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# Two new closely related species of *Copidognathus* (Acari: Halacaridae) associated with crabs

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**Abstract:** Juveniles and adults of two species belonging to the genus *Copidognathus* were found associated with crabs. *C. libiniensis* sp. nov. was found in the abdomen of males of *Libinia spinosa* H. Milne Edwards, 1934 (Decapoda, Pisidae) while *C. menippensis* sp. nov. was found in ovigerous and post-ovigerous females of *Menippe nodifrons* Stimpson,1859 (Decapoda, Menippidae). Both species are described and ecological remarks are made.

**Resumé :** *Deux très proches nouvelles espèces du genre* Copidognathus *(Acari : Halacaridae) associées à des crabes*. Des adultes et des immatures de deux espèces appartenant au genre *Copidognathus* (Acari, Halacaridae) ont été trouvés en association avec des crabes. *Copidognathus libiniensis* sp. nov. a été trouvée sur l'abdomen des mâles de *Libinia spinosa* H. Milne Edwards, 1934 (Decapoda, Pisidae) alors que *Copidognathus menippensis* sp. nov. a été trouvée sur des femelles ovigères et post-ovigères de *Menippe nodifrons* Stimpson,1859 (Decapoda, Menippidae). Les deux espèces sont décrites et des commentaires sur leur écologie sont également donnés.

*Keywords: Copidognathus*, *Libinia*, *Menippe*, Halacaridae, Crabs, Brazil.

## Introduction

Most members of the family Halacaridae are free-living forms. However, there are some records of the close association between members of the megafauna and halacarid mites in the literature. There is a great diversity of phyla participating in these associations and their occurrences are widely distributed. It is possible to suppose that this association of halacarids with individuals of other groups is more frequent than it is registered in the literature.

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Two species are found in association with sponges, *Halacarellus obsoletus* Bartsch, 1991 and *Spongihalacarus longiscutus* Otto, 2000. The latter is remarkable because of the specialized fashion of its gnathosoma with vestigial palps. This feature occurs apparently due to a long common history despite the unknown nature of the ecological relationship (Otto, 2000).

Three different cases of associations between halacarid mites and molluscs are found in the literature. Cáceres-Martínez et al. (2000) have registered the occurrence of *Copidognathus* inside the mantle chambers and on the gills of the bivalve *Mytilus galloprovincialis* Lamarck, 1819, apparently causing no damage to the host.

The members of the subfamily Halixodinae

(Halacaridae, Prostigmata), *Halixodes chitonis chitonis* Brucker, 1897 and *H. chitonis stoutae* Stout & Viets, 1959 are supposed to be parasitic, at least as nymphs, on the gills and inside the mantle chambers of *Cryptoconchus porosus* (Burrow, 1815) (Acanthochitonina, Acanthochitonidae) and of the limpet *Sigapatella novaezelandiae* (Lesson, 1831) (Prosobranchia, Calyptraeidae) in New Zealand (Stout & Viets, 1959).

*Parahalixodes travei* Laubier, 1960 was found in association with the nemertean *Cerebratulus hepaticus* Hubrecht, 1879. The species was supposed to be ectoparasite and the enlarged and pointed rostrum and chelicerae are apparently used for piercing the hosts (Laubier, 1960).

*Enterohalacarus minutipalpis* Viets, 1938, the single species of the sub-family Enterohalacarinae Viets, 1938, has some conspicuous features related to parasitism such as modified mouth parts, and was found in the gut of the sea urchin *Plesiodiadema indicum* (Doderlein, 1900) (Echinoidea, Aspidodiadematidae) in Philippines (Viets, 1938).

Regarding crustaceans, *Peza daps* Harvey, 1990 (Halacaroidea, Pezidae) was obtained from the gill chambers of *Engaeus fultoni* Smith & Schuster, 1913 (Decapoda, Parastacidae) (Harvey, 1990). *Astacopsiphagus parasiticus* Viets, 1931 was found attached to the gills of the Australian freshwater crayfish *Euastacus spinifer* Heller 1865 (Decapoda, Parastacidae) by their chelicerae (Viets, 1931). *Velardeacarus gasconi* Gil & Garzon, 1980 was obtained from the gill chambers of the marine crab *Peltarion spinulosum* (White, 1843) (Decapoda, Atelecyclidae) collected along the Uruguayan coast. Unfortunately, the description of the latter species has a lot of inaccuracies and it is possible that *Velardeacarus* is a junior synonymous of *Copidognathus*. *Copidognathus stevcici* Bartsch, 1976 was obtained from ovigerous females of *Maja squinado* Herbst, 1788 (Decapoda, Majidae). Finally, all stages of *Copidognathus matthewsi* Newell, 1956, including the eggs, were found on the gills of the Hawaiian lobster *Parribacus antarcticus* Lund, 1793 (Decapoda, Scyllaridae); necrotic spots, apparently due to mites feeding, could be observed in their gill filaments (Newell, 1956).

Halacarid mites were found during studies on ectosymbionts from decapod crustaceans conducted by M.Sc. Cynthia Santos. Two different species of crabs, *Libinia spinosa* H. Milne Edwards, 1934 (Decapoda, Pisidae) and *Menippe nodifrons* Stimpson, 1859 (Decapoda, Menippidae), were examined. Mites were observed alive on their hosts for the first time. However, the exact nature of the relationship between crabs and mites remains unknown.

Each species of crab has its own halacarid species associated and both are undescribed. In spite of both belonging to Copidognathinae and being included in the genus *Copidognathus* these mites have a combination of features that are not present in other species within that genus. Then, the definition of *Copidognathus* is extended in order to accommodate them.

## Materials and Methods

The crabs *Libinia spinosa* H. Milne Edwards, 1934 were collected by a double-ridged trawl at Poço Beach, São Sebastião Island (23°45' S, 45°17' W), during the months of September 2002, January, July and September 2003. The menippid crabs *Menippe nodifrons* Stimpson,1859 were collected by hand at Figueira Beach, São Sebastião (23°49' S, 45°24'W), in July 2003 and January 2004. Thirty-seven males and fifty-four females (forty-three ovigerous) of *L. spinosa*, six males and twenty-five females of *M. nodifrons* (fourteen ovigerous) were surveyed for the occurrence of mites. From the latter locality sand and algae surrounding crabs were collected in order to search for mites.

