NOTE

Two new records of sea anemones (Cnidaria, Anthozoa, Actiniaria) from the Eastern Pacific coast of El Salvador

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ABSTRACT. Two species of the genus *Actinostella* Duchassaing, 1850 are documented for the first time on the coasts of El Salvador: *A. bradleyi* (Verrill, 1869) and *A. californica* (McMurrich, 1893). Both species are briefly described, and images of live specimens showing their main external features are provided, as well as images of histological sections showing some taxonomic characteristics of their internal anatomy. These two species are distinguished from each other primarily by the number of tentacles, the number of mesentery pairs, the arrangement of gametogenic tissue, and some differences in their cnidom. The record of these two species in El Salvador increases the number of sea anemones recorded for the country to 12. Additionally, an updated list of sea anemone species documented in El Salvador is provided.

Key words: Actiniidae, *Actinostella bradleyi*, *Actinostella californica*, marginal ruff, benthic intertidal fauna.

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Dos nuevos registros de anémonas de mar (Cnidaria, Anthozoa, Actiniaria) en la costa del Pacífico Oriental de El Salvador

RESUMEN. Se documentan por primera vez en las costas de El Salvador dos especies del Género *Actinostella* Duchassaing, 1850: *A. bradleyi* (Verrill, 1869) y *A. californica* (McMurrich, 1893). Se describen brevemente ambas especies y se proporcionan imágenes de ejemplares vivos que muestran sus principales características externas, así como imágenes de cortes histológicos que muestran algunas características taxonómicas de su anatomía interna. Estas dos especies se distinguen entre sí principalmente por el número de tentáculos, el número de pares de mesenterios, la disposición del tejido gametogénico y algunas diferencias en su cnidoma. Con el registro de estas dos especies en El Salvador se eleva a 12 el número de anémonas de mar registradas para el país. Adicionalmente, se proporciona una lista actualizada de las especies de anémonas de mar documentadas en El Salvador.

Palabras clave: Actiniidae, *Actinostella bradleyi*, *Actinostella californica*, collar marginal, fauna bentónica intermareal.

The cnidarian animals commonly known as sea anemones (order Actiniaria) constitute one of the groups of marine invertebrates that frequently form part of benthic communities in many marine ecosystems (Daly et al. 2008). They are common and probably more diverse in intertidal coastal zones associated with rocky and reef substrates (González-Muñoz et al. 2016). In a recently published study, Ramírez-Orellana et al. (2024) describe the first record of three sea anemone species in the coastal areas of El Salvador. Additionally, they provide a taxonomic list that compiles the eleven known sea anemones for the country, of which ten are identified to the species level and one to the genus level (Barraza 2014), specifically from the genus *Phyllactis* Milne-Edwards and Haime, 1851, which has been synonymized with *Actinostella* Duchassaing, 1850 (Häussermann 2003; Barragán et al. 2024). Three species of *Actinostella* have been reported in the tropical American Pacific region: *Actinostella bradleyi* (Verrill, 1869), *Actinostella ornata* (Verrill, 1869), and *Actinostella californica* (McMurrich, 1893). However, the taxonomic history of Pacific *Actinostella* species is complex, and the information on characteristics to distinguish between these species is confusing. Nevertheless, Barragán et al. (2024) recently conducted a taxonomic review of *Actinostella* with species from both the western Atlantic and tropical eastern Pacific, concluding that there are only two valid species of this genus in the coastal waters of the tropical eastern Pacific region: *A. bradleyi* and *A. californica*. Both species have been documented on the coasts of the Baja California Peninsula, Mexico, and the Pacific coast of Panama (Barragán et al. 2024). According to Barragán et al. (2024), *A. bradleyi* and *A. californica* can be differentiated by various features of their external and internal anatomy, such as the number of tentacles, the number and arrangement of mesentery pairs, the arrangement of gametogenic tissue in the mesenteries, and some differences in their cnidom. In the present study, we documented the first record of the species *A. bradleyi* and *A. californica* on Salvadoran coast. Each species was briefly described based on observations made on specimens from Punta Amapala, in the southern coast of El Salvador, as well as from Los Cóbanos, a Natural Protected Area in the western Salvadoran coast. Additionally, we provided images of the live specimens and main features of their internal anatomy. Moreover, we updated the taxonomic list of previous sea anemone records of El Salvador, which now includes 12 known species for the country.

