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Description of a new hydromedusa from the southwestern Atlantic Ocean, *Bougainvillia pagesi* sp. nov. (Cnidaria, Hydrozoa, Anthoathecata)

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Keywords
Argentina; Bougainvillidae; Brazil; jellyfish; systematics.

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Abstract

A new hydromedusa species of the genus *Bougainvillia* (Anthoathecata; Bougainvillidae) is described. *Bougainvillia pagesi* sp. nov. was collected in shallow coastal waters from southern Brazil (~25–26°S) and northern Argentina (~36–38°S). It differs from other species of the genus mainly by two characters: (i) relatively large size (up to ~20 mm wide and high) and (ii) voluminous folded hanging gonads at perradial walls of the manubrium and extending to the proximal region of the radial canals. Its cnidoma is similar to the other species of the genus, with desmonemes (undischarged capsules: 7.08–10.01 × 2.5–5.59 μm) at marginal tentacles and microbasic euryteles (undischarged capsules: 7.66–11.44 × 2.64–4.43 μm) and smaller (undischarged capsules <2 μm) desmonemes at oral tentacles.

Introduction

Recently, in the southwestern Atlantic Ocean, hundreds of specimens of an unknown hydromedusa were collected in coastal waters and harbors. This species belongs to genus *Bougainvillia*, one of the most speciose among the Anthoathecata (see Bouillon & Boero 2000). This genus was established by Lesson, and its medusae are easy to recognize (Vannucci & Rees 1961; Schuchert 2007). *Bougainvillia* medusae possess four radially placed clusters of solid marginal tentacles, the tentacles of each cluster all alike, with four oral tentacles dichotomously branching, gonads on manubrium, with or without ocelli (Kramp 1961; Bouillon 1999; Bouillon & Boero 2000; Bouillon *et al.* 2004, 2006). The type species is *Bougainvillia macloviana*, first described as *Cyanaea bougainvilli* Lesson, 1830 (Vannucci & Rees 1961).

Vannucci & Rees (1961) revised the genus, recognizing 29 valid species, 20 of them with a known medusa stage. A more recent update by Bouillon & Boero (2000) recognizes 22 valid species. Subsequently, Xu & Huang (2004, 2006) and Xu *et al.* (2007a,b) described four new species, and Denitto *et al.* (2007) promoted a subspecies to species rank. In the World Hydrozoa Database (http://www.marinespecies.org/hydrozoa/) 51 names are listed, 31 considered valid, four of them – namely *Bougainvillia balei* Stechow, 1924, *Bougainvillia crassa* Fraser, 1938, *Bougainvillia inaequalis* Fraser, 1944 and *Bougainvillia meinertiae* Jäderholm, 1923 – only known from polyps. In total, 27 *Bougainvillia* medusae are currently known.

In the present study, a comparison of descriptions of all *Bougainvillia* medusae is made (Table 1), and a new species, *Bougainvillia pagesi* sp. nov., is described.

Material and Methods

A total of 3844 plankton samples were obtained from 25° to 55°S, between 1983 and 2008, using different nets (Biomoc, Bongo, Calvet, Motoda, Multinet, Nackthai, Pairovet or WP-2) with 200–500 μm mesh size. Most of

Table 1. Comparison of main characters of the valid medusae species (Bouillon & Boero 2000; World Hydrozoa Database) of the genus *Bougainvillia*.

