



UNIVERSIDADE ESTADUAL DE CAMPINAS

Instituto de Biologia

AMANDA FANTINATTI

Taxonomy and anatomy of a new Brazilian
micromollusc of the genus *Kelliella* (Bivalvia:
Kelliellidae)

Taxonomia e anatomia de um novo micromolusco
brasileiro do gênero *Kelliella* (Bivalvia: Kelliellidae)

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Taxonomia e anatomia de um novo micromolusco brasileiro do gênero *Kelliella* (Bivalvia: Kelliellidae)

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Orientador: Prof. Dr. Flávio Dias Passos

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RESUMO

Os Glossoidea Gray, 1847 (1840) compreendem uma superfamília de bivalves relativamente pequenos e taxonomicamente controverso. Tradicionalmente, baseados na conchiliologia e anatomia, eles vêm sendo subdivididos em três táxons, os Glossidae Gray, 1847, Vesicomidae Dall & Simpson, 1901 e Kelliellidae Fischer, 1887. Em relação aos Kelliellidae, a maioria das espécies podem ser caracterizadas como sendo bivalves muito pequenos, frequentemente menores que 15 mm em comprimento de concha, ocorrendo em águas frias e profundas. Uma nova *Kelliella* sp., encontrada em águas rasas, é aqui descrita, baseada em um material coletado na Bacia de Campos, uma área intensamente explorada pela riqueza de petróleo na costa brasileira, localizada no Oceano Atlântico sudoeste, durante dois Projetos: "HABITATS" e "AMBES". Aqui, a descrição dessa nova espécie do gênero *Kelliella* é baseada em observações detalhadas da concha e da parte mole obtidas através de estereomicroscópio, imagens de MEV e cortes histológicos. Essa possível nova espécie é pequena (até 2,3 mm em comprimento), com valvas arredondadas, ligeiramente inequilateral e uma lúnula bem demarcada e ampla. Superfície externa com linhas de crescimento microscópicas; micro pústulas presentes na dissoconcha, próximo ao limite com a prodissoconcha. Placa da charneira com três dentes cardinais em cada valva. Sobre a anatomia, é descrita com duas aberturas paliais; glândulas de muco margeando toda a abertura pediosal-inalante, também presente na margem do manto dorso-posterior. Ctenídeo completo; palpos labiais muito pequenos. Pé bem desenvolvido com formato de foice com uma glândula de bisso presente. Provavelmente dióicos. *Kelliella* sp. é comparada com outras espécies de *Kelliella* que ocorrem nos oceanos Atlântico, Antártico, Pacífico e Índico, provando ser uma possível espécie nova registrada para a costa Brasileira.

ABSTRACT

The Glossoidea Gray, 1847 (1840) comprises a relatively small but taxonomically controversial superfamily of bivalve molluscs. Traditionally, based on conchological and anatomical grounds, they have been subdivided in three taxa, the Glossidae Gray, 1847, Vesicomidae Dall & Simpson, 1901 and Kelliellidae Fischer, 1887. Regarding the Kelliellidae, most species can be characterized as being very small bivalves, often less than 15 mm in shell length, occurring in cold and deep waters. A new *Kelliella*, discovered in the shallow waters, is here described, based on material collected in Campos Basin, an intense explored oil-rich area of the Brazilian coast, placed in the southwestern Atlantic Ocean, during two research Projects: "HABITATS" and "AMBES". Herein, the description of this new *Kelliella* is based on detailed observations of the shell and the soft parts through stereomicroscope, SEM images and histological sections. This possible new species is minute (up to 2.3 mm in length), valves rounded in outline, slightly inequilateral and well demarcated, wide lunule. Outer surface with microscopic growth lines; micro pustules present in the dissoconch, near to its edge with the prodissoconch. Hinge plate with three cardinal teeth in each valve. About the anatomy, is described with two pallial openings; mucus glands bordering all the pedal-inhalant opening, also present at the dorso-posterior mantle margin. Complete ctenidia; labial palps very small. Well developed, sickle-shaped foot with a byssal gland present. Probably dioecious. *Kelliella* sp. is compared with the others species of *Kelliella* that occurring in the Atlantic, Antarctic, Pacific and Indian Oceans proving to be a possible new species registered to Brazilian coast.

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INTRODUÇÃO GERAL

Conhecido como o segundo maior grupo de invertebrados em número de espécies, o filo Mollusca é composto por sete classes: *Aplacophora*, *Polyplacophora*, *Monoplacophora*, *Scaphopoda*, *Gastropoda*, *Cephalopoda* e *Bivalvia*, sendo esta última considerada a segunda classe mais representativa, com cerca de 9.000 espécies descritas até o momento (Huber, 2010). Com uma distribuição cosmopolita, de modo geral, os Bivalvia podem ser definidos por compartilharem as seguintes sinapomorfias: (i) concha composta por duas valvas, (ii) ausência de uma cabeça; (iii) massa bucal sem rádula, (iv) corpo comprimido lateralmente e (iv) presença de bisco em pelo menos uma fase da vida (Giribet, 2008).

Dentre os bivalves mais conhecidos, destacam-se as ostras (*Ostreidae* Rafinesque, 1815), mariscos (*Veneridae* Rafinesque, 1815) e os mexilhões (*Mytilidae* Rafinesque, 1815), todos eles de grande importância econômica e amplamente utilizados na gastronomia de vários países. Do ponto de vista ecológico também apresentam um papel importante na cadeia trófica, não apenas como fonte de alimento para outros invertebrados como também por disponibilizarem a matéria orgânica em suspensão para outros organismos bentônicos, via pseudofeces. Com isso os bivalves provêm alimento (matéria orgânica) para diversas comunidades de micro-invertebrados como, por exemplo, organismos meiofaunais (Reise, 1981). Além disso, outras espécies de bivalves tem uma importância eco-toxicológica podendo atuar como bioindicadores de poluição, como por exemplo, os mexilhões que são acumuladores de metais pesados (Oliveira & Callisto, 2010; Zuykov *et al.*, 2013).

No meio de tantas características morfológicas, as relacionadas à concha estão entre as mais importantes, sendo amplamente utilizadas na taxonomia desse grupo. Alguns dos aspectos conchiliológicos essenciais observados durante descrições de novos táxons e/ou revisões taxonômicas destacam-se: (i) Formato e contorno da concha (arredondadas, triangulares, quadradas); (ii) Detalhes da escultura externa (estrias comarginais, espinhos, pústulas, costelas), posição dos umbos (ortógiros, prosógiros, opistógiros); (iii) Aspectos da charneira (edêntula, heterodonte, taxodonte, disodonte, isodonte); (iv) Posição do ligamento (anfidético, opistodético e prosodético); (v) Cicatrizes musculares (adutores, retratores, seio e linha palial) (Figs. 1 e 2).

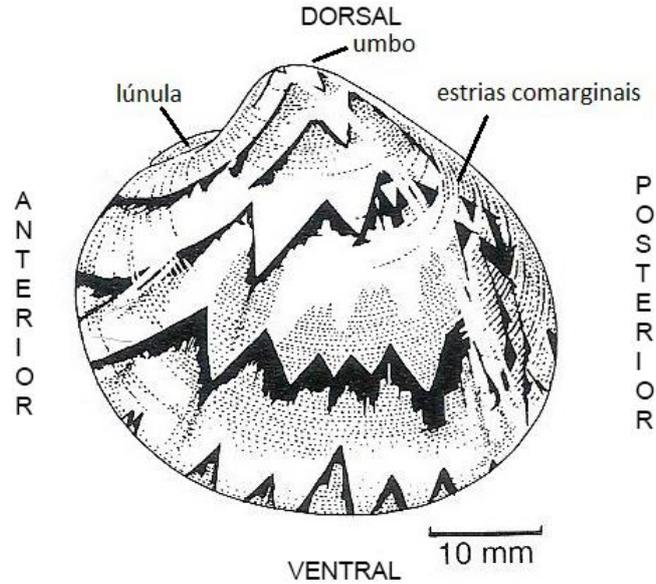


Figura 1. Caracteres morfológicos da superfície externa da concha importantes para a taxonomia de um bivalve [Shirley & Slack-Smith, 1998 (com modificações)].

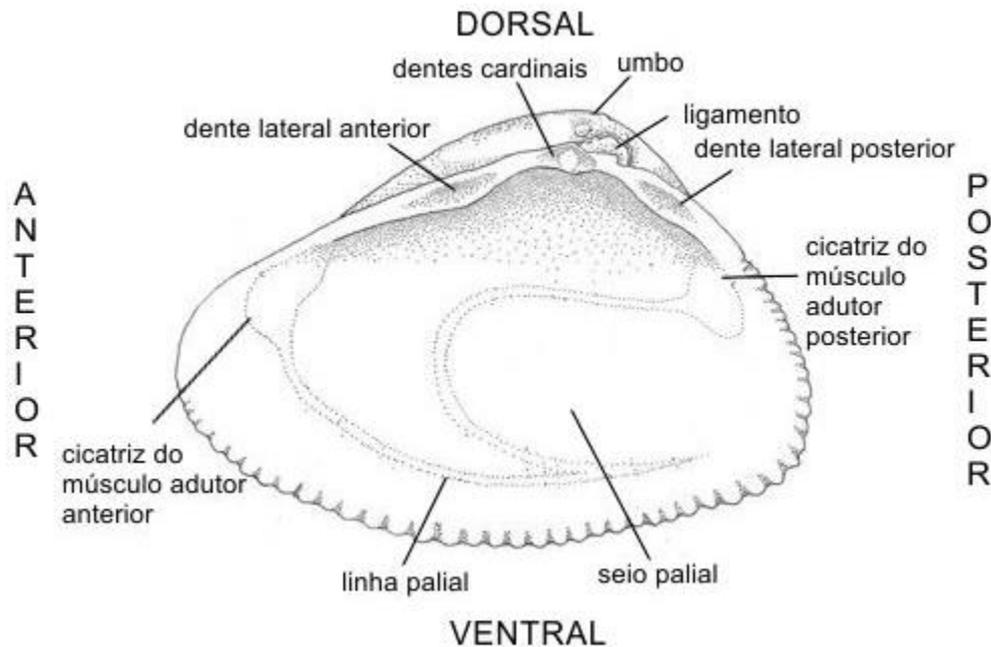


Figura 2. Caracteres morfológicos da superfície interna da concha importantes para a taxonomia de um bivalve [Passos & Domaneschi, 2004 (com modificações)].

Além dos aspectos da morfologia da concha, a anatomia também é de grande importância para a identificação destes moluscos. Dentre as principais características destaca-se que o corpo do bivalve, normalmente acomodado dentro da concha, é recoberto pelo manto, cujos lobos laterais secretam a concha, ou seja, cada um deles, uma valva. Por sua vez, entre os lobos do manto e o corpo propriamente dito situa-se a cavidade do manto, ou cavidade palial, onde estão abrigadas as brânquias, os palpos labiais, sifões e pé. No interior do corpo, mais dorsalmente estão os órgãos da

massa visceral. Todos esses órgãos compõem os sistemas vitais para o animal: digestório, circulatório, excretório, nervoso e reprodutor (Yonge, 1957).

A respeito da anatomia, os Bivalvia são comumente divididos em três grandes grupos, os protobrânquios, lamelibrânquios e septibrânquios, que se distinguem pela natureza de suas demibrânquias e conseqüentemente pelo modo de alimentação. Os protobrânquios, apresentam uma única função às suas demibrânquias foliáceas a de realizar as trocas gasosas, sendo depositívoros; os lamelibrânquios, que reúnem o maior número de espécies, cujas demibrânquias sofreram adaptações para, além das trocas gasosas, poderem filtrar a água corrente com uma maior eficiência de retenção do alimento que se mistura com todo o material em suspensão, são os conhecidos filtradores; e os septibrânquios, um grupo menor, onde ocorreu a hipertrofia das demibrânquias que se transformaram em septos musculares permitindo ao bivalve capturar presas vivas, ou seja, demonstram o hábito carnívoro.

Estando em contato direto com a água, é por meio dela que esses moluscos, geralmente, obtém o alimento e realizam as trocas gasosas. Nos lamelibrânquios, sendo os mais representativos do grupo, uma corrente criada pelos cílios das brânquias fazem com que a água entre na cavidade do manto, pela região posterior, através do sifão inalante ou de uma abertura inalante. (Fig. 3). Essa corrente de água atravessa os filamentos branquiais que irão reter o alimento com a ajuda dos cílios e este será encaminhado, anteriormente, em direção aos palpos labiais que por sua vez selecionam as partículas de alimento, dirigindo-as para a boca para serem ingeridas. O que não for aproveitado, ou seja, rejeitado pelos mecanismos de seleção dos órgãos da cavidade do manto, ou seja palpos labiais e brânquias, usualmente cairá em um trato ciliar de rejeição na região ventral da margem do manto, que será conduzido ao meio externo, por uma rápida contração dos músculos adutores, através da abertura ventral do manto na forma de pseudofeces (Fig. 3). O alimento ingerido sofrerá todo o processo de digestão, sendo encaminhado da boca para o esôfago e em seguida ao estômago, divertículo digestivo (que libera enzimas que absorvem o alimento), que se comunica com o estômago através de ductos, e intestino. O subproduto sairá pelo ânus, na forma de fezes, para dentro da cavidade palial, e em seguida será levado ao meio externo através do sifão exalante ou da abertura exalante (Morton & Yonge, 1964).

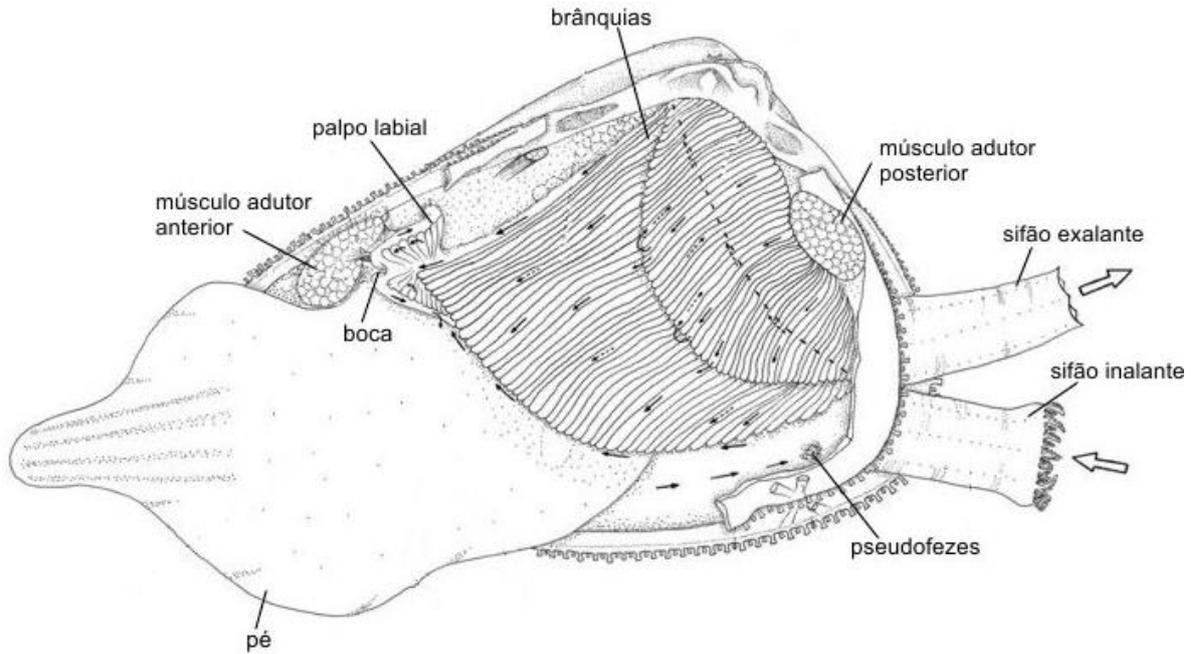


Figura 3. Anatomia geral de um bivalve lamelibranquiado, evidenciando algumas estruturas básicas importantes para a taxonomia. As setas indicam a direção da corrente de água [Passos & Domaneschi, 2004 (com modificações)].

