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# *Anheteromeyenia vitrea* (Porifera: Demospongiae) new species of continental sponge in Brazil

# *Anheteromeyenia vitrea* (Porifera: Demospongiae) nova espécie de esponja continental no Brasil

Antonio Alvaro Buso Junior[1]
alvaro.buso.jr@gmail.com

Cecília Volkmer-Ribeiro[2]
cvolkmer1427@gmail.com

Luiz Carlos Ruiz Pessenda[1]
pessenda@cena.usp.br

Vanessa de Souza Machado[3]
biologavsm@gmail.com

## Abstract

The siliceous spicules of continental sponges have proved to be valuable tools in paleoenvironmental reconstructions, whenever they are perceived in columns of recovered quaternary sediments. The spicules of such sponge collected at grassland subjected to short flooding periods in the Vale Nature Reserve, a preserved coastal area of Atlantic Rain Forest at Espirito Santo State (Brazil), were detected in soil samples recovered in the same region. Study under SEM of materials of the collected specimens indicated the need for description of *Anheteromeyenia vitrea* n. sp. and redefinition of genus *Anheteromeyenia*, with Nearctic/Neotropical distribution.

**Key words:** Neotropical freshwater sponges, genus *Anheteromeyenia* redefined, Spodosol, preserved coastal area.

## Resumo

As espículas silicosas das esponjas continentais vêm se mostrando instrumentos valiosos em reconstruções paleoambientais sempre que são detectadas em colunas de sedimentos quaternários recuperados. As espículas de uma dessas esponjas, coletada em ambiente de campos nativos na Reserva Natural da Vale, área preservada de Mata Atlântica no Estado do Espírito Santo (Brasil), foram identificadas em amostras de solo coletadas na mesma região. Estudos ao MEV de materiais dos espécimes coletados indicaram a necessidade da descrição de *Anheteromeyenia vitrea* sp. n. e redefinição do gênero *Anheteromeyenia,* com distribuição Neartica/Neotropical.

**Palavras-chave:** Esponjas de água doce neotropicais, gênero *Anheteromeyenia* redefinido, Espodossolo, área costeira preservada.

[1] Laboratório de Carbono 14, Centro de Energia Nuclear na Agricultura (CENA/USP), Av. Centenário, 303, 13416-000, Piracicaba, SP, Brasil.
[2] Seção de Invertebrados Inferiores, Setor de Poríferos Continentais, Museu de Ciências Naturais (MCN), Fundação Zoobotânica do Rio Grande do Sul (FZB), Av. Salvador França, 1427, 90690-000 Porto Alegre, RS, Brasil.
[3] Programa de Pós-Graduação em Geociências, Instituto de Geociências, Universidade Federal do Rio Grande do Sul. Av. Bento Gonçalves, 9500, Prédio 43113, 91501-970 Porto Alegre, RS, Brasil.

## Introduction

Continental siliceous sponge spicules preserved in sediments have been used as biological proxy in paleoenvironmental studies at Neotropical Region (Volkmer-Ribeiro *et al*., 2006, 2007; Parolin *et al*., 2007, 2008; Almeida *et al*., 2009, 2010; Machado *et al*., 2012). The ongoing research project "Interdisciplinary paleoenvironmental studies at Espirito Santo coast" (FAPESP 2011/00995-7) proposes the use of this and other proxies in the reconstitution of the late Quaternary coastal paleoenvironment at the northeastern region of Espirito Santo State, southeastern Brazil, and gives continuity to the studies initiated previously within the research project "Mid Holocene vegetation and climate reconstructions in Brazil" (FAPESP 2007/03615-5). During this former project, at a field expedition which intended to recover soil samples in native grassland at Vale Nature Reserve, Atlantic Rainforest region of Brazil, specimens of a continental sponge species were found at the sampling site adhered to the herbaceous vegetation. Preliminary studies have shown that spicules of this species are found along the recovered soil samples. As a new species of continental sponge belonging to genus *Anheteromeyenia* Schröder (1927), the species description now presented required the redefinition of the genus, and comprises one of the first results of the present research project. The description of this new species constitutes an essential first step for the adequate utilization of its fossil and subfossil spicules as paleoenvironmental proxy.

## Material and methods

### Study area

The Vale Nature Reserve (VNR) is located at the northern coast of Espírito Santo State, Brazil (Figure 1). The reserve protects one of the last remnants of the *tabuleiro* forest, lowland Tropical Rainforest, which extends from the State of Pernambuco to the State of Rio de Janeiro (Veloso *et al*., 1991; Rizzini, 1997). Beyond the *tabuleiro* forest the VNR also protects other types of natural vegetation, such as flood plain forests, marshes, gallery forests, *restingas*, grasslands and *muçununga* forest, according to the classification of vegetation types presented by Peixoto (1992).

*Tabuleiro* forest, the most representative vegetation type at VNR, is established over Yellow Argisol, on a flat, smooth undulated terrain (Santos *et al.*, 2004). This soil type is developed over the Barreiras formation, a sedimentary plain from Neogene (IBGE, 1987).

For the period comprising the years 1975 to 2002, local climate may be classified as Aw type in Köppen classification with mean annual precipitation of 1215 mm, mean annual temperature of 23.3º C and dry season during winter (Figure 2).

