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First record of the epiphyte sea anemone *Bunodeopsis pelagica* in the Mexican Atlantic

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Abstract

Bunodeopsis pelagica is one of the few species of sea anemones known to be found in the floating algae of *Sargassum* spp. It has been reported in the North Atlantic, particularly in the Canary Islands and the coast of Jamaica. The present study is the first to report the occurrence of *B. pelagica* in the Mexican Atlantic, found as epiphyte on *Sargassum natans* off Alacranes reef (southern Gulf of Mexico) and in Puerto Morelos reef (Mexican Caribbean), revealing that this species is much more widespread than has been reported. *Bunodeopsis pelagica* is mainly distinguished from other species of *Bunodeopsis* by having simple minute protuberances on its column, while its congeners have larger and much more developed vesicular projections. With the record of *B. pelagica*, the number of known species of actiniarian sea anemones from the Mexican Atlantic increases to 23.

Introduction

Bunodeopsis pelagica (Quoy and Gaimard, 1833) is one of the few known sea anemone species that lives as an epibiont on drifting seaweeds of *Sargassum* spp. (Fisher, 1976). This species was originally described as *Actinia pelagica* in a short paragraph by Quoy and Gaimard (1833), as a very small yellowish form with long, large, pointed, dirty yellow tentacles with brownish spots, and with a characteristic violet ring around the mouth. In 1976, Fisher carried out a taxonomic redescription of this species, providing detailed information on its external and internal anatomy, as well as its cnidae. This species has been reported on *Sargassum* spp. off the coast of Jamaica (Fisher, 1976), but also as a benthic species in the rocky intertidal of the coast of Tenerife, in the Canary Islands, and in Madeira (Ocaña *et al*., 1991; Ocaña and den Hartog, 2002). Although it has been suggested that *B. pelagica* could be found throughout the Caribbean carried by floating *Sargassum* (Ocaña *et al*., 2007), there are no known previous published records of this species in other localities along the Caribbean Sea.

In the present study, we document the novel occurrence of *B. pelagica* in two locations in the Mexican Atlantic, being found on floating mats of *Sargassum natans*: off the coast of the Alacranes reef, in the Campeche Bank, southern Gulf of Mexico, and in the coast of Puerto Morelos reef, in the Mexican Caribbean. This species is taxonomically diagnosed and images of living specimens are provided. In addition, the external taxonomic characteristics that distinguish this species from its congeners are discussed.

Materials and methods

Thirty specimens of *B. pelagica* were collected from fresh pelagic *Sargassum natans* found off the coast of Desterrada Island, in the Alacranes reef (Campeche Bank, southern Gulf of Mexico) (22.52°N, 89.78°W) in June 2016, and five from *S. natans* collected in the coast of Puerto Morelos reef (Mexican Caribbean) (20.84°N, 86.87°W) in August 2020 (Figure 1). Living specimens were photographed, relaxed in 5% $MgCl_2$ seawater solution and then fixed in 10% seawater formalin. Morphological features and internal anatomy was examined following Fisher's (1976) description. Specimens were deposited in the Collection of the Gulf of Mexico and Mexican Caribbean Sea (registration code: YUC-CC-254-11-001309) of Unidad Multidisciplinaria de Docencia e Investigación en Sisal (UMDI-Sisal) at the Universidad Nacional Autónoma de México (UNAM).

Figure 1. Map of the southern Gulf of Mexico and Mexican Caribbean indicating the localities sampled in this study: red star indicates Alacranes coral reef location, blue star indicates Puerto Morelos reef location.

Results

All diagnostic features and body measures observed of the specimens examined agree well with the description of *B. pelagica* by Fisher (1976).