Por serem organismos tão bem-sucedidos em consequência da sua adaptação para diferentes modos de vida, podem ser encontrados fixos por fios de bisso no substrato; perfurar madeiras/rochas; cimentados ao substrato; semi-infaunais; escavadores de diversos tipos de substrato inconsolidado (como lama ou areia) vivendo próximo à superfície ou mais profundamente; e até nadando livremente, por um curto tempo, quando são perturbados por algum predador (Fig. 4).

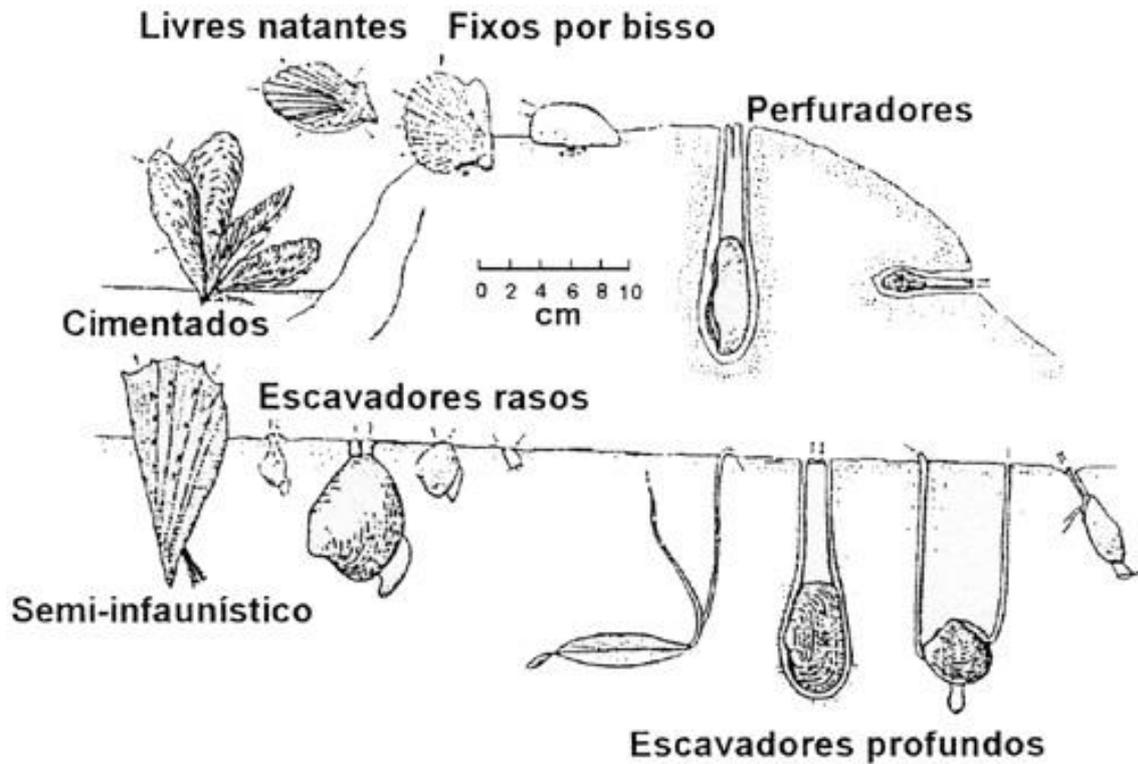


Figura 4. Modos de vida de um bivalve (Dias *et al.*, 2002).

Além dos três grandes grupos, citados acima, organizados com base na anatomia, Bieler *et al.* (2014) elaborou uma proposta filogenética obtida através da análise combinada entre dados moleculares e morfológicos, no qual estabelece no agrupamento de seis subclasses dentro de Bivalvia, sendo elas: Protobranchia, Pteriomorphia, Archiheterodonta, Paleoheterodonta, Anomalodesmata e Imparidentia (Fig. 5).

Na presente Dissertação, uma espécie do gênero *Kelliella* M. Sars, 1870 (Kelliellidae) é estudada sob o ponto de vista taxonômico e anatômico, através de uma comparação dos caracteres da concha e das partes moles com os de outras espécies já descritas na literatura. O texto desse estudo é apresentado a seguir na forma de artigo para publicação, já redigido em inglês.

1. Introduction to the Glossoidea

The Glossoidea Gray, 1847 (1840) comprises a relatively small but taxonomically controversial superfamily of bivalve molluscs, whose affinities to other groups has been recently much debated. Traditionally, based on conchological and anatomical grounds, they have being classified as composed by the Glossidae Gray, 1847, Vesicomidae Dall & Simpson, 1901 and Kelliellidae Fischer, 1887 (Bouchet *et al.*, 2010; Carter *et al.*, 2011), but phylogenetical studies are now putting this arrangement under scrutiny, and consequently questioning its monophyly (Bieler *et al.* 2014; Combosh *et al.*, 2016). The Glossidae is the less diverse of these families, with only one species which was investigated regarding its anatomy and biology, *Glossus humanus* (Linnaeus, 1758) (Owen, 1953). Among the Vesicomidae are some of the largest glossoideans, as members of *Calyptogena* Dall, 1891, which have being described in more detail related to its occurrences in the interesting sulfide-rich environments, such as the cold seeps and hydrothermal vents (e.g., Boss & Turner, 1980; Turner, 1985; Stuardo & Valdovinos, 1988; Krylova & Sahling, 2006). Most kelliellids are very small and from deep waters (e.g., Allen, 2001; Evseev *et al.*, 2004a; Coan & Valentich-Scott, 2012), and have attracted less attention than those large vesicomids. Molecular data are suggesting that the Vesicomidae and Kelliellidae are not directly related to glossids (Bieler *et al.*, 2014; Combosh *et al.*, 2016) but, related to the fact that neither many species of all these groups had their anatomy described in detail in those older classifications, nor most representative species of these families had their genes analyzed in the more recent molecular studies, these discussions on the relationship of the two taxons appear to be only in a starting point.

Not all the vesicomids reach large sizes and there is some confusion concerning the placement of some of its smaller species, which are frequently placed among the kelliellids. Apart from this, the validity of the Vesicomidae itself has been discussed, as a more precise diagnosis for this family was not never furnished (Boss & Turner, 1980; Krylova & Sahling, 2010; Krylova *et al.*, 2014), and because its type-

species, *Vesicomya atlantica* (E. A. Smith, 1885), was recognized as belonging to *Kelliella* M. Sars, 1970. These taxonomical problems are now, at least in part, overcome, as a result of revision works of important members of the Vesicomyiidae (Cosel & Salas, 2001; Krylova & Sahling, 2006; Amano & Kiel, 2007; Krylova & Sahling, 2010; Janssen & Krylova, 2012), and then a more precise definition of this group can now be accessed (Krylova & Sahling, 2006; Cosel & Olu, 2008; Krylova & Sahling, 2010). Anyway, those smaller species of vesicomyiids are awaiting general revisions, there remaining doubts about its affinities at the genus and families levels (Krylova & Sahling, 2010; Krylova *et al.*, 2014). This is the case, for example, of some species of *Vesicomya* Dall, 1886 and *Callocardia* Adams, 1864.

Regarding the Kelliellidae, most species can be characterized as being very small bivalves, often less than 15 mm in shell length, occurring in cold and deep waters (Shirley & Slack-Smith, 1998; Allen, 2001; Coan & Valentich-Scott, 2012; Evseev *et al.*, 2004a). This family has a wide geographic distribution, with species reported from Norway, Africa, Brazil, Argentina, Guyana, Suriname, Gulf of Mexico, USA, St. Paul Island, Ireland, France, Indonesia, Philippines, Japan and in the South China Sea (Dall, 1881, 1886, 1889; Thiele & Jaeckel, 1935; Boss, 1970; Allen, 2001; Evseev *et al.*, 2004b; Oliveira & Absalão, 2007; Raines & Huber, 2012; Okutani & Fujiwara, 2013). *Kelliella miliaris* Philippi, 1844, its type-species, was the first Kelliellidae that had its anatomy and biology described in detail, by Clausen (1958), who emended some former observations made by Sars (1870) [who called it as a new species: *Kelliella abyssicola*, considered a synonym of *K. miliaris* by Forbes, 1844]; Odhner (1960) and Allen (2001) discussed its taxonomy. Allen (2001) redescribed this species and analyzed more nine from the Atlantic deep-waters, five of them as new. Apart from these papers and others on *Kelliella* (Knudsen, 1970; Bernard, 1989), just a few ones have approached the anatomy of kelliellids, as Evseev *et al.* (2004a) on *Alveinus*. Evseev *et al.* (2004b) highlighted the importance of ontogenetic shell study for the taxonomy of this genus and also to the understanding of morphological relationships with other related taxa.

Fourth species of Glossoidea were already reported from Brazil, three of them from its southeastern coast. *Callocardia albida* Dall, 1889 was described by Dall (1889) from off Rio de Janeiro, being now frequently referred to *Vesicomya* (Vesicomyiidae) (e.g. Odhner, 1960). Domaneschi & Lopes (1990), described *Calyptogena birmani* Domaneschi & Lopes, 1990, based on specimens collected off Paraná State, and

Kelliella atlantica (E. A. Smith, 1885) (Kelliellidae), a species characterized by Allen (2001) as the most “common in the Atlantic and widely distributed on continental slope and in abyssal depths from the southern parts of the North America and West European Basins to the Angola and Argentine Basins, 400-4600 m”, was first recorded from the Campos Basin, Southeastern Brazil, by Oliveira & Absalão (2007). The fourth species, *Meiocardia agassizii* Dall, 1886 was firstly recorded from the South Atlantic by Narchi (1976), based on animals collected in the Espírito Santo State; he considered it as belonging to the Glossidae, but this species is now placed in the genus *Glossocardia* Stoliczka, 1870, among the Trapezidae Lamy, 1920 (Matsukuma & Habe, 1995).

A new *Kelliella* is here described, based on material collected in Campos Basin, an intense explored oil-rich area of the Brazilian coast, placed in the southwestern Atlantic Ocean. Herein, the description of this new *Kelliella* is based on detailed observations of the shell and the soft parts, which are compared to other Kelliellidae. For this, the literature was reviewed aiming to gather all the information about the anatomy of species from this family, with an emphasis to those referred to *Kelliella*.

2. Materials and Methods

Individuals of the new species of bivalve were obtained from bottom samples collected by a box corer during two research Projects: “HABITATS - Campos Basin Environmental Heterogeneity” and “AMBES - Environmental Characterization of the Basin of Espírito Santo and northern Campos Basin”. The first occurred during 2008 and 2009. Sampling was undertaken on the shelf and continental slope of the Campos Basin, an area of oil and natural gas exploitation off the southeastern coast of the Brazilian states of Rio de Janeiro and Espírito Santo. Numerous bottom samples were obtained from depths of 12 to 3.200 m and sieved through a 0.5 mm mesh. From 60 of these samples collected at depths of 53 to 147 m, 64 empty shells and 20 with soft parts of the new species were obtained. The second research Project occurred between 2012 to 2013, from depths of 25 to 3000 m off the state of Espírito Santo. From 15 of these samples collected at depths of 36 to 48 m, 14 empty shells and seven with soft parts were obtained. All of these specimens collected by the two Projects were initially fixed in 4% formalin and then transferred to 70% alcohol. Preserved specimens were selected to be dehydrated in an ascending series of ethanol, critical-

point dried and mounted on aluminum stubs for examination by a scanning electron microscopy (SEM). For histology, four individuals (two females and two males) were decalcified in a solution of 100 ml distilled water containing 0.88 g of NaCl and 1.02 g of ascorbic acid. These were dehydrated in an ascending ethanol series, and embedded in methyl methacrylate (Historesin®); then two females were serially sectioned in 5 µm thick through the transverse planes, and the two males through sagittal/parassagittal and frontal planes. The possible holotype, some paratypes and non-type specimens, as well the set of stubs and histological slides, will be deposited in the Museum of Zoology “Prof. Adão José Cardoso” of the State University of Campinas (ZUEC-BIV); other paratypes will be send to the Museum of Zoology of the University of São Paulo (MZSP) and to the National Museum of Rio de Janeiro (MNRJ).

For comparison with the Brazilian species, the type materials of some species were also examined: *Vesicomya rotunda* (USNM 298597), paratypes, Philippine Island, 1758 m; *Kelliella biscayensis* (NHMUK 1998177), holotype with disarticulated valves and paratypes with 2 shells with soft parts, West European Basin, 51°54.7'S, 12°07.4'W, 1015 m; and *Kelliella pilula* (MCZ 7981) Harvard Museum, holotype, 1 dried valve, United States of America, Florida, 24°8'N, 82°51'W, 339 fathoms. The abbreviations USNM, NHMUK and MCZ refers, respectively, to the collections from the “National Museum of United States” (Smithsonian Institution, Washington, USA), from the “Natural Museum of Natural History of London” (United Kingdom), and from the “Museum of Comparative Zoology of Harvard University” (Cambridge, USA). The lot USNM 217690 of *K. miliaris* from Scotland [one of the lots that was examined by Allen (2001) for the redescription of this species] was also examined, but could not be observed from its internal view, as it now contains only one specimen [not two as mentioned by Allen (2001)]; its fragile valves are still joined each other and may be broken if placed apart. The lot NHMUK 1988056 that was referred as “probable syntypes” of *Kelliella miliaris* is, in fact, of *Kellia miliaris* (Kelliidae).

Following the nomenclature used by Allen (2001), to facilitate understanding of the arrangement of the hinge teeth, numbers represents them. The right valve are represented by odd numbers and the left by even numbers.

3. Results

Family Kelliellidae Fischer, 1887

Genus *Kelliella* M. Sars, 1870

Type species: *Venus? miliaris* Philippi, 1844 by monotypy

Remarks: Allen (2001) furnished a complete diagnosis for this genus, based on both conchological and anatomical characters, when discussing ten species he referred from the deep Atlantic. This diagnosis is repeated here without modifications: "Shell usually small (<10 mm), white opaque or translucent, suborbicular, inflated, equivalve, smooth or with fine co-marginal sculpture, more or less equilateral, pallial sinus absent, periostracum fine and entire; umbos large, prosogyrous; lunule heart-shaped, usually sharply defined by incised margin, in some species escutcheon absent or ill-defined; ligament external, opisthodetic, attached to nymphs, small resilium present in some species; hinge with cardinals (2a,2b and 3a,3b) often scrolled, anterior cardinal (1) of right valve short horizontal lamella at ventral margin of hinge plate interlocking with socket on left hinge, posterior cardinal (4) of left hinge tends to horizontal and in some species is more elongate than cardinal (1), set in from ventral margin, right and left antero and postero-dorsal margins interlock with fine groove and ridge. Mantle margin typically with 3 folds, pedal gape extensive, exhalant aperture and in some species inhalant aperture separated by narrow tissue junctions of inner muscular fold, small exhalant retractile siphon developed from inner muscular fold may be present, both apertures with small papillate tentacles on the middle sensory fold, no siphonal embayment; anterior and posterior adductor muscles relatively large and subequal; gills flat, homorhabdic, inner demibranchs extensive interlocking anterior and posterior to foot, outer demibranchs reduced in size and may be reflected; labial palps extremely small, foot moderately well-developed, with heel, small byssal gland present in some species; sexes separate" (Allen, 2001, *ipsis litteris*). The new species presents most of these characters, as shown herein.

