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The caprellid *Aciconula acanthosoma* (Crustacea: Amphipoda) associated with gorgonians from Ecuador, Eastern Pacific

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Abstract

During a sampling programme focused on Anthozoa from Ecuador, the caprellid *Aciconula acanthosoma* was found attached to gorgonians of the genus *Leptogorgia* collected in Machalilla National Park in November 2012 and June 2013 between 15-20 meters depth. The present study represents the first record of *A. acanthosoma* for Ecuador, increasing its distribution range 3000 km southward.

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Introduction

The knowledge on marine organisms in Ecuador is scarce, and mainly focuses on species with special protected status such as marine turtles or marine mammals (Seminoff et al. 2008). However, it is generally accepted that littoral ecosystems of Ecuador harbour a high level of biodiversity (Cruz et al. 2003) and the scientific community has recognized the high priority that should be given to biodiversity research (Soler-Hurtado and López-González 2012).

Caprellids are small marine crustaceans distributed worldwide which constitute an important trophic link between primary producers and higher trophic levels in marine ecosystems (Woods 2009). They live on algae, hydrozoans, bryozoans, sponges, seagrasses, gorgonians, sediment and other marine invertebrates (Guerra-García 2001) and feed mainly on detritus (Guerra-García and Tierno de Figueroa 2009). Caprellids are considered useful marine bioindicators (Guerra-García and García-Gómez 2001; Ohji et al. 2002; Guerra-García et al. 2009a) and a potential resource in aquaculture (Woods 2009).

There is a lack of comprehensive studies dealing with caprellids from Ecuador, and, to our knowledge, only two species have been previously reported: *Caprella equilibra*, recorded near the coast of Ecuador, between Panama and the Galapagos Islands (McCain and Steinberg 1970) and *Caprella ungulina*, collected from Galapagos Islands (Sittrop and Serejo 2006). In fact, the caprellids from the west coast of central and South America have not been studied, apart from some surveys in the Central North Coast of Chile (Guerra-García and Thiel 2001; Thiel et al. 2003) where 7 caprellid species were recorded. Caprellid studies along the American Pacific coasts have focused in the coasts of Canada, United States and Mexico. Laubitz (1970) conducted a comprehensive work and provided details and/or figures of 26 species found in the North American Pacific between latitudes 40ºN and 60ºN, including ecological notes and a zoogeographical discussion. Watling and Carlton (2007) provided a detailed revision, including an illustrated guide and a list of 31 species of caprellids from California. Guerra-García and Hendrycks (2013) described a new species of *Liropus* from California, and Sánchez-Moyano et al. (2014) studied the littoral caprellids from Mexican Central Pacific coasts, reporting 7 species, 4 of them new to science. Consequently, all the information about caprellid biodiversity, ecology and distribution along the American Pacific coasts covers primarily the latitude 20ºN-60ºN and secondarily 20ºS-60ºS. The tropical fringe 20ºN to 20ºS, between the Tropics of Cancer and Capricorn, is still totally unexplored regarding caprellids.

During a sampling programme focused on Anthozoa from Ecuador, several caprellids associated with gorgonians were detected. This study describes and identifies those capprellids.

Methods

Important gorgonian gardens can be found in Ecuador between 5-30 meters depth (Fig. 1). Two gorgonians were selected for this study, *Leptogorgia obscura* Bielshowsky, 1918 and *Leptogorgia* sp. (Fig. 2). Both species are among the most common gorgonian species in the littoral of Ecuador and constitute important gorgonian gardens between 3-30 meters depth. The branching pattern in *Leptogorgia obscura* is irregularly dichotomous, branches are bushy, closely ramified and rigid (Bielschowsky 1929) (Fig. 2). In *Leptogorgia* sp. all branches are in the same plane. Machalilla National Park (Manabí, Ecuador) was selected as study area since in this site (1º30'14''S, 80º48'33''W) both gorgonian species are living together. The Machalilla National Park is one of the most important marine-terrestrial reserves of the country. It covers an area of more than 750 km² and it is situated in Manabí Province near Puerto López and the rural parish of Machalilla, a small fishing village in the vicinity of the park.