	Size (mm)	Peduncle	Basal trunk	Oral tentacles	Shape of tentacular bulbs
B. pagesi sp. nov.	4–18 wide; 5–20 high	Absent	Variable, up to half of total oral tentacle length	Branch 3–5 times	Wide and triangular
B. aberrans (Calder 1993)	1.1 wide; 1.2 high	Absent	Absent	Absent	Epaulette-shaped
B. aurantiaca (Bouillon 1980)	1.9 wide; 1.8 high	Very slight	Very long	Branch 2–3 times	Broad and hemispherical, orange
B. bitentaculata (Uchida, 1925)	1 high; 0.8 wide	Present	Short	Branch only twice	Rounded triangles
B. bougainvillei (Brandt, 1835)	9 high; 8 wide	Short	Short	Branch four times	Heart-shaped
B. britannica (Forbes, 1841)	12 high; 10 wide	Absent	Long	Branch in distal part 4-6 times (unbranched in newly born)	Broadly triangular, about half as wide as intervals, but can be contracted
B. carolinensis (McCrady, 1858)	Up to 4 high	Absent	Long	Branch 2–3 times	Rounded, bean-shaped to triangular
Bougainvillia chenyapingii (Xu, Huang & Guo, 2007)	0.8-2 high and wide	Absent	Short and thick	Branch 3-4 times, 1st branch very long	Nearly kidney-shaped
B. dimorpha (Schuchert 1996)	3-4, exceptionally 6 high; about as wide as high	Shallow peduncle may be present	No data available; apparently almost half length of oral tentacles (Fig. 19b in Schuchert 1996)	3	Triangular to heart shaped
B. frondosa (Mayer, 1900)	2 high	Absent	Long	Branch 2–3 times	Rounded and small
B. fulva (Agassiz & Mayer 1899)	1-14 high and wide	Absent	Short	Branch 2–8 times	Small, roughly rectangular in smaller specimens and tend to be triangular in larger ones
B. involuta (Uchida 1947)	4 high; 4.5 wide	Short	Short	Branch 2–7 times	Crescent shaped in young specimens; very large, sinuous and covering he greater part of the bell margin in large ones

Marginal Tentacles number per bulb	Ocelli	Gonads	Nematocysts	Distribution	Reference
12–18	Linear or crescent-shaped at the base of each tentacle	Folded and hanging, at perradial walls of manubrium extending on the proximal 1/3 of radial canals	Desmonemes at marginal tentacles and smaller desmonemes and microbasic euryteles at the tip of oral tentacles	South Brazilian coastal waters and Buenos Aires Province in Argentine	This study
2 or 3; very short and filiform	Absent	Gonads spent and ova shed.	Desmonemes and heterotrichous microbasic euryteles	Upper bathyal zone off Bermuda	Calder (1993)
2, rarely 3	Absent	As interradial pads	Heteronemes (microbasic euryteles?) and desmonemes	Papua New Guinea, China and the Mediterranean	Bouillon (1980); Schuchert (1996) (for cnidoma); Bouillon *et al.* (2004); Xu *et al.* (2007a);
2	A single between the bases of the two tentacles	4 interradial	Microbasic euryteles on oral tentacles and desmonemes on marginal tentacles	Japan	Kubota & Yamada (1982)
Ca. 12- 15	With ocelli at the base of tentacles	Interradial; sac-like	No data available	Bering Sea	Brandt (1838)
12-17; up to 30 (one in newly released medusae)	Linear ocelli on base of each tentacle	Adradial	Microbasic euryteles and desmonemes	North Atlantic; Indo-Pacific; Mediterranean, and Black Sea	Mayer (1910); Russell (1953); Edwards (1964a); Bouillon *et al.* (2004); Schuchert (2007)
3-12	Round at the base of each tentacle	Interradial	No data available	Atlantic	Vannucci (1951); Kramp (1955); Vannucci & Rees (1961); this study
2-3	Absent	Interradial; globular-like with medusae buds	No data available	Taiwan Strait	Xu *et al.* (2007b)
7-10	Round, one per tentacle situated at the bulbs	Perradial, separated interradially in males and contacted in females	Microbasic euryteles on eggs and desmonemes at the marginal tentacles	New Zealand	Schuchert (1996)
2	Absent	8 adradial, planulae develop on the surface of the manubrium in the females	No data available	Western North and South Atlantic; Taiwan Strait	Mayer (1910); Vannucci & Rees (1961); Bouillon (1999); Xu *et al.* (2007b)
3 (Agassiz & Mayer 1899) or 10-20 (other references)	Small and elongated, located on the base of each tentacle; dark purple	8 distinct adradial pads on manubrium walls	Microbasic eutyteles both at oral and marginal tentacles and desmonemes at marginal tentacles only	Tropical parts of the Indian Ocean and Eastern Pacific	Agassiz & Mayer (1899); Mayer (1910); Vannucci & Rees (1961); Schuchert (1996); For cnidoma: Bouillon (1980)
Up to 60	On the tentacles bases	Interradial, united to each other in large specimens and encircling the manubrium which is represented by a rounded voluminous body	No data available	Central Pacific	Uchida (1947); Vannucci & Rees (1961)

Table 1. (Continued).