Thirteen specimens of two species of sea anemones were collected from the intertidal rocky zone of Punta Amapala (13° 09′ 14.3″ N, 87° 55′ 20″ W), municipality of Conchagua, department of La Unión, as well as from Los Cóbanos Natural Protected Area (13° 31′ 37.51″ N, 89° 48′ 35.32″ W), municipality of Acajutla, department of Sonsonate, El Salvador (Figure 1). The collection was done manually using a hammer and chisel. Subsequently, the specimens were transferred to the laboratory where they were anesthetized in a 5% $MgCl_2$ solution in seawater and subsequently fixed with 5% formalin in seawater. Measurements of the oral disc, column, and pedal disc were recorded from live specimens. To examine the internal anatomy, fragments from two specimens of each of the two species were selected, dehydrated, and embedded in paraffin for histological sectioning. Transverse and longitudinal sections of 6-10 µm in thickness were made and stained with hematoxylin and eosin following the procedure of Estrada-Flores et al. (1982). To examine the types of cnidocysts in each species, small tissue portions (approximately 2 mm in diameter) were taken from the tentacles, marginal ruff, column, pharynx, and mesenterial filaments of two specimens of each species. Squash preparations of tissues were made on slides to be observed under a Zeiss-Axiolab light microscope at 1,000x magnification with immersion oil (Häussermann 2004). The identification of the types of cnidocysts followed the terminology described by Gusmão et al. (2018). Since the types and sizes of cnidocysts of these species have been recently documented and illustrated by Barragán et al. (2024), only the type of cnidocyst observed in the specimens exam-

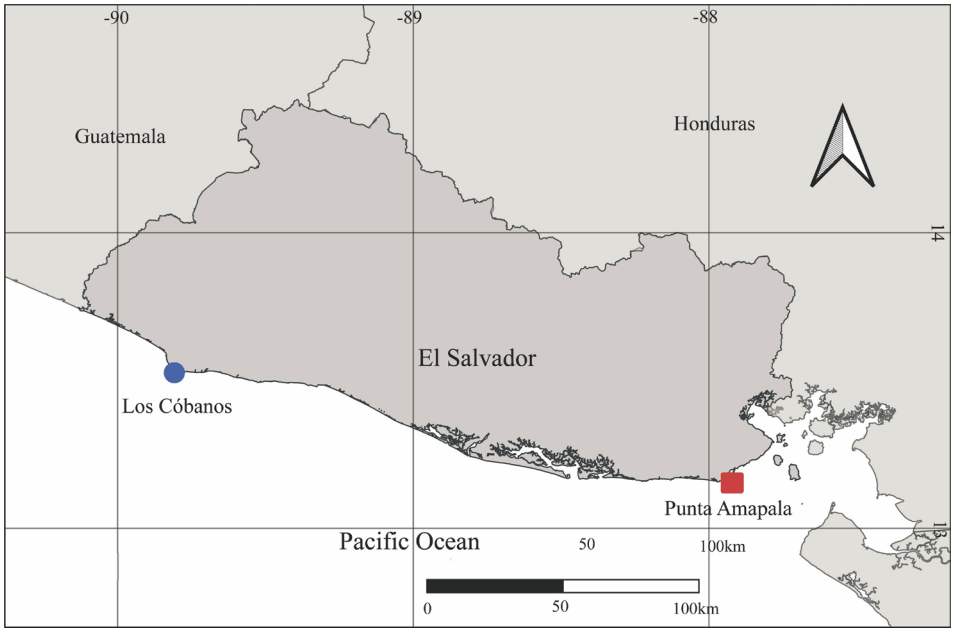

Figure 1. Map indicating localities studied along the coast of El Salvador.

ined was mentioned. Specimens were deposited in the scientific collection of aquatic invertebrates at the Institute of Marine Sciences and Limnology (ICMARES), Universidad de El Salvador. We followed the taxonomic classification of Rodríguez et al. (2014). The following description of each species is based on the examined specimens.

