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ORIGINAL ARTICLE

Malacoplax californiensis (Lockington, 1877) (Crustacea: Decapoda: Brachyura: Panopeidae) in the Gulf of California, Mexico

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ABSTRACT

A series of specimens of *Malacoplax californiensis* (Lockington, 1877) is reported from the Gulf of California, significantly increasing the known localities for the otherwise rarely reported species from 3 to 12. Depth range is increased to 110–114 m on the continental shelf. Environmental conditions associated with the crabs were: 12.4–27.0°C; 1.9–5.0 ml/l O2; 58–98% sandy sediments. Males and females were sexually distinct even at small sizes (4.2 mm and 3.5 mm CW, respectively). Two small specimens were infested with a rhizocephalan, a condition not reported previously for this species of panopeid.

KEYWORDS

Burrowing crab, western Mexico, distribution, tropical eastern Pacific, Rhizocephala

INTRODUCTION

About 450 species of true crabs (Brachuyra) have been reported for the tropical eastern Pacific (Hendrickx, 1995a). Despite an intensive series of field work performed in both coastal and offshore habitats, there is still a lack of distribution data for many species which are known from only a few localities. Although many species of crabs are regularly caught by fishing vessels in the Gulf of California, Mexico (*e.g.*, *Hepatus* spp., *Osachila* spp., *Portunus* spp., some majids and parthenopids) (Hendrickx, 1995b; 1997; 1999), other species are rarely collected or have been little studied, including burrowing species that often escape the fishing gear.

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Malacoplax californiensis (Lockington, 1877), the California burrowing crab, is a small crab living in muddy substrates (Garth and Abbott, 1980, Wicksten, 2012). The only member of its genus, it has been scarcely reported within its distribution range, from California to Costa Rica. In the Gulf of California there are only three records for this species. A large scale survey of the invertebrates fauna associated with the continental shelf of the Gulf of California and occasional sampling in coastal ecosystems allow for the capture of a series of specimens that increase significantly our knowledge on its distribution and its ecology.

Material and Methods

Specimens were all collected in the Gulf of California, Mexico, by hand and with a small dredge in costal ecosystems, or with sediment grabs and as part of the catch in trawl hauls during the CORTES 2 (March 1985) and CORTES 3 (August 1985) cruises aboard the R/V "El Puma" of the Universidad Nacional Autónoma de México (UNAM). Material examined is listed chronologically and was collected by the authors unless otherwise indicated. All the material was measured to the nearest 0.1 mm with a Vernier and deposited in the Regional Collection of Marine Invertebrates (ICML-EMU followed by catalogue number). Environmental data were taken from Hendrickx and Salgado Barragán (1991) and Hendrickx (1999). Abbreviations are: St., sampling station; CW, carapace width; Id., identified by; Coll., collected by.

Results and Discussion

Infraorder Brachyura Latreille, 1802

Superfamily Xanthoidea MacLeay, 1838

Family Panopeidae Ortmann, 1893

***Malacoplax californiensis* (Lockington, 1877)**

(Figs. 1–3)

Eucrate ? californiensis Lockington, 1877: 33.
Eucrate californiensis.– Brandão *et al.*, 2012: 1.
Speocarcinus californiensis.— Holmes, 1900: 77.— Rathbun, 1904: 190, pl. 9, fig. 1.— Rathbun, 1918: 42, textfig. 16, pl. 10, figs 2, 3.— Schmitt, 1921: 249, textfig. 148, pl. 34, fig. 7.— Johnson and Snook, 1927: 398, fig. 346.— Glassell, 1934: 454.— Garth, 1960: 118.— Garth, 1961: 155.

Figure 1. *Malacoplax californiensis*. Dorsal and ventral view of male (left) and female (right). Scale bar, 10 mm.

