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Out of the depths: new records of the sea anemone *Oulactis coliumensis* (Riemann-Zürneck & Gallardo, 1990) in shallow waters from northern Chile and Peru

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Abstract

New *in situ* records of the sublittoral sea anemone *Oulactis coliumensis* (Riemann-Zürneck & Gallardo, 1990) are provided from different localities of northern Chile and Peru. Specimens were generally observed buried in shallow soft bottoms (3–25 m depth), near port cities and in areas with a high organic load. This is the first report of the species outside its type locality (off the Bay of Coliumo, Chile; ~36°S), extending its range of distribution to lower latitudes.

Introduction

About half of the sea anemones described from Chile and Peru were discovered in the near-shore sublittoral (Häussermann, 2006), yet most of them have barely been reported ever since their original description. *In situ* records are even more scarce and, although there is type material for some of these species, the condition of their physiognomy prevents the determination of all the traits that are currently used for a complete characterization of a new taxon. This is especially pertinent in a global context of ocean acidification, where the distribution of species is deemed to change (Suggett *et al.*, 2012; Quattrini *et al.*, 2020), and studies on the physiological response of sea anemones are still mainly focused on intertidal taxa.

Oulactis coliumensis (= *Saccactis coliumensis* Riemann-Zürneck & Gallardo, 1990) was discovered off the Bay of Coliumo, Chile (36°30′S 73°00′W), around 50 m depth. It was first collected buried in hypoxic, eutrophicated coastal muds, which was expressly noted by the authors as a remarkable example of the anaerobic capacity of sea anemones. About a decade later, it was found again by Häussermann (2003) in the same area, but dredging at 20 m depth. Further notes on living specimens complemented the observation, and even though some traits were slightly different from the preserved individuals used by Riemann-Zürneck & Gallardo (1990) (e.g. colouration and position of acrorhagi), its distinction from the larger, mostly intertidal congeneric species *Oulactis concinnata* was well established at this point. The present study adds new evidence of how ecologically different these two species really are, focusing on dense populations of *O. coliumensis* from shallow subtidal waters. This is the first published record of the species outside its type locality, notably extending its range of distribution to much lower latitudes.

Methods

Although fragmentary reports of an *Oulactis*-like species go back to the late 1990s, it was not until 2008 that, as part of the Marine Coastal Biodiversity Project of the *Instituto del Mar del Peru* (IMARPE), the first individuals of this unconfirmed species were collected near Ica (14° 19′29″S 76°08′10″W). Years later, new occurrence records began to spread off Callao Bay (Peru), mainly around San Lorenzo Island (~12°04′33″S 77°12′52″W). While some specimens were found below 15 m depth, the majority appeared in much shallow waters. Some later records consolidated the distribution in Peru, discovering new patchy aggregations of the species in Paracas (13°49′46″S 76°18′08″W), and the Chincha Islands (13°38′55″S 76°24′06″W) (Figure 1; Supplementary Table S1).

In Chile, the main recent report of this sublittoral anemone came from a baseline study for a desalination plant near Tocopilla (22°03′54″S 70°11′55″W) (Rubio *et al.*, 2015). Hundreds of specimens were recorded at that time buried in very fine sand, at about 20 m depth, only exposing their tentacular crown and marginal ruff above the seabed. The population remained stable in successive monitoring and from which a total of eight large specimens were collected in February 2021; five destined to morphological examinations (fixing them in 10% formalin) and three were preserved in 95% alcohol for future genetic analyses. Voucher specimens were deposited at the Scientific Collection of IMARPE (IMARPE 06-000001, 06-000002, 06-000003,

