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SHORT COMMUNICATION

Hyperoche shihi sp. nov. (Crustacea : Peracarida : Amphipoda): a symbiont of a deep-living medusa in the Gulf of California

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From samples of deep-water zooplankton obtained in the Gulf of California, an undescribed species of the genus Hyperoche Bovallius was collected. The new species is similar to Hyperoche medusarum Kröyer and Hyperoche luetkenides Walker. It differs from its congeners mainly by the strong, large chela of pereopod 2 and the absence of processes or denticles along the posterior distal margin of same structure. It was collected at a depth of 1136 m as a symbiont of the bathypelagic hydromedusa Chromatonema erythrogonon (Bigelow). The amphipod remained grasped to the medusa subumbrellar cavity. Seven other associations are known between hyperiids and jellies in the Gulf of California, most from the epipelagic layer. This is the only deep-living species of Hyperoche known.

INTRODUCTION

The deep-water zooplankton fauna of the Gulf of California has been surveyed for several years (Wiebe *et al.*, 1988; Shushkina and Vinogradov, 1992). Our current knowledge of the gulf hyperiid fauna is compiled in two works (Siegel-Causey, 1982; Brinton *et al.*, 1986); most of this information was based upon samples from the epipelagic zone (0–200 m). Very little is known about the composition of hyperiid amphipods in deep waters of the Gulf of California.

Hyperiid amphipods have symbiotic relations with different kinds of gelatinous zooplankters; however, the nature of these biological associations in the deep-living forms has been studied recently (Gasca and Haddock, 2004). To the hyperiids, the symbiotic relation starts at the onset of their life cycle, when they are assumed to be strict parasites (Dittrich, 1987, 1992), but the relation is variable and includes ectocommensalism, endocommensalism, protection, micropredation, buoyancy and transportation (Vader, 1983). This aspect has become a key topic to understand their distributional patterns and biology.

Ongoing research on these associations have been developed based on *in situ* observations and sampling in order to discard the factors that might alter the results as an effect of standard (plankton net) zooplankton surveys (Lima and Valentin, 2001). This method has yielded new data and undescribed species of different zooplankton taxa (Pugh, 2001). Among the specimens of hyperiid amphipods collected during an oceanographic campaign in the central and southern Gulf of California, one female was tentatively identified as *Hyperoche medusarum* Kröyer, 1838 (Gasca and Haddock, 2004). A reexamination of this specimen allowed the recognition of an undescribed taxon.

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RESULTS AND DISCUSSION

Zooplankton was collected in the Gulf of California; the area was surveyed during an oceanographic cruise carried out on board the R/V *Western Flyer* of Monterey Bay Aquarium Research Institute (MBARI, USA) in March 12–31, 2003. The specimens were captured on March 29 during Dive 546 of a remotely operated submersible (ROV). The amphipod was observed *in situ* in association with the medusa and then captured and brought on board the ship. After initial manipulation *in vivo*, the specimens were fixed in 4% formaldehyde; the medusa was preserved in a solution of propylene glycol 4.5 %, propylene phenoxetol (0.5%) and sea water (95%) and the amphipod in 70% ethanol for further taxonomic examination. The morphological terminology used in the description follows Vinogradov *et al.* (Vinogradov *et al.*, 1996).

Taxonomy

Superfamily Phronimoidea Dana, 1852
Family Hyperiidae Dana, 1852
Hyperoche shihi n. sp. (Figs 1–4)