Crabs were transported to the laboratory facilities at the Centro de Biologia Marinha (CEBIMar-USP) where they were kept alive in tanks with flow-through seawater system.

The identification of crabs followed Melo (1996). Dissection of live crabs was performed in the specimens previously anaesthetised by cold temperature (10 minutes at -18°C). The crab carapace was cut with the aid of scissors and removed in order to provide complete access to the gills in both branchial chambers. All gills were removed with the aid of a forceps and put in a Petri dish filled with seawater. The gills, the branchial chambers, the carapace, the limb axillae, the abdomen and the sternum of male and non-ovigerous female crabs were carefully examined. Ovigerous female crabs were examined as above and their egg-bearing pleopods were removed for further examination. Mites were picked up under a dissecting microscope.

Prevalence of infestation was defined as the percentage of crabs infested, intensity of infestation (expressed as a range) was defined as the number of mites in each host specimen, and mean intensity as the average number of mites per infested crab (Margolis et al., 1982; Bush et al., 1997).

The sand and algae were washed above a fine-meshed sieve (meshes 50 $\mu$m wide) and the fauna obtained was surveyed for mites. In addition to the mites obtained as above, a female belonging to the same species, which was associated with *L. spinosa,* was found among phytal samples at Martim de Sá Beach, Caraguatatuba (23°38' S, 45°24'W). These samples were collected and sorted by researchers of the "Benthic marine diversity of the State of São Paulo" project, in the frame of the BIOTA/FAPESP program. Mites were cleared in lactic acid and mounted in glycerin jelly. The holotypes were deposited in the Museu de Zoologia da Universidade de São Paulo (MZUSP).

Drawings were made with the aid of a camera lucida.

Abbreviations used throughout text and captions: AD, anterior dorsal plate; AE, anterior epimeral plate; GA, genitoanal plate; GO, genital opening; GP, genital plate (nymphal stages only); OC, ocular plate; PD, posterior dorsal plate; PE, posterior epimeral plate; Legs numbered I to IV and the segments, in proximal to distal, named: trochanter, basifemur, telofemur, genu, tibia and tarsus; palpal segments in same order numbered P1 to P4; ds, dorsal setae, from anterior to posterior: ds-1 to ds-5; glp, gland pores; pgs, perigenital setae. Chaetotaxy formulas are referred without solenidia and parambulacral setae, from trochanter to tarsus. The position of certain structures was described according to Newell (1984), using the decimal system.

## Systematics

### Sub-family Copidognathinae Bartsch, 1983

There is a pair of gland pores on AD, another on OC, one or two on PD and a pore canaliculus on lateral of OC. AE bears three pairs of setae and a pair of epimeral pores. Female has three pairs of perigenital setae and a pair of subgenital setae. Male usually has a crown of perigenital setae and four, three or rarely five subgenital setae. Palp is four-segmented with one seta on P2 and none on P3. Tibiae I and II have no more than three ventral setae. Tarsi have large lateral claws and a reduced medial one. Only a single nymphal stage is present, the protonymph.

### Genus *Copidognathus* Trouessart, 1888

Female genital plate has three pairs of perigenital setae; genital sclerite has a pair of subgenital setae. Four-segmented palp has P2 with one distdorsal setae, P3 without setae and P4 usually with three basal setae, one distal setula and two terminal spurs. Tibiae I and II bear two or three ventral spines. Tarsi I and II have dorsolateral solenidion. Tarsus I bears three ventral setae, two-doublet eupathidia and dorsolateral famulus represented by a little hole on the claw lamella. Medial claw reduced. Only a single nymphal stage is present, the protonymph.

### *Copidognathus libiniensis* sp.nov.
(Figs 1-4)

*Material examined*

Eleven males of *L. spinosa* presented mites. Following specimens were examined.

*Holotype*

One female (MZUSP), on *Libinia spinosa* from 25 m depth at Poço Beach (São Sebastião Island, Ilhabela, São Paulo; 23°45' S, 45°17' W), 18 July 2003; Coll. C. Santos.

*Paratypes*

One male (MZUSP), 1 female (MZUSP), 3 eggs (author's collection), 1 quiescent male within protonymph (author's collection), 7 females (author's collection) and 1 male (author's collection), data as for holotype; 1 larva, 1 protonymph (MZUSP), 2 larvae, 1 protonymph, (author's collection), on *Libinia spinosa* from 25 m depth at Poço Beach (São Sebastião Island, Ilhabela São Paulo; 23°45' S, 45°17' W ), 02 September 2003; Coll. C. Santos. 1 female (author's collection), among phytal samples from Martins de Sá Beach (Caraguatatuba, São Paulo; 23°38' S, 45°24'W), 27 September 2001; Coll. BIOTA/FAPESP.

*Description*

The measurements are summarized in Table 1.

**Female:** Outline of body and plates as shown in Fig 1-A, B. Dorsal and ventral plates are separated by faintly striated cuticle. AD and PD completely smooth, without costae or areola but punctuated by canaliculi arranged in a mesh pattern as shown in Fig 1-D. Dorsal setae absent except ds-1 on AD and ds-2 on striated cuticle between AD and PD, both almost reduced to their alveolus. AD bears a pair of gland pores at level of leg I.

Ocular plates bear a well-developed porus canaliculus and glp-2 on external edge of plate. Ocular plates lack a cornea but most of them have a distinctly small refringent area that is not punctuated by canaliculi. A large amount of variation has been observed on shape of OC such as shown in Fig. 1C.

Posterior dorsal plate is apart from anal papilla by a large strip of membranous cuticle. Pair of glandular pores lies near posterior margin of PD. Adanal setae lie dorsal on anal papilla.

Ventral plates are punctuated in a pattern similar to that presented by dorsal ones. AE with three pairs of setae and a pair of well-developed epimeral pores near insertion of leg II. PE bears three ventral and one dorsal setae.

Genital anal plate usually bears three pairs of perigenital setae; however, some individuals present an increased number and an asymmetrical distribution of pgs (e.g. Fig. 1-B). One pair of setae lies on the genital sclerite, at the anterior area. The distance between anterior edge of GA and GO is 22-38 μm.