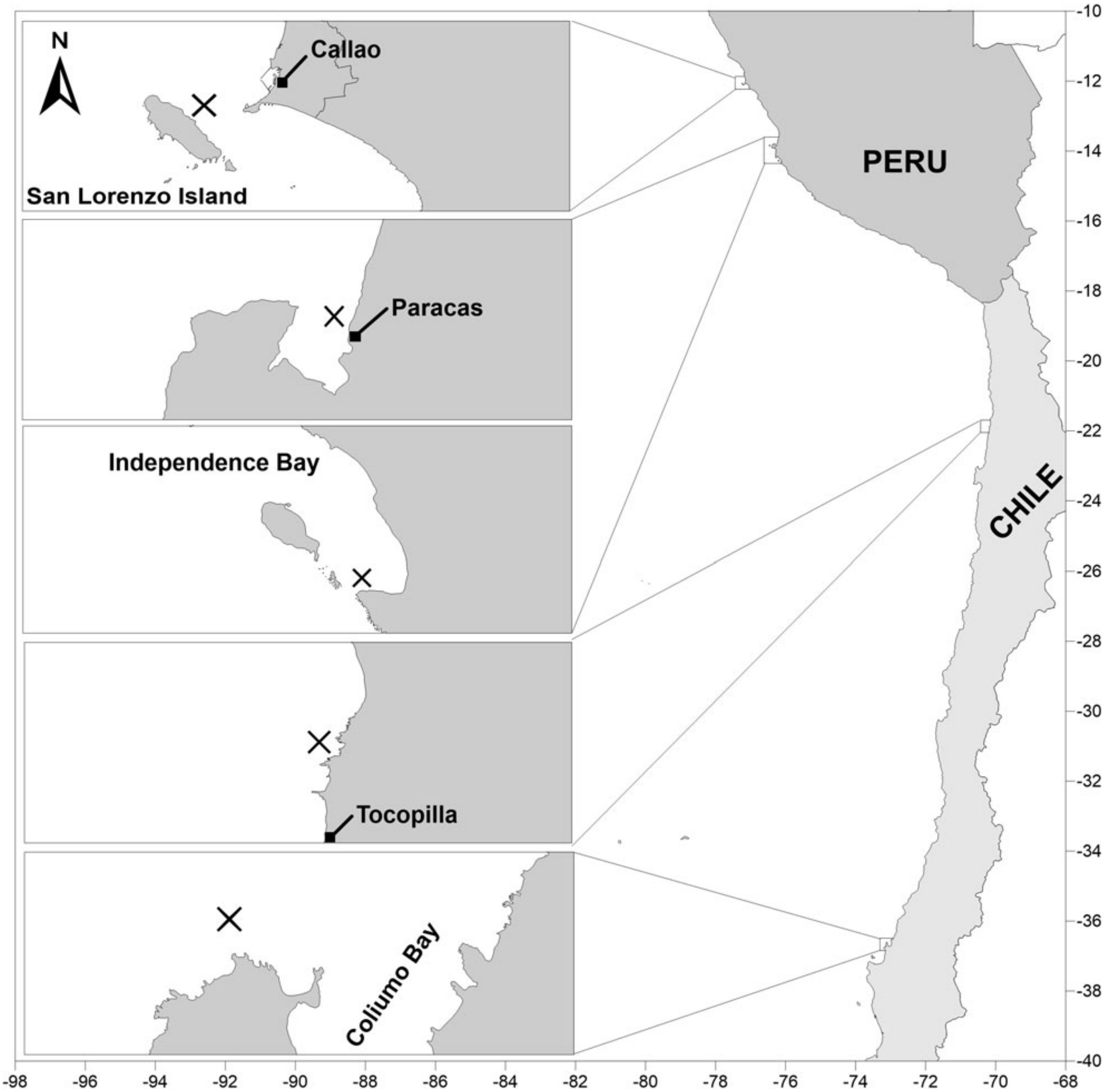

Fig. 1. Sampling sites of *Oulactis coliumensis*. Excluding the original description's collection site off the Bay of Coliumo, all records were carried out between 2008 and 2021.

06-000004, 06-000194, 06-000242, 06-000369) and the National Museum of Natural History of Chile (MNHNCL CNID-15069).