Sampling was undertaken in November 2012 (at the beginning of winter) and June 2013 (at the beginning of summer) to cover the two main tropical conditions during the year. The weather is warm in winter (November to May), and cooler in summer (June to October) due to the influence of the Humboldt Current. At each sampling period, ten colonies of each gorgonian species were collected by SCUBA at 15-20 meters deep. The entire colony was enclosed in a plastic bag to prevent faunal loss and then carefully detached from the substrate. Samples were abundantly washed through a 100 µm mesh sieve, and all the fauna were preserved in 70% of ethanol. All caprellids were sorted under the microscope and identified. Caprellids were quantified in terms of number of individuals per colony (see Carvalho et al. 2014).

Results and Discussion

All the caprellids identified from the gorgonian substrates belonged to the same species, *Aciconula acanthosoma* (Fig. 3). A total of 86 specimens were examined: 9 males (3-3.8 mm), 8 females (2.8-3.6 mm), 7 premature females (2-2.8 mm) and 62 juveniles (1-1.8 mm). Higher caprellid abundances were measured in June for both species. The caprellid density measured on

Leptogorgia obscura was 1.7 ± 0.8 individuals per colony (mean ± standard deviation, n=10) in November 2012 and 4.0 ± 1.1 individuals per colony in June 2013. *Leptogorgia* sp. was characterised by a caprellid density of 0.6 ± 0.3 individuals per colony (mean ± standard deviation, n=10) in November 2012 and 2.3 ± 0.8 individuals per colony in June 2013.

Chess (1989) described *Aciconula acanthosoma* from several sites on the Leeward side of Santa Catalina Island, California, United States, primarily from Isthmus Reef, depth 11-14 m. Later, Alarcón-Ortega et al. (2012) and Sánchez-Moyano et al. (2014) found the species in Mazatlán Bay and Isabel Island, Pacific Central Coast of Mexico. So far, these were the only records of this species. Although the species seems to be very common in these zones (Chess 1989; Alarcón-Ortega et al. 2012), its description and records are very recent. Probably, the underestimation of the species is due to its small size and the fact that specimens are usually covered by abundant detritus which make them very inconspicuous and easily overlooked.

Taxonomical remarks

The genus *Aciconula* presently comprises 4 species: *A. miranda* Mayer 1903, *A. acanthosoma*, *A. australiensis* Guerra-García 2004 and *A. tridentata* Guedes-Silva and Souza-Filho 2013. The genus was erected by Mayer (1903) based on two female specimens of *A. miranda* collected from Singapore, Malaysia and Koh Krau, Thailand. Mayer (1912) described the male of *A. miranda* based on material collected from Shark Bay, Australia. Chess (1989) described *A. acanthosoma* from California, USA. Guerra-García (2004a) described A. *australiensis* from Queensland and Western Australia, and Guedes-Silva and Souza-Filho (2013) described *A. tridentata* from Pernambuco, Brazil. Additionally, Guerra-García (2004b) and Guerra-García et al. (2006) recorded specimens belonging to the genus *Aciconula* (named as *Aciconula* sp based on the scarce material) from Phuket, Thailand and the Caribbean coast of Colombia, respectively.

The clearest diagnostic character to distinguish *A. acanthosoma* from the remaining species of the genus is the presence of abundance dorsal projections on head and pereonites (Fig. 3). However, there are other differences between *A. acanthosoma* and the other three species. A taxonomic key for the identification of *Aciconula* species can be found in Guedes-Silva and Souza-Filho (2013). Males of *A. miranda*, *A.australiensis* and *A. tridentata* lack abdominal appendages, while Chess (1989) described a pair of well developed appendages in *A. acanthosoma*. Takeuchi (1993) assumed this character (presence of appendages in male abdomen) as diagnostic for the genus based on the description of Chess (1989). However, the type species of the genus is *Aciconula miranda*, which seems to lack abdominal appendages (Mayer 1912; Guedes-Silva and Souza-Filho 2013). *Aciconula miranda*, *A. australiensis* and *A. tridentata* present sexual dimorphism affecting the number of articles of pereopod 3, the pereopod being two-articulate in males and four-articulate in females. In *A. acanthosoma*, however, the pereopod 3 and 4 are 2-articulate both in males and females. Moreover, the inner lobe of the maxilliped is totally different in *A. acanthosoma* (large and rectangular) in comparison with the remaining species (small and oval). Guerra-García (2004a) and Guerra-García et al. (2006), taking into account the presence of abdominal appendages in *A. acanthosoma*, and the feature of the inner lobe of the maxilliped (clearly different from the remaining species of *Aciconula*) suggested that *A. acanthosoma* could be transferred to a different genus. However, the remaining characters of antennae, gnathopods and pereopods, especially the morphology of the pereopod 5 agree with *Aciconula*. Additional collections of more specimens from different localities, and further molecular studies are necessary to understand the phylogenetic relationships among *Aciconula* species and to clarify if *A. acanthosoma* should be transferred to a new genus.

