like depressed area. Gemmular theca trilayered (78–83  $\mu\text{m}$  in thickness) with radially and densely arranged gemmuloscleres (Figure 4C, D). Outer layer from well developed to absent; when present it bears emerging distal rotules from the outer layer. Pneumatic layer as a weakly developed network of very fine spongin fibres (Figure 4C). Inner layer of sublayered compact spongin. Gemmuloscleres (63–79  $\mu\text{m}$  in length) straight or slightly bent are pseudobirotales to strongyles frequently bearing an apical acute spine surrounded by a crown of a few bent spines (hooks); pseudo-rotules (5.4–11.5  $\mu\text{m}$  in diameter); shaft with several acute spines (Figure 4H, I).

#### *Remarks*

All morphological traits and size of spicules match well those described by several authors for this widespread species and particularly spicular sizes from Barbados and Nevis Islands by Bass and Volkmer-Ribeiro (1998).

#### *Habitat*

Small sponges settled under boulders in standing quite brown shallow waters ca 15 cm of depth in a small pool near the greenhouses. This finding confirms stagnant turbid waters as the preferred habitat of this species (Harrison 1974).

#### *Geographic distribution*

The widespread genus *Radiospongilla* is represented in the Nearctic and Neotropical Regions by *R. crateriformis* and *R. amazonensis* Volkmer-Ribeiro and Maciel, 1983. This second finding of *R. crateriformis* in the West Indies, after that in Barbados and Nevis Islands by Bass and Volkmer-Ribeiro (1998), fits well the geographic range in Surinam, Yucatan, Mexico, and USA (Old 1932, 1936; Arndt 1933; Ezcurra de Drago 1975) (Tables I, II). On the other hand, this species shows a widely disjunct distribution and it is reported also from China, Philippines, Japan, and southern Asia (Penney and Racek 1968; Manconi and Pronzato 2002). The finding of the species exclusively in the Orto Botanico Nacional of Cuba suggests, however, the possibility of an accidental introduction.

### ***Radiospongilla* sp.** (Figures 1, 5)

#### *Material examined*

Five small specimens labelled DTRGFW599, from the Laguna del Tesor, La Boca-Guama, Cienaga de Zapata, west Cuba, 15 December 2000, R. Manconi leg.

#### *Description*

Growth form from encrusting to small cushion. Colour whitish-greenish. Consistence fragile both in vivo and in dry conditions. Surface smooth. Oscules conspicuous, 2–3 mm in

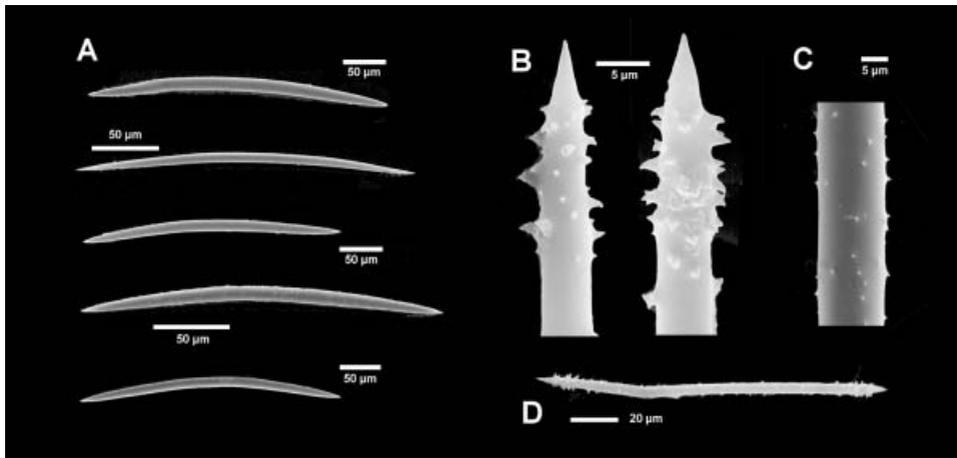


Figure 5. *Radiospongilla* sp. from Cuba (DTRGF599). SEM photomicrographs of spicular complement. (A) Megasclere oxeas with small spines; (B) spiny apices of microscleres; (C) microspined shaft of microsclere; (D) microsclere.

diameter, irregularly scattered. Ectosomal skeleton with tangential spicules in the dermal membrane, with few emerging tufts of two or three spicules. Choanosomal skeleton paucispicular with irregular meshes from alveolar to more or less triangular. Basal spongin plate well developed and spicular. Megascleres slightly bent oxeas ( $284\text{--}348 \times 9.3\text{--}14\ \mu\text{m}$ ) smooth to rarely spiny except at the sharp tips (Figure 5A). Apices sometimes bent or with two to three tips. Microscleres ( $112\text{--}163 \times 3\text{--}4.5\ \mu\text{m}$ ) few to rare straight acanthoxeas with spines increasing in density towards the sharply pointed tips; apical spines ornate by microspinousities (Figure 5B–D). Gemmules absent.