Results

Most specimens were found in shallow waters close to urban areas. Both Callao and Paracas (Peru), as well as Tocopilla and Concepcion (Chile), harbour large tonnage ports that receive vessels from around the world. All four sites are located in sheltered bays, with an average seawater temperature that generally ranges between 15.4–16.9°C in Callao (Graco *et al*., 2019), 18.1–25.3°C in Paracas (Sánchez *et al*., 2018), 13.5–17.7°C in Tocopilla (CENDHOC, 2021) and 10.4–16.0°C near Concepción (CENDHOC, 2021). As it is seasonally affected by intense upwelling episodes, dissolved oxygen especially fluctuates throughout this region and can vary from below 0.5 to more than 7 $mg\,l^{-1}$. The former scenario usually happens due to the intensification of the Peru–Chile undercurrent, which can cause oxygen depletion by the high respiratory demand of the settling and sedimentary organic matter (Gutiérrez *et al*., 2008). In Callao Bay, for example, the content of organic matter in marine sediments ranges between 0.9–13%, typically reaching higher values at greater depths (Velazco, 2011). Although the site in Tocopilla where the specimens were collected only has as reference the values reported in the baseline study (~ 2%), a profuse deposition of pellet-like organic matter has been observed in the field during summer.

All collected individuals had a well-developed pedal disc, frequently attached to rocks or empty shells underneath the sediment layer. Living specimens seemed to vary in shades of grey, however, under the light of a magnifying glass, their colouration was perceived to move towards dark-olive or ochre tones (Figure 2). Adhesive verrucae and tentacles were paler, somewhat transparent, and the oral disc of several specimens exhibited a white tetraradial pattern that extended from the lip to the oral margin. While the bright, papillae-rich, marginal ruff was quite noticeable in all cases, acrorhagi were only detectable in one third of the specimens examined. This did not seem to have much relation with the size of the individuals, but rather with the density of the population (i.e. acrorhagi were bigger in

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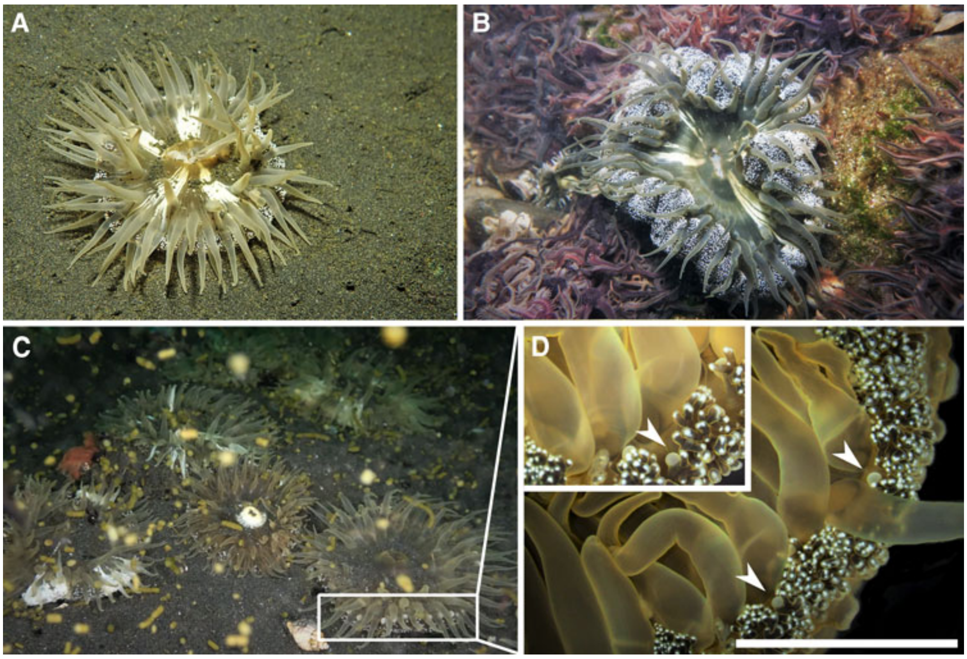

Fig. 2. *Oulactis coliumensis*: (a) specimen from Tocopilla; (b) specimen from Callao; (c) floor level picture from a dense population, actively feeding on suspended organic matter; (d) close-up to the marginal ruff and acrorhagi (arrowheads). Scale bar: 1 cm.