Order ACTINIARIA Hertwig, 1882
Suborder ENTHEMONAE Rodríguez & Daly in Rodríguez *et al.* (2014)
Superfamily METRIDIOIDEA Rodríguez & Daly in Rodríguez *et al.* (2014)
Family BOLOCEROIDIDAE Carlgren, 1924
Bunodeopsis pelagica (Quoy & Gaimard, 1833)
(Figures 2A and B)

Synonymy:
Actinia pelagica Quoy & Gaimard, 1833, pp. 146–147 (original description)
Anemonia pelagica Milne-Edwards, 1857, p. 235
Uncertain genus *pelagica* Quoy & Gaimard: Andres, 1883, pp. 578–579 nomen dubium
Bunodeopsis pelagica (Quoy & Gaimard, 1833): Fisher, 1976, pp. 103–110, 112–118

Short diagnosis: fully expanded oral disc and tentacles 3–7 mm in diameter in living specimens. Oral disc smooth, 2–4 mm in diameter, wider than column, transparent, with the insertions of the mesenteries clearly visible; mouth slit-like and raised, outlined by a thin violet ring (Figure 2A). Margin tentaculate. Tentacles irregularly arranged in 2–4 cycles (12–36 in number), long, slender, tapered, with numerous ridges containing batteries of nematocysts along their entire length; inner cycles of tentacles longer than outer ones, retractile and deciduous due to an endodermal sphincter muscle at their bases. Column cylindrical, widening towards the base, divided in capitulum and scapus. Capitulum smooth, transparent, with insertions of the mesenteries visible; scapus dark brown colour, translucent, with simple minute protuberances mainly on the lower half, arranged in longitudinal rows, creamy yellow in colour (Figure 2B). Cnidom: basitrichs, microbasic *p*-mastigophores and microbasic amastigophores.

Natural history: *Bunodeopsis pelagica* mostly lives on the floating seaweed *Sargassum* spp., although it has also been reported inhabiting on rocky substrate in the intertidal zone (Ocaña *et al.*, 1991). A nudibranch mollusc, which also lives on the sea weed, feeds on *B. pelagica* (Fisher, 1976). This species is associated with endosymbiotic dinoflagellates of family Symbiodiniaceae Fensome, Taylor, Norris, Sarjeant, Wharton & Williams, 1993 (Fisher, 1976).

Distribution: *Bunodeopsis pelagica* has only been reported from the North Atlantic, now including Caribbean Sea, southern Gulf of Mexico and Canary Islands and Madeira (Quoy and Gaimard, 1833; Fisher, 1976; Ocaña *et al.*, 1991; Ocaña and den Hartog, 2002; this study).

Taxonomic remarks: six valid species are currently known within the genus *Bunodeopsis* (Rodríguez *et al.*, 2023a) (Table 1). *Bunodeopsis pelagica* has a violet ring around the mouth (Fisher, 1976; Ocaña *et al.*, 1991), a feature shared with *Bunodeopsis australis* Haddon, 1898 (Haddon, 1898), and similar to the blue ring around the mouth reported for *Bunodeopsis antilliensis* Duerden, 1897 (Cairns *et al.*, 1986).

The main distinguishing characteristic of *B. pelagica* with its congeners lies in the minute protuberances on its scapus, in the lower half of its column, which are only thickened portions of the ectoderm, and are not true vesicles like those of the other members of the genus (Fisher, 1976) (see Figure 2B, Table 1). The vesicles of *B. australis* are of uniform size (Haddon, 1898), whereas those of *B. antilliensis*, *Bunodeopsis globulifera* (Duchassaing, 1850), *Bunodeopsis strumosa* Andrés, 1881 and *Bunodeopsis medusoides* (Fowler, 1888) are of unequal size and degree of development. Furthermore, the coloration of vesicles