Four-segmented palp has P2 with a distdorsal seta, P3 without setae and P4 with three basal setae, one distal setula and two terminal spurs. Rostrum is the same as 0.50-0.51 of overall length of gnathosome. Chelicera has a broad movable digit.

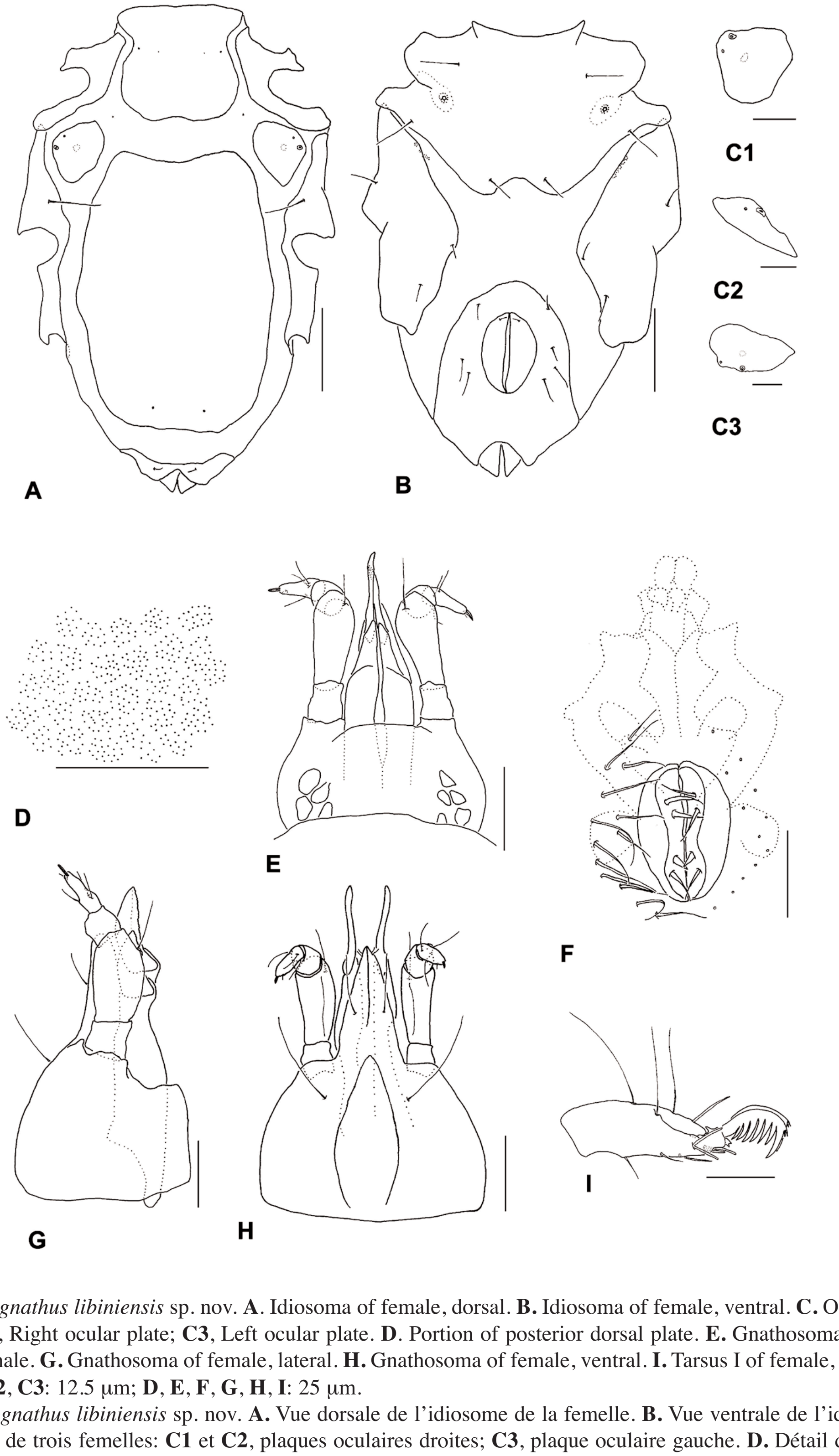


**Figure 1.** *Copidognathus libiniensis* sp. nov. **A**. Idiosoma of female, dorsal. **B.** Idiosoma of female, ventral. **C.** Ocular plates of three females: **C1** and **C2**, Right ocular plate; **C3**, Left ocular plate. **D**. Portion of posterior dorsal plate. **E.** Gnathosoma of male, dorsal. **F.** Genital opening of male. **G.** Gnathosoma of female, lateral. **H.** Gnathosoma of female, ventral. **I.** Tarsus I of female, anterior. Scale bars: **A**, **B**: 50 μm; **C1**, **C2**, **C3**: 12.5 μm; **D**, **E**, **F**, **G**, **H**, **I**: 25 μm.

**Figure 1.** *Copidognathus libiniensis* sp. nov. **A.** Vue dorsale de l'idiosome de la femelle. **B.** Vue ventrale de l'idiosome de femelle. **C.** Plaques oculaires de trois femelles: **C1** et **C2**, plaques oculaires droites; **C3**, plaque oculaire gauche. **D.** Détail de la plaque dorsale postérieure. **E.** Vue dorsale du gnathosome du mâle. **F.** Ouverture génitale du mâle. **G.** Vue latérale du gnathosome de la femelle. **H.** Vue ventrale du gnathosome de la femelle. **I.** Tarse I de la femelle, vue latérale. Échelles: **A**, **B** : 50 μm; **C1**, **C2**, **C3** : 12,5 μm; **D**, **E**, **F**, **G**, **H**, **I** : 25 μm.