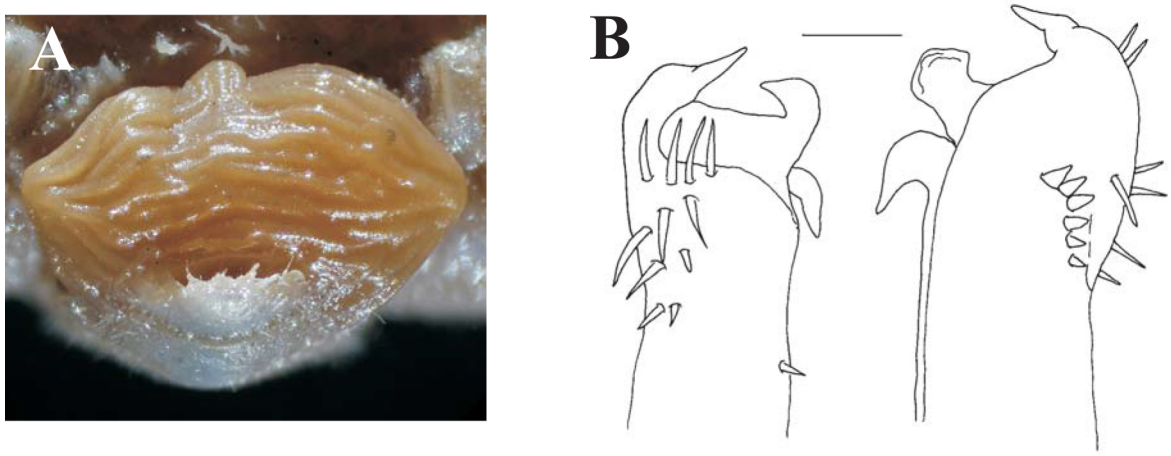

Figure 2. *Malacoplax californiensis*. A. Specimen (CW 6.3 mm) infested with parasitic Rhizocephala. B. Tip of first gonopod of male (CW 11.1 mm), frontal and caudal views. Scale bar, 0.1 mm.

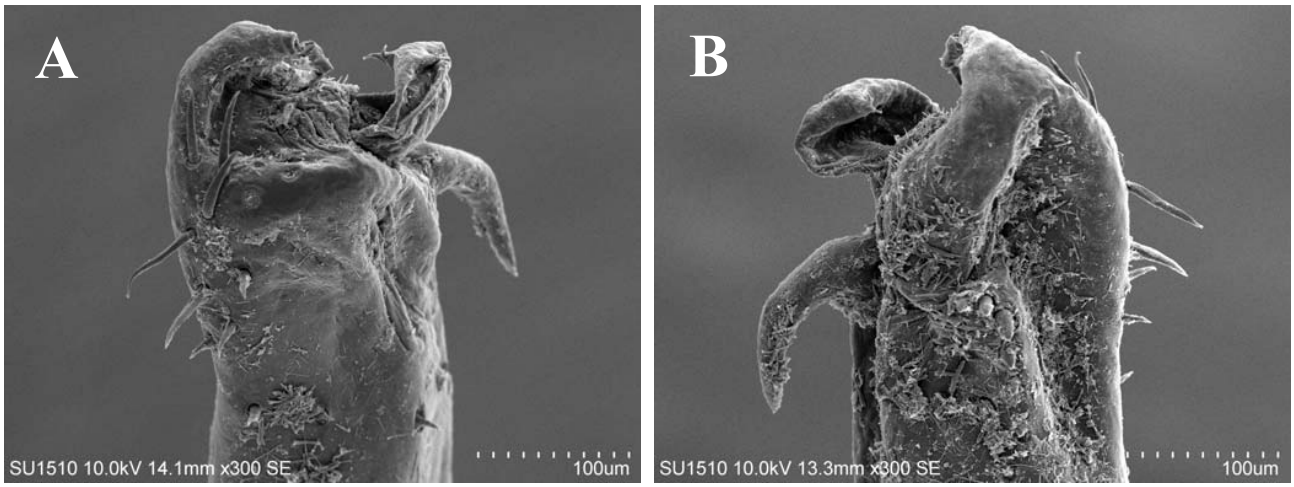

Figure 3. *Malacoplax californiensis* (male, CW 11.9 mm). SEM photographs. A. Tip of first gonopod, frontal. B. Same, caudal view.

Malacoplax californiensis.– Guinot, 1969a: 259, textfigs 7, 11, 15, 27, 260.– Guinot, 1969b: 707.– Guinot, 1970: 1079.– Garth and Abbott, 1980: 612, fig. 25.30.– Hendrickx *et al.*, 1983: 189.– Hendrickx, 1984: 34, pl. 2E, F.– Ricketts *et al.*, 1985: 357, fig. 274.– Martin and Abele, 1986: 186, fig. 4G.– Hubbard and Dugan, 1989: 55.– Hendrickx, 1993a: 314 (list 18) .– Hendrickx, 1993b: 10.– Campos *et al.*, 1995: 177.– Hendrickx, 1995a: 139.– Jensen, 1995: 33, fig. 30.– Hendrickx, 1996: 615.– Hendrickx, 2005: 187.– McLaughlin *et al.*, 2005: 258, 319.– Arzola-González and Flores-Campaña, 2008: 43.– Ng *et al.*, 2008: 189.– Vargas-Castillo, 2008: 109 (Table 1), 110.–Felder and Thoma, 2010: 133, fig. 5, Appendix 1.– Campos and de Campos, 2012: 3.– Wicksten, 2012: 241, fig. 56A.– Jensen, 2014: 37, textfig.– Thoma *et al.*, 2014: 89 (Table 1), 93, 102, fig. 1.– Cortés, 2017: Appendix 1 (on line).