Order Actiniaria Hertwig, 1882
Suborder Enthemonae Rodríguez and Daly, 2014, in Rodríguez et al. (2014)
Superfamily Actinioidea Rafinesque, 1815
Family Actiniidae Rafinesque, 1815
Genus *Actinostella* Duchassaing, 1850

***Actinostella bradleyi* (Verrill, 1869)**
(Figure 2 A-D)

Asteractis bradleyi Verrill, 1869.
Phyllactis bradleyi (Verrill, 1869): Stephenson 1922.
Non *Phyllactis bradleyi* (Verrill, 1869): Carlgren 1951.
Actinostella bradleyi (Verrill, 1869): Häussermann 2003.
Actinostella californica (McMurrich, 1893): Barragán et al. 2019 pro parte.

Material examined

Five specimens (ICMARES-UES-CI:19-23), Punta Amapala (13° 09′ 14.3″ N, 087° 55′ 20″ W), municipality of Conchagua, 1 m depth, June 15 2015, Col. Adriana Ramírez-Orellana; four specimens (ICMARES-UES-CI:27-30), Los Cóbanos (13° 31′ 37.51″ N, 089° 48′ 35.32″ W), municipality of Acajutla, 1 m depth, July 3 2015, Col. Adriana Ramírez-Orellana.

Description

Oral disc 10 to 12 mm in diameter, dark red with whitish spots towards the bases of the innermost tentacles (Figure 2 A). Marginal ruff brown, with radial rows of dark green or olive vesicles (Figure 2 A and 2 B). Column to 27 mm in diameter at its middle part, and to 30 mm in height, with 96 longitudinal rows of verrucae in the distal