**Table 1.** Measurements obtained from specimens of *Copidognathus libiniensis* sp. nov. (μm).
**Tableau 1.** Mensurations des spécimens de *Copidognathus libiniensis* sp. nov. (μm).

| | Female | | Male | | Protonynph | | Larva | |
|---|---|---|---|---|---|---|---|---|
| | Length | Width | Length | Width | Length | Width | Length | Width |
| Idiosoma | 355-390 | 225-255 | 345-365 | 235-255 | 223-251 | 123-181 | 148 | 119-122 |
| Gnathosoma | 108-118 | 91-75 | 89-104 | 75-77 | 86-89 | 66-79 | 55 | 47 |
| AD | 82-97 | 86-98 | 88-94 | 95-99 | 72 | 71 | 42-45 | 43-51 |
| OC | 28-55 | 57-25 | 28-50 | 33-55 | 30 | 28 | 17 | 12 |
| PD | 188-223 | 138-155 | 208-230 | 165-178 | 36-49 | 33 | 10-11 | 15-17 |
| AE | 113-141 | 188-230 | 105-121 | 200-208 | 61-80 | 100-111 | 58 | 119 |
| GA/GP | 113-133 | 94-113 | 145-157 | 128-132 | 30-41 | 42-47 | — | — |
| GO | 58-75 | 39-47 | 45-47 | 27-33 | — | — | — | — |

Leg chaetotaxy, observed in all individuals: leg I: 1, 2, 5, 4, 5, 6; leg II: 1, 2, 5, 4, 5, 3; leg III: 1, 1, 2, 3, 5, 4; leg IV: 0, 1, 2, 3, 5 ,3. Lateral claws have well-developed ventral teeth and accessory tooth. Medial claw reduced. Tarsi I and II have solenidion on dorsolateral claw fossa. Tarsus I (Fig 1-I) with three dorsal setae, parambulacral setae divaricate, solenidion, three ventral setae (one proximal and two distal unpaired ones) and famulus. A conical pore on the dorsal margin of the claw fossa membrane represents this. Tarsus II has parambulacral setae divaricate. Legs lack lamellae and bipectinate spines, in spite of medial and ventral setae of tibiae I and II are stronger than the dorsal ones. Length/height ratio from telofemurs I–IV: 1.49–1.69; 1.37–1.55; 1.89–1.97 and 2.14–2.76. The same for the tibiae I– IV: 1.47–1.69; 1.44–1.73; 2.50–2.80 and 2.41–3.08.

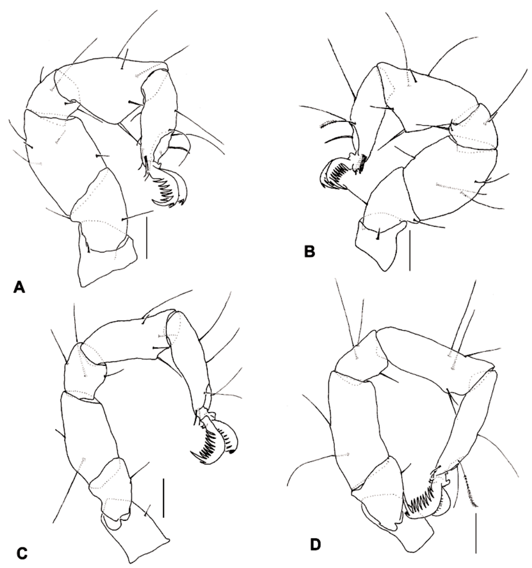


**Figure 2.** *Copidognathus libiniensis* sp. nov., **female**. **A.** Leg I, anterior. **B.** Leg II, anterior. **C.** Leg III, anterior. **D.** Leg IV, anterior. Scale bars: **A**, **B**, **C**, **D**: 25 μm.

**Figure 2.** *Copidognathus libiniensis* sp. nov., **femelle**. **A**. Patte I, vue antérieure. **B**. Patte II, vue antérieure. **C.** Patte III, vue antérieure. **D.** Patte IV, vue antérieure. Échelles : **A**, **B**, **C**, **D** : 25 μm.

**Male:** Males are similar to females except for the genital plate. GO is surrounded by 34 perigenital setae. Four pairs of subgenital setae are present; the first, second and fourth ones are seta-like, the third pair is spur-like. The distance between the edges of GA and GO is 71-79 μm; distance from anterior margin of GA to spermatophorotype is 24-27 μm. Crown of perigenital setae reaches the level of the first spermatophorotype arm.

**Protonymph:** Plates are less extensive than in the adults. PD is reduced to a little triangle-like plate. Dorsal setae could not be seen, except by alveolus of ds-1 and ds-2. Adanal seta lies dorsal on anal papilla. AE has three pairs of setae and a pair of well-developed epimeral pores. PE has one dorsal and two ventral setae. Underneath genital operculum there is a pair of genital suckers. This is separated from the anal plate by a stripe of striated cuticle.

Leg IV is five-segmented. Leg chaetotaxy: leg I:1, 2, 3, 4, 5, 6; leg II:1, 2, 3, 4, 5, 3; leg III:1, 1, 2, 3, 5, 4; leg IV:0, 3, 3, 5, 3.

**Larva:** Posterior dorsal plate is represented by a minute triangle-like sclerite. Dorsal setae could not be seen, except by a reduced pair of ds-1 and ds-2. Adanal setae lie dorsal on anal papilla. AE has three pairs of setae and a pair of well-developed epimeral pores. PE has only one ventral and none dorsal setae.

All legs have the femur fused. Leg chaetotaxy: leg I:1, 4, 4, 5, 6; leg II:1, 4, 4, 5, 3; leg III:1, 3, 3, 5, 3.