The specimens were collected at site NF (19º09'53.80''S and 39º56'17.30''W; ~25 m.a.s.l.) a natural vegetation type described as *campos nativos* (Peixoto, 1992) (Figure 1). These grasslands occur at southern Bahia and northern Espirito Santo States, interspersed among the *tabuleiro* forest (Monteiro and Kaz, 1992).

The soils under *campos nativos* at VNR were classified by Santos *et al*.

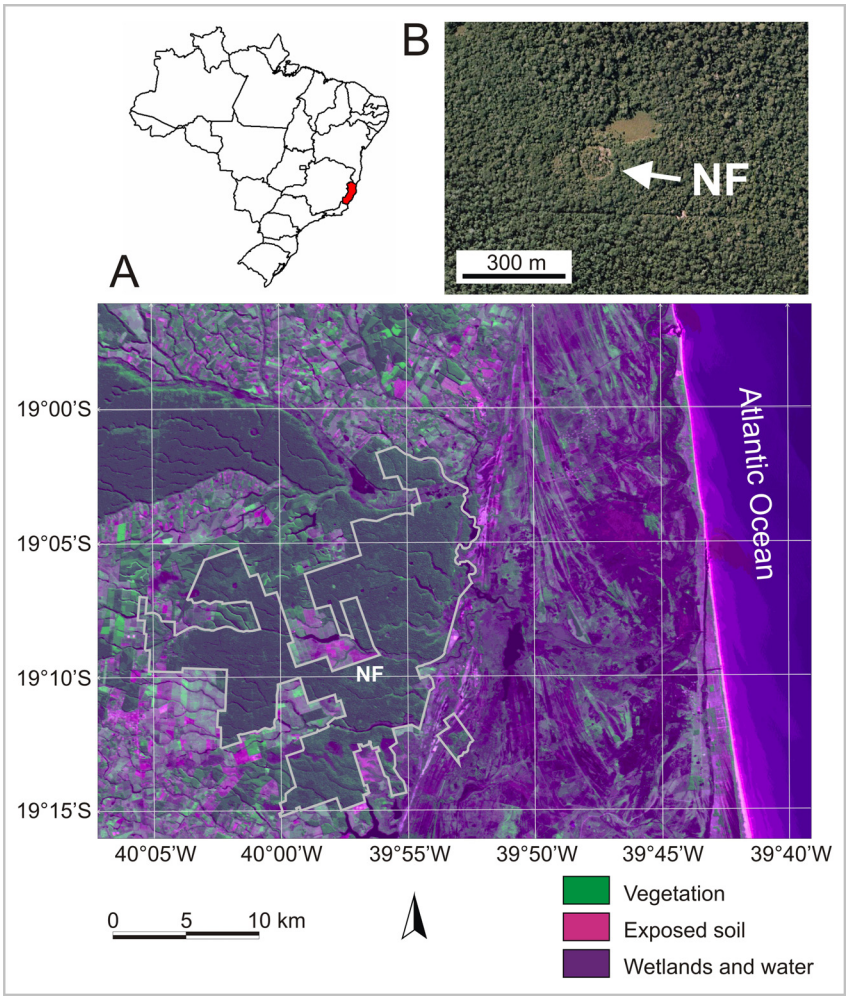


**Figure 1.** Study area; (A) Land use map for the year 2005 elaborated from CBERS2 CCD bands 3, 4 and 2 (INPE, 2005). The Vale Nature Reserve area is delimited. (B) Detailed image from NF site.

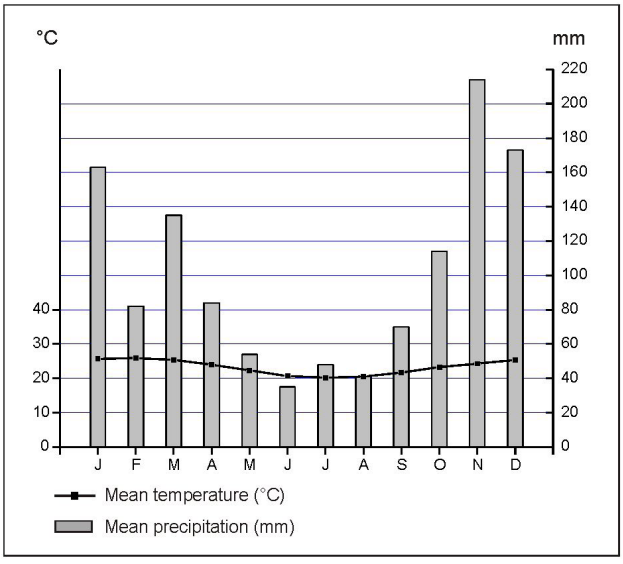


**Figure 2.** Climatic diagram for the period 1975 to 2002, based on data from Vale Nature Reserve's climatic station.

(2004) as Spodosol. The presence of an impermeable spodic horizon in this soil type makes these sites become water flooded during the rainy periods of the year. Distinct *campos nativos* show distinct physiognomies and plant species assemblages in response to water stress resulted from drainage, soil depth and granulometry (IBGE, 1987; Saporetti Jr., 2009).