Table 1. Capsule size ranges and distribution of cnidae of *Oulactis coliumensis* from different references and collection sites

Reference			Riemann-Zürneck & Gallardo (1990)	Häussermann (2003)	This study	
Specimen's collection site			Coliumo (N = 3)	Coliumo (N = 2)	Tocopilla (N = 4)	Callao (N = 5)
Tissue	Tentacles	Spirocysts	<33 × 3.0–3.5 µm	<33 × 3.0–3.5 µm	14.8–27.9 × 1.4–4.2 µm	17.8–27.8 × 2.2–3.5 µm
		Basitrichs	23–29 × 2.0–2.5 µm	19–29 × 2.0–2.5 µm	16.3–29.3 × 1.5–3.1 µm	19–32.2 × 1.9–3.0 µm
	Acrorhagi	Spirocysts	23–25 × 1.5–2.5 µm	–	–	19.8–28.8 × 2.3–2.8 µm
		Holotrichs 1	50–64 × 5.0–6.5 µm	50–70 × 5.0–6.5 µm	49.2–70.8 × 3.9–5.9 µm	49–57.9 × 6.5–7.7 µm
		Holotrichs 2	32–43.5 × 3.5–4.0 µm	29–44 × 3.5–4.0 µm	36.1–43.8 × 3.6–4.0 µm	32.7–44.4 × 3.3–4.5 µm
	Column and marginal ruff	Basitrichs	13–19 × 2.0–2.5 µm	13–21 × 2.0–2.5 µm	12.5–24.4 × 1.5–3.0 µm	13.8–18.3 × 1.7–3.0 µm
		Holotrichs 2	–	19–21 × 4.8 µm	–	–
	Pedal disc	Spirocysts	17–20 × 2.0–2.5 µm	17–25 × 2.0–2.5 µm	19–20.4 × 1.5–2.4 µm	15.8–24.4 × 1.8–3.3 µm
		Basitrichs	17–20 × 2.0–2.5 µm	17–20 × 2.0–2.5 µm	13.5–20.2 × 1.7–3.2 µm	13–19.5 × 1.9–2.7 µm
	Actinopharynx	Basitrichs	26–33 × 3.0 µm	21–33 × 3.0 µm	16.5–31.3 × 2.0–3.7 µm	22.3–30.7 × 2.0–3.7 µm
	Mesenterial filaments	Basitrichs	14.5–17.5 × 1.5–2.5 µm	10–17.5 × 1.5–2.5 µm	13.4–20.2 × 1.5–2.7 µm	13.6–18.7 × 1.6–2.6 µm
		p-mastigophore 1	17.5–20 × 3.5–4.5 µm	17.5–22 × 3.5–4.5 µm	19.4–25.2 × 2.8–5.2 µm	15.6–21.7 × 2.9–5.0 µm
		p-mastigophore 2?	20–25 × 3.0–4.5 µm	18–25 × 3.0–4.5 µm	–	19.1–25.8 × 2.5–5.0 µm
		b-mastigophore	35–46 × 4.5–6.5 µm	35–46 × 4.5–6.5 µm	32.1–50 × 4.8–7.1 µm	32–46 × 5.1–8.0 µm

N, number of individuals examined.

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anemones from larger populations; near Tocopilla, reaching an estimated average of 60 ind m^{-2}).

Living specimens normally ranged between 5–10 cm in height and around 4 cm in pedal disc diameter (when preserved, these measures tend to reduce by about 50%), noting the largest average sizes in the individuals collected off the Bay of Callao. The largest specimens typically had a maximum of 96 tentacles. Internally, the mesenteries were hexamerously arranged in 3–4 cycles, even though some specimens had up to 52 pairs of mesenteries. Two individuals had slightly bulky segments in non-directive mesenteries, probably related to the development of gametogenic tissue. The cnidom agreed with the descriptions of Riemann-Zürneck & Gallardo (1990) and Häussermann (2003), with only minor differences between size ranges (Table 1).

No other sea anemone was observed near the larger populations of *Oulactis coliumensis*. Accompanying fauna was generally represented by tubicolous polychaetes (e.g. *Diopatra chiliensis*), nasarid gastropods (e.g. *Nassarius gayii* and *Nassarius dentifer*), and hermit crabs (e.g. *Pagurus villosus*). In Camotal, Callao (12° 04′28″S 77°10′51″W), some specimens were also reported among ofiurid mats of *Ophiactis kroeyeri* (Figure 2B).