**Eggs:** Many eggs could be found attached to the ventral and marginal setae of crab abdomen. The eggs apparently

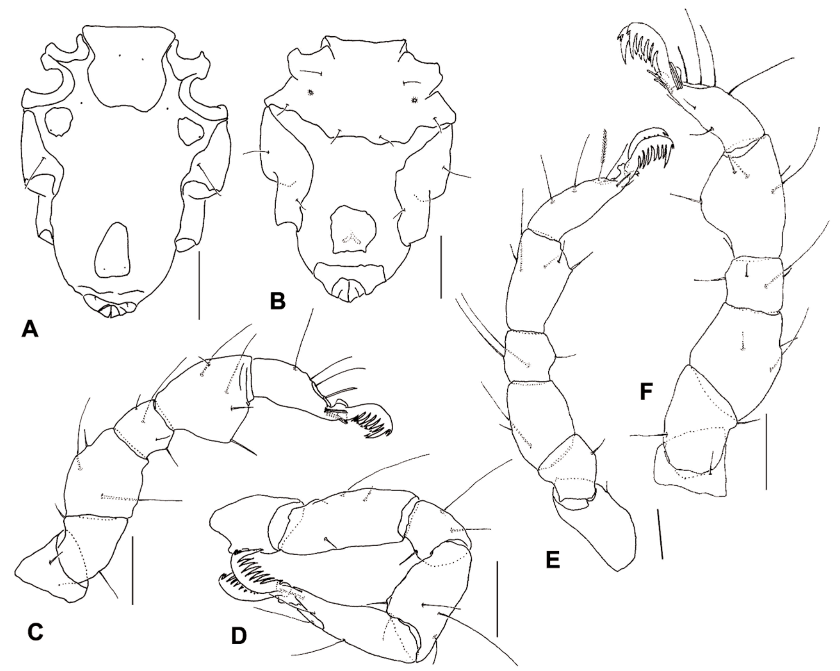


**Figure 3.** *Copidognathus libiniensis* sp. nov., **protonymph**. **A.** Idiosoma, dorsal. **B.** Idiosoma, ventral. **C.** Leg II, anterior. **D.** Leg IV, posterior. **E.** Leg III, anterior. **F.** Leg I, anterior. Scale bars: **A**, **B**: 50 µm; **C**, **D**, **E**, **F**: 25 µm.

**Figure 3.** *Copidognathus libiniensis* sp. nov., **protonymphe**. **A.** Idiosome, vue dorsale. **B.** Idiosome, vue ventrale. **C.** Patte II, vue antérieure. **D.** Patte IV, vue postérieure.**E.** Patte III, vue antérieure. **F.** Patte I, vue antérieure. Échelles: **A**, **B** : 50 µm; **C**, **D**, **E**, **F** : 25 µm.

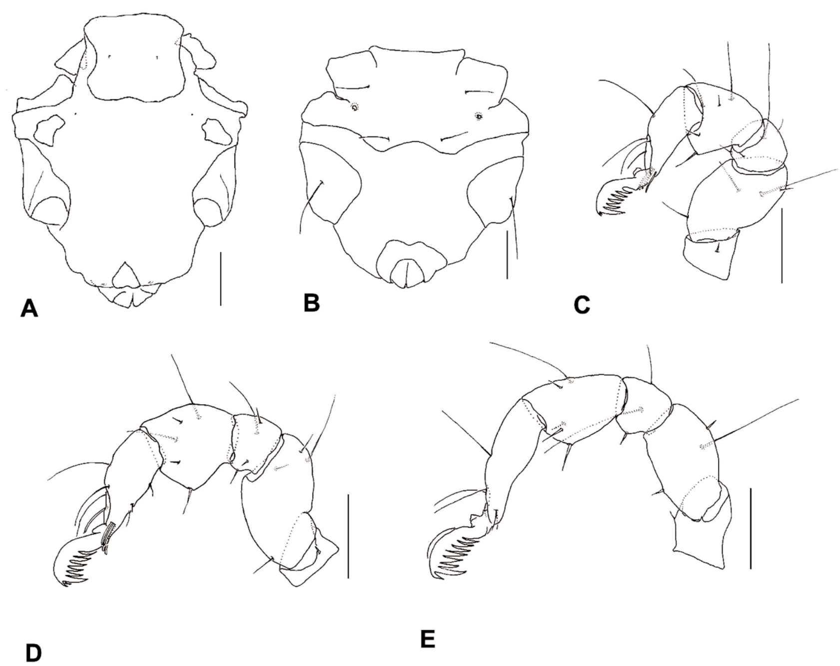


**Figure 4.** *Copidognathus libiniensis* sp. nov., **larva**. **A.** Idiosoma, dorsal. **B.** Idiosoma, ventral. **C.** Leg II, anterior. **D.** Leg I, anterior. **E.** Leg III, anterior. Scale bars: **A, B, C, D, E**: 25 µm.

**Figure 4.** *Copidognathus libiniensis* sp. nov., **larva**. **A.** Idiosome, vue dorsale. **B.** Idiosome, vue ventrale. **C.** Patte II, vue antérieure. **D.** Patte I, vue antérieure. **E.** Patte III, vue antérieure. Échelle: **A, B, C, D, E** : 25 µm.

are attached by a secretion that also involves them. They are joined in groups of different sizes, frequently more than three eggs, the maximum amount of eggs observed inside ovigerous females. It is remarkable that a significant number of eggs but no larva or protonymphs were found (except by a quiescent protonymph) in the samples obtained on July 18th while in the crabs collected on September 2nd both larvae and protonymph were obtained.

*Etymology*

Referring to the host species where these mites were obtained, *Libinia spinosa*.

*Copidognathus menippensis* sp. nov.
(Fig. 5-7)

*Material examined*

One ovigerous and one post-ovigerous females of *M. nodifrons* presented mites. The following specimens were examined.

*Holotype*

One female (MZUSP), on an ovigerous *Menippe nodifrons* from intertidal at Figueira Beach, (São Sebastião, São Paulo; 23°49' S, 45°24'W), 28 July 2003; Coll. C. Santos.

*Paratypes*

One male (MZUSP), 4 females (author's collection), 3 males (author's collection), 1 protonymph (author's collection); data as for holotype; 3 females (author's collection), on a post-ovigerous *Menippe nodifrons* from intertidal at Figueira Beach, (São Sebastião, São Paulo; 23°49' S, 45°24'W), 22 January 2004; Coll. C. Santos, A. R. Pepato, C. G. Tiago.

*Description*

Measurements are summarized in Table 2.

**Female:** Outline of body and plates as shown in Fig. 1-A, B. Dorsal and ventral plates are separated by faintly striated cuticle. AD and PD foveate throughout by rosette pores; it is made up of canaliculi around an alveolus. AD has three distinctly elevated areolae, one anterior and two posterior. AD bears ds-1 between posterior areola and glp-1 on its anterior margin.

Most individuals have ds-2 on striated cuticle between AD and PD, besides insertion on anterior edge of OC also was observed. Ocular plates have a well-developed porus canaliculus, a gland pore and two areas devoid of punctuation, similar to corneas.

Pair of ds-3 could not be found. Costae on PD with small modified rosette pores or single canaliculus as shown in Fig. 5-C. These costae reach the middle of plate and gradually get mixed up with the remaining plate. Outline of areola, cornea and costae are indicated in Fig. 5-A by dotted lines. Pair of ds-4 and ds-5 on posterior half of PD, frequently unpaired. PD bears a pair of gland pores near posterior margin. Adanal setae lie dorsal on anal papilla.