Site NF is a seasonally short flooded open circular area (Figures 1 and 3), with a diameter of ~100 meters, bordered by *muçununga* (Peixoto, 1992) forest. The site was visited during the dry season (July) and there were observed remnants of *Salvinia* sp, a free floating aquatic fern. The Spodosol at site NF seems to be very shallow, the spodic horizon placed at ca. 0.5 m depth. A layer of peat, ca. 0.3 m depth, covers the soil surface. Over the peat, the litter is composed of leaves of trees, herbs and dried individuals of *Salvinia* sp. (Figure 3).

## Methods

The collected material consisted of five specimens clumped together into a glassy, bright, dry mound. One specimen was elected holotype and the others paratypes and as such catalogued in the Porifera Collection of the Natural Sciences Museum of Fundação Zoobotânica do Rio Grande do Sul (MCN- POR). Preparations of spicular dissociations for all the specimens were performed according to Volkmer-Ribeiro (1985) and Volkmer-Ribeiro and Turcq (1996), for studies with, respectively, light optical and Scanning Electron Microscopy (SEM). The SEM photographs were obtained at the Electron Microscopy Laboratory of Universidade Luterana do Brasil (ULBRA), in Canoas, Rio Grande do Sul, and later treated and mounted with the use of computer graphics. Fifty (50) measurements were taken of each category of spicular component both from the holotype and two paratypes.

## Taxonomy

Family Spongillidae Gray, 1867

Genus *Anheteromeyenia* Schröder, 1927 redefined

*Heteromeyenia (Anheteromeyenia)* Schröder, 1927:108 (partim).
*Anheteromeyenia* Volkmer-Ribeiro, 1996:32 (and synonymy); Volkmer-Ribeiro, 2007; Manconi and Pronzato, 2002:929 (partim).

Type species: *Spongilla argyrosperma* Potts, 1880, subsequent designation by Penney and Racek, 1968:114.

Diagnosis. Continental sponges missing microscleres, with spiny, irregularly birotulated gemmoscleres which gradually proceed from long, stouter, into short slimmer ones; rotules of the longer gemmoscleres dome shaped, expanded and deeply indented into large incurved hooks or smaller and cut into incurved spines; rotules of the shorter gemmoscleres flatter, reduced to an irregular circle of small incurved spines; the shorter gemmoscleres predominate in the gemmular coat. Two series of megascleres may be present, the alfa megascleres, long, slim, spiny or smooth anfioxea which make up the skeletal structure and the beta megascleres, rare, spiny anfioxea to amphistrongyla, usually found close to the gemmules. Sponges forming patchy groups of large gemmules, barely covered by a fragile irregular skeleton with scanty spongin.

Redescription. Sponges forming from green to gray or glassy very fragile patchy crusts each consisting of a poor skeleton covering mounds of numerous gemmules.

Skeleton reduced and progressing from an irregular deposition of the megascleres on the gemmules to a reticulum composed of unispicular tracts or to a few largely spaced horizontal fibers giving off very few lateral fibers; ectosome thick at places eventually disclosing oscules and singular pores.

Megascleres in two categories. Alfa megascleres, from slim to stout, sparsely spined, to smooth, straight to slightly curved or sinuous, abruptly pointed oxea which make up the skeletal reticulum. Beta megascleres rare**,** about two thirds the length of the alfa ones, spiny anfioxea to stout amphistrongyla, usually found close to the gemmules.

**Figure 3.** Photograph of the seasonally short flooded grassland spot, bordered by *muçununga* vegetation where the studied specimens of *Anheteromeyenia vitrea* n. sp. were found dried out on the soil, sticking to the also dry remnants of *Salvinia* sp. and herb vegetation.

Microscleres absent.
Gemmoscleres as in the genus diagnosis.
Gemmules abundant and large, brownish, forming loose accumulations on the substrate; foraminal tube conspicuous, straight and set in a conical depression in the fully developed gemmules. Gemmoscleres rather radially embedded in the undulated pneumatic coat, the larger gemmoscleres projecting their extremities beyond the level of the outer coat. Inner gemmular coat thick, pneumatic coat also thick with small polyhedral air spaces, outer gemmular coat conspicuous and smooth.
Distribution. Nearctic-Neotropical with *A. argyrosperma* (Potts, 1880) found in the eastern half of the Nearctic Region, from Quebec to Florida and *A. ornata* (Bonetto and Ezcurra de Drago, 1970) and *A. vitrea* n. sp. in the Neotropical Region.
Habitat. Sponges found in running waters but then forming flat soft crusts on the lower side of stones or on rocky banks of streams. Most often sponges forming wool glass like tufts over patchy groups of gemmules in lentic waters. When exposed to light sponges are green, otherwise glassy or silvery bright with brown shadows due to the underlying mounds of gemmules.

*Anheteromeyenia argyrosperma* (Potts, 1880)
(Figure 8A)

*Spongilla argyrosperma* Potts, 1880: 357.
*Heteromeyenia argyrosperma;* Potts, 1881: 150; 1884: 216; 1887: 239, PL. VI, fig. i; PL. XI, figs. i, ii.
*Anheteromeyenia argyrosperma*; Penney and Racek, 1968: 116, pl. 10, figs. 8, 9, 10; Volkmer-Ribeiro and Traveset, 1987: 233, fig. 6; Volkmer-Ribeiro, 1996: 33-34, figs. 1, 2, 6, 10 (redescription and synonymy); Manconi and Pronzato, 2002: 930, figs 9-11.