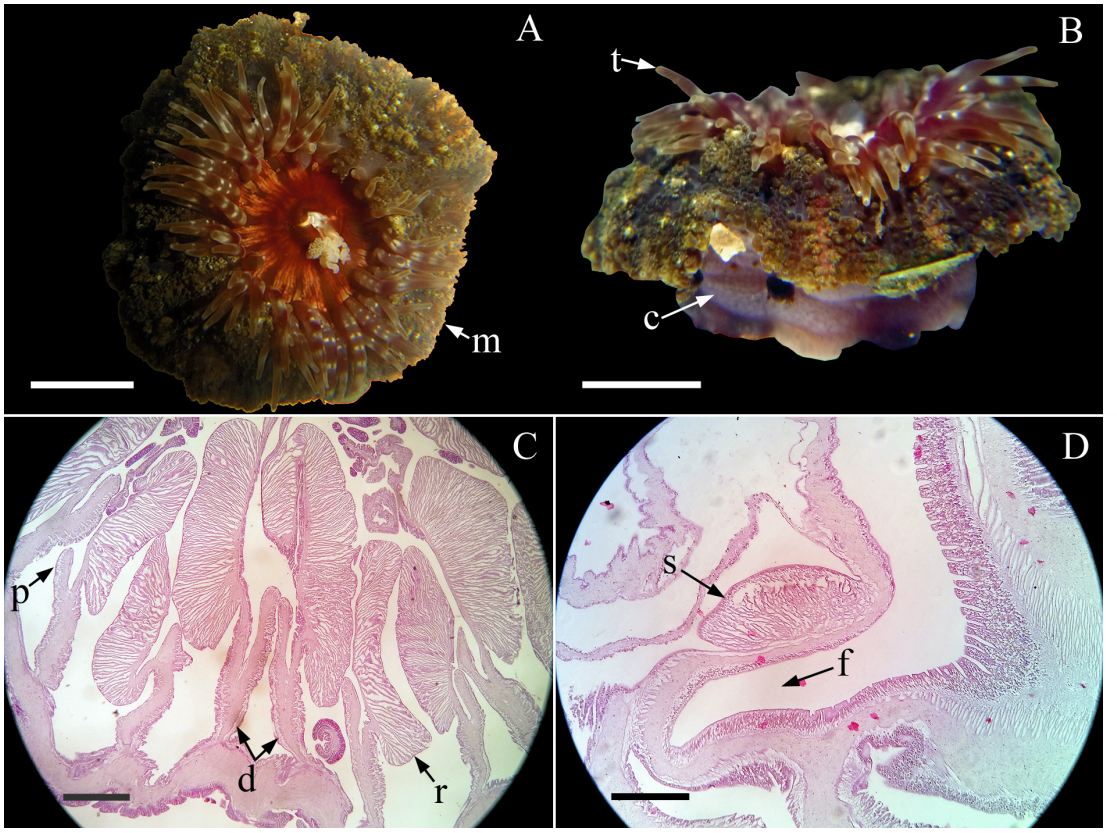

Figure 2. *Actinostella bradleyi*. A) Oral disc view. B) Lateral view. C) Cross-section through upper column, detail of mesenterial muscles. D) Longitudinal section through upper column, detail of the marginal sphincter muscle. Abbreviatures: c = column, d = directive mesenteries, f = fosse, m = marginal ruff, p = parietobasilar muscle, r = retractor muscle, s = marginal sphincter muscle, t = tentacle. Scale bars: A, B = 10 mm, C, D = 200 μm.

part, in each endo- and exocoel; column pale pink (Figure 2 B), with darker violet verrucae. Fossa deep. Pedal disc to 25 mm in diameter, pale pink, translucent. Tentacles arranged hexamerously in 5 cycles (96 in number), smooth, simple, relatively short, conical, and pointed, about 15 mm in length, reddish to greenish, with circular spots on the oral surface and almost throughout their length (Figure 2 A and 2 B). Forty-eight pairs of mesenteries arranged hexamerously in four cycles, with all cycles perfect in the distal part. Two pairs of directive mesenteries attached to two well-developed siphonoglyphs. Retractor muscles strong and restricted; parietobasilar muscles well-developed, with long free mesogleal lamellae (Figure 2 C). Gametogenic tissue in the strongest mesenteries of all cycles, including the directives; gonochoric. Basilar muscles well-developed. Marginal sphincter muscle endodermal and circumscribed (Figure 2 D). Longitudinal muscles of the tentacles ectodermal. Zooxanthellae mainly in the marginal ruff and tentacles.

Cnidom

Basitrichs (all tissues), basitrichs S (column and filaments), *b*-mastigophores (filaments), *p*-mastigophores A (pharynx and filaments), *p*-mastigophores B1 (filaments), and spirocysts (tentacles). For further information on cnidae see Barragán et al. (2024).

Remarks

According to Barragán et al. (2024), *A. bradleyi* is distinguished from its congeners by having 96 tentacles arranged in five cycles, and four cycles of perfect and fertile mesenteries, as well as the presence of *p*-mastigophores A in the marginal ruff and column. The characteristics of specimens reviewed were consistent with the description of *A. bradleyi* provided by Barragán et al. (2024), except that we did not find *p*-mastigophores A on the column or marginal ruff. The absence of *p*-mastigophores A in the column and marginal ruff is likely due to the low abundance of this type of cnidocyst in these tissues. Although it lives sympatrically with *A. californica*, these two congeneric species are easily distinguishable since *A. californica* has up to 48 tentacles arranged in four cycles.

Natural history and distribution

This species inhabits the intertidal zone, attached to rocky substrates and often found in sand-covered crevices. In El Salvador, it was found at depths of less than 1 m, although in Panama it has been reported at depths between 3 to 10 m (Barragán et al. 2024). Like all species of *Actinostella*, *A. bradleyi* hosts symbiotic photosynthetic zooxanthellae, mainly in the marginal ruff (Barragán et al. 2024), providing anemones with an additional source of energy. *Actinostella bradleyi* has been reported on the Pacific coast in Panama and Mexico (Barragán et al. 2024), but this is the first record for El Salvador.

