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Decapod crustaceans Eucalliacidae in chemoautotrophic bathyal bottoms of the Gulf of Cadiz (Atlantic Ocean), environmental characteristics and associated communities

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During the INDEMARES/CHICA 0610, 0211 and 0412 expeditions, carried out in the northern Spanish sector of the Gulf of Cádiz (Spain), samples were collected with a box-corer in 11 mud volcanoes and their adjacent bottoms. Chemoautotrophic communities were found in nine mud volcanoes. Among Decapoda, a rare eucalliacid, belonging to the genus Calliax and related to the Mediterranean infralittoral species C. lobata *(de Gaillande and Lagardère 1966), was present in three of them. Data on its morphology, biogeographic distribution, vertical distribution within the burrows, sediment composition, pH and redox potential values (each in 5 cm intervals) are given; information on the chemoautotrophic communities associated with this species are also provided.*

Keywords: Decapoda, *Calliax*, mud volcanoes, chemoautotrophic communities, Gulf of Cádiz

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INTRODUCTION

The deep sea, in general and within European waters in particular, represents an ecosystem that occupies an extensive area but is still scarcely known. Deep sea, fascinating habitats, such as cold seeps, cold-water coral mounds and reefs, canyons and anoxic environments, represent biodiversity hotspots (Weaver *et al.*, 2004) or may harbour endemic or rare species (Sibuet & Olu, 1998). Recent projects, supported by the European Union, are trying to fill this gap; such as HERMES, an integrated research project designed to gain new insights into the biodiversity, structure, function and dynamics of ecosystems along Europe's deep-sea margin (http://www.eu-hermes.net/). In addition, the LIFE + INDEMARES project is studying 10 Spanish offshore areas in the Atlantic, Mediterranean and Macaronesian regions, all away from the coastline, with the aim of contributing to the protection and sustainable use of the biodiversity, through the identification of valuable areas for the Natura 2000 Network. One of these areas is the Spanish waters of the Gulf of Cádiz (subproject 'Chimeneas de Cádiz'), where cold seeps and mud volcanoes are found between 300 and 1200 m. These areas with fluid emissions form a special habitat, supporting unique ecosystems based on methane oxidation as a primary source of energy (Milkov, 2000; Van Dover *et al.*, 2002; Vanreusel *et al.*, 2009), with biological communities supported by chemosynthetic processes and with respiratory adaptations to their hypoxic environment (Hourdez & Lallier, 2007).

In the Gulf of Cádiz, more than 60 mud volcanoes have been found (in Spanish, Portuguese and Moroccan waters) between 200 and 4000 m (Medialdea *et al.*, 2009; León *et al.*, 2012), and some faunistic studies have recently been carried out (Dworschak & Cunha, 2007; Génio *et al.*, 2008; Hilário & Cunha, 2008; Rodrigues *et al.*, 2008; Vanreusel *et al.*, 2009; Oliver *et al.*, 2011) and INDEMARES (Rueda *et al.*, 2012a, b). Data on decapods living in these special and restricted habitats are very scarce for the Gulf of Cádiz and the Mediterranean Sea (Olu-Le Roy *et al.*, 2004; Dworschak & Cunha, 2007; Taviani *et al.*, 2013). A general review of the decapod crustaceans from hydrothermal vents and cold seeps was provided by Martin & Haney (2005). Therefore, information on decapods inhabiting cold seeps within European waters, and the Gulf of Cádiz in particular, is needed in order to improve the knowledge on these ecosystems and on rare invertebrate species within European waters.

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MATERIALS AND METHODS

During the INDEMARES/CHICA 0610, 0211 and 0412 expeditions, samples were collected in different areas (in summits of seamounts, flanks, depressions, adjacent bottoms) of 11 mud volcanoes (MV) located within the Spanish sector of the Gulf of Cádiz (Albolote, Gazul, Anastasya, Tarsis, Pipoca, Chica1, Chica2, Hespérides, Almazán, Aveiro, St Petersburg) at depths from 300 to 1100 m (Figure 1). This mud volcano field is exposed to the highly saline (36.1–36.9) and warm (~12–14°C) Mediterranean Outflow Water (MOW), that forms a strong bottom current flowing towards the W and NW (into two main cores – at depths from 500 to 800 m and 800 to 1200 m respectively), below the less saline (35.6–36.8, 12–18°C) North Atlantic Central Water (NACW, formed in the western Atlantic basin) which flows from west to east in the Gulf of Cádiz at 100–600 m depth (Dubois-Dauphin *et al.*, 2014). Different sampling methods were used in each expedition: box-corer (BC: sampling area of ~0.09 m², N = 82), benthic dredge (DA: ~300 m² of sampling area, N = 56) and beam-trawl (BT: ~2000 m² of sampling area, N = 40) on board the RV 'Emma Bardán', 'Cornide de Saavedra' and 'Ramon Margalef'. Fauna collected in those samples was identified to the lowest taxonomic level and quantified. Individuals of eucalliacid decapods were identified, counted and sexed in each sample.