	Size (mm)	Peduncle	Basal trunk	Oral tentacles	Shape of tentacular bulbs
Bougainvillia lamellata Xu (Huang & Liu, 2007)	1-2 high; 0.8-1.4 wide	Very developed	~1/3 as long as oral tentacles	Branch twice	Kidney-shaped
B. longistyla (Xu & Huang 2004)	1–1.5 high, 1.2–2 wide	Absent	Very long, about 5/6 as long as oral tentacles	Branch 3–4 times	Kidney-shaped
B. macloviana (Lesson, 1830)	Up to 15 high and 15 wide	Large (absent in newly born medusae)	Very short	Branch 5–7 times	V–shaped
B. multitentaculata (Foerster 1923)	10 wide	Low and broad	Short	Branch 6-7 times	V-shaped
B. muscoides (M. Sars, 1846)	3-5 high and 3.3 wide	Rather shallow peduncle present	Short or of moderate length (1/5 or more of total length)	Branch 4–7 times	Rather large, rounded triangular
B. muscus (Allman, 1863)	1–4 wide and high	Short	Long	Oral tentacles long, divided 1-2 (rarely 3–6) times	Small
B. nana Hartlaub, 1911	0.75–2 wide; 0.65–1.4 high	Absent	?	Branches once or twice (sometimes unbranched)	Rounded
B. niobe (Mayer, 1894)	7 high; 5 wide	Absent	Long	Branch 4 times	Small and oval
B. paraplatygaster (Xu, Huang & Chen, 1991)	c. 10 wide and high	Absent	Short	Branch 6-7 times	Kidney shaped
B. platygaster (Haeckel 1879)	4-12 wide and high	Absent	Extremely short, divided immediately from base	Branch 5-6 times	Triangular, broad
B. principis (Steenstrup, 1850)	8–11 high; 5–11 high	With or without broad shallow peduncle	Very short, divided almost from base	Branch 5-6 times	Linear, wider than interspace, epaulette or kidney-shaped
B. pyramidata (Forbes and Goodsir, 1853)	3–5, up to 8 high and wide	Broad cone-shaped; only fully formed in mature medusae	Short to moderately long	Branch 3–4 times	Oval and rounded

Marginal Tentacles number per bulb	Ocelli	Gonads	Nematocysts	Distribution	Reference
3–4; with rings of nematocysts	Absent	Perradial; lamella-shaped	No data available	Changjiang River Estuary, China	Xu *et al.* (2007a)
4–6	Absent	Perradial, upside of gonads connected to stomach wall, downside extending along oral tentacle basal trunk	No data available	Taiwan Strait	Xu & Huang (2004)
30-65, arranged in a double row (2-3 in newly released)	Adaxial, round or crescent-shaped, on bulbs near bases of tentacles; yellow, red or brownish black	Extending along the stomach lobes on the adradial sides of the peduncle (Vannucci & Rees 1961); on perradial lobes of manubrium and extending along peduncle (Schuchert 1996, 2007)	Microbasic euryteles and desmonemes	Atlantic with a broad Sub-Antarctic distribution; North Sea, New Zealand	Browne & Kramp (1939); Vannucci & Rees (1961); Pagès *et al.* (1992); Schuchert (1996, 2007)
50-60, placed in a zig-zag row	Brown, a the base of each tentacle (Foerster 1923) or at the bulb (Vannucci & Rees 1961)	Perradial?; Interradial,	No data available	British Columbia and Puget Sound	Foerster (1923); Vannucci & Rees (1961); Arai & Brinckmann-Voss (1980)
3–8 (only one in newly released medusae)	Absent	Bulging interradial pads on stomach wall	Desmonemes and large and small microbasic euryteles	Northeastern Atlantic; Chile	Edwards (1964b); Bouillon (1995); Galea (2007); Schuchert (2007)
2-5 (rarely 6–9); long	Round	Interradial reaching perraddii, globular in females, prolonged along perradial sides of peduncle in males	Microbasic euryteles on the eggs	Atlantic, Indo-Pacific, Mediterranean and Arctic	Vannucci & Rees (1961); Bouillon *et al.* (2004); Schuchert (2007); this study
2-3	Two dark-red ocelli at each bulb	Interradial	Microbasic euryteles and desmonemes on the hydroids and microbasic euryteles on the medusae eggs	SE Italy and North Adriatic	Denitto *et al.* (2007)
8	Present, dark	8 adradial gonads	No data available	Atlantic and Mediterranean	Mayer (1910); Kramp (1961); Bouillon *et al.* (2004)
14–17	Linear at the base of the tentacles	Perradial extending along adradial sides of stomach	No data available	Minnan-Taiwan Bank	Xu *et al.* (1991)
7-14; short	Crescent-shaped, with concavity direct outwards	Gonads flat, as interradial pads. Young medusa frequently present medusae buds on the adradial stomach walls	No data available	Tropical and subtropical regions of the Atlantic and Indic Oceans	Mayer (1910); Kramp (1961); Bouillon (1995); Bouillon *et al.* (2004); Schuchert (2007)
Usually 20-30 (up to 40) in a single row (3 in newly born)	Linear or rounded, on the bulb	8 adradial pads; confluent interradially and clearly separated by perradial cleft	No data available	North Atlantic	Mayer (1910); Vannucci & Rees (1961); Edwards (1966); Schuchert (2007)
4–9 (2 in newly released medusae)	Rounded, on bulbs	Adradial; lying along the basal margin of the stomach and its peduncle	Microbasic euryteles and desmonemes	West Coast of British Islands; Chile	Russell 1953; Vannucci & Rees 1961; Edwards 1964b; Galea 2007 (for cnidoma); Schuchert 2007;