#### Remarks

The absence of gemmules, probably due to the active life cycle phase of the sponges, renders it impossible to determine the taxon at the species level. Diagnostic skeletal traits of the sponge such as shape and size of the spicular complement suggest the ascription of specimens to a species of the genus *Radiospongilla*.

#### Habitat

Sponges were settled under limestone boulders in waters rich in carbonates of a lentic habitat along the northern edge of the Laguna del Tesor. The latter is the largest (900 hectares) natural and most pristine wetland of Cuba (maximum depth 10 m, mean ca 4 m) within the Gran Parque Natural de Montemar with large extension of swamps and coastal brackish lagoons.

#### Discussion

Cuban spongillids, all displaying an encrusting body shape of small size, were in the active phase of the life cycle at the beginning of the dry wintertime. Most sponges were characterized by the typical presence of gemmules able to withstand unfavourable environmental conditions to survive in situ as resting bodies or to perform dispersal

(Manconi and Pronzato 1991, 1994, 1996, 2002; Pronzato and Manconi 1994; Manconi et al. 2004). All sponges were settled in shallow waters but their lifestyle appears strictly skiophilous, in accord with the preferential shaded microhabitats in both lotic and lentic typologies ranging from streams and rivers, to coastal basins, man-made lakes and small pools.

Spongillidae were found in five out of the 12 surveyed sites in the western area of Cuba (Figure 1), confirming the hypothesis by de Laubenfels (1936). The spongillofauna of western Cuba appears, since the present first survey, notably rich with four species belonging to four genera. Results suggest a notable diversity of the taxon Spongillidae although species richness in the island appears impoverished with respect to the continental neighbouring regions. The rare findings of freshwater sponges hitherto in the Greater Antilles seem to be due to a lack of surveys. The presence of two syntopic species belonging to two different genera, *Anheteromeyenia* and *Ephydatia*, within the same hydrographic basin of Rio San Juan in a small artificial lake and down in the neighbouring tract of its outlet stream, respectively, confirms the high biodiversity of the Reserva de la Biosfera of the Sierra del Rosario. On the other hand, *E. facunda* appears widespread and is found in distant lotic habitats sharing a high water mineral content, the river Rio Ariguanabo and the stream Rio San Juan (Sierra del Rosario).

These first results are constrained by the limited study area, the short-term nature of the survey, and the low number of samplings. However, they refer to the most ancient area of Cuba and could be suggestive of a general condition of richness. The present records from Cuba and the presumed absence of freshwater sponges in the other Greater Antilles do not fit the high values of diversity of Spongillina in the Nearctic and Neotropical regions, suggesting the need for new investigations on these unexplored islands. Two families, Spongillidae and Metaniidae, are present in the Nearctic region, the former with 27 species ascribed to 11 genera, namely *Spongilla*, *Anheteromeyenia*, *Corvospongilla*, *Dosilia*, *Duosclera*, *Ephydatia*, *Eunapius*, *Heteromeyenia*, *Racekiela*, *Radiospongilla*, and *Trochospongilla* (Potts 1887; Penney and Racek 1968; Harrison 1974; Frost 1991; Manconi and Pronzato 2002) (Table II).

Three families, Spongillidae, Metaniidae, and Potamolepidae, are recorded from the Neotropical region with 29 species of Spongillidae ascribed to 13 genera, namely *Spongilla*, *Anheteromeyenia*, *Corvoheteromeyenia*, *Corvospongilla*, *Dosilia*, *Ephydatia*, *Eunapius*, *Heterorotula*, *Racekiela*, *Radiospongilla*, *Saturnospongilla*, *Trochospongilla*, and *Uruguayella* (Penney and Racek 1968; Volkmer-Ribeiro 1981a, 1981b; Manconi and Pronzato 2002). The Nearctic and Neotropical regions share nine genera (Table II).