The sediments collected with the box-corer (generally down to 0.15–0.20 m below sea floor 'mbsf') were sectioned at 5 cm intervals and sieved (0.5 mm) in order to study the vertical distribution of fauna and of eualliacid decapods in particular. Values of pH and Eh were obtained along the sediment column on board by means of pHenomenal portable pH- and Eh-meter before sub-sampling. Grain size analysis was also done along the vertical column by dry sieving (from >2 to 0.063 mm) and Sedigraph III 5120 (<0.063 mm) in the laboratory. The organic matter and carbonate content of the sediments was obtained by Loss of Ignition (LOI) method.

The specimens were preserved in 70% ethanol, and deposited in the reference collection of Centro Oceanográfico de Málaga (Instituto Español de Oceanografía), in the collection of Departamento Biología Animal of University of Málaga and one specimen was donated to the Naturhistorisches Museum Wien (MHNW).

The carapace length (CL), dorsally from the rostrum to the end of the carapace, has been measured as a reference of the size.

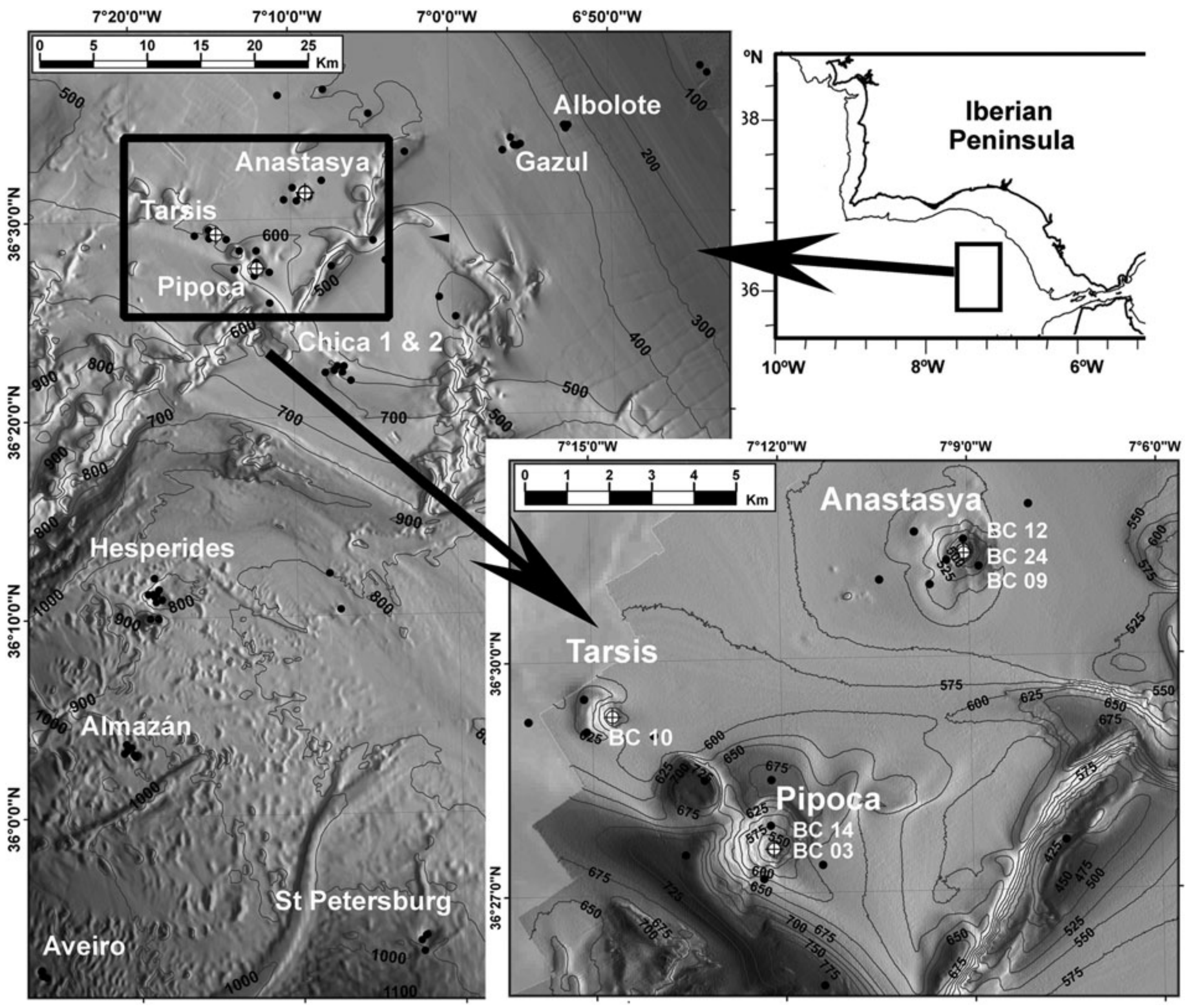

Fig. 1. Area of study and sampling points. Box-corer samples (black circles) obtained in the mud volcano field within Spanish waters of the Gulf of Cádiz, highlighting those that contained individuals of *Calliax lobata* (white circles) in mud volcanoes of El Laberinto fishing grounds.

RESULTS

Chemoautotrophic communities were found in 9 out of 11 mud volcanoes, including the decapod *Calliax lobata* that was detected in two mud volcanoes (MV): Anastasya and Pipoca. In addition, remains of one specimen of *Calliax* were found in Tarsis MV (BC10, 548 m). All *Calliax* individuals were collected in box-corer samples and no individuals were found in samples collected with other sampling techniques (e.g. benthic dredge, beam trawl). Both the chemoautotrophic communities and this eucalliacid decapod were always found at the summit of mud volcanoes, however remains of this typical cold seep fauna (mainly of lucinids and solemyids bivalve shells) were also present in