Sánchez-Moyano et al. (2014) reported that the morphology of Mexican specimens was in general agreement with the Californian material described by Chess (1989) but they pointed out that the Mexican specimens showed some intraspecific variation in the head projections pattern (2 anterior prominent spines and 2 posterior reduced projections instead of the 4 prominent curved projections of the material type from California). Furthermore, in some specimens from Mazatlán Bay (Mexico), one or two posterior head projections were absent or very reduced. Additionally, the length was slightly smaller in Mexican *A. acanthosoma* (male to 5.5 mm, female to 4.5) than material type (male and female to 7.3 mm and 6.3 mm, respectively). The present material collected from Ecuador also showed the intraspecific variation in dorsal projections on the head, depending on the degree of development and the size of specimens. The examined specimens were even smaller than material from Mexico (male to 3.8 mm and female to 3.6 mm); however we must point out that the male specimens collected from the gorgonians were subadults so the length could be underestimated. Anyway, taking into account the length differences between the type specimens and the material from Ecuador, we carefully examined antennae, gnathopods, and pereopods (Figs. 4, 5) and all the characters were in general agreement with the figures of the original description provided by Chess (1989). The male abdomen also presented a pair of appendages, as in the original description, differing from the remaining *Aciconula* species which lack appendages. The mouthparts were also in total agreement with the figures of Chess (1989); the most distinctive character was the presence of a well-developed inner plate in the maxilliped (see Chess 1989: 664, Fig. 2G), which is reduced in the other *Aciconula* species. Some males from Ecuador (see Fig. 3) showed a more developed pleura than specimens described from California and Mexico, but in some species of caprellids pleura morphology can change during ontogenetic development (pers. obs.)

Ecological remarks

Chess (1989) pointed out that *A. acanthosoma* was common and persistent during 15 years of sampling and he found it in the gut contents of 8 species of fishes. He also pointed out that interannual variations in abundance tended to be greater than seasonal variations, with the lowest numbers occurring during and following the El Niño events of 1976 and 1983. Our study also seems to reveal that abundances are higher in winter than in summer. Chess (1989) found the species within nearshore habitats protected from prevailing oceanic swells, and reported its presence on 12 types of substrates, including sand, rock, the briozoan *Bugula neritina,* and different species of algae. He pointed out that the maximum densities of the species were found on algae, mainly *Cystoseira neglecta* and *Sargassum palmeri*. Sánchez-Moyano et al. (2014) also found *A. acanthosom*a attached to different substrates, but reported that the species was absent in most of the algae collected and abundant in different species of hydroids, gorgonians (*Leptogorgia rigida*, *L. peruviana*, *Pacifigorgia* sp, *P. cf. agassizii*, *Muricea* sp, *M. cf californica*) and bryozoans (*Bugula sp*). Although in temperate ecosystems the highest densities of caprellids can be found in seaweeds (Guerra-García 2001), in the tropical region caprellids are mainly associated to hydroids and secondarily to gorgonians and other corals (Guerra-García 2006; Scinto et al. 2008). The only algal species in which Sánchez-Moyano et al. (2014) found *A. acanthosoma* (*Zonaria cf. farlowii*) showed a high cover of hydroids, and these authors suggested a possible relationship between this caprellid and cnidarians. Most caprellids are non specific in their habitat requirements and occur on a variety of organisms (Caine 1978; Guerra-García 2001; Laubitz and Lewbel 1974). However, some species can show specific relationships with their substrates, such as equinoderms (Vader 1978), branching hydroids (Aoki 1991; Bavestrello et al. 1996; Caine 1998; Ros and Guerra-García 2012), appendages of deep-sea lithoid crabs (Takeuchi et al. 1989) among others. Even those caprellid species occurring on different substrates may exhibit some substrate-specific morphological adaptations (Caine 1978). It is the case, for example, of some varieties of *C. equilibra* and *C. penantis* which inhabit gorgonians and lack the grasping spines in the pereopods (McCain 1968). Laubitz and Lewbel (1974) reported that *Caprella gorgonian* was, so far, the only species inhabiting exclusively gorgonians. Recent molecular and morphological studies have revealed that an isolated variety of *C. penantis,* inhabiting exclusively gorgonians, belongs to different and undescribed species of *Caprella* (see Cabezas et al. 2013).