Kelliella sp. (Figs 1-8)

Material examined All collected in the continental shelf of Rio de Janeiro and Espírito Santo States, Brazil, by the "HABITATS" and "AMBES" Projects – sta AMB 1 FOZ-18 R2, (19°50'22"S, 39°40'6"W) 14.xii.2010, 53 m (1 shell with articulated valves); sta

AMB 1 FOZ-16 R3 (20°1'4"S, 39°50'14"W) 16.xii.2010, 53 m, (2 shells with articulated valves); sta AMB 14 B-03 R3 (20°34'53"S, 40°6'28"W) 12.xii.2013, 49 m (1 with articulated valves); sta AMB 7 A-02 R1 (21°3'27" S, 40°22'59"W) 22.i.2012, 40 m (2 shells, 1 with articulated valves and another 1 with disarticulated valves); sta AMB 7 A-02 R1 (21°3'27" S, 40°22'59"W) 22.i.2012, 40 m (1 shell with soft parts); sta AMB 14 A-02 R1 (21°3'31"S, 40°23'00"W) 11.vii.2013, 39 m (1 shell with articulated valves); sta HAB13 I-02 R2 (21°22'59"S, 40°19'42"W) 05.iii.2009, 52 m (2 shells with disarticulated valves); sta HAB13 I-02 R1 (21°22'59"S, 40°19'42"W) 05.iii.2009, 52 m (3 shells and 1 isolated valve); sta HAB13 H-05 R3 (21°42'38"S, 40°8'59"W) 10.iii.2009, 147 m (2 shells with soft parts); sta HAB16 H-04 R3 (21°42'54"S, 40°10'14"W) 07.vii. 2009, 98 m (1 shell with disarticulated valves); sta HAB13 H-04 R2 (21°42'54"S, 40°10'16"W) 09.iii.2009, 98 m (3 shells with articulated valves); sta HAB13 H-04 R3 (21°42'54"S, 40°10'16"W) 09.iii.2009, 99 m (1 shell with soft parts); sta HAB16 H-03 R2 (21°43'10"S, 40°11'31"W) 08.vii.2009, 72 m (1 shell with disarticulated valves); sta HAB16 G-04 R1 (22°3'38"S, 40°6'59"W) 06.vii.2009, 89 m (5 shells with disarticulated valves); sta HAB16 G-04 R3 (22°3'38"S, 40°6'59"W) 07.vii.2009, 90 m (1 shell with disarticulated valves); sta HAB16 G-03 R1 (22°3'45"S, 40°9'59"W) 06.vii.2009, 76 m (1 shell with soft parts); sta HAB11 G-03 R2 (22°3'45"S, 40°9'59"W) 25.ii.2009, 75 m (1 shell with soft parts); sta HAB16 G-03 R2 (22°3'46"S, 40°9'59"W) 06.vii.2009, 75 m (1 shell with disarticulated valves); sta HAB16 G-03 R3 (22°3'46"S, 40°10'00"W) 06.vii.2009, 75 m (1 shell with disarticulated valves); sta HAB11 B-05 R2 (23°11'29"S, 41°0'49"W) 21.ii.2009, 117 m (1 shell with disarticulated valves).

Geographic range Up to now, known only from the Rio de Janeiro and Espírito Santo States, Brazil. Bathymetric range, based on 27 specimens with internal tissues: 36 to 147 meters.

Diagnosis Shell thin, minute (up to 2.3 mm in length), inflated, whitish to translucent, equivalve. Valves rounded in outline, slightly inequilateral, with prosogyrate umbones and well demarcated, wide lunule. Periostracum thin, transparent, colorless. Outer surface with microscopic growth lines; micro pustules present in the dissoconch, near to its edge with the prodissoconch. Prodissoconch I small (63.8 µm in length), rounded in outline, with a rugose surface; prodissoconch II large (169.3 µm in length), rounded to subtrigonal, with fine commarginal striae. Inner margins smooth. Hinge plate narrow

and short. In right valve: anterior cardinal tooth 1 short, roundly pointed; cardinal 3a elongated forming a short shelf below the shell margin; and cardinal 3b short and robust. In left valve: cardinal 2a convex; cardinal 2b spoon-shaped; and cardinal 4 small, obliquely elongated, subtrigonal, fused dorsally to the hinge plate. Ligament external, opisthodontic. Anterior adductor muscle scar slightly oval, elongated; posterior rounded, smaller. Two pallial openings separated by a single ventro-posterior point of mantle fusion: an antero-ventral, wide pedal-inhalant, and a posterior, narrow exhalant with an inturned siphon; four small tentacles present in the former, two in the fusion point, and five or seven around the dorsal half of the exhalant. Mucus glands bordering all the pedal-inhalant opening, also present at the dorso-posterior mantle margin, above the hind gut, and at the dorsal half of the base of the exhalant siphon. Homorhabdic, complete ctenidia; inner demibranchs larger and composed by almost equal descending and ascending lamellae, the latter attached by tissue to the visceral mass; shorter outer demibranchs extending along the 4/5 posterior length of the ctenidial axis, with higher ascending lamella fused by tissue to the mantle. Posterior tip of all demibranchs fused each other and also joined to the posterior fusion point of the mantle lobes. Interlamellar junctions only present in the outer demibranchs and near the free margin of the inner; marginal food grooves absent. Labial palps very small. Well developed, sickle-shaped foot with a narrow ventral sole bearing a deep pedal groove; byssal gland present, secreting a thin, single byssal thread. Paired well developed anterior and posterior retractor muscles; protractor muscles are absent. Digestive system with globular stomach communicated to digestive diverticula by right and left antero-lateral, wide opened large gastric ceca; and postero-ventrally to a short crystalline style sac combined with the mid gut. Nervous system with paired visceral, supra-esophagic and pedal ganglia. Statocysts oval shaped, with spherical statolith. Paired kidneys. Probably dioecious.

3.1 Shell morphology

Shell thin and delicate, minute (up to 2.3 mm in length), inflated (proportions: L 2 ± 0.37 mm; H 1.8 ± 0.34 mm; W 1.8 ± 0.30 mm), whitish to translucent, equivalve, not gaping; valves with a rounded outline, slightly inequilateral (Fig. 1, 2a-c, 2e). Umbones positioned at the 1/3 anterior length, prosogyrate and inturned, produced in some individuals (Fig. 1, 2a-e, 2h, i). In larger specimens, more than 1 mm in length, anterior dorsal margin, short, slightly convex and interrupted by a notch in the confluence with

the short anterior margin (Fig. 1a, 1c, 2a, 2c, 2e, 2f); posterior dorsal margin longer, slightly convex next to the umbones and almost flat in the confluence with the higher posterior margin; ventral margin uniformly rounded and continuous with anterior and posterior margins (Fig. 1a, 1c, 2a, 2c). Smaller, less than 1mm in length specimens almost orbicular in outline, with continuous and uniformly rounded anterior, ventral and posterior margins (Fig. 2d, g). Lunule wide, well demarcated, with a triangular shape, and delimited in its most anterior portion by deep grooves which form the notch between the antero-dorsal and anterior margins of the shell (Fig. 2e, f); in smaller individuals (<1mm in length) these grooves are weak. Escutcheon absent. Periostracum thin, smooth, indehiscent, transparent, colorless (Fig. 1a-c, 2a, 2d, 2g); slightly greenish in some well-preserved adults. Outer surface of the valves with microscopic growth lines, more evident in the median and latero-ventral regions (Fig. 2a, c, d). Micro pustules (~1 μm in diameter) present in the dissoconch, only visible by the SEM, restricted to the dorsal region near to the limit with the prodissoconch, and generally placed according to growth lines; closer each other in the posterodorsal region near the ligament, and more spaced in the anterodorsal and lateral regions (Fig. 2j, k). Prodossoconch well visible, but generally eroded in most specimens; prodossoconch I small, 63.8 μm in length (n=6), rounded in outline, with a rugose surface; prodossoconch II large, 169.3 μm in length (n=7), rounded to subtrigonal, with fine commarginal striae; limits between them well visible by the SEM in preserved shells (Fig. 3).

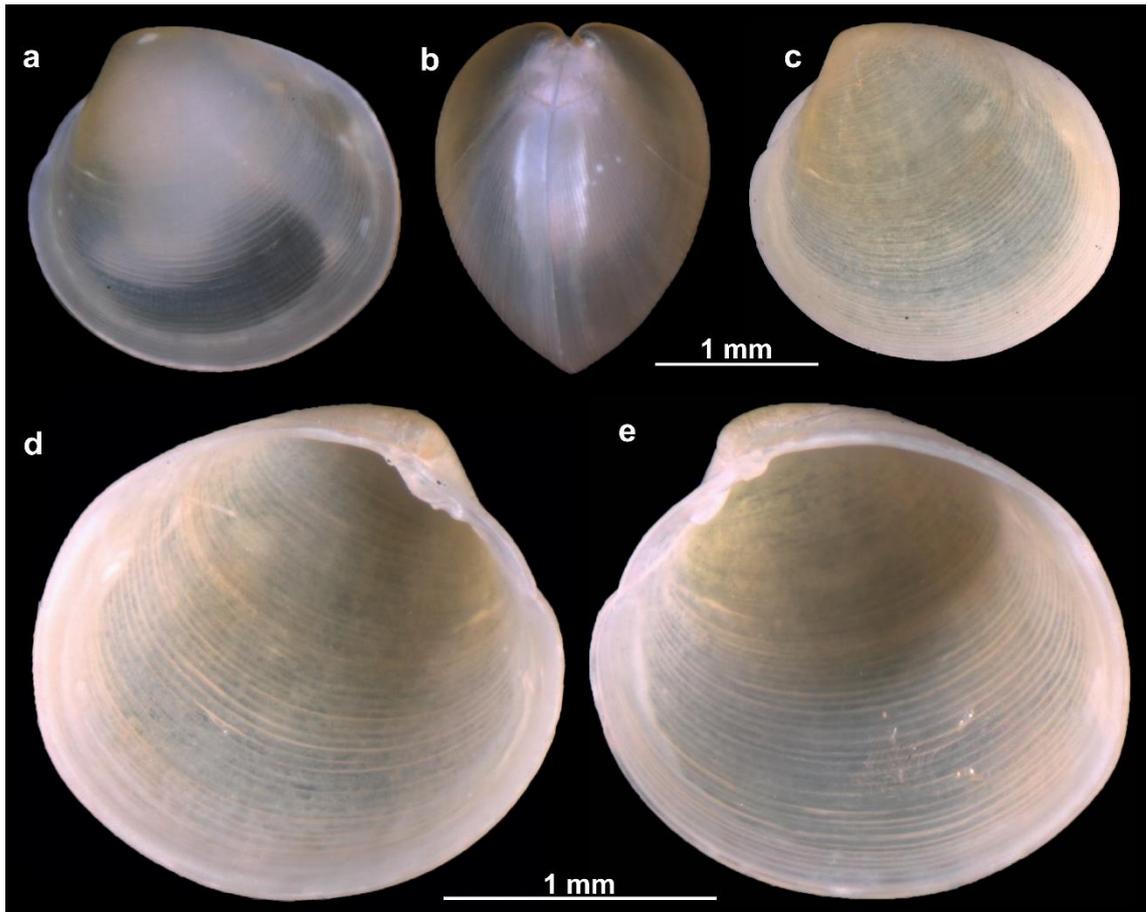


Fig. 1 *Kelliella* sp. Photomicrographs of the general and main aspects of the shell. External view from the left side obtained before (**a**) and after (**c**) extraction of the soft parts; **b**, in frontal view. Internal view of the left (**d**) and right (**e**) valves. The scale is the same for **a-c**; and for **d** and **e**.

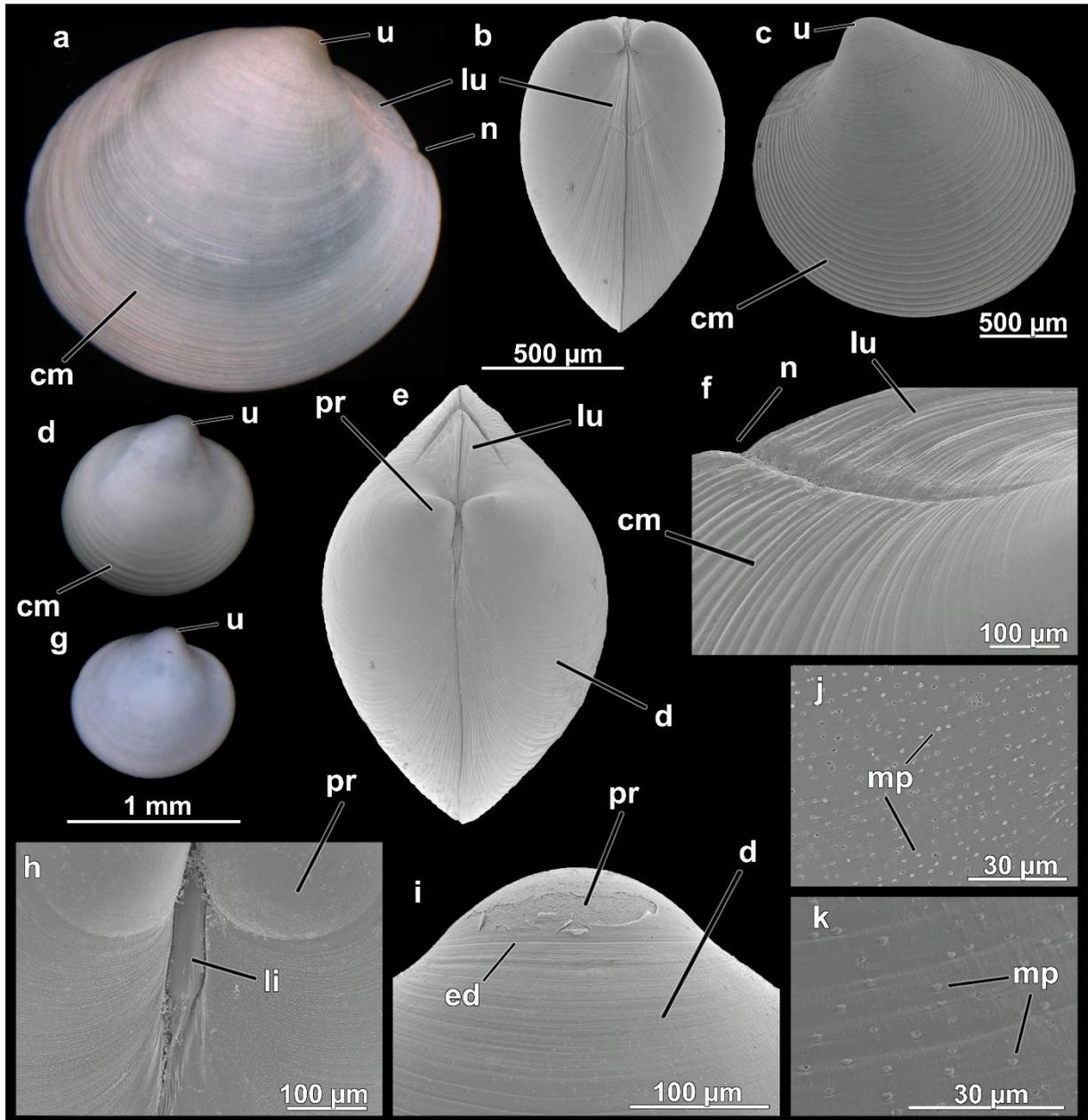


Fig. 2 *Kelliella* sp. Photomicrographs of external shell features as viewed by the stereomicroscope (**a**, **d**, **g**) and SEM (**b**, **c**, **e**, **f**, **h-k**). **a**, **d**, **g**, outer surface of the right valve, showing a growth series; **b**, frontal view; **c**, left valve of a specimen with a well preserved commarginal sculpture; **e**, dorsal view; **f**, lateral detailed view of the anterior region of the lunule, showing the notch between the dorso-anterior and anterior margins; **h**, detailed view of the postero-dorsal region, near the ligament; **i**, lateral surface of the shell, in the limits between the prodissoconch and dissoconch; **j**, **k**, micropustules viewed in two different higher magnifications. Abbreviations: *cm*, commarginal sculpture; *d*, dissoconch; *ed*, edge between the prodissoconch and the dissoconch; *li*, ligament; *lu*, lunule; *mp*, micropustules; *n*, notch between the dorso-anterior and anterior margins; *pr*, prodissoconch; *u*, umbo. The scale is the same for **a**, **d** and **g**; and for **b** and **e**.