sediment close to the MV (e.g. bottom depression) and were found in the box-corer, the beam-trawl and the benthic dredge samples. Sediment characteristics (grain-size, % organic material, % carbonate, pH and Eh between 0 to 0.20 mbsf (intervals of 0.05 m)) where populations of *C. lobata* occur were obtained (Table 1).

The capture of the *Calliax lobata* in bathyal bottoms of the Gulf of Cádiz represents the first record of the genus in the western European margin.

Order: Decapoda Latreille, 1802
Infraorder: Axiidea de Saint Laurent, 1979
Family: Eucalliacidae Manning & Felder, 1991
Genus: *Calliax* de Saint Laurent, 1973
Calliax lobata (de Gaillande & Lagardère, 1966)
(Figures 2–5)

MATERIAL CAPTURED AND EXAMINED

Indemares-Chica 0211: Anastasya mud volcano (MV) – CH0211-BC12, 36°31′21.144″N 07°09′04.369″W, 22 Feb 2011, 457 m, 7♀♀ (1 female is deposited in NHMW 25511), 4♂♂, 3 juveniles and 1 carapace; CH0211-BC24, 36°31′20.884″N 07°09′04.335″W, 28 Feb 2011, 458 m, 1♀, 1 juvenile. Pipoca MV – CH0211-BC14, 36°27′33.646″N 07°12′09.624″W, 23 Feb 2011, 501 m, 1♂. Indemares-Chica 0412: Pipoca MV, CH0412-BC03, 36°27′33.804″N 07°12′09.360″W, 12 Apr 2012, 500 m, 1 ♀. Anastasya MV, CH0412-BC09, 36°31′19.056″N 07°09′ 03.888″W, 17 Apr 2012, 455 m, 1 ♂, 1 ♀. Remains of one specimen, Tarsis MV, CH0412-BC10, 36°29′17.268″N 07°14′40.992″W, 17 Apr 2012, 548 m.

COMPARATIVE MATERIAL EXAMINED

Callianassa (*Callichirus*) *lobata* de Gaillande & Lagardère, 1966: 4 specimens Port Miou, près de Toulon, de Galliande coll. 1972, MNHN-IU-2009-2297 (ex MNHN-Th674).

The morphological features of our 21 specimens (Figures 2–4) allow us to assign them to the genus *Calliax*: carapace without dorsal oval and with linea thalassinica lateral to antennae, straight antero-posteriorly on carapace; rostrum obsolete; eyestalk usually dorsoventrally flattened and contiguous; pleurobranch absent on pereopods 2 to 4 (P2–P4); dactylus of third maxilliped (Mxp3) ovate, and without exopod; and uropodal exopod without yellow-transparent circular structure (Sakai, 1999, 2005, 2011; Ngoc-Ho, 2003).