Type material: By present designation ANSP PO4538 is elected lectotype and ANSP PO4587 paralectotype.
Type locality. Lehigh River at Lehigh Gap, Pennsylvania, USA.
Remarks. The species was precisely, though shortly described by Potts (1880) and later extensively described and illustrated by Potts (1887) with emphasis placed on the differing shape of the longer and the shorter gemmoscleres. This same characteristic was reinforced with SEM illustrations of dissociated gemmoscleres by Volkmer-Ribeiro and Traveset (1987) and again the longer and shorter ones seen in situ in the gemmular wall by Volkmer-Ribeiro (1996). The assumption by Manconi and Pronzato (2002) that the insertion of some gemmoscleres at different levels in the gemmular wall would account for they being considered longer ones is fully dismissed by the upper referred SEM studies and by Manconi and Pronzato's own Figures 11 B, F, where not only the size, but the shape of the gemmoscleres illustrate the property of the original description and so justify the maintenance of the status of *A. argyrosperma*.
The present designation of lectotype and paralectotype for *A. argyrosperma*, examined in situ by Volkmer-Ribeiro and Traveset (1987), follows the Declaration 44 of the International Commission on Zoological Nomenclature (2003).

*Anheteromeyenia ornata* (Bonetto and Ezcurra de Drago, 1970)
(Figure 8B)

*Radiospongilla ornata* Bonetto and Ezcurra de Drago, 1970: 39, fig. 1; Volkmer-Ribeiro, 1981: 88; De Rosa-Barbosa, 1984: 130; Ezcurra de Drago, 1993: 122.
*Anheteromeyenia ornata*; Volkmer-Ribeiro, 1996: 34, figs. 3-5, 11, (redescription and distribution, schizoholotype studied, MCN-POR 570 - Arroio Paranay Guazu, Prov. de Missiones, Argentina. Ezcurra de Drago col. IX. 1968); 2002: 25, 38; 2003: 43, fig. 2; 2007: 119; 2008: 236; Ezcurra de Drago, 2004: 201; Fontoura *et al*. 2004: 152.

Type locality. Arroyo Paranay Guazú, tributary of the Upper Paraná River at Misiones Province, Argentina.
Remarks. Bonetto and Ezcurra de Drago (1970) described, nominated and illustrated a second kind of megasclere, smaller, rare and found close

to the gemmules which they also considered it might be megascleres on the way to attain the regular size. *A. ornata* was next registered in four lotic environments in Brazil; three in Rio Grande do Sul State (Volkmer-Ribeiro, 1996; Fontoura *et al*., 2004) and one in Amazonas State (Volkmer-Ribeiro, 1996). The gemmules in these specimens, similarly to those of *A. argyrosperma*, have a distinct porus tube and gemmoscleres grading from longer sparsely spined to shorter heavily spined birotulates with rotules composed of an irregular arrangement of incurved rays or spines. *A. ornata* integrates the Brazilian Official List of threatened species (Volkmer-Ribeiro, 2008).

*Anheteromeyenia vitrea* n. sp.
(Figures 4-8C)

Type material. Holotype, BRAZIL. Espirito Santo: Linhares (Reserva Natural Vale, 19º09'53.80''S and 39º56'17.30''W, Nativo do Flamengo), 15.VII.2009, A.A. Buso & L.C.R. Pessenda leg. (MCN-POR 8663). Paratypes: BRAZIL. Espírito Santo: Linhares (Reserva Natural Vale, 19º09'53.80''S and 39º56'17.30''W, Nativo do Flamengo), 15.VII.2009, A.A. Buso and L.C.R. Pessenda leg. (MCN-POR, 8679, 8680, 8681, 8682, 8683).

Diagnose. Sponges glassy, spongin scarce, skeletal reticulum open, plumose or irregular, barely covering clumps of abundant gemmules, pinacoderm conspicuous at places disclosing at the SEM unprecedented pore structures. Microscleres absent. Megascleres in two categories, the alfa megascleres long, straight to slightly curved, stout, smooth, abruptly pointed anfioxea grading to shorter, sparsely spined, also abruptly pointed anfioxea, the beta megascleres rare, stout, short, spiny anfioxea to amphistrongyla bearing a few large conical projections around the shaft extremities and small sparse spines or bumps along the shaft. Gemmoscleres amphistrongyla to anfioxea grading from stouter ones with an irregular circle of spines, bumps or conical projections around the shaft extremities to slimmer anfioxea with an irregular circle of small straight to curved spines around the shaft extremities. Gemmules extremely abundant, foraminal tube long, contained inside the thick, undulated pneumatic layer and with a conspicuous hanging collar.

Description. Sponges bright, extremely fragile, forming glass wool like clumps around fallen twigs, herb stems or on the decaying leaves of *Salvinia* sp. Skeleton structure into very open unispicular tracts with a plumose or an irregular distribution and barely covering patches of abundant loose gemmules (Figures 4, 5A, 7A).