Table 1. (Continued).

	Size (mm)	Peduncle	Basal trunk	Oral tentacles	Shape of tentacular bulbs
B. reticulata Xu & Huang 2006	2 high, 1.7 wide	Absent	Very hick and long (~2/3 of total length)	Branch twice	Wide; kidney-shaped
B. rugosa Clarke 1882	1.5	Absent	Absent	Unbranched	No data available on the shape; highly colored
B. superciliaris (L. Agassiz, 1849)	7–12 high (usually up to 10)	Short and broad; conspicuous	Very short	Branch 4-5 times (up to 8 times)	Crescent to heart shaped triangular
B. vervoorti Bouillon 1995	4–10 high and slightly smaller wide	Slight peduncle present	Moderately short	Long oral tentacles branching 5-7 times, not always dichotomous	Rounded triangular to broad U-shape, less than half as wide interradial spaces

the samples were collected by the Instituto Nacional de Investigación y Desarrollo Pesquero (INIDEP). In addition, 813 samples from South Brazil (~25–27°S) were obtained with bottom trawls, using shrimp fishing nets, 6–12 m wide and 1.5–3 cm in mesh size. These collections occurred monthly between late 1997 and 2009. More individuals were obtained from manual sampling (*e.g.* dip nets, snorkeling), and from others fishing gears, such as gill nets. All material was preserved in 4% formalin, usually after being anesthetized with menthol crystals. The nematocysts were identified from fixed medusae and only undischarged capsules were measured; the cnidome nomenclature followed Mariscal (1974).

The type material was deposited at the cnidarian collection of the Museu de Zoologia da Universidade de São Paulo (MZUSP), with additional paratypes deposited at the British Museum of Natural History (NHMUK), the Natural History Museum of Geneva (MHNG INVE), and the University of Salento Hydrozoan Collection (USHC). Most of the rest of the material is stored at the Cnidarian collection of the Zoology Department of the Paraná Federal University and the Medusozoa collection from Estación Costera Nágera (MedusAS), Universidad Nacional de Mar del Plata–INIDEP.