Characters of the material also fit those described for the infalittoral Mediterranean species *Calliax lobata* by de Gaillande & Lagardère (1966), de Saint Laurent & Božić (1976), Sakai (1999) and Ngoc-Ho (2003) and also the features observed in loaned specimens from MNHN Paris. Therefore, a complete morphological description is not given, but Figures 2A–H, 3A–H and 4A–K are shown for comparative purposes.

However, some morphological differences among specimens of small and large size were observed. The triangular proximal tooth on the dactylus of minor cheliped (P1)

Table 1. Characteristics and physico-chemical conditions of sediments within burrows of the ghost shrimp *Calliax lobata*, at different depth intervals.

Expedition	Box-corer	Depth (mbsf)	pH	Eh (mV)	%OM	ST	N *Calliax*
0211	BC12	0.00–0.05	7.32	−139.8	6.17	Clay	1♀
		0.05–0.10	7.43	−103.6	5.79	Clay	3♀♀
		0.10–0.15	7.34	−369.1	5.25	Clay	2♂♂ + 1♀ + 3j
		0.15–0.20	6.83	−388.8	4.00	Clay	2♂♂ + 2♀♀ + 1c
0211	BC14	0.00–0.05	7.40	111.2	8.42	Clay	–
		0.05–0.10	7.48	−108.7	7.93	Clay	–
		0.10–0.15	7.45	−118.9	7.45	Clay	1♂
		0.15–0.20	7.47	−127.4	7.41	Clay	–
0211	BC24	0.00–0.05	7.37	−142.7	5.94	Clay	–
		0.05–0.10	7.40	−142.6	5.05	Clay	–
		0.10–0.15	7.39	−142.9	6.34	Clay	–
		0.15–0.20	6.81	−393.9	6.73	Clay	1♀ + 1j
0412	BC03	0.00–0.05	7.27	21	9.99	Clay	–
		0.05–0.10	7.30	−28.5	8.90	Clay	–
		0.10–0.15	7.48	−153.5	8.70	Clay	1♀
		0.15–0.20	–	–	–	–	–
0412	BC09	0.00–0.05	7.27	108.2	10.57	Clay	1♂
		0.05–0.10	7.41	−75.8	9.52	Clay	1♀
		0.10–0.15	7.37	−90.3	9.38	Clay	–

ST, sediment texture; %OM, percentage of organic matter; pH and Eh (redox potential); mbsf, metres below sea floor; N *Calliax*, abundance of *Calliax* in each sample and sediment depth interval (♂ – male, ♀ – female, j – juvenile, c – carapace).

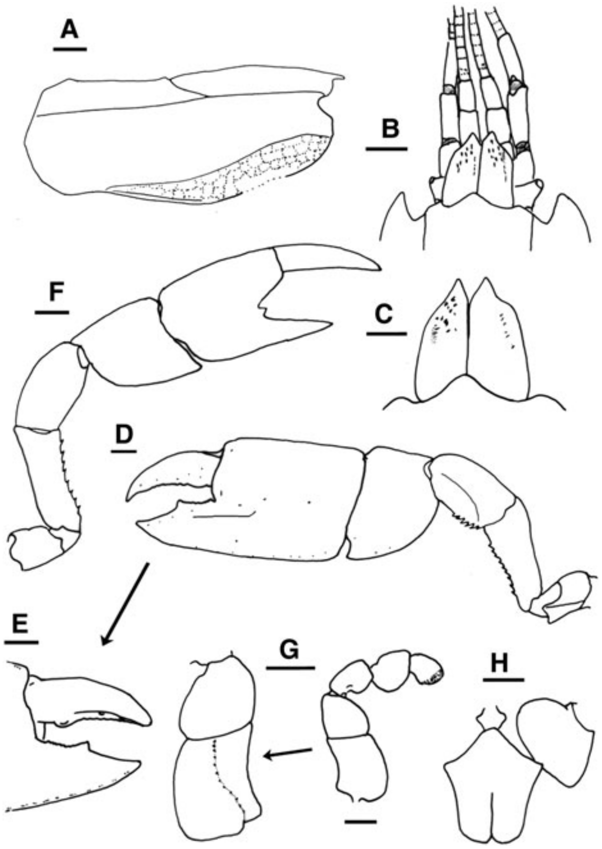

Fig. 2. *Calliax lobata*. (A) carapace, lateral view; (B) carapace, anterior-dorsal view; (C) eyestalk; (D, E) first left pereopod and detail of fingers, inner and outer views respectively; (F) first right pereopod, outer view; (G) third maxilliped, outer and inner views; (H) mid-sternal plate. Female specimen 12.25 mm carapace length (sample BC12. Scale bars: 1 mm, except C: 0.5 mm.