Inner margins smooth (Fig. 1d, 1e, 4a, 4c, 4d, 4h, 4k, 4l). Hinge plates narrow, short, almost restricted to the area below the umbones and slightly anteriorly displaced; three cardinals in each valve. In right valve: anterior cardinal tooth 1 short, roundly pointed, placed at the margin of the ventrally extended anterior part of the hinge plate; posterior cardinal 3a anteriorly placed, more elongated forming a short, almost horizontal shelf below the shell margin just anterior to the umbo; posterior cardinal 3b short, robust, slightly wider at the base where it is continuous with the hinge plate ventral margin (Fig. 4b); 3a and 3b almost fused each other in smaller specimens (Fig. 4e, f). In the left valve: anterior cardinal 2a convex, leaving a ventral pit for fitting of the right valve cardinal 1; posterior cardinal 2b spoon-shaped, where its dorsal concavity accommodates the right valve cardinal 3a; and cardinal 4 small, obliquely elongated, subtrigonal, fused dorsally to the margin of the shell (Fig. 4g); 2a and 2b fused each other in smaller specimens (Fig. 4i-j). There are no lateral teeth; the anterior and posterior dorsal margins are slightly grooved, where the opposite valve thickening is fitted. Ligament external, opisthodetic, relatively narrow and inserted on nymphs of the hinge plates at the dorso-posterior margins near the umbones (Fig. 2h, 3d, 4b, 4f). Adductor muscles scars barely visible, the anterior slightly oval, elongated and seated ventrally to the region of the lunule; posterior adductor muscle scar rounded, smaller. Retractor muscle scars and pallial line not visible.

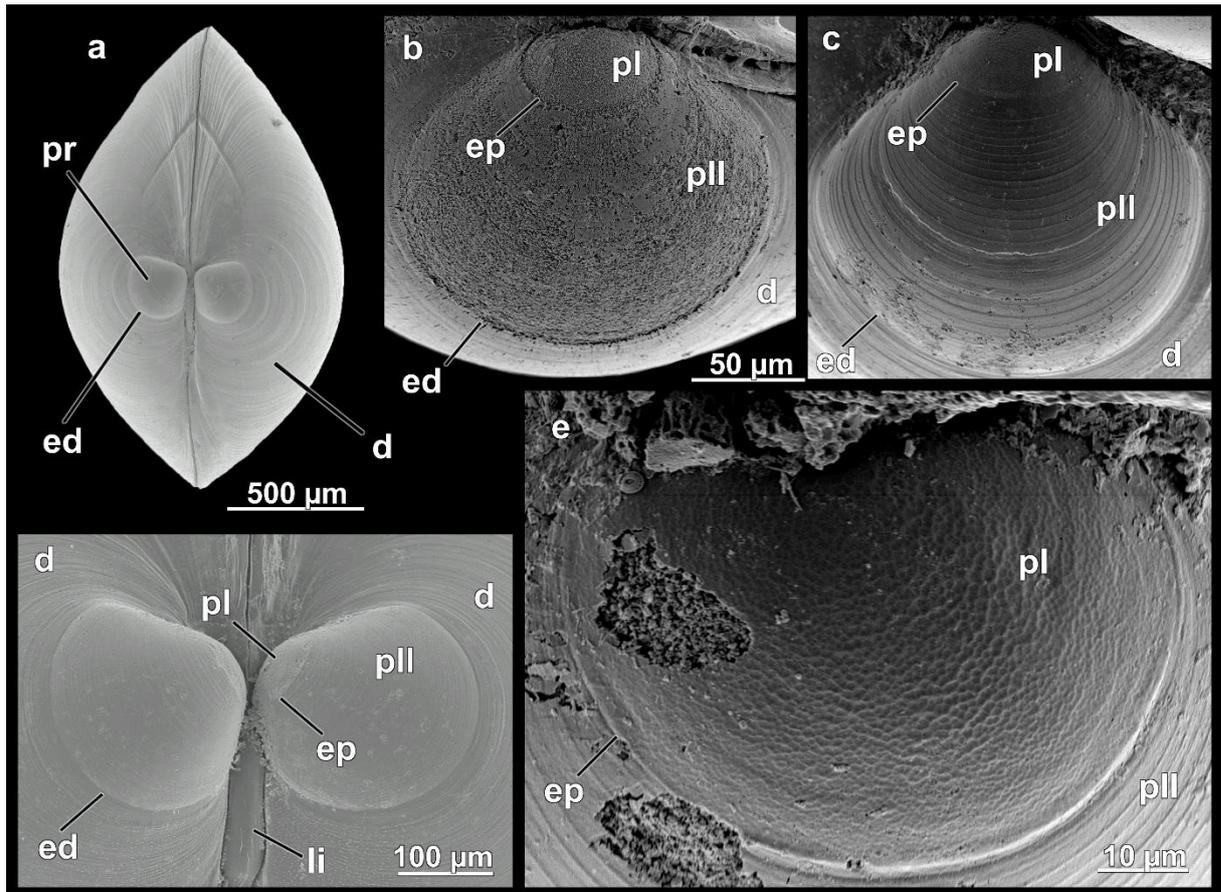


Fig. 3 *Kelliella* sp. SEM photomicrographs of the larval shell. **a**, dorsal view of an adult specimen, with its larval shell valves detailed in **b**; **c** and **d**, prodissoconch I and II from an eroded and a well preserved specimen, respectively, showing the commarginal sculpture of the prodissoconch II in the latter; **e**, detailed view of the prodissoconch I. Abbreviations: *d*, dissoconch; *ed*, edge between the prodissoconch and the dissoconch; *ep*, edge between the prodissoconch I and II; *l*, ligament; *p*, prodissoconch; *pl* and *pll*, prodissoconch I and II, respectively. The scale is the same for **b** and **c**.

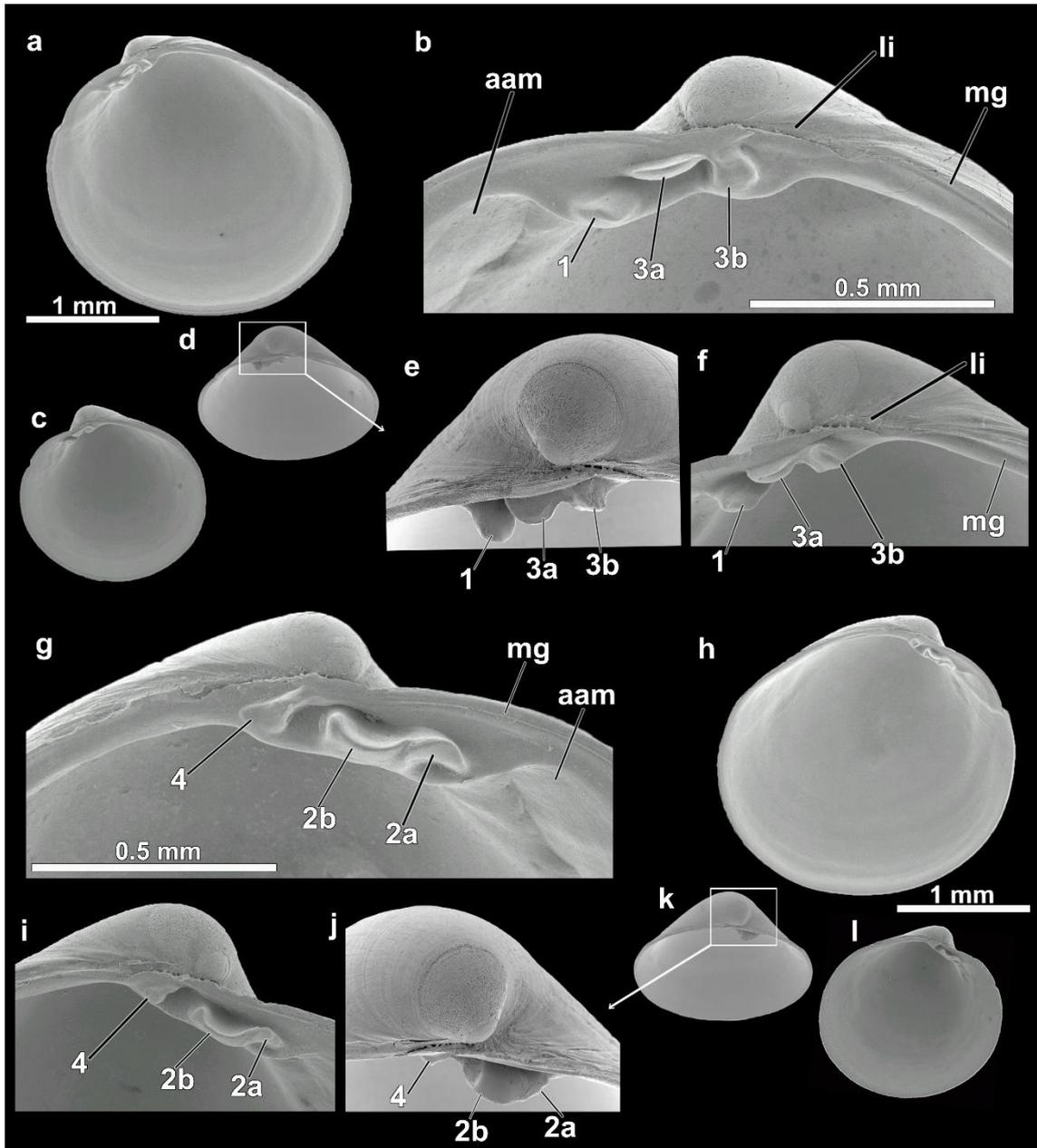


Fig. 4 *Kelliella* sp. SEM photomicrographs of the internal characters of the valves. Inner view of the right (a, c, d) and left valves (h, k, l). Detailed view of the right (b, e, f) and left valve hinges (g, i, j). In d, e, j and k the valves and hinges are viewed in an oblique dorsal view. The specimen illustrated in a and h has 2.3 mm in length; in c-f and i-l has 1.3 mm; and in b and g has 1.7 mm. Abbreviations: *aam*, anterior adductor muscle scar; *li*, ligament; *mg*, marginal groove of the shell; 1, 3a, 3b, cardinal teeth of the right valve; 2a, 2b, 4, cardinal teeth of the left valve. The scale is the same for a, c and d; for b, e and f; for g, i and j; and for h, k and l.

3.2 Anatomy description

Mantle

The mantle lobes have the typical three marginal folds (inner, middle and outer), which are all fused dorsally, between the adductor muscles. The inner folds are united too in one single point in the postero-ventral margin, consequently delimiting two openings: an antero-ventral, wide, pedal-inhalant opening and a posterior, narrow, exhalant opening (Fig. 5a). In the latter, the inner folds are extended as an exhalant siphon with a very thin wall that was observed by the SEM and histology as an inturned, contracted membrane (Fig. 5b). Ventrally, the inner folds are thickened, this being even more developed at the posterior fusion point, where these folds are also joined to the posterior tip of ctenidia, being composed by muscle fibers (Fig. 5d). There are small tentacles around both openings: two pairs in the ventral portion of the pedal-inhalant opening (P-I), one pair below the fusion point (F) (Fig. 5c, e), and two or three pairs plus one unpaired arranged in a semicircle around the dorsal half of the exhalant opening (E), external to the base of the exhalant siphon (Fig. 5h) following the arrangement (4 P-I + 2 F + 5-6 E). Through the SEM, a tuft of cilia was observed emerging from the tip of each tentacle (Fig. 5e). Apart from these presumably sensory cilia, scattered tufts were visible along the edge of the inner mantle fold near the fusion point.

From the region just below the anterior adductor muscle up to the mid ventral margin of the mantle lobes, there is a continuous epithelial glandular tissue, which is whitish in whole preserved specimens and stained in light blue in histological sections (Fig. 5a, d, f). It forms a longitudinal tract dorsal to the inner marginal fold, and is composed by large vesicles (28-87 μ m in diameter) which are extruded into the mantle cavity (Fig. 5f, g, j). Dorsal and parallel to this glandular tract, a continuous, narrow, longitudinal rejectory ciliary tract runs up near to the posterior fusion (Fig. 5i, g). That glandular tissue is also present in two other places: at the dorso-posterior mantle margin, just above the hind gut, and at the dorsal half of the base of the exhalant siphon; in these places, the histological structure of the glandular tissue is very similar to that of the glands of the ventral margin, but the extrusion of vesicles was not observed (Fig. 5a).