Results

Class Hydrozoa Huxley, 1856
Subclass Anthoathecata Cornelius, 1992
Order Filifera Kühn, 1913
Family Bougainvillidae Lütken, 1850
Genus *Bougainvillia* Lesson, 1836
***Bougainvillia pagesi* sp. nov. (Figs 1 and 2)**

Material examined

826 specimens. Holotype: MZUSP 1480 (Fig. 1), specimen collected on 30 June 2009 with gill nets from Pontal do Paraná, Brazil (25°36′31″S, 48°22′26″W). Paratypes: MZUSP 0903, three specimens collected on 8 August 2003. MZUSP 0902, two specimens collected on 20 September 2003. All of them were sampled with shrimp fishing nets from Guaratuba, Paraná, Brazil (25°54′S, 38°3′W). MHNG INVE 74571, three specimens, NHMUK 2010.24-26, one medusa each and USHC 2010BOU.1, three specimens, all of them sampled by the Evaluation cruise CC 01/06 by INIDEP at Argentina at 7.5 m depth (37°30′S, 57°10′W) in 3 February 2006 with Bongo plankton net 200-μm mesh aperture.

Additional specimens

559 specimens from the south coast of Brazil (25°20′–26°04′S; 48°05′–48°35′W), collected with shrimp fishing nets and manual sampling and deposited at the Cnidarian collection of the Zoology Department of the Paraná Federal University; 252 specimens from the coast near Buenos Aires (Argentina, 36°16′–38°22′ S, 56°26′–57°45′ W), collected with a Bongo net and manual sampling and deposited at Medusozoa collection, Estación Costera Nágera, Universidad Nacional de Mar del Plata – INIDEP.

Marginal Tentacles number per bulb	Ocelli	Gonads	Nematocysts	Distribution	Reference
8–9; club-shaped	Rounded on bulbs, at the base of each tentacle; brown	Adradial; four pairs in the sides of stomach lobes extensions	No data available	Fujian coast, China	Xu & Huang 2006;
3	One at the base of the first and second tentacle only, with no indication of producing ocelli at the basis of the third tentacle	Juvenile animals; no data available on gonads	No data available	North-western Atlantic	Clarke 1882; Mayer 1910; Vannucci & Rees 1961;
Up to 22 (usually 11-15; 5-9 when newly released)	Crescent-shaped, on base of tentacles; reddish brown to black	Interradial, planulae develop *in situ* within capsules	Desmonemes and microbasic euryteles of two size classes	Arctic species,; North Atlantic and Pacific in cold waters	Bigelow 1913; Russell 1953; Edwards 1966; Arai & Brinckmann-Voss 1980; Schuchert 2007;
18-30 (usually 20)	Round, dark red at the base of the tentacle	On interradii of the stomach and extending largely on the perradial lobes (Bouillon 1995); or 4 pairs on adradial sides of basal extensions of manubrium (Schuchert 1996)	Microbasic euryteles and desmonemes	New Zealand	Bouillon 1995; Schuchert 1996

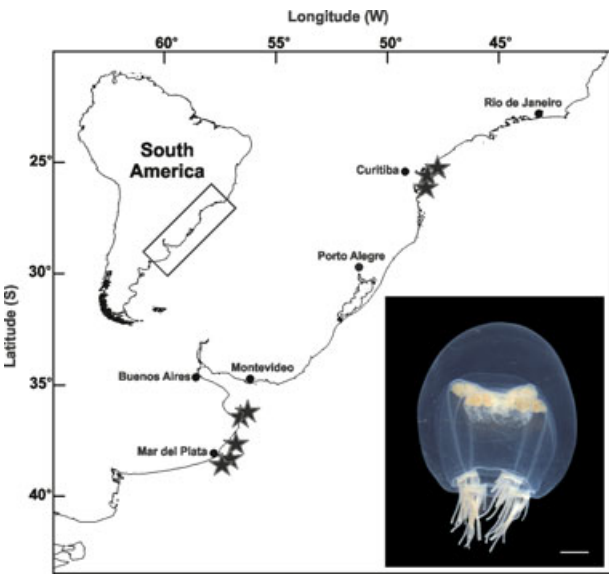

Fig. 1. Collection sites for *Bougainvillia pagesi* sp. nov. (stars). Photo insert is the holotype (MZUSP – 1480). Scale = 2 mm.

Etymology

The species was named in honor of Dr. Francesc Pagès (1962–2007), eminent hydrozoan researcher which gave the first author important assistance and encouragement in the early steps of this study.

Diagnosis

Bougainvillia medusa with globular umbrella and thick mesoglea; folded and voluminous gonads, hanging at perradial walls of the manubrium and along proximal part of the radial canals.