Most of ventral plates are punctuated by large canaliculi arranged as exemplified in the inferior portion of Fig. 5-D. AE has three pairs of setae and a pair of well-developed epimeral pores, PE with three ventral setae and a dorsal one.

Besides variations observed in one of the sides of genitoanal plates, most of them presented three pairs of setae (e.g. Fig. 5-B). Genital sclerite bears a pair of subgenital setae on their anterior area. The distance between the anterior margin of GA and GO is 58-70 μm.

Rostrum is the same as 0.52-0.57 overall length of gnathosoma. Palps have one distodorsal seta on P2; P3 without seta; P4 with three basal setae, one setula and a terminal spur. Chelicerae have a broad movable digit.

Legs without well-developed lamellae. Chaetotaxy as follows: leg I: 1, 2, 5, 4, 5, 6; leg II: 1, 2, 5, 4, 5, 3; leg III: 1, 1, 2, 6, 5, 4; leg IV: 0, 1, 2, 3, 5, 3. Lateral claws with strong ventral teeth and accessory tooth. Medial claws are reduced. Tarsi I and II with dorsal solenidion. Tarsus I has three ventral setae, one proximal and two paired distal; three dorsal setae and divaricate eupathidia. Tarsus I also bears a famulus represented by a small canal that opens at posterior face of claw fossa membrane. Tarsus II has parambulacral setae divaricate. Length/height ratio from telofemurs I–IV: 1.59–1.7; 1.57–1.82; 1.97–2.15 and 2.37–2.07. The same for the tibiae I–IV: 1.71–1.86; 1.72–1.91; 2.07–2.18 and 2.13–2.43.

**Male:** Males resemble females in most features. GA bears 42-47 perigenital setae. Genital sclerite with four pairs of subgenital setae joined in an anterior and other posterior couple. The third pair of subgenital setae is spur-like; the remaining ones are seta-like. Distance between anterior edge of GA and GO is 71-77 μm, distance between anterior margin of GA and spermatophorotype is 38-44 μm. Crown of perigenital setae reaches near the second arm of spermatophorotype.

**Protonymph**: Dorsal plates reduced when compared to the adult ones. Pair of ds-1 between posterior areolae of AD. Pair of ds-2 on striated cuticle in front of OC. Pair of ds-3 could not be seen. PD rectangle-shaped, with ds-4 and ds-5, a pair of costae and a pair of gland pores. PD is apart from anal papilla by a wide band of striated cuticle. Anal papilla bears a dorsal pair of adanal setae.

AE has three pairs of setae and a pair of well-developed epimeral pores. PE with three ventral and one dorsal setae. Genital plate with a pair of internal acetabula. This is apart

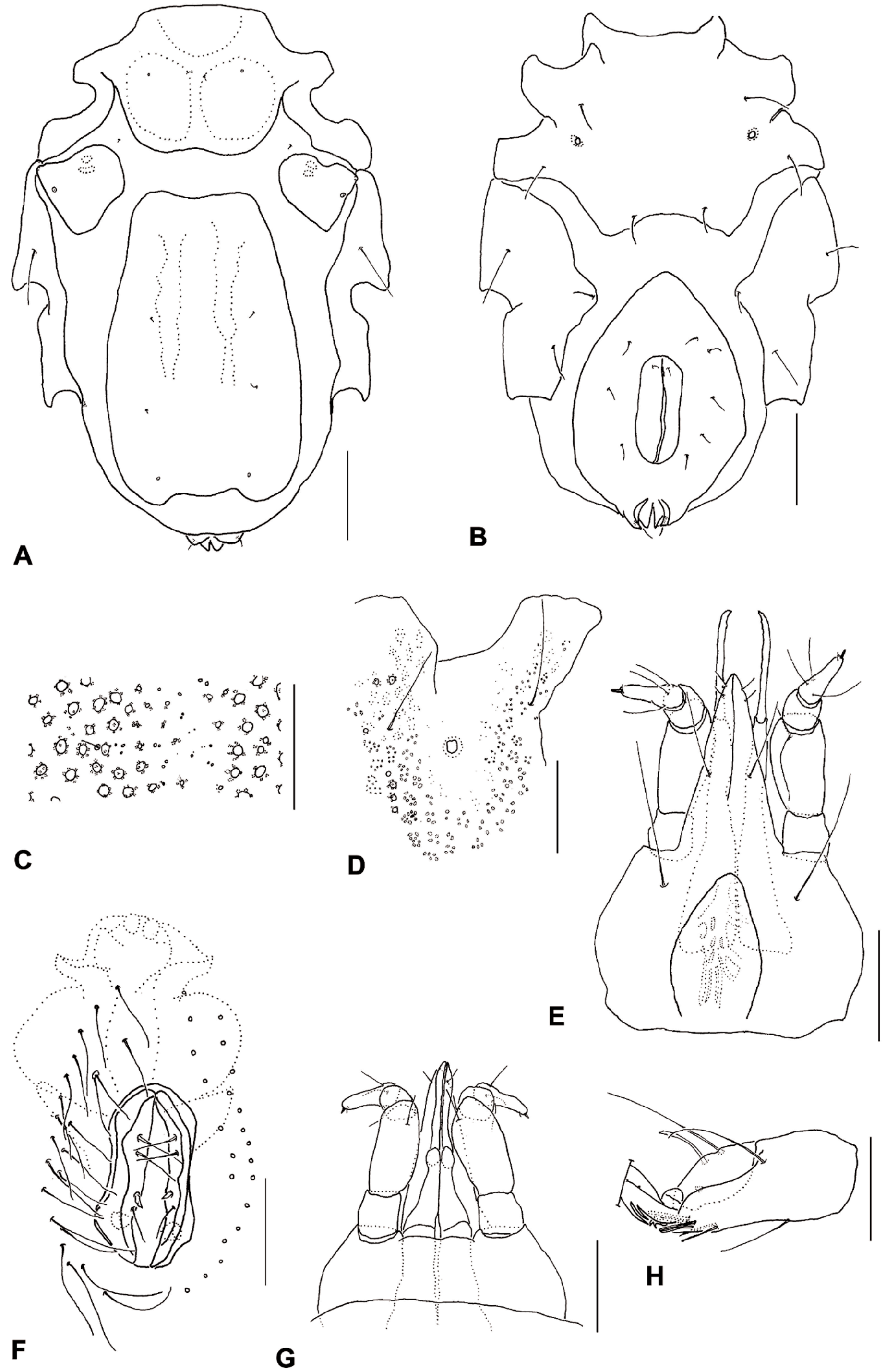


**Figure 5.** *Copidognathus menippensis* sp. nov. **A.** Idiosoma of female, dorsal. **B.** Idiosoma of female, ventral. **C.** Portion of PD close to ds-4 **D.** Portion of AE close insertion of Leg I. **E.** Gnathosoma of male, ventral. **F.** Genital opening of male. **G.** Gnathosoma of female, dorsal. **H.** Tarsus I of male, anterior. Scale bars: **A**, **B**: 50 µm; **C**, **D**, **E**, **F**, **G**, **H**: 25 µm.