A. acanthosoma does not seem to exclusively inhabit gorgonians since it has been found inhabiting a great variety of other substrates. Furthermore, the pereopods 6-7 do not lack grasping spines, which has been considered a characteristic of gorgonian epibionts. However, gorgonians seem to constitute an adequate habitat for this species (Sánchez-Moyano et al. 2014; present study).

Chess (1989) analyzed the gut contents of *A. acanthosoma* from California and he found spicules of sponges and ascidians, presumably scraped from the substrates. Alarcón-Ortega et al. (2012) studied the diet of the species in the Mexican coast and found that the species feeds mainly on detritus, crustaceans (basically copepods) and hydroids. According to Caine (1977) this species should be considered in the category 3 (predators) based on the lack of swimming setae, and the presence of a mandibular palp and molar process. Guerra-García and Tierno de Figueroa (2009) also found that the presence of a molar was generally related to a diet with high detritus content, as in *A. acanthosoma*. Further caprellid collections and studies in the Pacific coast of Central and South America are needed to properly understand the ecological importance of amphipod communities in marine tropical habitats.

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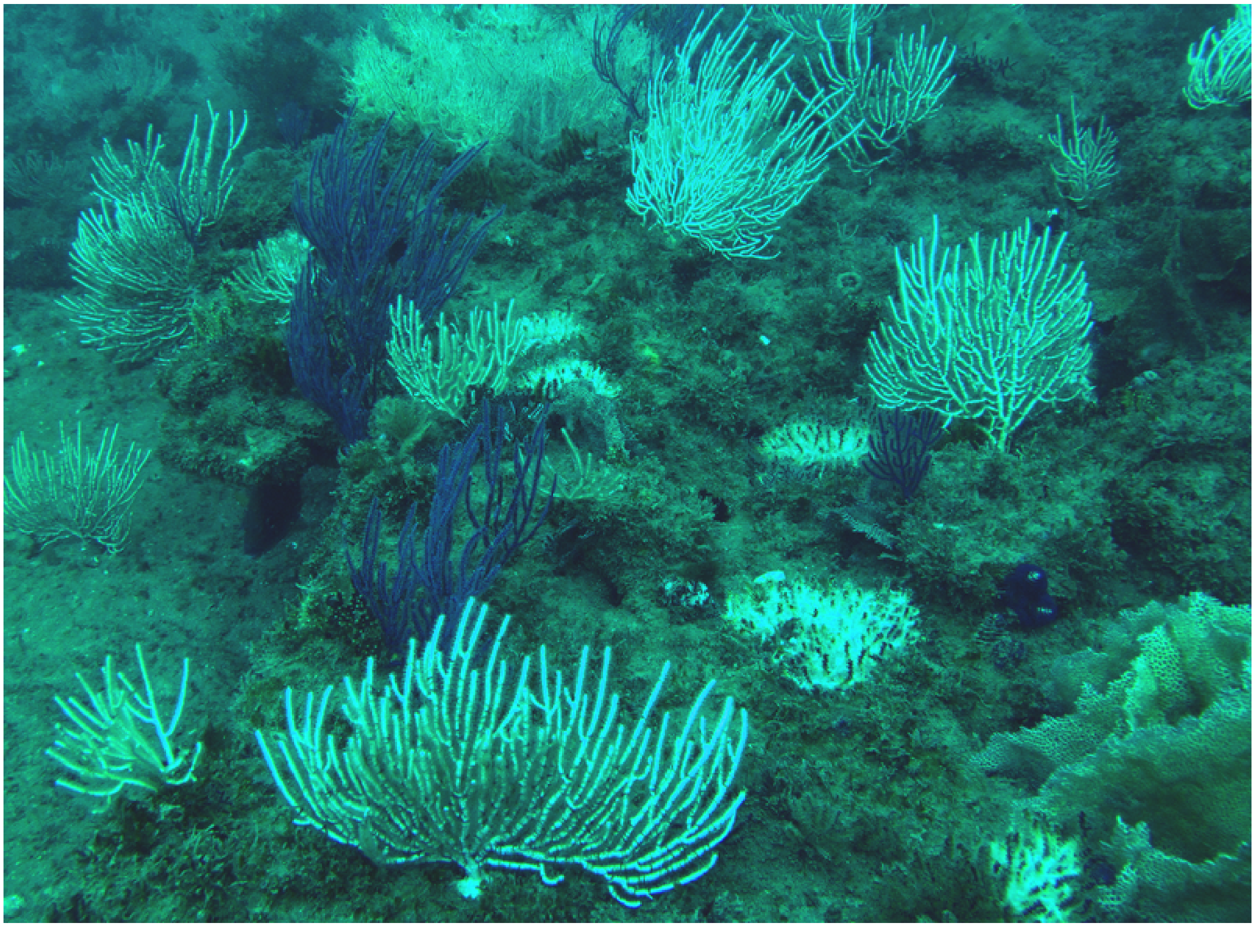