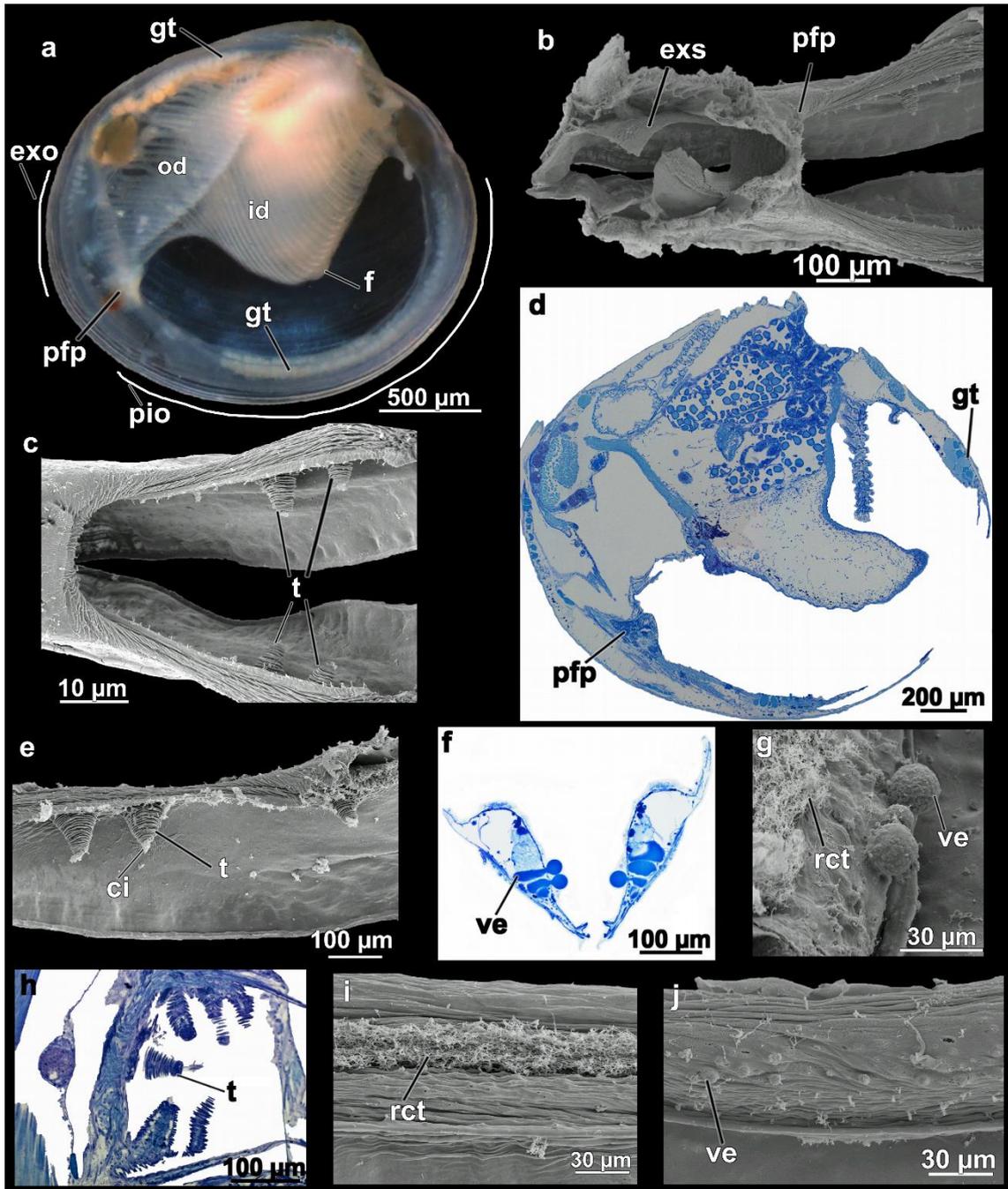


Fig. 5 *Kelliella* sp. Photomicrographs of the pallial organs viewed from the right side by the stereomicroscope after removal of the right valve and respective mantle lobe (**a**); of specific parts by the SEM (**b**, **c**, **e**, **g**, **i**, **j**) and through histological sections (**d**, **f**, **h**). **b**, detailed view of the ventro-posterior mantle margin, from the mantle cavity. **c**, detailed view of the pedal-inhalant opening, near the posterior region of the mantle fusion. **d**, parasagittal histological section, showing the epithelial tissue glands and the posterior fusion point. **e**, detailed view of the mantle margin, anterior to the posterior fusion point, showing the tentacles. **f**, **g**, transversal section and detailed view through the SEM of the mantle margin, showing the vesicles being extruded into the mantle cavity. **h**, detailed view of a frontal section showing the tentacles in semicircle around the exhalant opening. **i**, **j**, detailed views of the mantle margins showing the rejectory ciliary tract and the vesicles, respectively. Abbreviations: *ci*, cilia; *exo*, exhalant

opening; *exs*, exhalant siphon; *f*, foot; *gt*, glandular tissue; *id*, inner demibranch; *od*, outer demibranch; *pio*, pedal-inhalant opening; *pfp*, posterior fusion point; *rct*, rejectory ciliary tract; *t*, tentacle; *ve*, vesicle.

Ctenidia and labial palps

Kelliella sp. has eullamelibranchiate, homorhabdic, complete ctenidia (Fig. 5a), the axis of each being attached to the body-wall in its anteriormost half and free hanging in the mantle cavity at its posteriormost half (6a). The inner demibranchs are large and its filaments have descending and ascending portions with almost the same length. The distal ends of these filaments are attached by tissue to the visceral mass (Fig. 6b) in the anterior part of demibranchs, and in the posterior part, ventral to the visceral mass, the ones from one demibranch are fused to the others of the opposite demibranchs; the free edges of these demibranchs are maintained together anterior and posterior to the foot. The outer demibranch is shorter, extending along the 4/5 posterior length of the ctenidial axis (Fig. 5a). Its ascending lamella is higher than the descending, with a supraxial extension that is fused by tissue to the mantle by the distal ends of its filaments. The posterior tip of all demibranchs are fused each other, also joining the posterior fusion point of the mantle lobes (Fig. 6b). There are few interfilamentar junctions in both demibranchs; interlamellar junctions are only present near the free margin of the inner demibranchs (Fig. 6c). In such way, a large suprabranchial cavity is left continuous between the right and left inner demibranchs. Marginal food grooves are absent. All filaments have frontal, lateral and eulaterofrontal cilia; prolaterofrontals and abfrontals were not observed in histological sections nor by the SEM.

The labial palps are very small, minute when compared to ctenidia, hardly visible in the examined fixed specimens. Through the SEM and the histological sections, they could be observed as highly ciliated organs in its apposed surfaces, which are unfolded (Fig. 6d). The inner palps have the form of very small lamellae, while the outers are a little bit more developed, as anterior lips continuing as lateral lamellae (Fig. 6d). The antero-ventral margin of the inner demibranchs are fused to the inner palp lamellae, characterizing this association as of the "Category type III" of Stasek (1963).

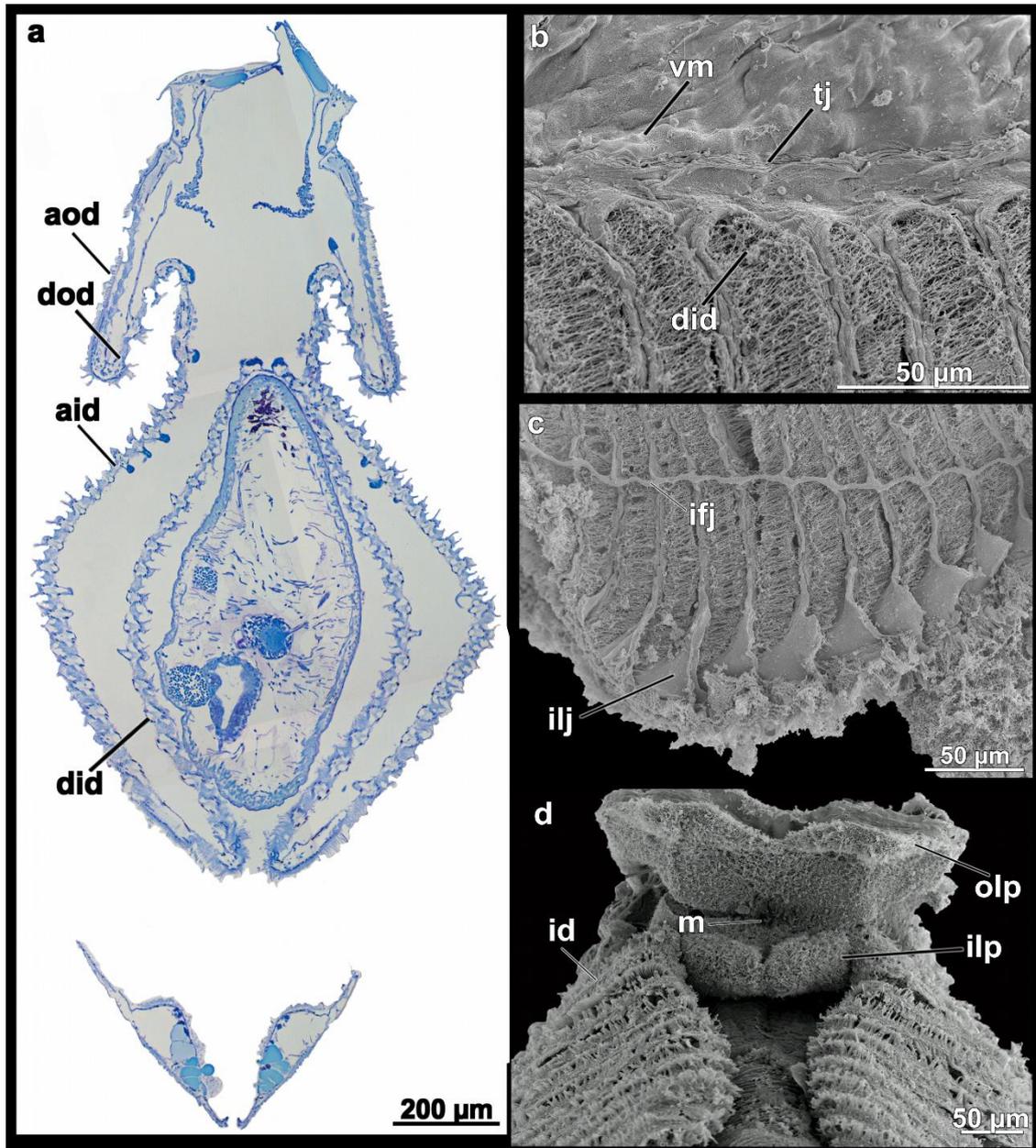


Fig. 6 *Kelliella* sp. Photomicrographs of a frontal histological section (**a**) and through the SEM (**b**, **c**, **d**). **b**, detailed view of the tissue junction attachment of the distal tips of the inner demibranchs filaments to the visceral mass. **c**, detailed view of the abfrontal surface of inner demibranchs filaments, near their free margin, showing the interfilamentar and interlamellar junctions. **d**, frontal view of the mouth surrounded by labial palps. Abbreviations: *aid*, ascending lamellae of inner demibranch; *aod*, ascending lamellae of outer demibranch; *did*, descending lamellae of inner demibranch; *dod*, descending lamellae of outer demibranch; *id*, inner demibranch; *ifj*, interfilamentar junction; *ilj*, interlamellar junction; *ilp*, inner labial palps; *m*, mouth; *olp*, outer labial palps; *tj*, tissue junction; *vm*, visceral mass.

Foot, byssal gland and musculature

As only fixed animals were analyzed, the foot is mostly in a strongly contracted condition, hidden between the inner demibranchs (Fig. 5a); a few individuals, however,

had them in a partially relaxed state, allowing dissections for the examination through the SEM. It is well developed, sickle-shaped, with pointed anterior end, a narrow ventral sole and a well defined, but little produced posterior heel (Fig. 7a). In the ventral sole, a deep pedal groove was observed by the SEM and histology, extending through all its length, from the near the tip up to the heel (Fig. 7b). There is a byssal gland in the heel, opening through a duct into the ventral groove (Fig. 7b); through histological sections, a thin, single byssal thread was observed running inside the duct (Fig. 7c, d). The musculature of the foot is composed by fibers that form paired well developed anterior and posterior retractor muscles, which are attached to the valves dorsally to and contiguous to the anterior and posterior adductor muscles, respectively (Fig. 7f, g); protractor muscles are absent. Except dorsally, in the vicinities to the visceral mass and in the ventral sole, the epithelium of the foot is highly ciliated (Fig. 7a). These cilia form a dense covering over the tip, in the latero-ventral surfaces, in the heel, and along the pedal groove, from the tip up to the opening of the byssal duct (Fig. 7b).

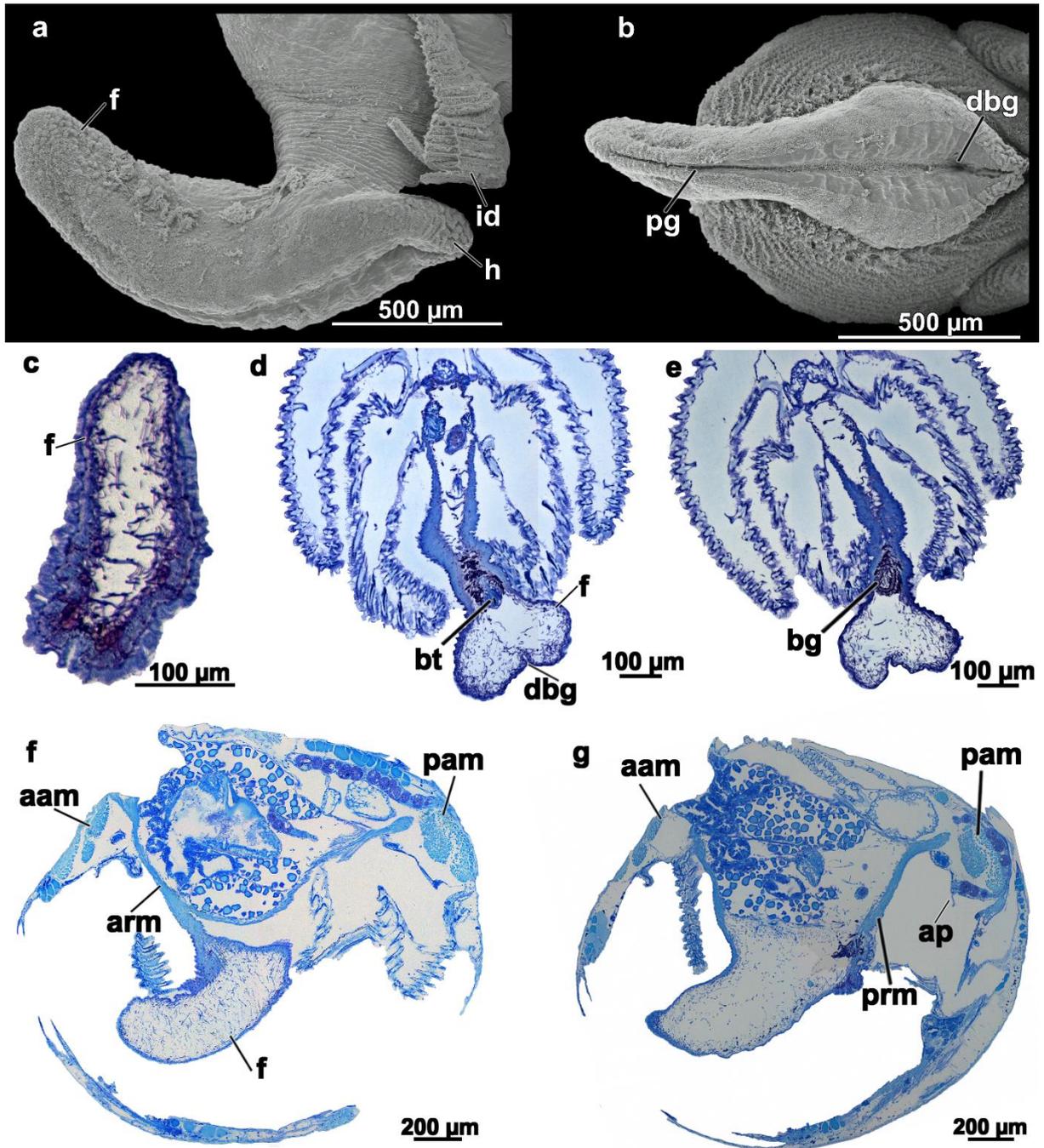


Fig. 7 *Kelliella* sp. Photomicrographs of the foot viewed through the SEM (**a**, **b**) and by histological section (**c**, **d**, **e**, **f**, **g**). **a**, left lateral view showing its sickle-shape and the heel. **b**, ventral view showing its deep groove and the duct of the byssal gland. **c**, **d**, **e**, transversal sections of the foot in its distal, medial and posterior regions, respectively. In **d** a single byssal thread is viewed inside the duct of the byssal gland. **f**, **g**, parassagittal sections through the whole animal. Abbreviations: *aam*, anterior adductor muscle; *arm*, anterior retractor muscle; *ap*, anal papilla; *bg*, byssal gland; *bt*, byssal thread; *dbg*, duct of the byssal gland; *f*, foot; *h*, heel; *pam*, posterior adductor muscle; *prm*, posterior retractor muscle; *pg*, pedal groove.