Pinacoderm conspicuous at places disclosing at the SEM oscular and poral openings. Porocytes around 50 micrometers in diameter with an undulated fringe and displaying several steps of the pore closing process and the porocyte regression due to the drastic and sudden drought which may seasonally occur in this temporarily flooded spot (Figure 5D, E, F). Also the abundant gemmule production documents this drought episode.

Microscleres absent.

Megascleres in two categories, the alfa megascleres long, straight to slightly curved, stout, smooth, abruptly pointed anfioxea grading to shorter, sparsely spined also abruptly pointed anfioxea, the beta megascleres rare, robust, short, spiny anfioxea to amphistrongyla bearing a few large conical projections around the shaft extremities and small sparse spines or bumps along the shaft (Figure 6A, B).

Gemmoscleres grading from long to very short, from straight to slightly curved, from stout to slim, abundantly spined anfioxea to amphistrongyla with an irregular circle of straight to curved spines, around the spicule extremities, shaft spines small, the ones at the middle straight (Figure 6A, C, D).

Gemmules large, extremely abundant, foraminal tube conspicuous, contained inside the thick, undulated pneumatic

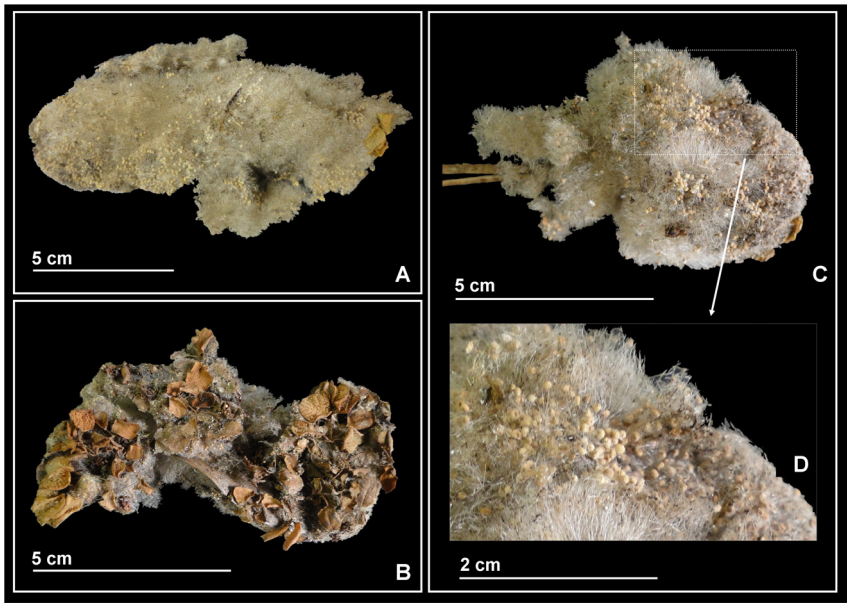


**Figure 4.** *Anheteromeyenia vitrea* n. sp. A= photograph of the holotype MCN-POR 8663; B= photograph of the paratype MCN-POR 8681; C and D= photographs of the paratype MCN-POR 8682.The photos illustrate the glass wool aspect and slender skeleton fibers of the skeletal network extending over the gemmular mounds. Also depicted are the dried *Salvinia* sp. leaves and the herb sticks used as support by the sponge.