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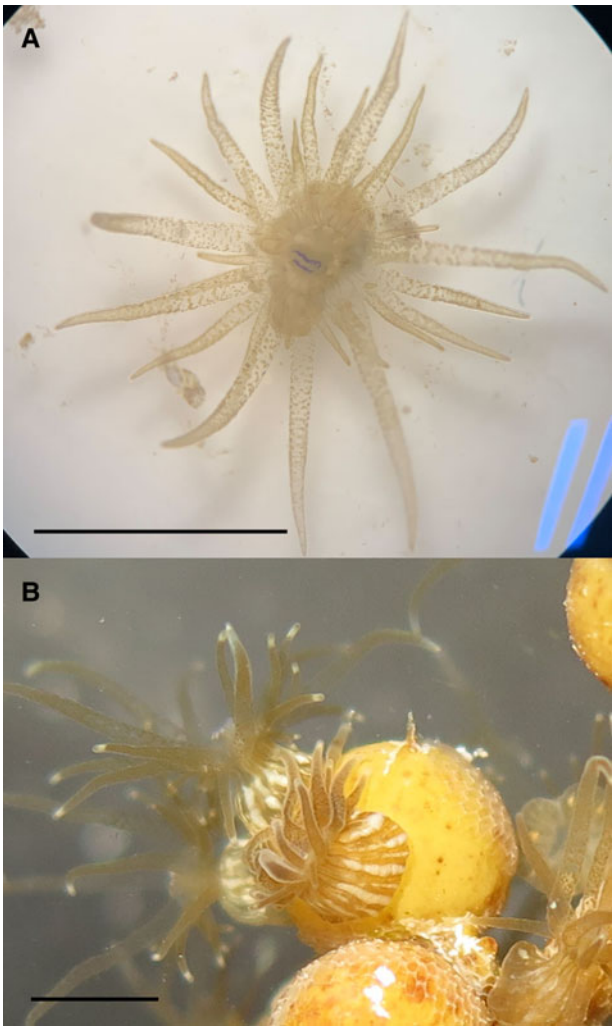

Figure 2. *Bunodeopsis pelagica* (Quoy and Gaimard, 1833): (A) specimen with oral disc and tentacles fully expanded, note the violet ring around the mouth; (B) specimens attached to *Sargassum natans*, note the simple protuberances in the column. Scale bars: 5 mm.

and tentacles also varies between these species (Table 1). In addition, *B. medusoides* is the only species of the genus reported with two siphonoglyphs (Cutress, 1979), while these structures are absent in the other species. Differences in cnidae arrangement and size ranges between species of the genus *Bunodeopsis* are difficult to assess, because different nomenclatures were probably used to classify the various types of cnidae. For example, Fisher (1976) and Carlgren (1952) report basitrichs in the tentacles of *B. pelagica* and *B. strumosa*, respectively, while Cutress (1979) reports microbasic *b*-mastigophores rather than basitrichs for *B. medusoides*, and none of these types of cnidocysts were reported in the tentacles of *B. antilliensis* (González-Muñoz *et al.*, 2012). Similarly, some authors identify cnidocysts as microbasic amastigophores, while others mention them as microbasic *p*-mastigophores (Table 2). Furthermore, the studies by Carlgren (1952), Fisher (1976), Cutress (1979) and Chintiroglou and den Hartog (1995) do not include photographs or drawings of the different types of cnidocysts reported, so a proper comparison is not possible. Moreover, no information is known about the cnidae of *B. australis*. Table 2 summarizes the currently known information on the cnidocysts of the species within the genus *Bunodeopsis*. More studies on the types and size ranges of cnidocysts in all species of the genus *Bunodeopsis* are required in order to establish their differences and their specific characteristics.

Discussion

The seaweed *Sargassum* spp. is known to provide habitat for a diverse community of animals and plants, which in turn support larger migratory species such as tunas, marlins, sharks, and turtles (Pendleton *et al.*, 2014). These algae are carried by currents and normally arrive and accumulate on the coasts, but in low abundances and at irregular intervals (van Tussenbroek *et al.*, 2017). However, since 2011 there has been an unprecedented massive influx of drifting *Sargassum* off the coasts of Caribbean countries, peaking between July and August 2015 (Rodríguez-Martinez *et al.*, 2016; van Tussenbroek *et al.*, 2017).

Some cnidarians are common members of the living invertebrate community that inhabit of drifting *Sargassum* spp., including several species of hydrozoans (e.g. Cunha and Jacobucci, 2010, Cunha *et al.*, 2018; Mendoza-Becerril *et al.*, 2020) and at least three species of sea anemones: *Anemonia sargassensis* Hargitt, 1908, *Bartholomea annulata* (Le Sueur, 1817), and *B. pelagica* (Carlgren and Hedgpeth, 1952; Fisher, 1976).

Although several taxonomic studies have been carried out on sea anemones in the Mexican Atlantic (e.g. González-Muñoz *et al.*, 2012, 2013; De la Cruz-Francisco *et al.*, 2016; De la Cruz-Francisco and González-Muñoz, 2019; Herrera-Bojórquez *et al.*, 2020), the species *B. pelagica* had never been observed. Thus, we hypothesize that the recent encounter of this species could be related to this extraordinary massive arrival of large quantities of *Sargassum* spp. to the coasts of the Caribbean.