***Actinostella californica* (McMurrich, 1893)**

(Figure 3 A-D)

Oulactis californica McMurrich, 1893.
Non *Asteractis concinnata* (Drayton in Dana, 1846): Pax 1912.
Phyllactis californica (McMurrich, 1893): Stephenson 1922.
(?)*Phyllactis bradleyi* (Verrill, 1869): Carlgren 1951.
(?)*Phyllactis concinnata* (Drayon in Dana, 1846): Carlgren 1951.
Actinostella californica (McMurrich, 1893): Häussermann 2003.
Actinostella californica (McMurrich, 1893): Barragán et al. 2019.
Phyllactis sp. Barraza 2014.

Material examined

Two specimens (ICMARES-UES-CI:2-3), Punta Amapala (13° 09′ 14.3″ N, 087° 55′ 0″ W), municipality of Conchagua, 1 m depth, June 15 2015, Col. Adriana Ramírez-Orellana; two specimens (ICMARES-UES-CI:4-5), Los Cóbanos (13° 31′ 37.51″ N, 089° 48′ 35.32″ W), municipality of Acajutla, 1 m depth, July 3 2015, Col. Adriana Ramírez-Orellana.

Description

Oral disc to 25 mm in diameter, pale beige. Marginal ruff dark-brown or dark-green (Figure 3 A). Column to 28 mm in diameter at its middle part, and to 34 mm in height, with 48 longitudinal rows of verrucae in the distal part, in each endo- and exocoel; column pinkish white, with pale verrucae (Figure 3 B). Fosse deep. Pedal disc to 30 mm in diameter, pinkish white. Tentacles arranged hexamerously in four cycles (48 in number), smooth, simple, relatively short, conical, and pointed, about 25 mm in length, beige, translucent, with circular spots on the oral surface (Figure 3 A). Twenty-four pairs of mesenteries arranged hexamerously in three cycles, with the two first cycles perfect and the third imperfect. Two pairs of directive mesenteries attached to two well-developed siphonoglyphs. Retractor muscles strong and restricted; parietobasilar muscles well-developed, with long free mesogleal lamellae (Figure 3 C). Gametogenic tissue in the strongest mesenteries of all cycles (Figure 3D), including the directives; gonochoric. Basilar muscles well-developed. Marginal sphincter muscle endodermal and circumscribed. Longitudinal muscles of the tentacles ectodermal. Zooxanthellae mainly in the marginal ruff and tentacles.