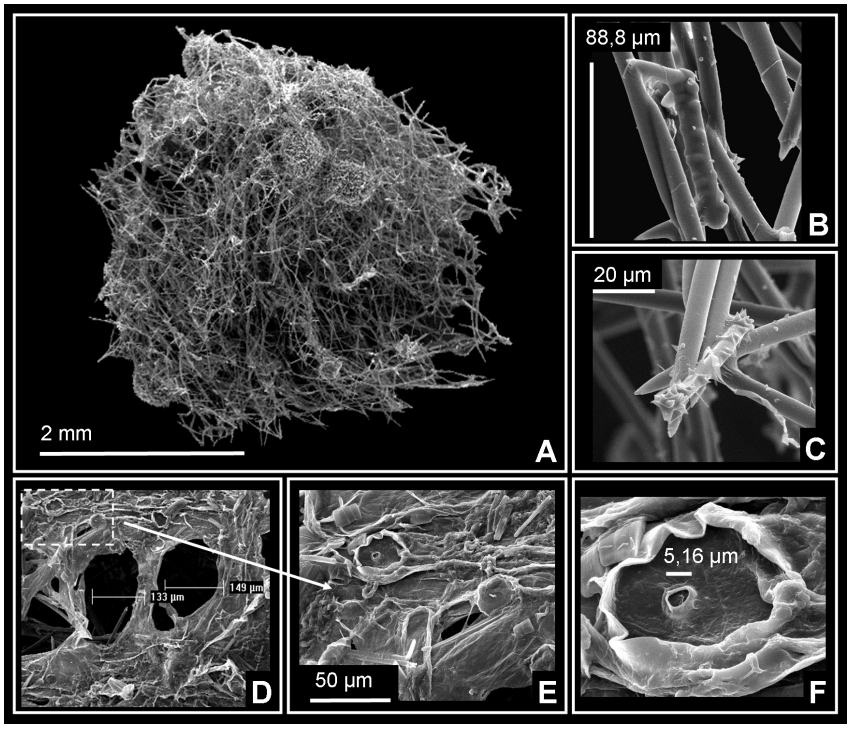


**Figure 5.** *Anheteromeyenia vitrea* n. sp. The skeleton and the shrunk dry preserved pinacoderm at SEM (MCN-POR 8663); A= the unispicular fibers composing a glass wool like structure concealing several gemmules. B and C= beta megascleres interspersed among the alfa megascleres; D= pinacoderm with large oscules and several small porocytes undergoing regression; E= enlargement of the area seen at upper left of fig. D evincing details of several porocytes, the largest one depicting the pore orifice, F= the largest porocyte seen in fig. E and its central pore.

coat. Inner gemmular coat thin, pneumatic coat thick, undulated, corklike, gemmoscleres radially embedded in the pneumatic coat, their rotules piercing the thick outer gemmular coat. Porus tube long, contained inside a conical concavity of the pneumatic layer and finished into a conspicuous hanging collar cut into several digitiform pendants (Figures 5A, 7A-E).

Dimensions of spicules and gemmules in Table 1.

Type locality. Nativo do Flamengo, 19º09'53.80''S and 39º56'17.30''W (Reserva Natural Vale), Linhares, Espírito Santo State, Brazil.

Distribution: presently known only from the type locality.

Habitat. Seasonally short flooded grassland spot, bordered by *muçununga* (Peixoto, 1992) vegetation (Figure 3).

Etymology. The species name refers to the glass wool like aspect of the specimens.

## Key to *Anheteromeyenia* species

1. Beta megascleres present. They are stout short spiny amphistrongyla with prominent conical or bumped projections around the shaft extremities .... .. .....*A. vitrea* n. sp. (Figure 8C)

1a. Beta megascleres absent ..... 2

2. Longer gemmoscleres with stout sparsely spined shafts, the rotules large, umbonate and deeply cut into an irregular number of large recurved hooks..... .....*A. argyrosperma* (Figure 8A)

2b. Longer gemmoscleres with slim heavily spined shafts, the rotules reduced to a circle of incurved spines around the flattened, rounded or pointed shaft extremities ..... ..... *A. ornata* (Figure 8B)

## Discussion

The sub-genus *Anheteromeyenia* Schröder (1927), elevated to generic rank by Laubenfels (1936), was originally defined to contain those *Heteromeyenia* Potts (1881) species which missed microscleres. Penney and Racek (1968) selected *Spongilla argyrosperma* Potts, 1880, as type species, enlarged Schröder´s original definition, recognized the exclusive characters of *A. argyrosperma* and grouped the few species of the genus into two morphologically distinct groups. *A. argyrosperma* was solely placed in a group on account of its gemmules having a distinct porus tube and two classes of gemmoscleres differing in length rather than in shape. The other four species, *A. ryderi* (Potts, 1882), *A. pictouensis* (Potts, 1885), *A. conigera* (Old, 1931) and *A. biceps* (Lindenschmidt, 1950), composed the second group of species having gemmules devoid of a porus tube and with two classes of gemmoscleres exhibiting sharp differences in shape as well as in size.

Bonetto and Ezcurra de Drago (1970) described *Radiospongilla ornata* from Argentinian waters. The gemmules in this species, similarly to those of *A. argyrosperma*, have a distinct porus tube and gemmoscleres grading from longer to shorter birotulates with rotules composed of an irregular arrangement of rays or spines. Volkmer-Ribeiro *et al*. (1988) described *Anheteromeyenia sheilae* from South Brazil, included in the *A. ryderi* species group.

The characteristics shared by *A. argyrosperma* and *A. ornata* induced next Volkmer-Ribeiro (1996) to restrict genus *Anheteromeyenia* to the type species plus *A. ornata,* with the corresponding generic redefinition. The new genus *Acanthodiscus* was then defined to contain *A. ryderi* and *A. sheilae.* Next Bass and Volkmer-Ribeiro (1998) proposed the new name *Racekiela* to replace *Acanthodiscus* which was seen to be preoccupied. However, Volkmer-Ribeiro (1996)

**Table 1.** Dimensions in micrometers of the megascleres, gemmoscleres and gemmules of *Anheteromeyenia vitrea* n. sp. Min=Minimum, Max=maximum, Ave=average and SD= standard deviation.

| | Alfa Megascleres | | Beta Megascleres | | Gemmoscleres | | Gemmules |
|---|---|---|---|---|---|---|---|
| | Length | Width | Length | Width | Length | Width | Diameter |
| Min | 188.4 | 7.8 | 124.6 | 9.1 | 84.3 | 3.4 | 435.0 |
| Max | 421.1 | 17.4 | 279.4 | 18.1 | 195.1 | 11.1 | 688.0 |
| Ave | 322.1 | 13.0 | 176.3 | 14.0 | 128.5 | 6.6 | 589.1 |
| SD | 38.1 | 1.7 | 34.8 | 2.2 | 23.5 | 1.4 | 68.5 |