Organs of the visceral mass

In the digestive system of *Kelliella* sp. the mouth is small, continuous to a calibrous (~76µm in diameter) and long (~576µm in length) oesophagus that joins the antero-dorsal part of the stomach (Fig. 8a). The wall of the oesophagus is formed by a highly ciliated, cylindrical epithelium which is also present in the roof of the stomach up to its most posterodorsal portion. The stomach is globular, about 345 µm in diameter, and is externally covered on almost all of its extension by the gonads and digestive diverticula, the latter latero-dorsally and also around the esophagus, and the former being more ventral and posteriorly placed in the visceral mass. Internally, the gastric chamber has an epithelium with a thin cuticular tissue (gastric shield) restricted to its postero and anterolateral walls (Fig. 8a). In sections, large fragments of thecate algae were observed inside the stomach. Two, right and left antero-lateral, wide openings communicate the gastric chamber to the digestive diverticula, so forming large gastric ceca fused to the stomach wall. The postero-ventral part of the stomach floor is continuous to a short crystalline style sac that is combined with the mid gut. The communication between these two latter is wide, being interrupted by only two typhlosoles, one larger in the right side and other minor in the left; no crystalline styles were observed inside the style sacs of the sectioned individuals. The intestine, without typhlosoles, rises posteriorly and after a loose coiling extends dorsally, reaching the same level as the dorsal wall of the stomach, where it curves towards the posterior region of the visceral mass (Fig. 8a). Then, it crosses the pericardial cavity and becomes the hind gut that passes dorsal to the kidneys and ventral to the posterior dorsal mucus glands of the mantle margin; eventually, it ends as a rectum that bypasses the dorsal and posterior surfaces of the posterior adductor muscle and, ventral to this, opens into the supra-branchial cavity by an anal ciliated papilla (Fig. 7g). Large rounded fecal pellets (~60µm in diameter) with fragments of thecate algae were observed inside the ascending portion of the intestine and up to the rectum of most individuals (Fig. 8b).

A typical bivalve nervous system is present, with three pairs of ganglia communicated by connectives: one anterior supraesophagic (cerebro-pleural), one posterior visceral and one pair of pedal ganglia. Applied to the dorsal surface of the pedal ganglia is a pair of separate statocysts, each one characterized by a simple

ciliated capsule (~36µm in diameter) with a single, large and free spherical statolith (~11µm in diameter); it is similar to the statocysts “type B1” of Morton (1985) (Fig. 8c).

One right and one left kidney are situated in the postero-dorsal region of the visceral mass; they are completely separated each other, but anteriorly there is narrow communication between them (called a renal commissure by Clausen, 1958) (Fig. 8d). Renopericardial ducts were not observed. The pericardial cavity is placed in front of the kidneys and close to the external dorsal body wall; it surrounds the central part of the heart, composed by the ventricle that is deeply penetrated by the hind-gut all along its length (Fig. 8f). Posteriorly, two atria are communicated to the ventricle. The walls of the pericardium and of the heart are very thin, the laterals of the former presenting the so called pericardial glands composing also the excretory system together with the kidneys (Fig. 8f).

No ovaries and testes were observed in a single individual at the same time, so *Kelliella* sp. is possibly dioecious. The gonads are paired and large in mature individuals, where they fill most of the space of the visceral mass. Both ovaries and testes are formed by follicular lobes and inside them different cell types could be observed through the histological sections in distinct phases of gametogenesis. In the testis, spermatogonia and spermatocytes are positioned in its central part, while fully developed spermatozoa are more placed peripherally (Fig. 8e). In the ovaries, by histology and also by the SEM, there were: immature oocytes, the smallest ones (10-15 µm in diameter) and directly attached to follicle wall; and pre-vitellogenic and mature oocytes (20-30 µm in diameter), always attached *via* a stalk, and characterized by a small amount of yolk surrounding a large central nucleus (Figs. 8a, g). Each gonad is drained by independent gonoducts that open directly into the suprabranchial cavity. No specimens had ovocytes, embryos or larvae inside this cavity, and so brooding care could not be observed in this species.

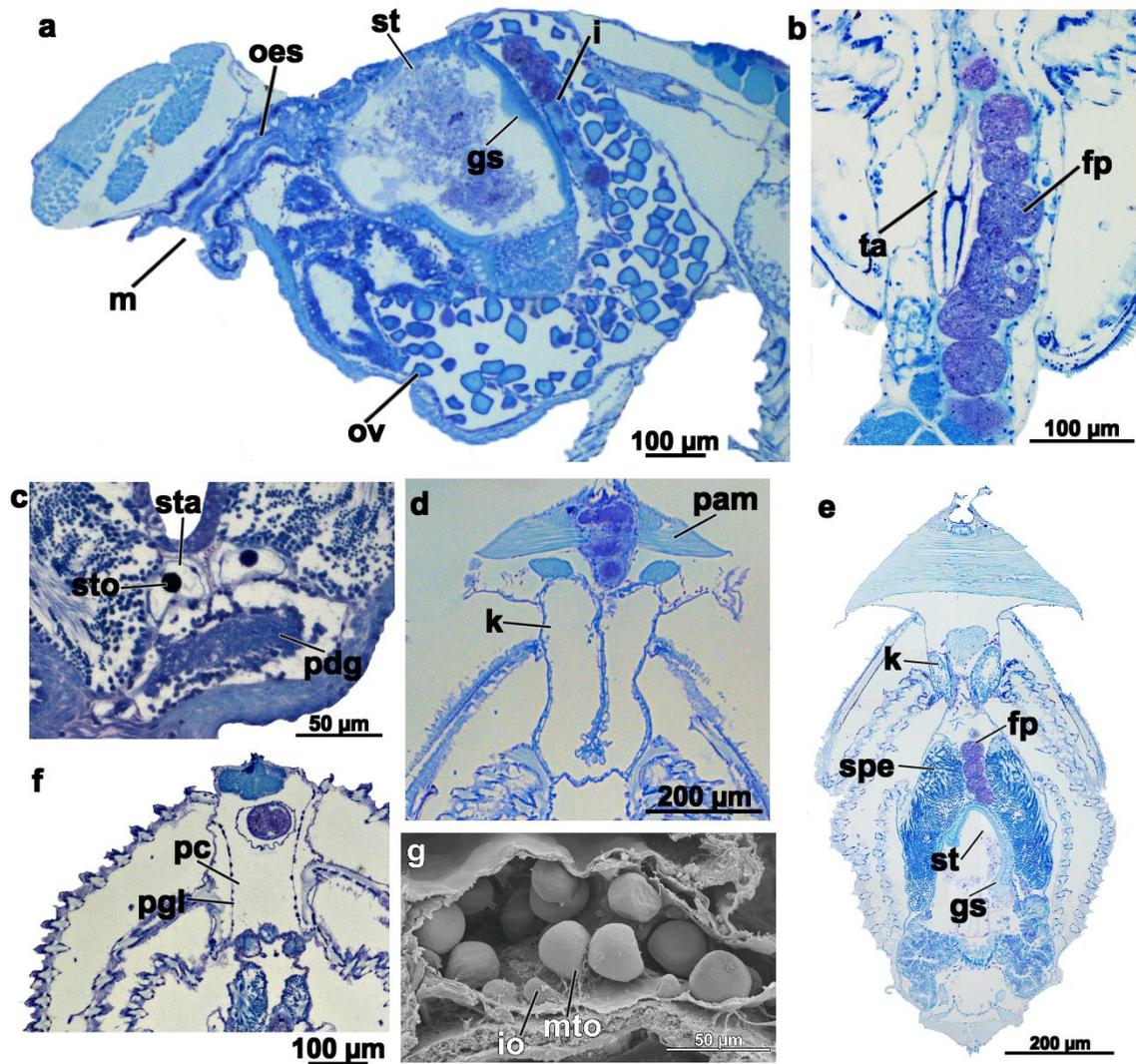


Fig. 8 *Kelliella* sp. Photomicrographs of histological sections (**a**, **b**, **c**, **d**, **e**, **f**) and obtained by the SEM (**g**) of the organs of the visceral mass. **a**, sagittal section through the digestive system and the ovaries. **b**, frontal section of the intestine showing the faecal pellets and a thecate algae. **c**, transversal section of the statocysts and pedal ganglia. **d**, frontal section of the kidneys. **e**, frontal section of the whole animal, indicating some organs of the visceral mass. **f**, transversal section with the pericardial cavity. **g**, view of the ovaries with some immature and mature oocytes. Abbreviations: *fp*, faecal pellets; *gs*, gastric shield; *i*, intestine; *io*, immature oocytes; *m*, mouth; *mto*, mature oocytes; *oes*, oesophagus; *ov*, ovaries; *k*, kidney; *pam*, posterior adductor muscle; *pc*, pericardial cavity; *pdg*, pedal ganglia; *pgl*, pericardial glands; *spe*, spermatozoa; *st*, stomach; *sta*, statocyst; *sto*, statolith; *ta*, thecate algae.

4. Discussion

4.1 Conchological remarks

The shell of *Kelliella* sp. has the main external characteristics of a Kelliellidae, generally characterized as small bivalves (<15 mm) with thin to robust, equivalve,

inflated shells, composed by rounded to suborbicular or subtrigonal valves with a smooth or fine commarginal sculpture, bearing prominent umbones, and well marked lunule in adults (Thiele, 1935; Boss, 1982; Shirley & Slack-Smith, 1998; Huber, 2010). Currently, this family has about 15 species in Recent fauna, distributed in three genera, *Kelliella*, *Alveinus* and *Pauliella* Munier-Chalmas, 1895 (Allen, 2001; Bouchet & Gofas, 2015; Bouchet & Sartori, 2015; Sartori, 2015). The rounded outline of the shell of *Kelliella* sp., with its well evident lunule and the configuration of hinge teeth, differs from the more subtrigonal (with more central umbones) species of *Alveinus*, as *Alveinus miliaceus* (Issel, 1869) and *Alveinus ojanus* (Yokohama, 1927) known from the Red, Arabian and Japan Seas (see Oliver & Zuschin, 2000, fig. 3a,b; Evseev *et al.*, 2004b, fig. 2l,j). The contour of the shell of *Pauliella bernardi* Munier-Chalmas, 1895, the single species of *Pauliella* (see Thiele, 1935; Keen, 1969 for a description of this genus), is very similar to the one of *Alveinus*, and consequently different of *Kelliella* sp. According to Oliver & Zuschin (2000), although similar in shape, the hinge teeth and the position of ligament in species of *Alveinus* are different from those found in *Pauliella*, by having a larger upper tooth in the right valve, a weaker postero-dorsal portion of the tooth of left valve, and by the presence of a marginal or flange groove and flange ridges in the anterior and posterior dorsal inner margins of the valves (see Evseev *et al.*, 2004a, fig. 1). The micropustules observed in the dissoconch of *Kelliella* sp. was never reported from all the Kelliellidae or Vesicomylidae described until now, there remaining some doubts if this shell character is really exclusive for this species from Brazil, or if it is shared with other taxa among these families or the Glossoidea in general.

The hinge plate of *Kelliella* sp. is moderately developed and similar to the others species already referred to *Kelliella*, bearing the characteristic cardinals 1, 3a and 3b in the right valve, and 2a, 2b and 4 in the left. Thiele (1935) characterized the hinge of kelliellids as variably strong, with two or three teeth in each valve; this same pattern was observed for species of *Kelliella*, *Alveinus* and *Pauliella*. The hinge dentition of these genera usually varies according to the shell morphogenesis, hampering the standardization of the nomenclature by using numbers according to their position in the hinge plate. In *Kelliella*, for example, the same left (“2a”, “2b”, “4”) and right (“1”, “3a”, “3b”) cardinals teeth described by Allen (2001) were also referred for the dentition of their congeneric, although for the hinge teeth of *Alveinus* there are

some variations in this nomenclature (see Evseev *et al.* 2004b, fig. 3 and Oliver & Zuschin, 2000, figs. 3, 7b).

According to Bouchet & Gofas (2015), 28 species are currently referred to *Kelliella*, most of these (12) being from the Atlantic Ocean (Table 1). The type-species of this genus, *K. miliaris* [but see Huber (2010) for a discussion about this, with an alternative view that this is *Kellia abyssicola* Forbes, 1844], is recorded from the Mediterranean as well as from the Atlantic coast of North Africa and Western Europe (up to Norway) (Clausen, 1958; Allen, 2001); Odhner (1960) pointed out that it can be found in very shallow waters as 11 meters. Its shell was illustrated by Sars (1870), Clausen (1958), Sorensen (1984), Warén (1989), Allen (2001) and Janssen & Krylova (2012). Allen (2001) examined specimens from Norway and Scotland and redescribed this species. Based on all these papers, it can be characterized as being small (up to 3 mm), with almost spherical shell valves [see Clausen (1958), fig. 1; Sorensen (1984), fig. 6; Wáren (1989) fig. 16; Allen (2001), fig. 2; Janssen & Krylova (2012) pl. 2, figs. 6-9 and also Figure 9a, b], very similar in size and contour to the ones of *Kelliella* sp. Great distinctions among these two species are shown in the hinge dentition, where in the right valve they differ by the form of the cardinal 3b, which is short and robust in *Kelliella* sp., while in *K. miliaris* it was described and illustrated by Allen (2001) as a “posteriorly directed lug which curves ventrally to hinge margin where it extends posteriorly as curved ridge merging into thickened ventral margin of posterior hinge plate”; in the left valve, similarly, the cardinal 2a was characterized as forming an arch in *K. miliaris* [see Clausen (1958), fig. 1; Allen (2001), fig. 1], while in the Brazilian species it is in a form of a convex, but not so curved shelf. Other differences between them are also present in the soft parts, as will be discussed in the “anatomical remarks” of this dissertation. Apart from this, *Kelliella* sp. can be distinguished from the other Atlantic species of *Kelliella*, as follows.

Table 1. Atlantic and Antarctic species names already referred to *Kelliella*. This list was based on Bouchet & Gofas (2014). When available, data about the taxonomy, shell, soft parts, paleontology, or the bathymetric and geographical distribution can be found in the cited references.