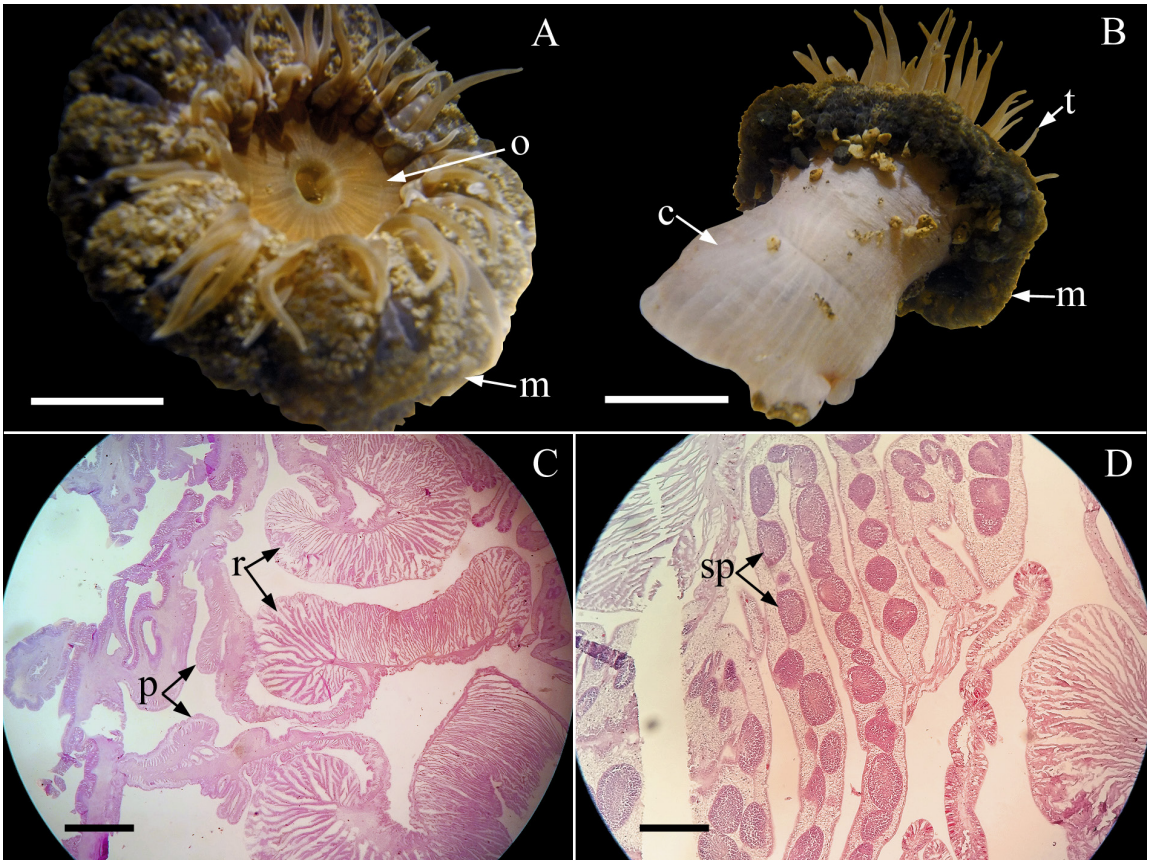

Figure 3. *Actinostella californica*. A) Oral disc view. B) Lateral view. C) Cross-section through upper column, detail of mesenterial muscles. D) Cross-section through column, detail of spermatic cysts. Abbreviatures: c = column, m = marginal ruff, o = oral disc, p = parietobasilar muscle, r = retractor muscle, sp = spermatic cysts, t = tentacle. Scale bars: A, B = 10 mm, C, D = 200 µm.

Cnidom

Basitrichs (all tissues), basitrichs S (column and filamets), *b*-mastigophores (filaments), *p*-mastigophores A (pharynx and filaments), *p*-mastigophores B1 (filaments), and spirocysts (tentacles). For further information on cnidae see Barragán et al. (2024).

Remarks

Actinostella californica is distinguished from *A. bradleyi* by having only 48 tentacles and 24 pairs of mesenteries, whereas *A. bradleyi* has 96 tentacles and 48 pairs of mesenteries. According to Barragán et al. (2024), one characteristic that distinguishes *A. californica* from *A. bradleyi* is that the former has three cycles of mesenteries, with the first two being perfect and the third imperfect, whereas in the latter, all mesenteric cycles are perfect in the distal part of the body. However, it is worth noting that in most species of the genus *Actinostella*, all mesenteric cycles can appear perfect if dissections are made in the most distal part of the column, just below the level of the marginal ruff (Durán et al. under review). Therefore, this characteristic may be of questionable taxonomic utility. Another distinguishing feature of *A. californica* is that it presents only basitrichs in the marginal ruff and the column (Barragán et al. 2024). In his study on the

marine invertebrates of El Salvador, Barraza (2014) includes a photograph of a sea anemone with a marginal ruff, which he identifies as *Phyllactis* sp., a genus that was synonymized with *Actinostella* (Häussermann 2003; Barragán et al. 2024). The anemone in the photograph has around 48 tentacles, leading us to assume that it belongs to the species *A. californica*.