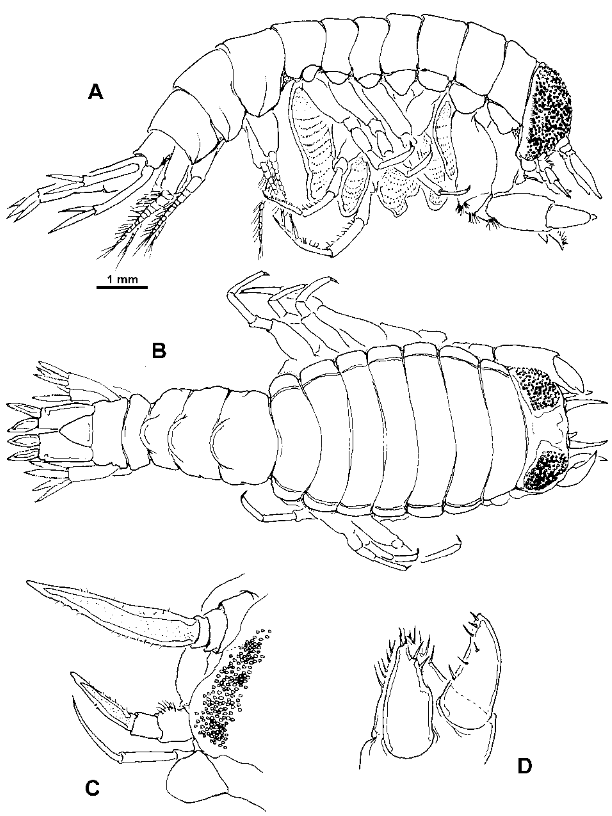

Fig. 1. *Hyperoche shihi* sp. nov., Holotype adult female. Gulf of California. **A**, lateral view; **B**, dorsal view; **C**, lateral view of head; **D**, mandibles.

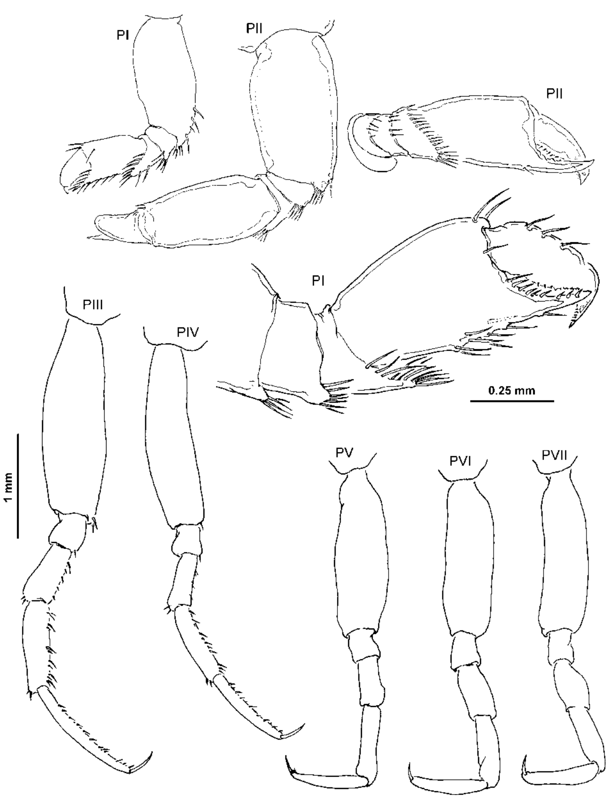

Fig. 2. *Hyperoche shihi* sp. nov., Holotype adult female. Pereopods I–VII.

Material examined

Adult ovigerous female, collected at 1136 m, March 29, 2003, in Carmen Basin south of Guaymas Basin in the Gulf of California, lattitude 26°11.04′ N; longitide 111°36.07′ W (type locality); collector Bruce Robison. Specimen undissected, preserved in 70% ethanol, Collection of Zooplankton of El Colegio de la Frontera Sur (ECOSUR), cat. ECO-CH-Z-02507.

Diagnosis (adult female)

Body length more than 10 mm. Head 2.5 times wider than long, 0.5 times longer than first pereonite. Epimerons with conspicuous keel stretching to posterior distal end, first one rounded, relatively shorter than remaining two; third epimeron subrectangular. Second segment (S2) of all pereopods with concavity for carpus. S4 of PI with long, distal process five times as long as its anterior length. S5 process pointed, reaching distal end of S6. PII stronger and longer than PI; S5 noticeably robust, 1.2 times as long as S2 (including process), margins straight and parallel. S5 process long, strong, representing ca. 1/3 of total length of bearing segment; process stretches beyond S6. Anterior margin of process with low protuberances from which short, seta arise. PIII and IV S4–6 with sets of one long and one short paired setae arranged along posterior