Fig. 1. Submarine landscapes dominated by gorgonians in Los Frailes (15 meters depth), Machalilla National Park, Ecuador.

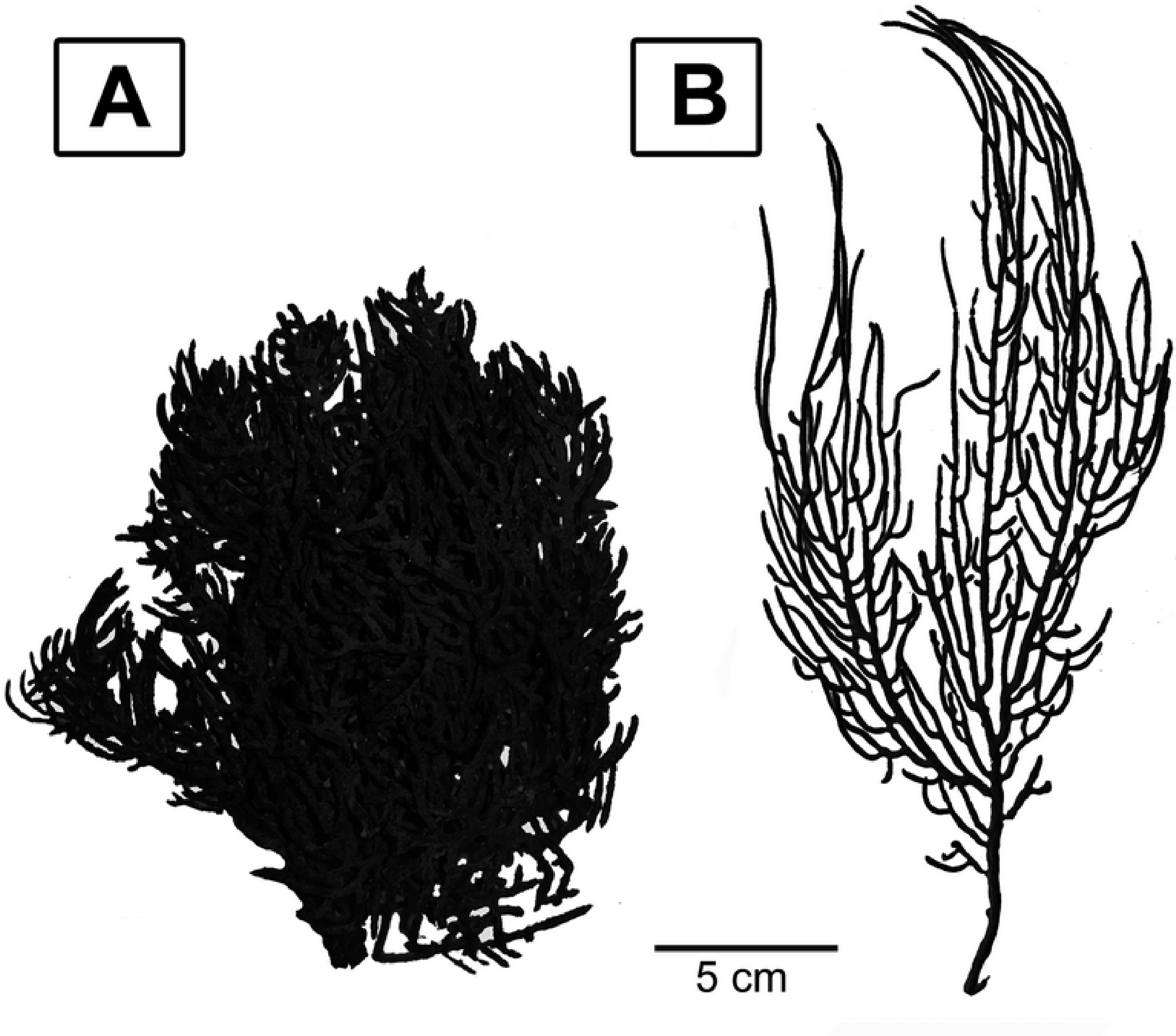