The specimens collected in both places in the Mexican Atlantic were found in floating *Sargassum*, which is the usual substrate for this species (Fisher, 1976), although in the Canary Islands it has also been reported as an epibiont of filamentous green algae, as well as on intertidal rocky substrate (Ocaña *et al.*, 1991). Since this species can presumably colonize new biotopes and adapt to benthic life (Ocaña *et al.*, 1991), there is a probability that it can establish itself locally and compete for space and resources with local populations. However, it would be premature to classify this species as potentially invasive, since its native origin is still unknown.

Although only five distributional records of *B. pelagica* are known to date, it can be assumed that its distribution range is linked to the distribution of the *Sargassum* algae, which in turn is dependent on sea currents. This floating marine brown macroalgae is commonly found in the surface waters of the northwestern Gulf of Mexico, the Sargasso Sea and the Caribbean Sea, but has also recently been reported in abundance along northeastern Brazil and western Africa, including the coasts of the Canary Islands and Cape Verde (Franks *et al.*, 2016). Similarly, the distribution of *A. sargassensis*, another species of sea anemone that can be found in *Sargassum* (Fisher, 1976), overlaps greatly with the distribution of this macroalgae, including the Atlantic coast of the northern United States, the Gulf of Mexico and the Caribbean Sea, the northeast coast of Brazil and Cape Verde off the coast of Senegal (Rodríguez *et al.*, 2023b). Therefore, it could be suggested that the distribution of *B. pelagica* is similar to that of *A. sargassensis*, that in both cases it is dependent on the distribution of *Sargassum*, and that the few records in its distribution could be due to the fact that this species has gone overlooked, probably due to its diminutive size. Either way, it is clear that *B. pelagica* is much more widespread than previously reported. This is the third species of the genus *Bunodeopsis* reported in the region, increasing the total number of known actiniarian species from the Mexican Atlantic to 23.

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Table 1. Comparison of some external anatomical characteristics between species of the genus *Bunodeopsis*

Species	Shape and arrangement of columnar structures	Vesicles coloration	Tentacle coloration	Mouth coloration	Siphonoglyphs	Commonness	References
Bunodeopsis pelagica	Simple minute protuberances (not true vesicles), arranged in longitudinal rows	Creamy yellow	Translucent white or pale-brown	Translucent white with a violet ring around mouth	Absent	Uncommon	Fisher (1976); Ocaña and den Hartog (2002)
Bunodeopsis antilliensis	Sessile or stalked globular vesicles of unequal size (1.7 ± 0.2 mm in diameter) and development, simple or compound	Greenish-brown or whitish, sometimes with light-blue flashes	Translucent white	Translucent white, occasionally with blue ring around mouth	Absent	Common	Duerden (1897); Cairns *et al.* (1986); Day (1994); González-Muñoz *et al.* (2012)
Bunodeopsis globulifera	Sessile or stalked globular to digitiform vesicles of unequal size (0.7 ± 0.1 mm in diameter) and development, sometimes clavate and tuberculate	Brown or white, sometimes with blue-green streaks	Translucent white	Translucent white	Absent	Common	Seaton (1981); Day (1994)
Bunodeopsis strumosa	Sessile or stalked bubble-like vesicles of unequal size (no data available on vesicle size) and development, sometimes clavate and tuberculate	Brownish-green with golden yellow	Translucent greenish mottling with brownish stripes	Translucent white	Absent	Uncommon	Chintiroglou and den Hartog (1995); Ocaña and den Hartog (2002); Çinar *et al.* (2014)
Bunodeopsis medusoides	Sessile or stalked sub-spherical to ovoid vesicles of unequal size (≈0.5 mm in diameter) and development, smallest simple or stellate, largest papillose	Light-grey to white, largest green to brownish-green	Translucent white with slight tint of greenish-brown	Translucent white	Two	Common	Cutress (1979)
Bunodeopsis australis	Sessile vesicles of equal size (no data available on vesicle size), arranged in a single row	Yellowish tipped with violet	Translucent pale-brown with madder-brown marks on the basal portion of two first cycles	Translucent white, lips violet	Absent	Uncommon	Haddon (1898)