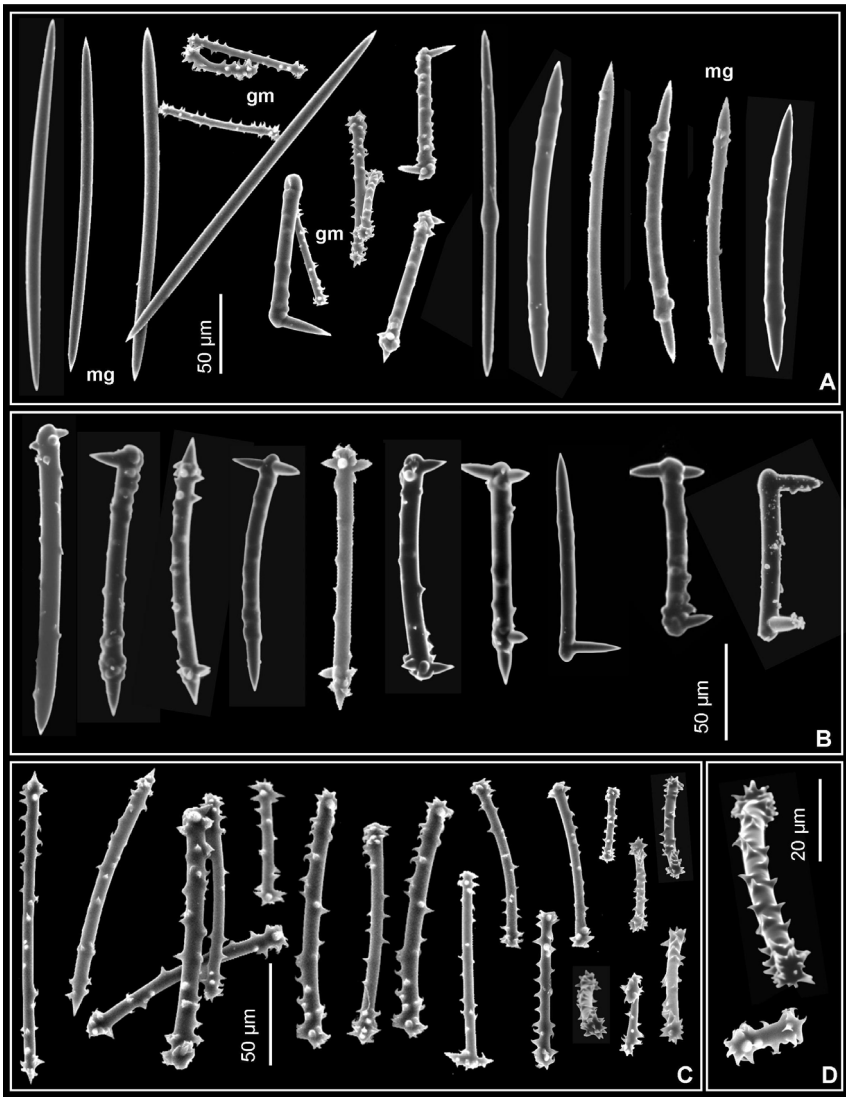


**Figure 6.** *Anheteromeyenia vitrea* n. sp. The spicules at SEM; A= from left to right: smooth megascleres, gemmoscleres and beta megascleres, spiny shorter megascleres. B= variations of the beta megascleres. C= variations of the gemmoscleres. D= the smaller gemmoscleres at higher magnification; mg= megascleres; gm= gemmoscleres.

did not proceed to nominally synonymize *A. pictouensis* (Potts, 1885), *A. conigera* (Old, 1931) and *A. biceps* (Lindenschmidt, 1950) with *A. ryderi,* in spite of having listed the literature which supported that proposition and having keyed out the genus with only *R. ryderi* and *A. sheilae*. As a consequence, Manconi and Pronzato (2002) followed the definition proposed for *Racekiela* by Volkmer-Ribeiro (1996) and Bass and Volkmer-Ribeiro (1998) but left *A. pictouensis* (Potts, 1885), *A. conigera* (Old, 1931) and *A. biceps* (Lindenschmidt, 1950) behind in genus *Anheteromeyenia* with gemmoscleres imprecisely described as (p. 929) "pseudobirotulates radially embedded in the theca".

The characteristics presented by *A. vitrea* n. sp. bridge up and enforce a group of Nearctic/Neotropical species which have in common a poorly developed skeleton almost deprived of spongin, remarkable abundance of gemmules forming distinct mounds on the substrate, gemmules with a conspicuous foraminal tube, and megascleres and gemmoscleres, which may spread into two size and shape categories, the longer gemmoscleres and the second category of rare megascleres. On the other side, the second category of megascleres of the new species depicting evidently truncated rotules, brings insight into evolutionary aspects, which indicate the ancestral existence of a large birotulated spicule which, due to its size, cannot participate in the gemmular coat, remaining in its proximity.