Species	Maximum shell length (mm)	Bathymetric distribution (m)	Geographical distribution	References
<i>Kelliella abyssicola</i> Allen, 2001	3	2185 - 4632	North Atlantic: Southwest of Ireland, Sierra Leone and Guyana Basins	Allen (2001)
<i>Kelliella adamsi</i> (E. A. Smith, 1885)	15	1512 - 5300	Sierra Leone and Romanche Deep to off Namibia (Allen, 2001, also cited from the Surinam Basin)	Smith (1885), Odhner (1960), Allen (2001), Cosel & Salas (2001), Krylova & Sahling (2010)
<i>Kelliella albida</i> (Dall, 1889)	9	108	Off Rio de Janeiro, Brazil, Southwestern Atlantic	Dall (1889), Smith (1900), Odhner (1960), Boss (1970), Domaneschi & Lopes (1990), Krylova & Sahling (2010)
<i>Kelliella atlantica</i> (E. A. Smith, 1885)	13.5	400 - 4600	North Atlantic: southern North America and Western Europe, including Azores to Cape Verde Basin; South Atlantic Ocean: Sierra Leone, Angola, Campos (Rio de Janeiro, Brazil) and Argentine Basins	Smith (1885), Dall (1886), Odhner (1960), Allen (2001), Ceregato & Tabanelli (2001), Cosel & Salas (2001), Oliveira & Absalão (2007), Krylova & Sahling (2010)
<i>Kelliella biscayensis</i> Allen, 2001	1.6	465 - 1015	Bay of Biscay, Northeastern Atlantic	Allen (2001), Krylova & Sahling (2010)
<i>Kelliella concentrica</i> Allen, 2001	2.5	457 - 811	North America Basin (Atlantic Ocean)	Allen (2001), Janssen & Krylova (2012), Krylova & Sahling (2010), Krylova et al. (2014)
<i>Kelliella elongata</i> Allen, 2001	3	478 - 5100	North and southwest Atlantic: North America, Guyana, Sierra Leone, Angola and Argentine Basins	Allen (2001), Cosel & Salas (2001), Krylova & Sahling (2010), Krylova et al. (2011)

<i>Kelliella goësi</i> Odhner, 1960	1.8	180 - 540	Caribbean Sea (St. Martin and Anguilla)	Odhner (1960)
<i>Kelliella laevis</i> (Pelseneer, 1903)	2.6	378 - 4572	Antarctic waters to east and west of the Antarctic Peninsula	Pelseneer (1903), Odhner (1960), Muhlenhardt-Siegel (1989), Allen (2001), Krylova & Sahling (2010), Engl (2012)
<i>Kelliella miliaris</i> Philippi, 1844	3	11 - 1170	Northeastern Atlantic (from off Iceland and Norway and in the Western Europe), Mediterranean Sea, and North Africa	Sars (1870), Clausen (1958), Odhner (1960), Sorensen (1984), Warén (1989), Allen (2001), Janssen & Krylova (2012), Janssen et al. (2015)
<i>Kelliella nitida</i> Verrill, 1885	5.5	2700 - 4750	Northwestern Atlantic	Verrill & Bush (1898), Odhner (1960), Abbott (1974), Allen (2001), Krylova & Sahling (2010)
<i>Kelliella pilula</i> (Dall, 1881)	2.6	537 - 619	Florida, Florida Strait, Porto Rico and West Indies	Dall (1881, 1886), Smith (1900), Dall & Simpson (1901), Odhner (1960), Abbott (1974)
<i>Kelliella sirenkoi</i> Egorova, 1998	3.7	1812 - 4696	East Weddell Sea, West Antarctica	Egorova (1998), Linse (2004), Krylova & Sahling (2010), Engl (2012)
<i>Kelliella tenina</i> Allen, 2001	3	1014	Walvis Bay, Namibia	Allen (2001)
<i>Kelliella</i> sp.	2.3	147	Southeastern Brazil, Atlantic Ocean	This study

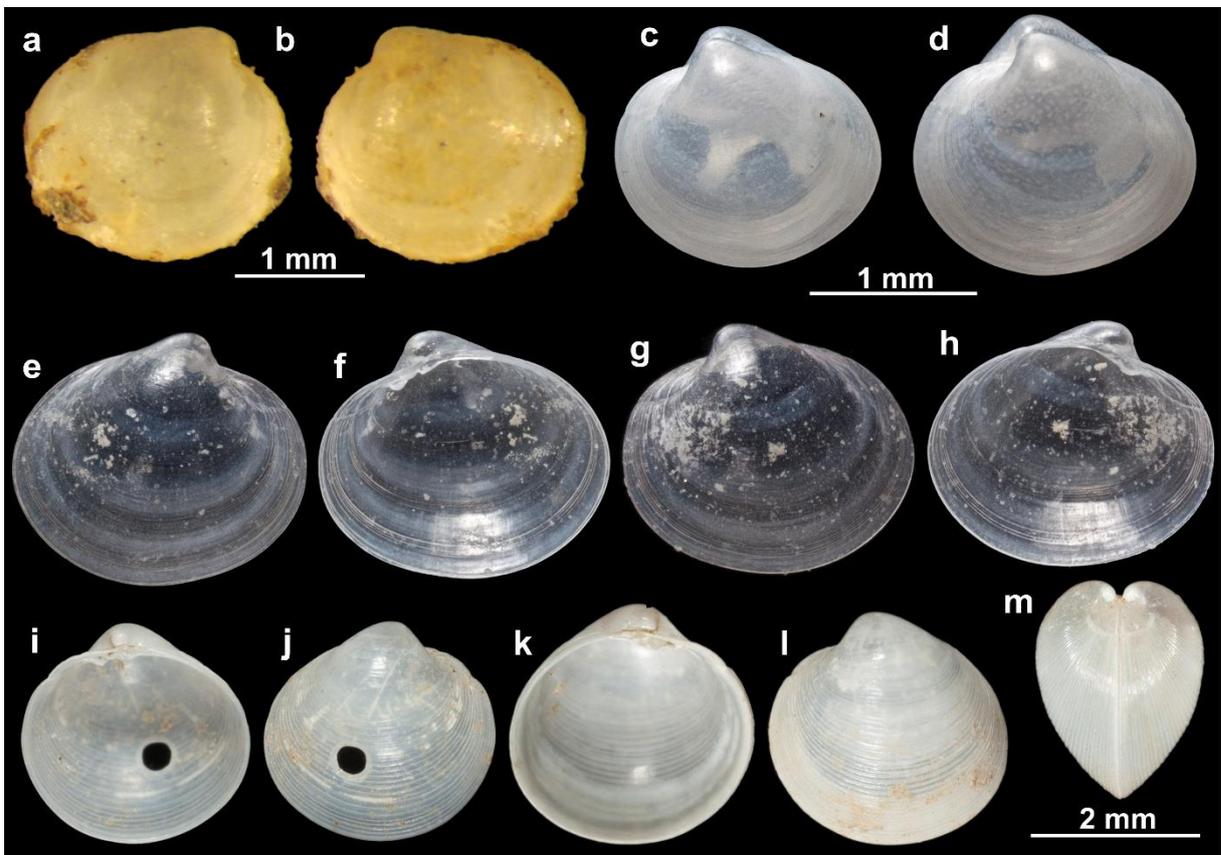


Fig. 9 Photomicrographs obtained by stereomicroscopes of *Kelliella miliaris* (USNM 217690) (**a-b**), *K. biscayensis* (NHMUK 1998177) (**c-h**) and *K. rotunda* (USNM 298597) (**i-m**). External view of the right (**a, e, j**) and left valves (**b-d, g, l**); internal view of the right (**f, i**) and left valves (**h, k**); **m**, frontal view.

Kelliella nitida Verrill, 1885 and *K. atlantica* have larger shells, the former up to 4.6 mm and the latter reaching more than 10 mm in length. Both have valves with rotund or subcircular outlines [Smith (1885), figs. 8-8b; Verrill & Bush (1898), pl. XCI, fig. 8; Abbott (1974), fig. 5827; Allen (2001), figs. 3, 4, 6, 7; Ceregato & Tabanelli (2001), fig. 3; Cosel & Salas (2001), figs. 6-8, type-specimens in figs. 12-13; Oliveira & Absalão (2007), figs. 1-6], and so distinct from the rounded, small valves of *Kelliella* sp. *K. concentrica* Allen, 2001 was described as bearing a distinguished, well marked commarginal striation in the external surface of the shell, a depressed lunule, a well-defined escutcheon and a broad, anteriorly positioned hinge plate [Allen (2001), figs. 14, 15]; in *Kelliella* sp. a commarginal striation is just a little bit visible, the lunule is well demarcated but its marginal groove is only well-defined anteriorly, there is no escutcheon and the hinge plates are narrow. *K. elongata* Allen, 2001 and *K. tenina*

Allen, 2001 have characteristic elongate shells [Allen (2001), figs. 17, 27], very distinct from the rounded ones of *Kelliella* sp. The hinge teeth are the most distinctive characters among *K. abyssicola* Allen, 2001 and the new species: in the right valve of the former the cardinals 3a and 3b are not clearly separated and form an elongate, slender ridge [Allen (2001), fig. 21], while in the latter they are distinct, the 3a as a short shelf and 3b being robust; and in the left valve the cardinal 2a is convex in *Kelliella* sp., while in *K. abyssicola* it is slender. Based on the contour of the valves, *Kelliella* sp. can be considered similar to *K. biscayensis* Allen, 2001, but in this latter species the umbones are larger [Allen (2001), fig. 24; and also Figure 9c - h]; their hinge dentitions are also similar but differences are noted mainly in the right valve, where there are spoon-shaped cardinal 1 and fused 3a/3b teeth in *K. biscayensis* [Allen (2001), fig. 25], contrasting to the roundly pointed 1, shelf-shaped 3a and short and robust 3b of *Kelliella* sp. *K. adamsi* (E. A. Smith, 1885) has a large shell (up to 14 mm in length), whose form and dentition [Smith (1885), figs. 7-7b; Odhner (1960), figs. 8-11; Allen (2001), fig. 31; Cosel & Salas (2001), figs. 15-22, 76-77, 99], are similar to the ones of *K. atlantica* [as pointed out by Allen (2001)], and so distinct from *Kelliella* sp. Although similar in contour, the small valves of *Kelliella goësi* Odhner, 1960 have a commarginal sculpture described by Odhner (1960, figs. 11, 12, 24, 25) as “concentric regular thick and obtuse depressed costae separated by fine impressed lines” that are not present in the Brazilian species. *Kelliella* sp. can be distinguished from *K. pilula* (Dall, 1886) by the contour of the valves, which are subcircular in the latter [Dall (1886), pl. VIII, fig. 13; Abbott (1974), fig. 5835], somewhat similar to that of a young of *K. atlantica* [as pointed out by Dall (1886)], and so distinct from the rounded of the former. Two species are recorded from the Antarctic waters: *K. laevis* (Pelseneer, 1903) and *K. sirenkoi* Egorova, 1998. The first of this species has a small shell, whose valves bear an outline and hinge teeth that can be distinguished from that of *Kelliella* sp.: the description of Allen (2001, figs. 10, 11) show their subcircular contour [also in Pelseneer (1903), figs. 129-130; Muhlenhardt-Siegel (1989), pl. IV, fig. 37; and Engl (2012), pl. 9, fig. 5] and the cardinal 3a dorsally placed to 3b, while the cardinal 2a is very reduced, conditions that are different from those found in *Kelliella* sp. The shell of *K. sirenkoi* is triangular-rounded and is more thick [Egorova (1998), figs. 1-8; Engl (2012), pl. 9, fig. 4] than of the species from Brazil. Linse (2004) and Engl (2012) recorded *K. sirenkoi* is an abundant bivalve species in the Scotia Arc and East Weddell Sea.

When compared to other species referred to *Kelliella* from other oceans apart from the Atlantic and the Antarctic, *Kelliella* sp. appears to be closely related to *Kelliella rotunda* (Thiele & Jaeckel, 1931), recorded from the Pacific Ocean. Both species have rounded valves, but in *K. rotunda* the umbones are more inflated, the cardinal tooth 1 of the right valve is upturned (not pointed), and the tooth 4 of the left valve is smaller when compared to the teeth 2a and 2b [as described by Boss (1970), figs. 12, 15, 16; Haines & Huber (2012), fig. 43; and also Figure 9i - m]. All other *Kelliella* species from the Pacific and Indian Oceans recorded by Thiele & Jaeckel (1931), Knudsen (1970), Boss (1970), Filatova (1971), Coan & Valentich-Scott (2012) and Okutani & Fujiwara (2013) are distinct from *Kelliella* sp. by the shell form, sculpture and hinge dentition (Table 2).

Table 2. Indo-Pacific species names already referred to *Kelliella*. This list was based on Bouchet & Gofas (2014). When available, data about the taxonomy, shell, soft parts, paleontology, or the bathymetric and geographical distribution can be found in the cited references.

Species	Maximum shell length (mm)	Bathymetric distribution (m)	Geographical distribution	References
<i>Kelliella bruuni</i> (Filatova, 1969)	7	5900 - 9200	Kermadec Trench (Pacific Ocean)	Filatova (1969), Knudsen (1970), Cosel & Salas (2001), Krylova & Sahling (2010)
<i>Kelliella galathea</i> Knudsen, 1970	7	1760 - 4000	Northeastern Pacific from off Triangle Island, British Columbia, to the Golfo de Panamá	Knudsen (1970), Bernard (1989), Coan et al. (2000), Cosel & Salas (2001), Coan & Valentich-Scott (2012), Krylova & Sahling (2010)
<i>Kelliella indica</i> Knudsen, 1970	12.3	4350	Central Indian Ocean	Knudsen (1970), Cosel & Salas (2001), Krylova & Sahling (2010)
<i>Kelliella ossisocia</i> Okutani & Fujiwara, 2013	7	226	Kyushu, Japan - Mar da China Oriental	Okutani & Fujiwara (2013)
<i>Kelliella pacifica</i> (E. A. Smith, 1885)	8.2	1200 - 6200	Mid-North Pacific Ocean and Tuffs Abyssal Plain, Oregon (USA) to Valparaiso (Chile)	Smith (1885, 1900), Odhner (1960), Coan et al. (2000), Coan & Valentich-Scott (2012), Krylova & Sahling (2010), Krylova et al. (2014)
<i>Kelliella profund</i> (Filatova, 1971)	5.5	7120 - 9050	Kuril-Kamchatka Trench, Northwestern Pacific; Aleutian Trench	Filatova (1971), Krylova & Sahling (2010), Krylova et al. (2014)
<i>Kelliella rotunda</i> (Thiele & Jaeckel, 1931)	3	30 - 1785	Indonesia, South China Sea, Philippine Islands, Okinawa (Japan), Easter Island (Isla de Pascua, Chile)	Thiele & Jaeckel (1931), Odhner (1960), Boss (1970), Hayame & Kase (1993), Krylova & Sahling (2010), Raines & Huber (2012)

<i>Kelliella sergeevi</i> (Filatova, 1971)	4.8	6090 - 9530	Kuril-Kamchatka Trench, Northwestern Pacific	Filatova (1971), Krylova & Sahling (2010), Krylova et al. (2014)
<i>Kelliella sumatrana</i> (Thiele & Jaeckel, 1931)	7.5	750	Philippines Islands and Indonesia, Indo-Pacific	Thiele & Jaeckel (1931), Odhner (1960), Boss (1970)
<i>Kelliella sundaensis</i> Knudsen, 1970	3.9	6900 - 7000	Sunda Trench (Indian Ocean)	Knudsen (1970), Cosel & Salas(2001), Krylova & Sahling (2010)
<i>Kelliella tasmanensis</i> Knudsen, 1970	6.2	4400	Tasman Sea (Pacific Ocean)	Knudsen (1970), Cosel & Salas(2001), Krylova Sahling (2010)

4.2 Anatomical remarks

Among more than 110 Recent species belonging to the superfamily Glossoidea Gray, 1847 (1840) only 24 have some records of their soft parts (full or partially) illustrated in the literature. And although this group is well known with respect to shell morphology, the anatomical aspects are still poorly studied generating uncertainty about the taxonomic status and on the phylogenetic relationships of this superfamily as a whole (see Carter *et al.*, 2011; Bieler *et al.*, 2014, tables 5, 6). For purposes of anatomical comparison, this work considers the Glossoidea as a valid superfamily, composed for the families Glossidae Gray, 1847 (1840), Kelliellidae e Vesicomidae Dall & Simpson, 1901.