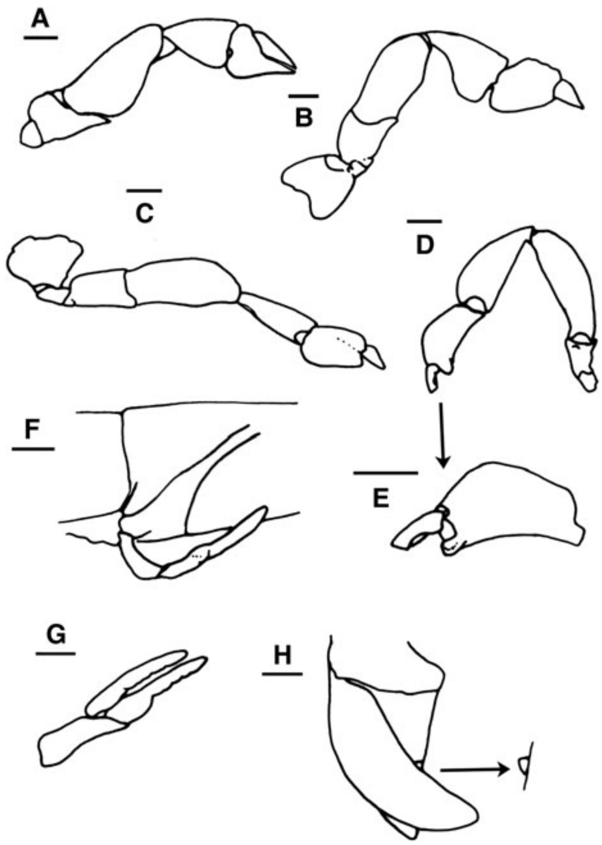

Fig. 3. *Calliax lobata*. (A) second right pereopod, outer view; (B) third right pereopod, outer view; (C) fourth right pereopod, outer view; (D, E) fifth right pereopod and detail, inner views; (F) first right female pleopod; (G) second left female pleopod; (H) third right pleopod, outer view, and detail of appendix interna. A to G female specimen 12.25 mm carapace length (sample BC12); H male specimen 6.1 mm carapace length (sample BC12). Scale bars: 1 mm.

(palm with w-shaped distal margin) is minuscule in small specimens and large in large ones (Figures 2F & 4E, H); the number of spines on the lower margin of merus of major cheliped is smaller in small specimens (Hyžný & Gašparič, 2014: Figure 3) than in large ones (Figure 2D); and the distal part of the first male pleopod is more curved in large specimens (Figures 4J, F, K). Also, this first pleopod is not developed in specimens CL <2.8 mm.

Colour: whitish.

Size range: Males, CL 4.7–8.0 mm; females CL 3.1–12.3 mm.

Sex ratio (females/males): 2.75/1.

Distribution

Calliax lobata was described from the Mediterranean Sea, in Port Miou, Toulon, France, at a depth of 2–8 m (de Gaillande & Lagardère, 1966), and later reported from Patras (=Patraikos) Gulf, Greece, at 15 m in sandy mud (Thessalou-Legaki & Zenetos, 1985; Thessalou-Legaki, 1986) and near Rovinj, Croatia, in silty sand at 21 m (Števčić, 1985, 1990). Recently, in Italy, Taviani *et al.* (2013) found specimens of *Calliax* sp. in the Strait of Sicily at ~800 m, and Sakai (2017) in Palinuro Seamount, southern Tyrrhenian Sea, at 622 m. Our captures represent a new record for the North-east Atlantic Ocean: Gulf of Cádiz (Spain), in clay bottoms at summits of MV, 455–501 m.