Description (based on several specimens, Figs 1 and 2)

Umbrella globular with round top, 3.3–18 mm wide and 3–20 mm high, usually slightly higher than wide. Mesoglea thick at apical region, representing c. 1/3 (20–47%) of total umbrelar height in preserved material; manubrium quadrate, short, without peduncle; mouth quadratic with slightly crenulated lips; oral tentacles with basal trunk usually short (up to half of total oral tentacles length), arising perradially above mouth rim, dichotomously branching three to five times, distal portion armed with nematocyst clusters; four simple radial canals; four folded hanging gonads, white in live material and very voluminous when developed, extending from perradial walls of the manubrium and along proximal part of radial canals. In a few (n = 3) small medusae sampled (<4 mm), the gonads were less developed, differing from others only by being much less voluminous and not folded; velum narrow; tentacular bulbs triangular and broad, with 7–16 short tentacles, typically 9–14; linear or crescent-shaped ocelli, black or red, located on the adaxial base of each tentacle.

Morphological variations

In four specimens from Brazil (of 565) one radial canal branched dichotomously once in the distal portion. None of the 261 medusa sampled from Argentina was a variant.

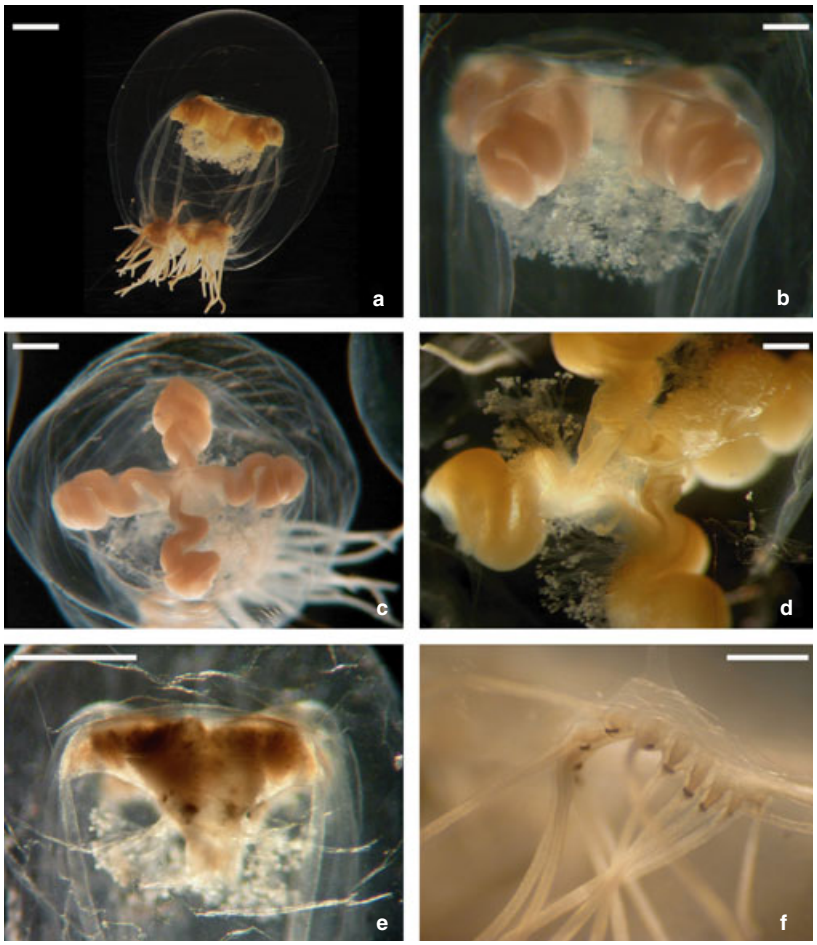

Fig. 2. *Bougainvillia pagesi* sp. nov. (a) Specimen from Argentina with fully developed gonads. (b,c,d). Lateral, aboral and oral views of gonads respectively. (e) Incompletely developed gonads. (f) Detail of marginal bulb and ocelli. Scale bars = 2 mm (a), 1 mm (b, c, d and e) and 0.5 mm (f).