On the other hand, seven genera of Spongillidae were reported from the Mesoamerican subregion with 10 species, namely *Dosilia palmeri* (Potts, 1885), *Radiospongilla crateriformis* and *Spongilla cenota* Penney and Racek, 1968 from Yucatan, *Eunapius fragilis* (Leidy, 1851) from Guatemala, *Racekiela ryderi* (Potts, 1882) from Belize, *Eunapius carteri* (Bowerbank, 1863), *Trochospongilla leidii* (Bowerbank, 1863) and *T. horrida* (Weltner, 1893) from Panama, *Spongilla alba* Carter, 1849 and *Ephydatia fluviatilis* from El Salvador, *Spongilla cenota*, *Radiospongilla* sp., *Dosilia* sp., and *Trochospongilla* sp. from Costa Rica (Potts 1885; Meek 1905; Penney and Racek 1968; Jones and Rützler 1975; Poirrier 1977, 1990; Oakland and Oakland 1989; Roush 1999; Poirrier and Trabanino 1989; Manconi and Pronzato 2002) (Tables I, II).

In summary, three families of freshwater sponges with 48 species and 18 genera are known from the pan-Caribbean area: Spongillidae (39 species, 14 genera), Metaniidae (eight species, three genera), and Potamolepidae (four species, two genera) (Table I).

The composition of the western Cuba spongillofauna suggests, at the genus level, strict relationships to the circum-continental areas, but it appears notably impoverished at the family level in the absence of Metaniidae and Potamolepidae.

Cuba shares its genera (*Anheteromeyenia*, *Ephydatia*, *Radiospongilla*) with both the Neotropical and the Nearctic regions, and Mesoamerica, and two genera with some other Caribbean islands (Tables I, II). The geographic distribution of the Cuban genera ranges from cosmopolitan to widespread. At the species level the presence of *E. facunda*, never reported in Mesoamerica and hitherto known only from Brazil, enlarges its geographic range to the north. Our data extend the range of *R. crateriformis* to the entire Caribbean insular arc. Finally, the presence of *Anheteromeyenia cheguevarai* nov. sp. matches the high levels of diversity and endemism of western Cuba in accordance with the old geological and natural history of the area and its ancient endemic fauna and flora.

The knowledge of freshwater sponges from the Antilles is at present inadequate to attempt an exhaustive biogeographic analysis; however, these data appear to fit the classic North America–Caribbean and South America–Caribbean biogeographic tracks suggested by Rosen (1975). The composition and richness of the spongillofauna of Cuba and the other Caribbean islands shared at the genus level with the circum-Caribbean area seem to imply a relatively recent diversification and/or immigration related to their geological history and climatic vicissitudes. Bass and Volkmer-Ribeiro (1998) hypothesized for Barbados and Nevis islands a dispersal of *R. crateriformis* from the south-eastern USA by winds and/or animal carriers. Debrot and van Soest (2001) suggested anemocorous dispersal for *Spongilla alba* and *Corvoheteromeyenia heterosclera* on the volcanic island of Curaçao from southern continental areas. Smith (1994) hypothesized that dispersal of *E. fluviatilis* occurred eastward across the Greater Antilles arc from Central America. On the other hand, the presence of the new species in the ancient area of Cuba suggests the existence of a typical Cuban/Antillean freshwater sponge fauna.

The geographic range of Cuban genera at a regional scale confirms that, as suggested by Donnelly (1988) for other taxa, different hypothetical dispersal routes could explain the composition of the Antillean spongillofauna, namely from the neighbouring Nearctic region and Mesoamerica by land bridges, and from the Neotropical region by means of a “stepping stones” process along the insular Caribbean arc.

The present findings together with the numerous records from insular freshwater habitats of all biogeographic regions except Antarctica (Weltner 1895; Gee 1932; Penney and Racek, 1968; Manconi and Pronzato 1994, 2002; Pronzato and Manconi 2002) confirm that Spongillidae is a super tramp taxon able both to colonize oceanic islands and to persist and survive during the geological vicissitudes of fragments of continental land mass.

### Acknowledgements

We thank Mauro Michetti and Claudio Uliana (Centre for Electron Microscopy, Università di Genova) for the valuable help with photography. We are grateful to Achille Casale for the critical revision of a preliminary version and to Pedro Alcolado for the kind help. Aurora Lunesu helped us to focus on this work. This research was supported by grants from the Università di Sassari. The European program INTERREG III and the Italian Ministero dell’Istruzione, dell’Università e della Ricerca (MIUR PRIN 2004057217) funded electron microscopy investigations.

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