Habitat

The chemoautotrophic community of these cold seeps occurring at summits of MV, in which *C. lobata* has been found, includes frenulate polychaetes (*Siboglinum* sp.) (densities up to 100 ind. m^{-2}) and bivalves (*Lucinoma asapheus* Oliver, Rodrigues & Cunha, 2011 and *Solemya elarraichensis* Oliver, Rodrigues & Cunha, 2011) (densities up to ~70 ind. m^{-2}). Other dominant living species in the different mud volcanoes are listed in Table 2. In Anastasya MV, *C. lobata* shows a patchy distribution at the summit with densities between 22.2 and ~150.0 ind. m^{-2} in anoxic muddy sediments (redox potential Eh between −90.3 and −393.9 mV, pH between 7.4 and 6.8), with strong sulphide smell. This eucalliacid inhabits burrows (Figure 5b), in which the sediment surface between burrow openings seems covered by bacterial mats, and displays the highest densities at 0.1–0.2 mbsf, being the dominant species at this level. Some of the burrows were also occupied by the bivalve *S. elarraichensis* (at densities of 66.7 ind. m^{-2}); other chemosymbiotic species occurring at the summit were *L. asapheus* and *Siboglinum* sp.1. In Pipoca MV, this eucalliacid also occurs at the summit but was less abundant than in Anastasya MV, occurring at densities of 22.2 ind. m^{-2} in anoxic clay sediments (Eh −127.4 mV, pH 7.47) at the 0.1–0.15 mbsf level. In spite of this the species shows a higher dominance due to a low

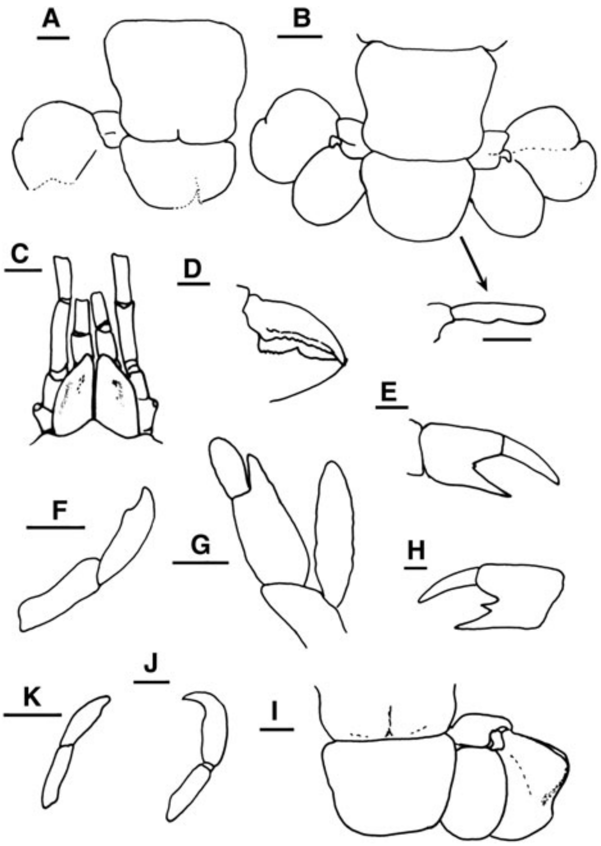

Fig. 4. *Calliax lobata*. (A, B) posterior part of pleon, telson and uropods, and lateral view of telson; (C) eyestalks, antennular and antennal peduncles; (D) finger of first large pereopd, (E) finger of first small pereopod; (F) first male pleopod; (G) second male pleopod; (H) propodus and dactylus of small first pereopod (large specimen); (I) telson and uropods; (J, K) first male pleopods, from adult and juvenile respectively. A female specimen 12.25 mm carapace length (sample BC12); B to G male specimen 6.1 mm carapace length (sample BC12); H to J male adult specimen 8.0 mm carapace length (sample BC14); K male juvenile specimen 4.5 mm carapace length (sample BC12). Scale bars: 1 mm; except F, G, J and K: 0.5 mm.

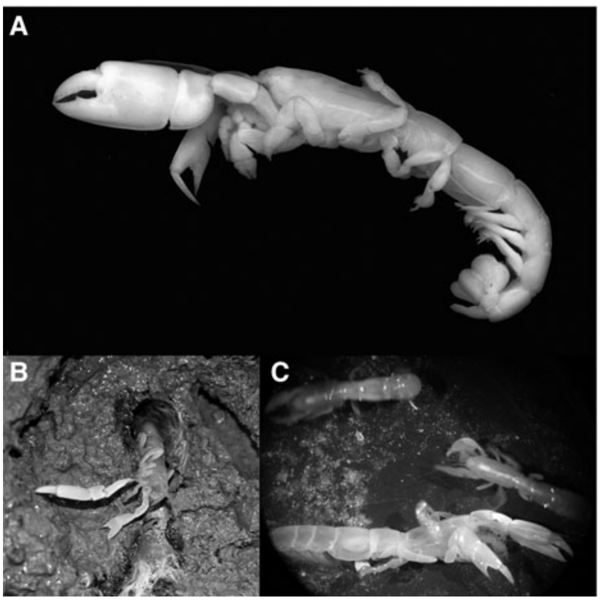

Fig. 5. *Calliax lobata*. (A) general view, (B) specimen leaving its burrow, (C) group of three recently caught specimens under the microscope.