**Figure 5.** *Copidognathus menippensis* sp. nov. **A.** Vue dorsale de l'idiosome de la femelle. **B.** Vue ventrale de l'idiosome de la femelle. **C.** Détail de la plaque dorsale postérieure proche de ds-4. **D.** Détail de le plaque coxale antérieure proche de l'insertion de la patte I. **E.** Vue ventrale du gnathosome du mâle. **F.** Ouverture génitale du mâle. **G.** Vue dorsale du gnathosome de la femelle. **H.** Tarse I du mâle, vue antérieure. Échelles: **A**, **B** : 50 µm; **C**, **D**, **E**, **F**, **G**, **H** : 25 µm.

**Table 2.** Measurements obtained from specimens of *Copidognathus menippensis* sp.nov (µm).
**Tableau 2.** Mensurations des spécimens de *Copidognathus libiniensis* sp. nov. (µm).

| | Female | | Male | | Protonynph | |
|---|---|---|---|---|---|---|
| | Length | Width | Length | Width | Length | Width |
| Idiosoma | 340-375 | 216-285 | 335-355 | 230-255 | 306 | 226 |
| Gnathosoma | 90-99 | 70-82 | 96-97 | 72-75 | 85 | 63 |
| AD | 80-107 | 132-149 | 86-97 | 127-132 | 75 | 74 |
| OC | 49-74 | 52-58 | 61-68 | 53-55 | 39 | 42 |
| PD | 200-228 | 120-145 | 180-200 | 150-160 | 110 | 64 |
| AE | 113-138 | 208-235 | 120-132 | 210-230 | 86 | 198 |
| GA/GP | 155-175 | 120-150 | 150-160 | 127-135 | 53 | 43 |
| GO | 52-74 | 30-50 | 50-52 | 30-33 | — | — |

from anal plate by a band of striated cuticle.

Femur IV undivided. Chaetotaxy as follows: leg I: 1, 2, 3, 4, 5, 6; leg II: 1, 2, 3, 4, 5, 3; leg III: 1, 1, 2, 3, 5, 4; leg IV: 0, 3, 3, 5, 3.

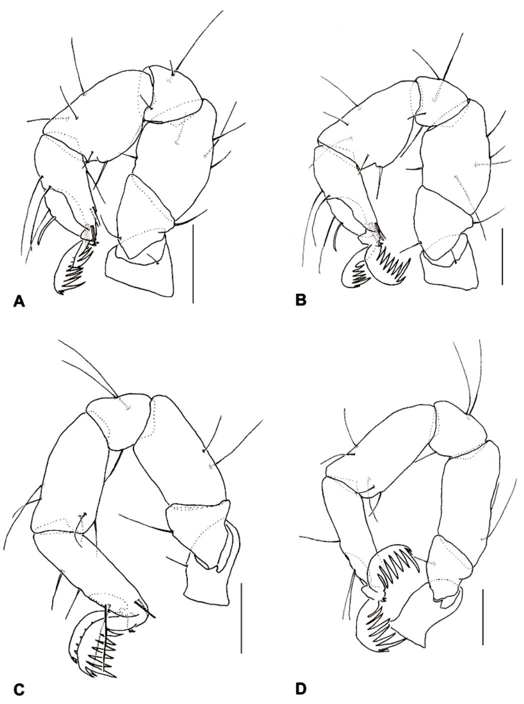


**Figure 6.** *Copidognathus menippensis* sp. nov. **A.** Leg I of male, anterior. **B.** Leg II of female, anterior. **C.** Leg III of male, anterior. **D.** Leg IV of male, anterior. Scale bars: **A, B, C, D**: 25 µm.

**Figure 6.** *Copidognathus menippensis* sp. nov. **A.** Patte I du mâle, vue antérieure. **B.** Patte II de la femelle, vue antérieure. **C.** Patte III du mâle, vue antérieure. **D.** Patte IV du mâle, vue antérieure. Échelles: **A**, **B**, **C**, **D** : 25 µm.

*Etymology*

Referring to the generic name of the host species, *Menippe nodifrons*.

## Discussion

Both species can be easily separated from each other by the presence of costae, areola and four dorsal setae in *C. menippensis* while *C. libiniensis* lacks dorsal ornamentation and most of dorsal setae. Moreover, whereas *C. libiniensis* has 22-25 pgs around male GO and the distance between anterior margin of female GA and GO is 22-38 µm, *C. menippensis* has 42-47 pgs on males and the referred distance is 71-77 µm.

In spite of these differences, both species share most features of typical *Copidognathus* such as direct development of protonymphs, presence of one pair of subgenital setae in females, absence of setae in P3, presence of three setae on basal P4, three ventral setae and doublet parambulacral setae on tarsus I. However, they also share a feature that could not be found in any other species belonging to this genus, the chaetotaxy of tibiae I and II. All *Copidognathus* species found in the literature have seven setae at these segments instead of five found in the species described above. Besides this, the unusual strong ventral teeth on lateral claws and the absence of bipectinate setae are regarded as apomorphics traits, which let us infer that these species are closely related.

Other two *Copidognathus* associated with crabs, *Copidognathus stevcici* Bartsch, 1976 and *Copidognathus matthewsi* Newell, 1956, both have seven setae on tibiae I and II. *Velardeacarus gasconi* Gil & Garzon, 1980 needs a more detailed study because its description has a lot of inaccuracies; probably it belongs to *Copidognathus*. However, *V. gasconi* was figured with two bipectinate medial spines on tibia I, and both species described here are devoid of these spines.