Table 2. Cnidae comparison between species of genus *Bunodeopsis*

		(Fisher, 1976)	(González-Muñoz *et al.*, 2012)	(Carlgren, 1952)	(Chintiroglou and den Hartog, 1995)	(Cutress, 1979)
Tissue type	Cnidae type	*B. pelagica*	*B. antilliensis*	*B. globulifera*	*B. strumosa*	*B. medusoides*
Tentacles	Basitrics	8–9 × 2	–	–	9.0–14.0 × 1.5–2.2	–
	Microbasis *b*-mastigophores	–	–	–	–	13 × 2–3
	Microbasic amastigophores	19–28 × 6	–	26.8–35 × 5.6	–	–
	Microbasic amastigophores	28–32 × 4	–	–	31.0–40.5 × 5.5–7.0	–
	Microbasic *p*-mastigophores	–	7.61–21.8 × 1.92–4.11	–	8.5–15.5 × 2.0–2.7	10 × 3
	Microbasic *p*-mastigophores	–	20.66–40 × 3.29–8.01	–	29.0–39.0 × 3.5–4.0	28–37 × 3.5–4
	Spirocysts	–	11–30 × 2.27–7	–	18.5–30.5 × 3.5–6.0	15–33 × 2.5–4.5
Column	Basitrics	8–9 × 2	6–12.24 × 2–3	–	10.7–14.2 × 1.8–2.2	–
	Microbasis *b*-mastigophores	–	–	–	–	10 × 2
	Microbasic amastigophores	19–21 × 4.5	–	28.2–42.3 × 5–6	–	–
	Microbasic amastigophores	24–28 × 4	–	19.7–28.2 × 2.8–3	30.9–44.9 × 5.5–7.5	–
	Microbasic amastigophores			–		
	Microbasic *p*-mastigophores	5 × 3	13–37.95 × 2.37–5.87	–	8.1–9.8 × 2.2–2.7	12 × 3
	Microbasic *p*-mastigophores	–	26–45.93 × 5.32–9	–	18.0–27–0 × 3.0–4.0	23–27 × 4–4.5
	Macrobasic *p*-mastigophores	–	–	–	–	23–24 × 4–4.5
Actinopharynx	Basitrics	–	8–18.66 × 1.67–3	14.1–24 × 2.8–3.5	–	–
	Microbasic amastigophores	19–21 × 4–5	–	21.1–28.2 × 4.2–5	–	–
	Microbasic *p*-mastigophores	5 × 3	16.56–36 × 2.57–6	–	18.7–26.7 × 3.6–4.5	22–30 × 4
	Microbasic *p*-mastigophores	–		–	8.9–11.6 × 2.0–2.7	–
Filaments	Basitrics	8–9 × 2	–	–	8.5–9.8 × 1.6–1.8	–
	Microbasis *b*-mastigophores	–	–	–	–	10–13 × 2
	Microbasic amastigophores	21 × 5	–	–	–	–
	Microbasic amastigophores	19–23 × 4	–	–	–	–
	Microbasic amastigophores	28–30 × 4	–	–	–	–
	Microbasic *p*-mastigophores	5 × 3	–	–	5.3–7.1 × 2.7–3.6	5 × 3
	Microbasic *p*-mastigophores	–	–	7–10 × 2.8–3.5	8.5–10.7 × 2.2–2.7	10 × 2
	Microbasic *p*-mastigophores	–	22.21–37 × 3.29–5	24–31.7 × 4.2	22.0–28.0 × 3.0–5.5	22–30 × 4–5
Pedal disc	Microbasic amastigophores	20 × 4	–	–	–	–
	Microbasic *p*-mastigophores	–	–	–	–	12–15 × 3–3.5

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Author's contribution. R.G.-M., J.S.-R., N.S. and J.L.T.-M. collected the specimens and devised the idea for the present study. R.G.-M., J.L.T.-M. and F.H.A. examined specimens and made taxonomic identification of the species. R.G.-M. and F.H.A. wrote the manuscript with input from all authors.

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Conflict of interest. The authors declare none.

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