Cnidome

Marginal tentacles – desmonemes, undischarged capsule varying from 2.5 to 5.59 μm wide (mean ± SD = 4.55 ± 0.6, n = 70), and from 7.08 to 10.01 μm high (mean = 8.4 ± 0.83, n = 70). Oral tentacles – microbasic euryteles, undischarged capsules varying from 2.64 to 4.43 μm wide (mean = 3.56 ± 0.56, n = 32) and from 7.66 to 11.44 μm high (mean = 9.48 ± 1.03, n = 32); and small desmonemes with undischarged capsules smaller than 2 μm.

Biological notes

In Brazilian specimens around 5.5% of individuals were parasitized by one or two metacercariae of the genus *Opechona* (Digenea, Lepocreadiidae) and four animals had an unidentified nematode on their mesoglea.

Seasonality

On the Brazilian coast this medusa was collected throughout the year, but 88% of all individuals were caught in August and September (21% and 67%, respectively); this period corresponds to the transition between the austral winter and spring when the water temperature increases and usually is above 20° C. From Argentina the species was only collected during the austral summer (January–March) at temperatures of 19°–21°C.

Distribution

South Brazilian (~25–26°S) and Argentinean (~36–38°S) shallow coastal waters (Fig. 1).

Discussion

The specimens described correspond with the diagnosis of the genus *Bougainvillia* (Kramp 1961; Vannucci & Rees 1961; Bouillon & Boero 2000) and their characters show that it is a new species (Table 1).

The most distinctive character of *Bougainvillia pagesi* sp. nov. is the shape and position of the gonads, which are perradial like in *Bougainvillia dimorpha* Schuchert 1996; *Bougainvillia lamellata* Xu, Huang & Liu, 2007, *Bougainvillia longistyla* Xu & Huang 2004; *Bougainvillia macloviana* (Lesson, 1830) and *Bougainvillia paraplatygaster* Xu, Huang & Chen, 1991. However, none of them presents folded voluminous hanging gonads along the proximal

part of the radial canals as *B. pagesi* sp. nov. (Figs 1 and 2b–d). Moreover, *B. dimorpha* is smaller and has round ocelli; *B. lamellata* is smaller, the oral tentacles branch only twice, it has fewer tentacles and no ocellus; *B. longistyla* has a long basal trunk in the oral tentacles, the bulbs are kidney-shaped with only four to six tentacles each and no ocellus; *B. paraplatygaster* has bulbs that are kidney-shaped and the oral tentacles are branched six to seven times; and *B. macloviana* has a well developed peduncle and 35–65 marginal tentacles arranged in a double row (Table 1). The shape of the ocelli and the tentacular bulbs of *B. pagesi* sp. nov. may resemble those of *Bougainvillia platygaster* (Haeckel, 1879). Both species differ in the shape and position of the gonads. The relatively larger size of *B. pagesi* sp. nov. compared with other *Bougainvillia* medusae is also remarkable. Although *B. macloviana* may reach up to 15 mm, *B. pagesi* sp. nov. is larger, up to 20 mm high (Table 1).

Despite the high number of planktonic samples analyzed (3844) that covered the entire Continental shelf of Argentina, Uruguay, and South Brazil, *B. pagesi* sp. nov. was only collected in three coastal ones and more individuals were obtained with demersal nets, gill nets and manual sampling along the coastal line. This coastal distribution could be the reason why the species did not appear in most plankton samples from the continental shelf. In subtropical waters (Brazil), the species was present throughout the year but it was mostly collected in late winter and early spring when temperatures were higher than 20°C. In temperate waters (Argentina), this medusa occurs only in summer when the temperature was 19–21°C. It was not recorded during the colder seasons. In temperate environments, species with metagenetic life cycles present a marked seasonality. During unfavorable periods they are represented by benthic stages with medusae release occurring in pulses constrained to shorter periods during favorable seasons (*e.g.* Calder 1990; Bavestrello *et al.* 2006). Among the well studied hydroid fauna of the region (see Genzano *et al.* 2009 for a review), no polyp stage could be linked or related to *B. pagesi* sp. nov. medusa. Resting stages could be involved in the life cycle of this species and further studies will be necessary to determine seasonal occurrence patterns, including resting stages, if any.

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Conflicts of Interest

None of the authors have any potential conflicts of interest.

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