Fig. 2. *Leptogorgia obscura* (A) and *Leptogorgia* sp. (B).

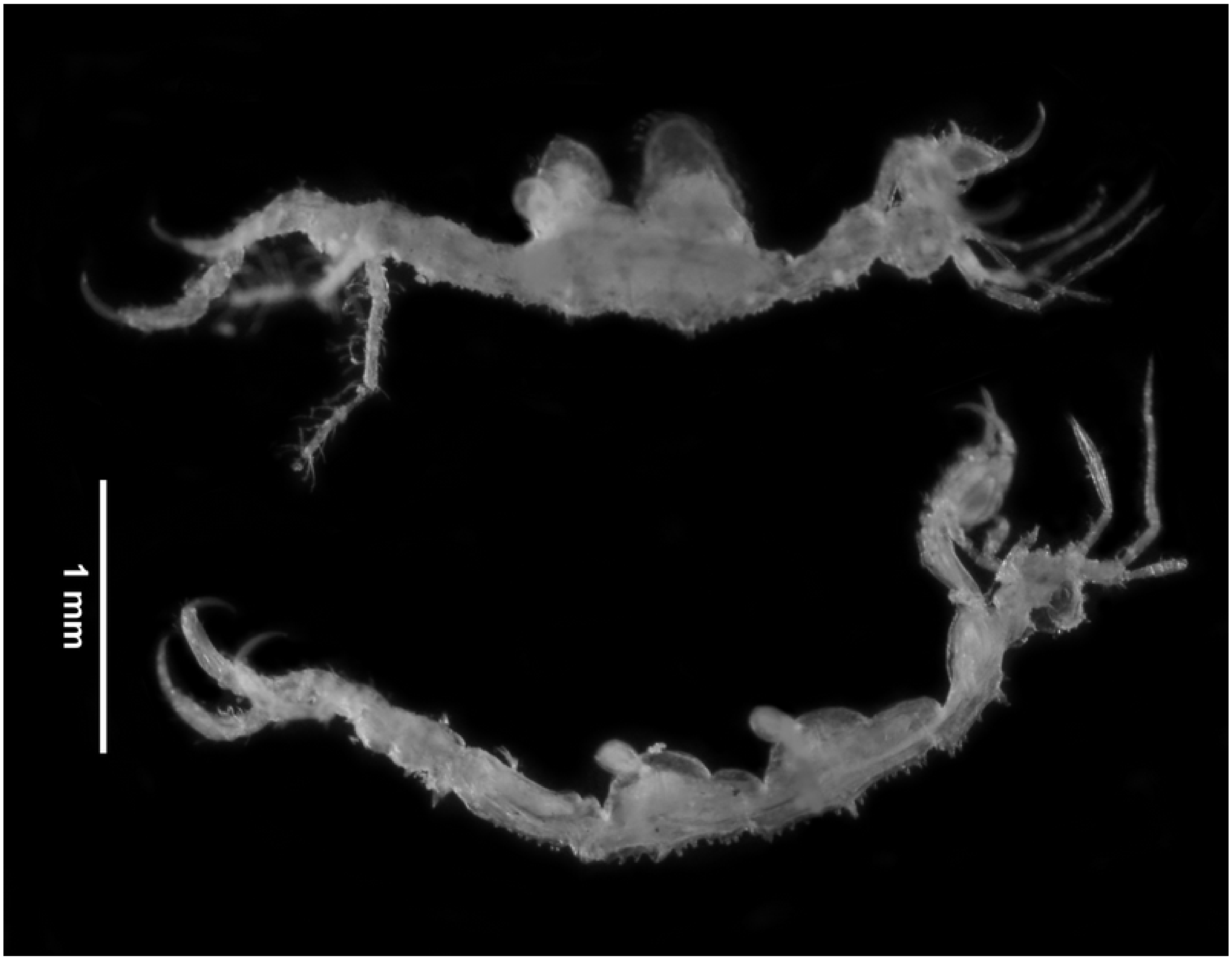

Fig. 3. Lateral view of male (right) and female (left) of *A. acanthosoma* from Ecuador.