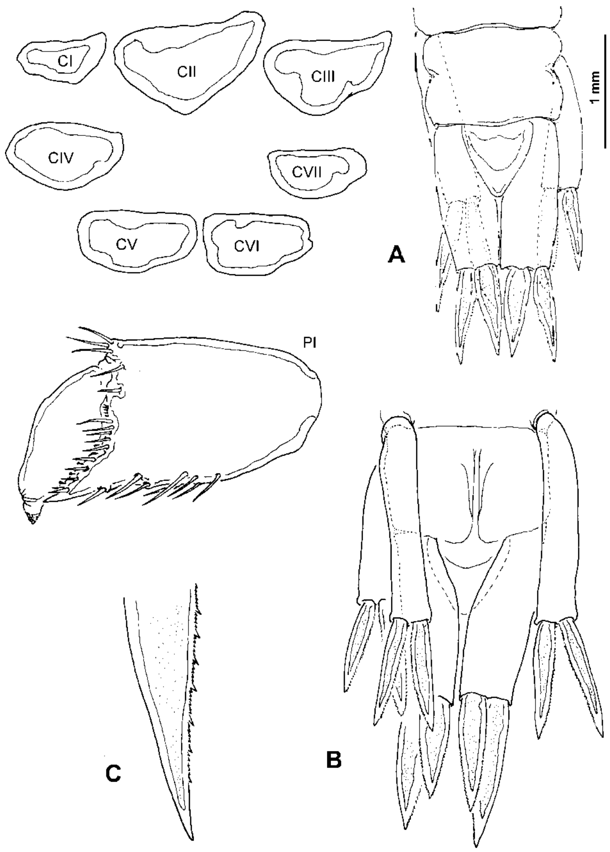

Fig. 3. *Hyperoche shihi* sp. nov., Holotype adult female. Coxae (C) I–VII; **A**, urosome, dorsal view; **B**, urosome, ventral view; **C**, third uropod (U3) exopod, ventral view.

margin. S5 with no processes or denticles but setae along posterior distal margin. Length of telson slightly less than half the pedicele of third uropod (U3).

Male unknown

Description

Adult female Total length: 10.3 mm from anterior end to posterior margin of telson. Head 2.5 times wider than long, 0.5 times longer than first pereonite. Head representing 72% of first two pereonites together. Antennal gland extending about 1/5 the height of head. Pereonites 4 and 5 relatively smaller than the first three. The three pleonites, together about 2/3 of total length of pereion. Epimerons with a conspicuous keel stretching to posterior distal end. Epimerons slightly acute, first one rounded, relatively shorter than remaining two; third epimeron subrectangular.

First urosomal segment smaller than remaining two together. Telson triangular, as long as wide at base, apex rounded. Length of telson slightly less than half the pedicele of U3. Internal margin of endopods and exopods of U1–3 denticulated.

First antenna. Longer than head, 0.33 times longer than second antenna. First segment of antennal peduncle large, robust, longer than two following segments together. Flagellum equalling three times length of peduncle, flagellar margins smooth.

Second antenna. First segment small, inconspicuous, second antennal segment rounded, about 1.6 times as wide as third segment. Flagellum with spinules with row of short hair-like setae on dorsal surface. Peduncle 2/3 the length of flagellum.

Mandible. With thin palp, almost as long as second antenna. Third segment of mandibular palp about 40% longer than second.

First pereopod. Second segment oval shaped, with moderately convex anterior margin. Same segment with anterior margin forming concavity in which S5 can be inserted. Posterior margin almost straight, with long setae on distal half plus small distal process reaching 1/3 of posterior length of S3 (including process of S3). Third segment with long setae on posterior margin with small process. Fourth segment with long, distal process five times as long as its anterior length. Large to 40% of base of distal process of S5. Segment with long spiniform setae on posterior margin. Fifth segment (carpus) well developed, with spiniform setae on posterior and lateral margins. Spines longer on anterodistal end. Carpal process pointed, reaching distal end of S6 and having strong spiniform setae along anterior concave margin. Sixth segment gradually thinner distally, anterior margin convex, with spiniform setae shorter and thinner than those on anterodistal end of fifth segment. Posterior margin with short spiniform setae and a serrate distal portion. Dactylus about 0.4 times as long as S6, with short spinules scattered on anterior surface, with single row of spinules along posterior margin. Dactylus not retractile.