Natural history and distribution

This species inhabits the intertidal zone, attached to rocky substrates within sandy crevices at a depth of less than 1 m. *Actinostella californica* has been reported on the Pacific coast in Panama and Mexico (Barragán et al. 2024), but this is the first record for El Salvador.

The new records of *A. bradleyi* and *A. californica* in El Salvador are geographically positioned between the two previously documented occurrences for these species. The closest previous record to the north is on the Baja California Peninsula, Mexico, approximately 2,300 km away in a straight line, while to the south it is on the Panamanian coast, about 1,070 km distant in a straight line (Barragán et al. 2024). Therefore, both *Actinostella* species likely have a contiguous distribution range spanning from northern Mexico to Panama in the eastern tropical Pacific. These new records increase the documented number of sea anemone species in El Salvador to 12 (Table 1). However, these do not encompass all sea anemone species found in the country. We have also observed several other anemones of the genus *Anthopleura* that remain unidentified at the species level but are likely new records (Ramírez-Orellana 2017). Similarly, we have observed anemones of the genus *Nemanthus* on black corals of the species *Myriopathes pana-*

Table 1. Current list of sea anemone species from El Salvador. New records in bold. References: 1: Torrey (1906). 2: Carlgren (1949). 3: Häussermann (2003). 4: Daly (2004). 5: Barraza (2008). 6: Barraza (2014). 7: Ramírez-Orellana et al. (2024). 8: this study.

	Species	Localities	References
1	***Actinostella bradleyi* (Verrill, 1869)**	Punta Amapala (Conchagua), Los Cóbanos (Acajutla)	8
2	***Actinostella californica* (McMurrich, 1893)**	Punta Amapala (Conchagua), Los Cóbanos (Acajutla), La Libertad	6, 8
3	*Anthopleura dowii* Verrill, 1869	Los Cóbanos (Acajutla)	4
4	*Anthopleura mariscali* Daly and Fautin, 2004	Punta Amapala (Conchagua)	7
5	*Anthopleura nigrescens* (Verrill, 1928)	Punta Amapala (Conchagua), Los Cóbanos (Acajutla)	7
6	*Anthopleura xanthogrammica* (Brandt, 1835)	Los Cóbanos (Acajutla)	1
7	*Bunodosoma californicum* Carlgren, 1951	Los Cóbanos (Acajutla)	3, 4
8	*Bunodosoma grande* (Verrill, 1869)	Los Cóbanos (Acajutla)	6
9	*Phymactis papillosa* (Lesson, 1830)	San Salvador	2
10	*Exaiptasia diaphana* (Rapp, 1829)	Punta Amapala (Conchagua), Los Cóbanos (Acajutla)	7
11	*Telmatactis panamensis* (Verrill, 1869)	Punta Amapala (Conchagua), Los Cóbanos (Acajutla)	6, 7
12	*Metridium farcimen* (Brandt, 1835)	East off Meanguera Island	5

mensis (Verrill, 1869), at depths of 30-40 m, which we suspect belong to the species *Nemanthus californicus* Carlgren, 1940 (Segovia 2023), previously reported in nearby locations in Costa Rica (Excoffon et al. 2009). The identification and recording of sea anemone species in El Salvador are of great importance, not only to complete inventories of the local marine fauna but also because these species play significant roles in the ecological balance of local ecosystems (Daly et al. 2008). Additionally, there is a growing global interest in these animals due to the secondary metabolites they produce, such as toxic compounds (e.g. Sánchez-Rodríguez and Cruz-Vázquez 2006) and UV light protectors (e.g. Arbeola et al. 2010). Thus, we aim for these studies on the species richness of anemones in the country to serve as a foundation for future research in ecological, toxicological, and biochemical fields.

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Author contributions

Adriana Ramírez-Orellana: conceptualization; methodology; investigation; data curation; writing-original draft. Johanna Segovia: conceptualization; methodology, investigation; resources. Fabián H. Acuña: conceptualization; methodology; data curation. Agustín Garese: conceptualization; methodology; data curation. Ricardo González-Muñoz: conceptualization; methodology; data curation; writing-original draft.

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