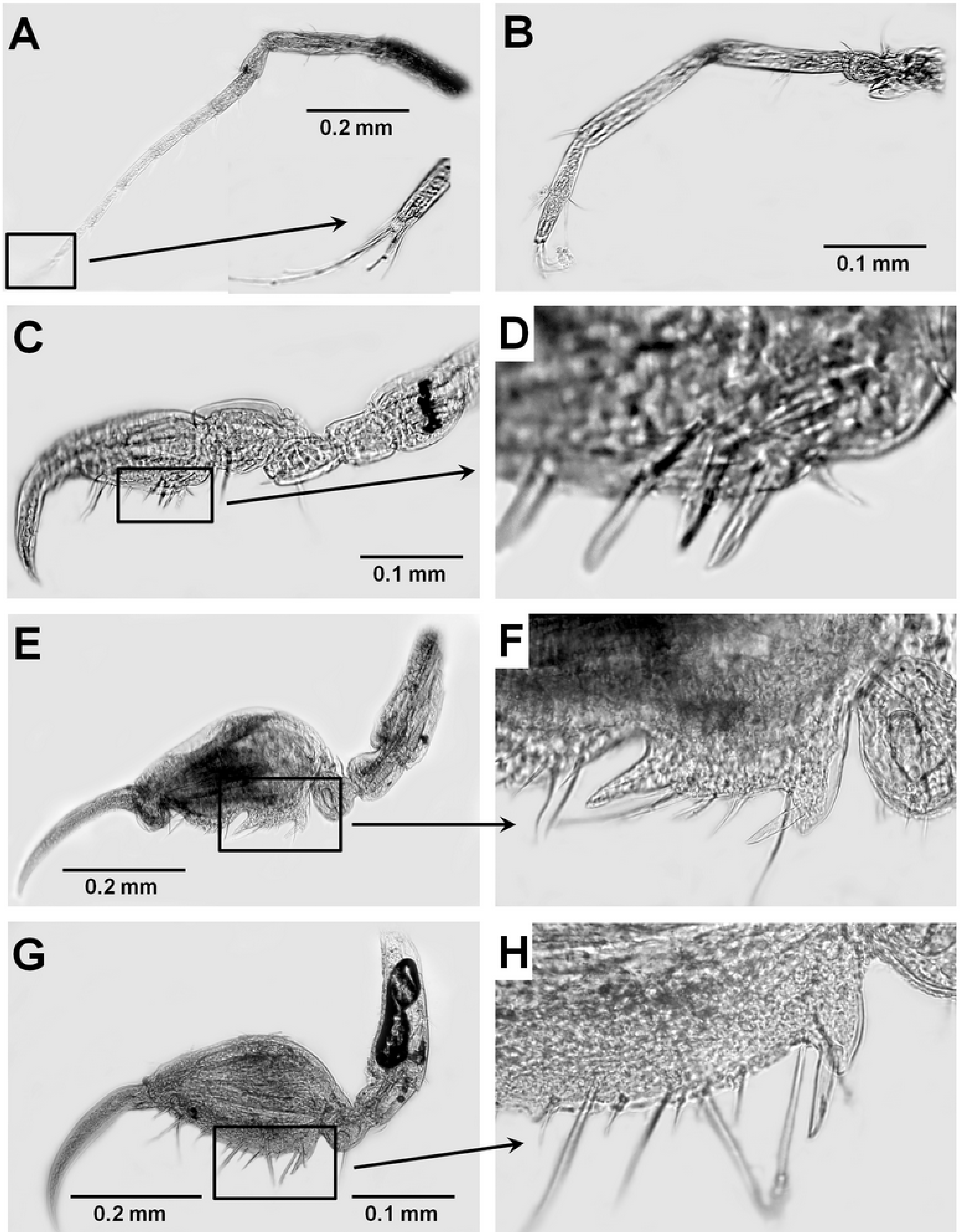

Fig. 4. A) Male antenna 1 showing a detail of the distal article of the flagellum; B) Male antenna 2; C) Male gnathopod 1; D) Detail of spines in the propodus of male gnathopod 1; E) Male gnathopod 2; F) Detail of male gnathopod 2; G) Female gnathopod 2; H) Detail of female gnathopod 2.