Second pereopod. Stronger and longer than first one. Second segment subrectangular, anterior margin with longitudinal pouch as in PI, with short process armed with setae. Segment three with no process, but with setae. Segment four with small posterior process armed with long setae. Fifth segment noticeably robust, 1.2 times as long as second segment (including process), margins straight and parallel. Carpal process long and strong, representing ca. 1/3 of total length of bearing segment; process stretches beyond sixth segment. Anterior margin of process with low protuberances from which short seta arise. Sixth segment similar in shape, 1.5 times than that of first pereopod. Dactylus not retractile, triangular, base wider than in that of first pereopod, with setae along posterior margin.

Third and fourth pereopod. Second segment elongated with posterior margins straight and anterior margins convex; like in PI and PII these have longitudinal pouch along anterior margins in which the next segments can be inserted. This pouch is present also in PV–VII but on the posterior distal portion. S4–6 with sets of one long and one short paired setae arranged along posterior margin. S5 with no process or denticles but setae along posterior distal margin. S7 with small denticles along 1/5 of proximal posterior margin.

Fifth to seventh pereopods. PV–VII shorter than PIII and IV. Pereopods with usual morphology and ornamentation in the genus, with no setae or denticles on S2–7; S2 rectangular.

Eggs spherical, contained in ventral marsupium; 26 eggs, average diameter 0.39 mm.

Colour. *In vivo*, body orange, eyes red (Fig. 4); body yellowish after fixation.

Etymology

This species was named in honour of Dr. Chang-tai Shih for his outstanding work on hyperiid amphipods and for his help in exploring this group in Mexican waters.

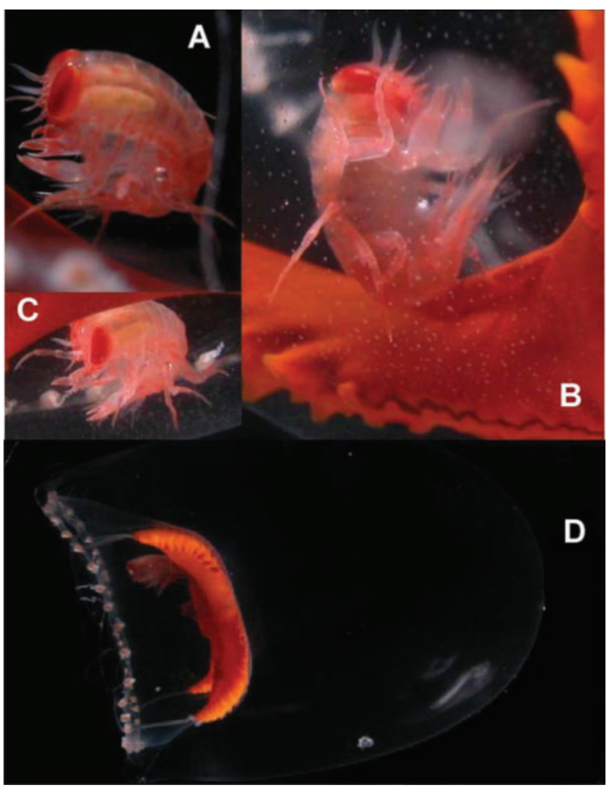

Fig. 4. **A**–**D**, *Hyperoche shihi* sp. nov. specimen photographed alive on the medusa *Chromatonema erythrogonon* (Bigelow, 1909). **A**, Holotype specimen *in vivo*, lateral view; **B**, same, attached to gonad of host, ventral view; **C** and **D**, specimen on subumbrellar cavity (Photos by Steven H. D. Haddock).