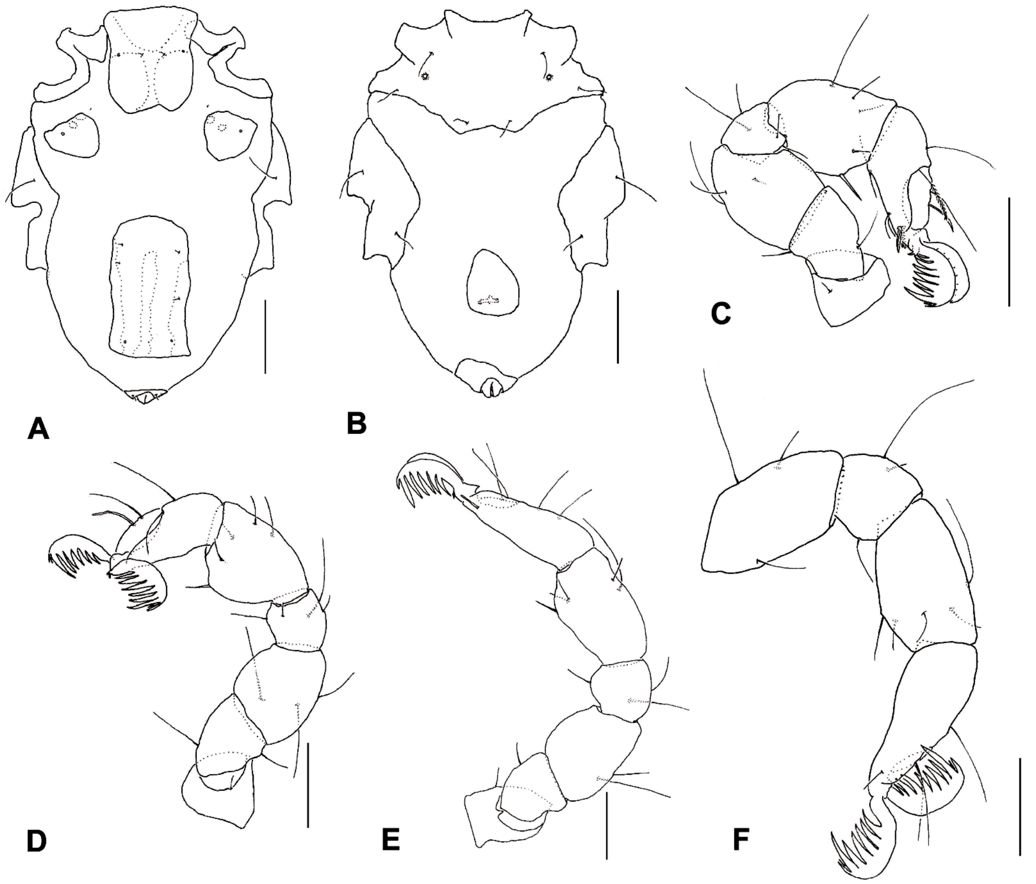


**Figure 7.** *Copidognathus menippensis* sp. nov., **protonymph. A.** Idiosoma, dorsal. **B.** Idiosoma, ventral. **C.** Leg I, anterior. **D.** Leg II, anterior. **E.** Leg III, anterior. **F.** Leg I, posterior. Scale bars: **A, B**: 50 µm; **C, D, E, F**: 25 µm.

**Figure 7.** *Copidognathus menippensis* sp. nov., **protonymphe. A.** Idiosome, vue dorsale. **B.** Idiosome, vue ventrale. **C.** Patte I, vue antérieure. **D.** Patte II, vue antérieure. **E.** Patte III, vue antérieure. **F.** Patte IV, vue postérieure. Échelles : **A**, **B** : 50 µm ; **C**, **D**, **E**, **F** : 25 µm.

*Ecological observations*

*Copidognathus libiniensis*: The overall prevalence of infestation by *C. libiniensis* sp. nov. in *Libinia spinosa* was 12.1%. The intensity of infestation varied from 1 to 20; the mean intensity of infestation was 7.1. Only male hosts were infested. The prevalence of infestation in males was 29.7%.

*Copidognathus menippensis*: The overall prevalence of infestation by *C. menippensis* in *Menippe nodifrons* was 6.5%. The intensity varied from 5 to 16; the mean intensity was 10.5. Only females were infested; however, the number of observed males was low, only six. The prevalence of infestation on females was 8.0%. All halacarids were found on the pleopods of *M. nodifrons* and the infested females were ovigerous or post-ovigerous. No mites belonging to this species was found in the substrate near the crabs.

*Ecological remarks*

The samples obtained are insufficient to accept or reject any hypothesis on the nature of the relationship between mites and crabs.

As no direct evidence of feeding on crabs or crab's eggs was found in the course of the present study the possibility that these species feed on accompanying species, such as cirripeds, copepods and nemerteans could not be rejected. However, the absence of infested females of *L. spinosa* might be due to the differences observed in morphology of abdomen in males and females of this crab species. The abdomen was the preferred infestation site by *C. libiniensis* sp.nov. that also occurred in the sternum of their hosts. The ventral side of the abdomen of males is more delicate than that of females of *Libinia spinosa*. This softness might enable the halacarids to pierce the exoskeleton in this area to obtain nutrients from the host. On the other hand, *C.*

*mennipensis* sp. nov. was found only in ovigerous or post-ovigerous females of *M. nodifrons* which let us suppose this species to be an egg-predator.

The morphology of claws in Halacarid apparently is related to the need of a better grip to the substrate, as due to strong wave action (Pugh et al., 1987). As beaches where individuals of both species are not exposed to strong waves it is possible that claw structure has been evolved due to selection benefiting a better grip to the host surface. However, as the entire life cicle of these mites are unknown this feature could be related to other environmental factor. *C. libiniensis* and *C. menippensis* also present chelicerae with broad movable digits that could be used to pierce the delicate exoskeleton present at the ventral side of the abdomen of males of *L. spinosa* or the egg membrane of *M. nodifrons*.

To support these hypotheses more collections must be done to increase the number of hosts observed and also experiments regarding feeding behaviour of both species must be conducted.

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