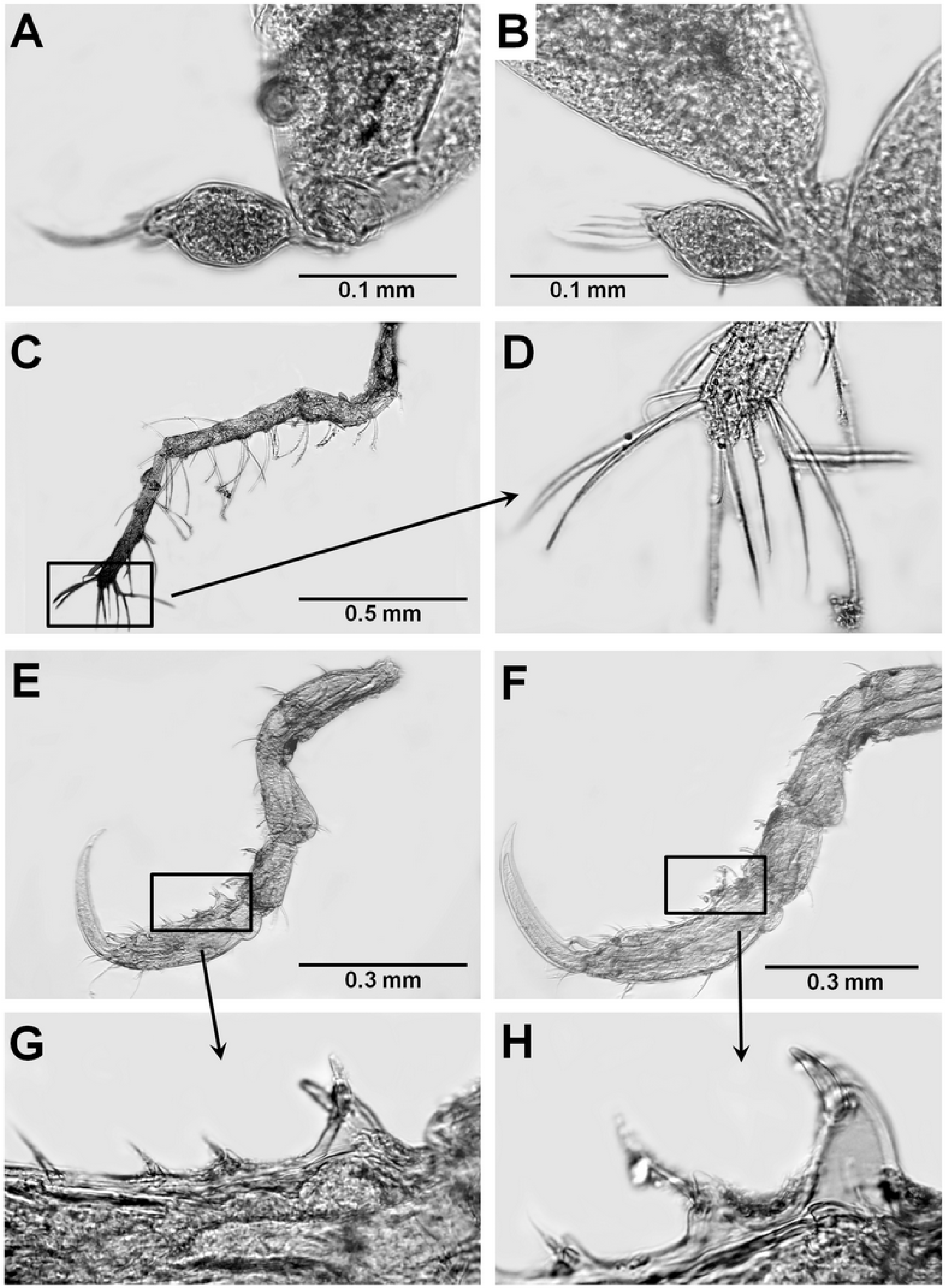

Fig. 5. A) Male pereopod 3; B) Male pereopod 4; C) Female pereopod 5; D) Detail of female pereopod 5; E) Male pereopod 6; F) Male pereopod 7; G) Detail of graping spines in male pereopod 6; H) Detail of grasping spines in male pereopod 7

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