About the Kelliellidae, specifically, there are seven species with anatomical records and among these only *Kelliella miliaris* and *Alveinus ojanus* have had their anatomical aspects described in details (organs of the pallial cavity and visceral mass, living specimen observation). The other species as *K. indica*, *K. atlantica*, *K. concentrica* and *K. biscayensis* were described only by topography of internal organs (gross anatomy); already *K. ossisocia* has not been described anatomically, but a single photo of the foot was recorded by Okutani & Fujiwara (2013). The anatomy of *Kelliella* sp., therefore, was compared with all these kelliellids and also with other related taxa, specially Glossidae and Vesicomidae species.

Glands in the mantle margin

In all specimens of *Kelliella* sp. examined, the presence of a withish glandular tissue in the ventral and posterodorsal mantle margins is well evident. This same glandular tissue, formed by large vesicles, also already been observed in *K. miliaris*, *Kelliella laevis* [= accepted as *Callocardia laevis*], *K. concentrica*, *Kelliella elongata* [= accepted as *Isorropodon elongata*], *K. biscayensis* and *A. ojanus*, located exclusively in the ventral mantle margin (Clausen, 1958, fig. 2; Allen, 2001, figs. 12, 14, 19, 22, 26, 29; Evseev *et al.*, 2004a, figs. 3-6, respectively). In addition, a similar tissue was also reported to the larger species of Glossoidea as *Glossus humanus* (~6 cm in length) (Glossidae), *Calyptogena magnifica* (3.5 to 26 cm in length) and *Isorropodon bigotti* (~2 cm in length) (Vesicomidae), in both also located only in the ventral mantle margin (Owen, 1953, pg. 92; Morton, 1986, figs. 5-6; Cosel & Salas, 2001, pg. 346, respectively). Although each author have used a different name to designate this glandular tissue, its function as mucus producer, seems to be a consensus among

most of them. In *A. ojanus* (Kelliellidae), however, this glandular tissue apparently has another function; the granules [= vesicles] that compose this tissue would a food resource used by adult specimens during the winter gametogenesis (Evseev *et al.*, 2004a). Already in *Kelliella* sp., this glandular tissue also appears to have a mucus production function, your type cell and position in the mantle margin justifies its function when compared to the species of *Kelliella* listed above. However, different of all species cited, *Kelliella* sp. also has the same glandular tissue in the posterodorsal mantle margin, lined to the most posterior portion of the hind gut and near to the posterior adductor muscle. In this case, the function of this mucus gland is uncertain.

Mantle openings and sensory tentacles

In *Kelliella* sp. there are only two mantle openings: exhalant and pedious-inhalant. Among their congeneric, *K. miliaris* and *K. biscayensis* also have two openings; and although similar, the number and arrangement of small sensory tentacles around these openings can be used as a distinguishing feature between these species. In *Kelliella* sp. were observed only 11 tentacles: 4 in the most posterior portion of pedious-inhalant opening (P-I), 2 closed applied to the fusion (F) that separate the openings and 5 in the exhalant opening (E). In *K. miliaris*, for example, were reported 16 to 20 tentacles with the following arrangement, 7-8 P-I + 2 F+ 7-10 E; while in *K. biscayensis* (19 tentacles: 12 P-I + 7 E), both with different patterns from that observed in the new species (Sars, 1870; Clausen, 1958; Allen, 2001). In *Kelliella* species with three mantle openings (exhalant (E), inhalant (I), pedious (P)) the number and arrangement of tentacles also varies: in *K. concentrica* (15 tentacles: 8 I + 2 F + 5 E); *K. indica* (45 tentacles: no arrangement reported) and *K. atlantica* (4 to 8 tentacles: 4-6 I + 2F) (Knudsen, 1970; Allen, 2011).

It is noteworthy that among the Kelliellidae, the number and the arrangement of these tentacles can also present a variation over growth; in *K. miliaris* and *Alveinus ojanus*, for example, the number of sensory tentacles increases with the size of individuals i.e. larger specimens have more tentacles than smaller (Clausen, 1958; Evseev *et al.*, 2004a). Even with this variation, this feature seems to function well for distinguishing congeneric species.

The presence of sensory papillate tentacles around the mantle openings is also common to other Glossoidea. To the genus *Vesicomya* (Vesicomoridae), for example, the number of tentacles varies among individuals of the same species and this character is important for the taxonomy of genus (Krylova *et al.*, 2014). In

Glossidae, specifically, the species *Glossus humanus* also has a variable number of tentacles (50 to 90) at the base of the inhalant and exhalant openings (Owen, 1953). For *Calyptogena* species (Vesicomoridae), these sensory tentacles are usually observed in greater number around of inhalant siphon and also present a variation; in *C. magnifica*, for example, were found 24 sensory inhalant tentacles, while in *C. australis* (= *Ectenagena australis*) 35 small tentacles were reported; already in *C. pacifica* Dall, 1891, 2-4 rows of small tentacles in the inhalant and usually 1 tentacle in exhalant siphon (Morton, 1986; Stuardo & Valdovinos, 1988; Krylova & Sahling, 2006).

Digestive system

Among the visceral mass organs, the stomach of *Kelliella* sp. stands out for its wide connection with the digestive diverticula and by the junction with a combined crystalline style sac and mid gut. A similar connection between stomach and digestive diverticula (gastric cecum), also was observed in *K. miliaris* by Clausen (1958) and to other Glossoidea as *Calyptogena magnifica* by Boss & Turner (1980) and *Glossus humanus* (Glossidae) by Owen (1953); in both were described one pair of large openings from the stomach to the digestive diverticula. Yonge (1946) correlated large openings into the digestive diverticula with great amounts of inorganic material mixed with the food. The presence of fragments of thecate algae inside of the stomach of *Kelliella* sp. seems to corroborate this idea.

Another digestive feature observed in *Kelliella* sp. and which is also shared by other Glossoidea, is the absence of crystalline style, probably reducing the digestion capability of these species. According to Yonge (1925) and Morton (1973) the crystalline style is the source of certain extracellular enzymes which are liberated into the stomach by the dissolution of the style. Morton (1986) related the reduced extracellular digestive activity in *C. magnifica* with a reduced crystalline sac and with the possibly absent of a crystalline style. For him, this poor digestion capability would be correlated with the notion of *Calyptogena* feeds principally on the very fine bacterial particles. In *Kelliella* sp. the absence of a crystalline style must be compensated by a large digestive diverticula that probably actively participates in the lyses of algae fragments. In *A. ojanus* a similar pattern was observed, lot of thecate algae inside the stomach, but here there a short crystalline style with a reduced digestive diverticula. In *G. humanus* (Glossidae), for example, the crystalline style was also not observed (Owen, 1953). According to Yonge (1923, 1925, 1926) the disappearance of the crystalline style seems to be common in bivalves that have a free communication

between style sac and mid gut or also when the normal activities of these animals are suspended.

The junction of stomach with a combined style sac and mid gut also seems to be a shared characteristic not only between Kelliellidae but also among to most Glossoidea (Owen, 1953; Clausen, 1958; Bernard, 1989; Boss & Turner, 1980; Morton, 1986; Evseev *et al.*, 2004a). In *Kelliella* sp. these organs shares a common gastric chamber, which dorsally is partially covered by a gastric shield and ventrally covered by ciliated cells with a large typhlosole. A similar gastric chamber also has been observed in *K. miliaris*, *A. ojanus* and *G. humanus* (Owen, 1953; Clausen, 1958; Evseev *et al.*, 2004a).

It is noteworthy that the set of information about the stomach of *Kelliella* sp. classifies it as "Type V" of Purchon (1987), the same type reported by *G. humanus* (Purchon, 1987). Although poorly studied, the stomach appears to be important for the taxonomy of species of Kelliellidae. According to Evseev *et al.*, (2004a) the morphology of the stomach is an important character to the taxonomy of *A. ojanus* (Kelliellidae).

Foot and byssus

Although only fixed specimens of the new species have been examined, the good state of preservation of the foot of *Kelliella* sp. allowed us to compare it with that of other Kelliellidae. In general, the foot of *Kelliella* sp. is well development in individuals moderately contracted, with a well-defined heel and has a tiny pedal groove that extends from near the tip to the heel. In sections, a small byssal gland and a single byssus thread also were observed. A similar pattern seems to be shared among most Kelliellidae, although when live some species have variations of this pattern. In living specimens of *Kelliella miliaris* and *Alveinus ojanus* for example, a huge and extensible foot with two to three times the length of the shell was observed (see Sars, 1870, Tab XIII figs. 19-21; Clausen, 1958, text fig. 4; Evseev *et al.*, 2004a , fig. 1). A functional byssus thread also been reported to these living species, in *K. miliaris* a network of short byssus thread was observed, while in *A. ojanus* one or two thin and semi-transparent byssus threads have been seem (Clausen, 1958; Evseev *et al.*, 2004a). Even though not seen alive, the histological and morphological similarities between the foot of *Kelliella* sp. and these living species indicate that possibly living individuals of the new species also has a huge foot with a functional byssus thread.

In *Kelliella ossisocia*, for example, a member of whale bone-associated fauna a well development and pigmented foot (reddish) was observed (Okutani & Fujiwara,

2013, fig. 2E); this reddish foot is well different of whitish to semi-transparent feet reported to most Kelliellidae. The foot of *K. ossisocia* seems to be more associated with Vesicomidae than the Kelliellidae species. According to Boss & Turner (1980) in life, the tissues of *Calyptogena magnifica* Boss & Turner, 1980 are red, included the foot with dark red blood vessels.

In additional, other Glossoidea also present a foot similar to the *Kelliella* sp. as *Glossus humanus*, *Vesicomya galathea* (Knudsen, 1970), *Callocardia laevis* Pelseneer, 1903, *Isorropodon elongata* (Dall, 1916) and *Isorropodon tenina* (Allen, 2001) (Owen, 1953; Knudsen, 1970; Allen, 2001).

Statocysts

The same type of statocyst observed in *Kelliella* sp. had also been reported for *Kelliella miliaris* and *Alveinus ojanus* (see Clausen, 1958, pl. III, fig. 17 and Evseev *et al.*, 2004a, fig. 9, respectively). In these species, each statocyst is basically formed by a multicellular capsule with a large, single and free statolith inside. In addition, the paired statocysts are always closely applied to the dorsal surface of pedal ganglia and separated each other. According to Morton (1985), this configuration of statocysts is characterized as “Type B1”. Worth mentioning that in *A. ojanus* the statocysts were classified mistakenly as “Type B2”, once that the authors did not observed the presence of cristal-like statoconia inside the capsules (see Evseev *et al.*, 2004a, fig. 9). This same type of statocysts observed to these Kelliellidae (Type B1) also been reported for another microbivalve species, *Cyamiocardium domaneschii* Passos & Machado, 2014 (Cyamiidae) which could indicate, perhaps, a close relationship between the life habits of these species (see Passos & Machado, 2014, fig. 4B). Morton (1985) related the “Type B1” to bivalve species which have the ability to orient themselves, performing more precise movements. The remarkable similarity between the statocysts of these species make us believe that *Kelliella* sp., perhaps, shares the same lifestyle reported for *K. miliaris* and *A. ojanus* i.e. infaunal shallow digger with byssus thread attached to the sand grains and a locomotion *via* slow creep movements (Clausen, 1958; Evseev *et al.*, 2004a).

It is noteworthy also that there is no information about the statocysts of other Glossoidea in the literature; this important sense organ is completely unknown to the Vesicomidae and Glossidae members. Histological studies of *Vesicomya* species, for example, could provide important information about their statocysts, consequently facilitating the distinction between members of Vesicomidae and Kelliellidae families.

5. Conclusions

Kelliella sp. can be considered a rare species in the southeastern Brazilian coast, from where hundreds of bottom samples were obtained by the Habitats and Ambes Projects, which resulted in just only 27 whole specimens with soft parts. This rarity, however, would be an artifact of methodology, if one assumes that this species occurs in a restricted place, or has a random and aggregated distribution, or live associated to the a specific ecological niche; in such cases, a higher abundance could then be hidden. Despite this, up to now this species can be characterized as a bivalve living exclusively in the continental shelf, a part of the Brazilian coast that is still poorly known regarding its malacofauna. The part of the Brazilian malacofauna composed by smaller, rare, or ecologically specific species are awaiting for being described, how is the case of some groups which were almost unknown in past times (e.g. Aplacophora: Corrêa et al. 2014; Passos et al. 2016), or families, genera and species which have interesting biological traits (e. g.: Passos and Machado 2014; Machado and Passos 2016; Machado et al. 2016; Morton et al. 2016a, b). *Kelliella* sp. represents one more species of these poorly known Brazilian molluscs, revealing that part of marine biodiversity from the Atlantic, and particularly the one outside the intertidal zone, which is probably more rich than it is currently known.

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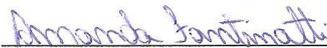
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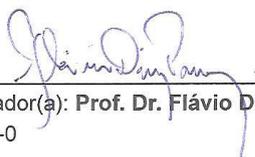
ANEXOS

Declaração

As cópias de artigos de minha autoria ou de minha co-autoria, já publicados ou submetidos para publicação em revistas científicas ou anais de congressos sujeitos a arbitragem, que constam da minha Dissertação/Tese de Mestrado/Doutorado, intitulada **Taxonomy and anatomy of a new Brazilian micromollusc of the genus Kelliella (Bivalvia: Kelliellidae)**, não infringem os dispositivos da Lei n.º 9.610/98, nem o direito autoral de qualquer editora.

Campinas, 03 de maio de 2017.

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DECLARAÇÃO

Em observância ao §5º do Artigo 1º da Informação CCPG-UNICAMP/001/15, referente a Bioética e Biossegurança, declaro que o conteúdo de minha Dissertação de Mestrado, intitulada "*Taxonomy and anatomy of a new Brazilian micromollusc of the genus Kelliella (Bivalvia: Kelliellidae)*", desenvolvida no Programa de Pós-Graduação em Biologia Animal do Instituto de Biologia da Unicamp, não versa sobre pesquisa envolvendo seres humanos, animais ou temas afetos a Biossegurança.

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