Remarks

Hitherto, *Hyperoche* Bovallius, 1887 contained seven species (Vinogradov *et al*., 1996): *H. medusarum* (Kröyer, 1838), *Hyperoche martinezi* (Müller, 1864), *Hyperoche cryptodactylus* Stebbing, 1888, *Hyperoche picta* Bovallius, 1889, *Hyperoche luetkenides* (Walker, 1906), *Hyperoche mediterranea* Senna, 1908 and *Hyperoche capucinus* Barnard (1930). *H. shihi* sp. nov. represents the eighth species of the genus.

Hyperoche shihi sp. nov. is morphologically most closely related to *H. medusarum*; it was tentatively identified as the latter species (Gasca and Haddock, 2004). It has affinities also with *H. luetkenides*. The new species can be distinguished from *H. medusarum* by having setae, not denticles, on the posterior margin of S5 of PIII and PIV. A setose posterior margin of this segment is present also in *H. luetkenides* (Weigmann-Haass, 1991) but in *H. shihi* n. sp. setae are arranged in pairs. Also, *H. shihi* sp. nov. differs from these two congeners in the absence of processes or denticles on S5 of PIII, these are present in the other two species. In *H. shihi* the posterior distal process of S4 of PI does not reach half the length to the base of distal process S5 (Fig. 2, PI), whereas in *H. medusarum* the process reaches beyond the base (Vinogradov *et al*., 1996). The most striking distinctive character of *H. shihi* is the particularly large, strong P2 with a very robust S5, which is 10% longer than S2 versus a 25% shorter condition in the other two species. The process (S5 of P2) is a third of the length of the segment in the new species (Fig. 4).

The other species of *Hyperoche* are all epipelagic or even coastal forms (Weigmann-Haass, 1990; Vinogradov *et al*., 1996; Vinogradov, 1999). *Hyperoche shihi* is the only deep-living species of the genus known to date. The new species was found to be symbiotic to the leptomedusa *Chromatonema erythrogonon* (Bigelow, 1909), an inhabitant of intermediate and deep waters of the Eastern Tropical Pacific (Kramp, 1965). The medusa (cat. number ECO-CHZ- 02508) was ca. 60 mm both in diameter and height when alive (Fig. 4) and has 45 tentacles. The taxonomy of the three species contained in *Chromatonema* (*C. erythrogonon*, *Chromatonema hertwigi* Vanhoeffen, 1911 and *Chromatonema rubrum* Fewkes, 1882) is still under discussion as differences between the former and the latter are subtle and based on the number of tentacles, which is a variable character. This is the first information on the symbiotic relations of this medusa.

The amphipod moved within and remained grasped (PV–VII) to the subumbrellar cavity of the medusa. The observation *in vivo* showed that, together with the fact that the medusa was intact, the amphipod was not feeding upon the medusa but probably shared the food with its host (Dittrich, 1992). Other species of *Hyperoche* cause no damage on the hosts (Brusca, 1970; Evans and

Sheader, 1972; Flores and Brusca, 1975); the amphipod uses its host as food only when no other food source is available (Dittrich, 1992). This evidence is contrary to the view that hyperiids are entirely parasitic forms (Laval, 1980).

Juvenile hyperiids cannot search and infest their potential host (Laval, 1980); probably, the ovigerous female of *H. shihi* was about to deposit the demarsupiated juveniles onto the cavity of *C. erythrogonon*. Later on, juveniles will probably behave as true parasites and feed upon the medusa as they grow (Laval, 1980), or, as suggested by von Westernhagen (von Westernhagen, 1976) and Dittrich (Dittrich, 1992) for *Hyperia galba* (Montagu) and *Hyperoche. medusarum*, will primarily share the food with the medusa.

Associations between hyperiid amphipods and medusae have been known mainly from standard plankton surveys, but its nature is best studied *in situ* (Madin and Harbison, 1977; Gasca and Haddock, 2004). There are seven other associations known between hyperiids and medusae in the Gulf of California (Gasca and Haddock, 2004).

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