Table 2. Top dominant species at the summits of the mud volcanoes (MV) that displayed populations of *Calliax lobata*.

MV	Dominant species
Anastasya	*Gibberula turgidula* (18.5%), *Siboglinum* sp.1 (17%), *Aricidea (Acmira) assimilis* (14%), *Fageapseudes* cf. *retusifrons* (7%), *Calliax lobata* (6%), *Euclymene* sp. (4.5%)
Pipoca	*Siboglinum* sp.1 (19,6%), *Spiochaetopterus typicus* (8.7%), *Calliax lobata* (8.7%), *Gibberula turgidula* (8.7%), *Abra longicallus* (6.5%), *Phyllochaetopterus socialis* (4.3%)
Tarsis	*Phyllochaetopterus socialis* (6.4%), *Ledella messanensis* (4.8%), *Amage* sp. (3.2%), *Pseudocapitella* cf. *incerta* (3.2%); *Spiochaetopterus typicus* (3.2%), *Thenea muricata* (3.2%), *Granulina minusculina* (1.6%), *Calliax lobata* (<1%)

Relative abundance values in parentheses.

abundance of other components of the community. Another chemoautotrophic species from this community is *Siboglinum* sp.1 (densities up to 80 ind. m^{-2}), which represents the top dominant species. Remains of *L. asapheus* were found in the sediment samples of this mud volcano, but no living individuals. In Tarsis MV, remains of *C. lobata* were only found at the summit (with lowest densities 11.1 ind. m^{-2}), being only present at the 0.1–0.15 mbsf level with anoxic muddy sediments (Eh −125.8 mV, pH 7.35). *Siboglinum* sp.1 is also present (densities up to 30 indiv. m^{-2}) and no remains of chemoautotrophic bivalves were found in this sample.

In all mud volcanoes *C. lobata* is practically one of the few macrofaunal species (except the chemoautotrophic bivalves *S. elarraichensis* and *L. asapheus*) inhabiting sediment below 0.1 mbsf. The highest relative abundances, in relation to the total number of *Calliax* individuals collected along the sediment column, were found between 0.10–0.15 and 0.15–0.20 mbsf intervals (40 and 33% respectively) (Table 1).

In general, *C. lobata* populations display a low frequency of occurrence within the mud volcano field of the Spanish margin (3 MV of El Laberinto fishing grounds out of 11 MV within Spanish waters), considering that there was similar sampling effort in all mud volcanoes. Moreover, these populations are always restricted to summits of these submarine structures and they were never found in the flanks or adjacent seafloor depression of each MV.

DISCUSSION

During the three INDEMARES/CHICA expeditions the presence of populations of a rare deep eucalliacid species was detected, in anoxic bottoms of mud volcanoes of the Gulf of Cádiz, whose morphology is similar to the Mediterranean species *Calliax lobata*, originally captured and described from shallow waters (2–8 to 21 m, de Gaillande & Lagardère, 1966; Števčić, 1985; Thessalou-Legaki, 1986) and subsequently found in deep bottoms (622 to 840.9 m, Taviani *et al.*, 2013; Sakai, 2017). Also, the abundance of *C. lobata* in the mud volcanoes of the Gulf of Cádiz contrast with the scarcity of records and individuals found in the shallow Mediterranean species *C. lobata* (previous references).

In this study it was the only axiidean species caught. Nevertheless, in deep waters of the Southern Iberian

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Peninsula (Gulf of Cádiz and Alborán Sea, García Raso, 1996) other species were found: *Calocaris macandreae* Bell 1846, and *Calocarides coronatus* (Trybom, 1904). Probably, the most common and abundant axiidean in Mediterranean deep waters is *Calocaris macandreae* (Axiidae) (Cartes & Sarda, 1992; Cartes *et al.*, 2004; Follesa *et al.*, 2009), a species relatively abundant down to about 1000 m, with isolated individuals appearing down to 1300–1500 m, and dominant at 600 m (Catalan Sea, Cartes & Sarda, 1992). Axiideans can also represent an important resource in the diet of other deep-water decapods (e.g. *Calocaris macandreae* for *Plesionika heterocarpus* (A. Costa, 1871), *Plesionika ensis* (A. Milne-Edwards, 1881) and *Polycheles typhlops* Heller, 1862 (Labropoulou & Kostikas, 1999)).