This is the first time freshwater sponges porocytes are SEM illustrated providing a serial record of their regression at the onset of seasonal drought in a small pool of water. Harrison (1972a, 1972b) carried out a detailed study of porocyte structure and behavior in *Corvomeyenia carolinensis* Harrison, 1971 using phase contrast observation and micrography of living sponges coupled with histochemical techniques. He published

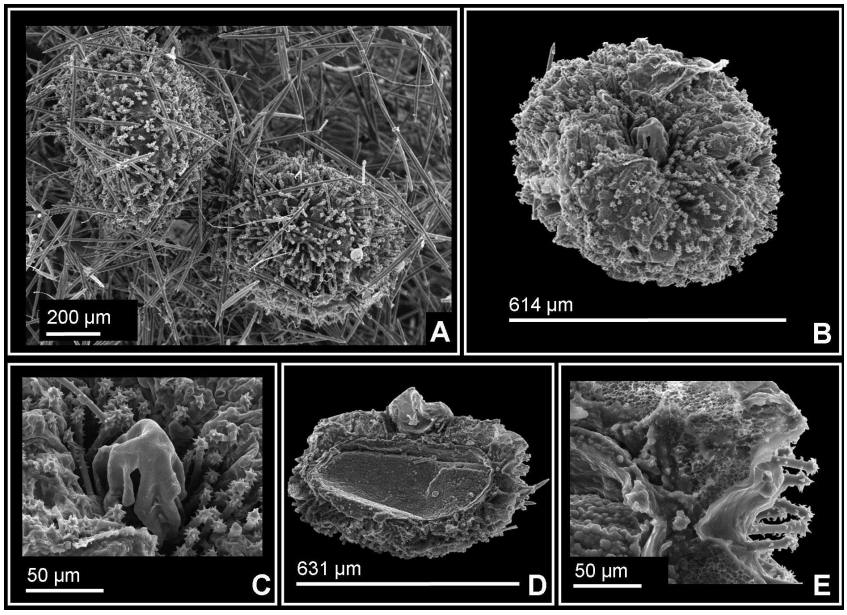


**Figure 7.** *Anheteromeyenia vitrea* n. sp. Gemmular structure at SEM. A= two young gemmules yet deprived of the pneumatic coat also evincing the paucity of the unispicular fibers; B= one mature gemmule and its foraminal tube; C= detail of the collar of the foraminal tube; D= one gemmule at cross section evincing the laminated inner coat, the large undulated pneumatic coat and the quite thick outer coat; E= from left to right the abundant archeocytes, the laminated inner coat, the corklike structure of the air spaces at the undulated pneumatic coat with protrusion of several gemmoscleres.

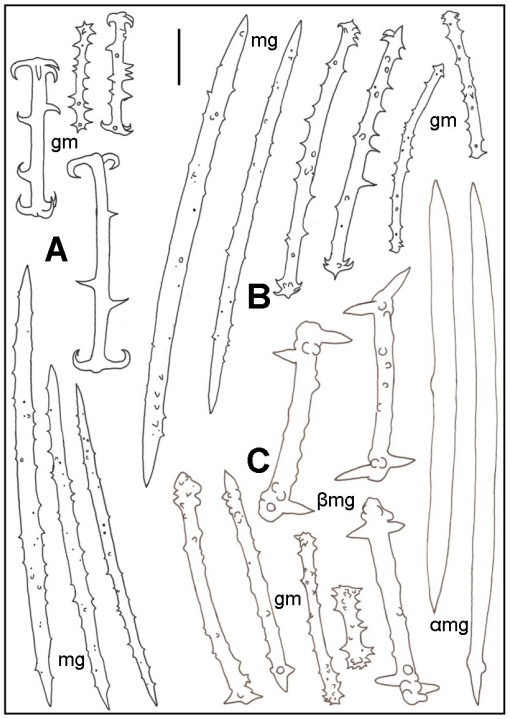


**Figure 8.** Camera lucida drawings for the spicular sets of respectively A= *Anheteromeyenia argyrosperma*; B= *Anheteromeyenia ornata*; C= *Anheteromeyenia vitrea* n. sp. mg= megascleres; αmg= alfa megascleres; βmg= beta megascleres; gm=gemmoscleres. Scale bar= 50 micrometers.

convincing photographs of the pores as a contractile central aperture of the porocyte (Harrison, 1972a, figure 2; 1972b, figures 1-3). These pictures match in shape and scale our SEM illustrations for what we understand are porocyte units in *A. vitrea* n. sp. These structures, around 50 micrometers in diameter, are placed at the sponge pinacoderm, sharing space with the large oscular apertures (Figure 5, D-F). One has to bear in mind that this picture illustrates a dried out pinacoderm, where cellular boundaries are no longer clear, since the whole sponge was in its way to cellular regression induced by the drastic and sudden drought which may seasonally occur in its small, temporarily flooded habitat. The abundant gemmule production also documents this drought episode. The lucky incidental finding of these specimens provides a clear picture of the several steps of the pore closing and the porocytes regression marked by the yet conspicuous spherical contour of several such units seen in the SEM (Figure 5, D-F).

The three species also have in common the occupation of remarkably shallow and seasonal environments. In this sense it is all proper to recall that Potts (1887) described the spot he found the first specimens of *A. argyrosperma* at Lehigh Gap, Pennsylvania as (p. 238): "...a mill race…choked by the fallen and blackened timbers, amongst which the water could hardly have been said even to creep…".

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