Discussion

The marginal ruff is the most distinctive feature of the genus *Oulactis* (formerly *Saccactis* Carlgren, 1949; Häussermann, 2003), which, in Chile and Peru, is only represented by two species: *Oulactis concinnata* and *Oulactis coliumensis*. The first is quite common in the rocky intertidal of the south-eastern Pacific coast, especially in tide pools and sand-filled crevices (Häussermann, 2003). Like *O. coliumensis*, small pebbles and broken shells adhere to the column through the verrucae (*contra* Riemann-Zürneck & Gallardo, 1990), showing that, even in relatively different habitats, both species conserve the same defence behaviour (see Hart & Crowe, 1977). In contrast, as *O. concinnata* is usually spatially constrained by hard substratum, once settled, its oral disc tends to occupy a much wider space (often displaying over 400 tentacles in adult specimens; Häussermann, 2003). *Oulactis coliumensis* is also comparatively less colourful than *O. concinnata*, although new *in situ* records show that, instead of being purely brown (as originally depicted by Riemann-Zürneck & Gallardo, 1990), populations may contain individuals with different pigmentation patterns in the oral disc.

It is worth noting that with more individuals having been examined, some of the traits mentioned in the descriptions of *Oulactis coliumensis* seem to be more likely idiosyncrasies of the specimens, rather than diagnostic features of the species. For instance, the prominence of the lip or the density of spirocysts in the pedal disc showed major differences among individuals. The length of unfired cnidae also looked to be strongly related to the size of the specimen (see Francis, 2004), and even though most of the types found by Häussermann (2003) were seen in the populations from Callao and Tocopilla, some were completely absent in certain tissues (e.g. holotrichs only appeared in acrorhagi, never in the column or marginal ruff; see Table 1). Perhaps the most noticeable difference was the lack of opaque *p*-mastigophores in the populations from northern Chile, which, given their closeness in size, possibly represent a more developed state of the *p*-mastigophores observed sporadically in the mesenterial filaments.

These new records expand the distribution of the *Oulactis coliumensis* beyond the Intermediate Area (~30°S to ~40°S), and towards the northern edges of the Peruvian Province (~6°S to ~30°S) (Häussermann, 2006). This represents more than 2000 km of distance from the type locality, which make a much more plausible hypothesis that the higher number of sightings are due to the species having approached the coast from deep unexplored waters, rather than to a sudden latitudinal expansion up north. Furthermore, the one outer constant that was emphasized in the original description and was also apparent in all the places from where specimens were collected, is that *Oulactis coliumensis* seems to abound in areas that are specially affected by the low oxygen regime of the Peru–Chile undercurrent. Although no hypoxic episode was recorded during sampling, the accumulation of organic matter and the periodic effect of upwelling events suggest that this happens on a seasonal basis (Arntz *et al*., 1991). In fact, some of the largest populations were collected in very organically enriched sites, such as the immediacies of a naval base drain discharge (Callao), or near a submarine wastewater outfall (Tocopilla). Riemann-Zürneck & Gallardo (1990) inferred that the marginal ruff may have an adaptive value in this sense, favouring gas exchange in time spans of oxygen deficiency. As these episodes – usually linked to the expansion of the oxygen minimum zone – become more intense and shallower in depth due to climate change (Bakun *et al*., 2015; Valdés *et al*., 2021), more and more individuals may likely disperse towards the coast (see Häussermann *et al*., 2021); which, not only raises new questions about their potential impact on shallow-water ecosystems, but also presents *O. coliumensis* as a suitable bioindicator of eutrophicated sediments.

Supplementary material. The supplementary material for this article can be found at https://doi.org/10.1017/S002531542200039X.

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Author contributions. C.A.S., P.C. and V.H. devised the idea for the present study. P.C., B.G. and C.A. worked out all the technical details and led the sampling of the specimens. C.A.S. wrote the manuscript with input from all authors.

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Conflict of interest. The authors declare that they have no conflict of interests.

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