Only a few species of axiideans in chemosynthesis-based communities inhabiting hydrothermal vents, cold seeps and mud volcanoes have been found in the last years (Martin & Haney, 2005) and studies have shown that the physiology of the axiideans is generally well adapted to hypoxic and sulphidic conditions (Atkinson & Taylor, 2005; Wardiatno, 2009). Only six species have been mentioned to occur in reducing environments: *Bathycalliax geomar* Sakai & Türkay, 1999, off Oregon, at 627 m (Sakai & Türkay, 1999); *Callianassa truncata* Giard & Bonnier, 1890, around the islands of Milos and Santorini, Aegean Sea, at ~12 m (Dando *et al.*, 1995); *Nihonotrypaea thermophila* Lin, Komai & Chan, 2007, off north-eastern Taiwan and Kagosima Bay, Japan, at 105–310 m (Lin *et al.*, 2007; Komai & Fujiwara, 2012); *Paraglypturus calderus* Türkay & Sakai, 1995, submarine volcano Esmeralda Bank, in the Mariana Arc (63–114 m) (Türkay & Sakai, 1995); *Vulcanocalliax arutyunovi* Dworschak & Cunha, 2007, from MV of the Gulf of Cádiz, Atlantic Ocean (Captain Arutyunov MV) at 1327–1339 m (Dworschak & Cunha, 2007) and *Cheramus cavifrons* Komai & Fujiwara, 2012 off Cape Nomamisaki, Kyushu, Japan, at 226 m (Komai & Fujiwara, 2012). Recently, in a pockmark field in the Strait of Sicily and at 820–840 m depth, specimens of *Calliax* sp. have also been found by Taviani *et al.* (2013).

The shallow Mediterranean *Calliax lobata* inhabits muddy and silty bottoms at 2–21 m depth (de Graillande & Lagardère, 1966; Števčić, 1990). The deep-water specimens of *Calliax* cited by Taviani *et al.* (2013) (which also share characters with *C. lobata*) were captured in a pockmark field in the Strait of Sicily at 811–840.9 m depth, and our specimens collected in the Gulf of Cádiz inhabit clay and silty bottoms of MV located at ~500 m depth. In all these cases the specimens are living in a reducing sedimentary environment. On the other hand, although it is not common that a same axiidean species occurs over such a wide bathymetric range, in all cases mentioned above the specimens are living in a reducing sedimentary environment, and there are some examples of callianassid that occur over a wide bathymetric range. In the Mediterranean and Atlantic waters, *Callianassa subterranea* (Montagu, 1808) has been found from 10 to 270 m depth (Sakai, 2005) and *C. marginata* Rathbun, 1901, from 55 to 640 m depth in the Western Atlantic Ocean (Sakai, 2005).

So, the Mediterranean Outflow Water current that runs through the mud volcano field of the Gulf of Cádiz, together with the special anoxic environmental conditions of sediments occurring at the summits of mud volcanoes, could justify the presence of a Mediterranean species in the studied Atlantic area (close to the Mediterranean Sea). For the same reason it is very probable that this rare species can be found and captured in other Mediterranean areas, with reducing environments, although for this (it is a burrowing species) an appropriate sampling method should be used.

The presence and maximal abundance of *C. lobata* in Anastasya and Pipoca MV could be related to a higher or moderate seepage activity when compared with other MV from the Spanish field. Moreover, species such as *Siboglinum* sp., *Solemya elarraichensis* and *Lucinoma asapheus*, typical of anoxic muddy substrates with low potential redox and living in symbiosis with chemotrophic bacteria (using methane and sulphide as energy sources) are more abundant in these two mud volcanoes (specially Anastasya) when compared with others located in the area, such as Tarsis or Gazul (Oporto *et al.*, 2012; Rueda *et al.*, 2012a, b). This differential distribution of typical cold seep fauna in mud volcanoes of the Gulf of Cádiz seems to be very common and has been related to the heterogeneity of nutrient sources (nitrogen and sulphur) and the ability for exploiting different resources by the different species (Rodrigues *et al.*, 2013). In addition, the tanatocoenosis from MV of the Spanish margin displays a high abundance of remains of this callianassid in Anastasya and Pipoca as well as of putative gastropods associated with cold seeps (e.g. *Taranis moerchii* (Malm, 1861)), as was observed by Taviani *et al.* (2013) in sediments collected in the Gela Basin pockmark field in the strait of Sicily. The infaunal life habit of this species that burrows deeply in the sediment may have also influenced the scarcity of previous records in shallow or deep sea bottoms.

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