Material examined. Estero El Verde (23°25'30"N 106°33'00"W), December 11, 1979, 1 male (CW 11.9 mm), dredge (ICML-EMU-643) (Id. M.K. Wicksten) (see Hendrickx, 1984).

Estero de Urías (23°12'27"N 106°23'06"W), January 22, 1982, 1 female (CW 18.4 mm), beam trawl, 2–4 m (ICML-EMU-5463) (Coll. M. Hernández-Garza).

Agua Brava coastal lagoon (approximately 22°08'N 105°33'W), October 16, 1985, 2 males (CW 12.6–14.0 mm) and 1 female (CW 8.7 mm), intertidal, hand taken (ICML-EMU-3479).

CORTES 2, St. 25 (29°12'30"N 112°31'24"W), March 18, 1985, 1 male (CW 12.7 mm), 110–114 m, Otter trawl; St. 42 (30°11'54"N 112°47'W), March 17, 1985, 2 females (CW 4.5–4.9 mm), 32–34 m, Otter trawl (ICML-EMU-3478-A); St. 52 (25°40'06"N 109°28'48"W), March 20, 1985, 2 males (CW 4.6–

11.1 mm) and 2 females (CW 5.8 mm), Van Veen grab, 31m (ICML-EMU-3478-B), and 4 males (CW 5.2–14.7 mm), 4 females (CW 5.2–8.5 mm), 1 juvenile (CW 3.5 mm), and 1 specimen infested with Rhizocephala (CW 6.0 mm), Smith McIntyre grab (ICML-EMU-3478-C).

CORTES 3, St. 32 (29°46'24"N 114°19'18"W), August 3, 1985, 2 males (CW 7.6–12.1 mm), 3 females (CW 6.9–10.7 mm), 1 ovigerous female (CW 9.4 mm), and 1 specimen infested with Rhizocephala (CW 6.3 mm) (ICML-EMU-3477-A), 1 female (CW 6.8 mm) and 1 ovigerous female (CW 9.4 mm) (ICML-EMU-4002), 25–29 m, Van Veen grab; St. 42 (30°12'42"N 112°47'42"W), August 5, 1985, 8 males (CW 4.2–7.7 mm) and 8 females (CW 3.5–6.5 mm), 30 m, Otter trawl (ICML-EMU-3478-D); St. 49C (27°00'24"N, 111°59'12"W), August 7, 1985, 1 female (CW 10.1 mm), 23 m, Otter trawl (ICML-EMU-3477-B).

Santa Maria-La Reforma Bay (20°06'N, 108°08'W), March 30, 2005, 1 male (CW 21.7 mm) and 4 females (CW 4.8–16.3 mm), Yabby pump, muddy intertidal with stones and shell debris (ICML-EMU-12090).

Estero de Urías (23°10'N 106°20'W), March 14, 2008, 1 male (CW 5.8 mm) and 2 females (CW 8.0–10.4 mm), (ICML-EMU-9486) (Coll. L. Sauma).

Estero de Urías (23°12'N 106°23'W), December 4, 2017, 3 males (CW 9.3–12.7 mm) and 4 females (CW 10.0–15.5 mm), Yabby pump, muddy intertidal with some rubble (ICML-EMU-12091).

Previously reported localities. San Diego (type locality), and San Pedro, California, USA (Holmes, 1900). Venice and Alamitos Bay, California (Rathbun, 1918). Anaheim Creek, California (Schmitt, 1921). Mugu Lagoon, California, USA; San Luis Gonzaga Bay, Baja California and Punta Rocosa, Sonora, Mexico (Garth, 1960). Puerto Parker, Puerto Culebra and Golfo Dulce, Costa Rica (Garth, 1961). Angeles Bay, Baja California, Mexico (Guinot, 1969a). The locality "Ansheim Bay" given by Guinot (1969a) is Schmitt's (1921) Anaheim Creek (Orange County). Marina del Rey, Los Angeles, and "Estero" El Verde, Sinaloa, Mexico (Hendrickx, 1984; Arzola-Gonzaléz and Flores-Campaña, 2008). Conchalito, La Paz (approximately 24°10'N 110°25'W), Baja California Sur, Mexico (Campos *et al.*, 1995). Gulf of Papagayo and Salinas Bay, La Cruz, Costa Rica (Vargas-Castillo, 2008; R. Vargas-Castillo pers. comm, 2018). Morro Bay, California, and Magdalena Bay, Baja California, Mexico (Wicksten, 2012). Punta Banda Estuary (approximately 31°48'N 116°48'W), near Ensenada, Baja California (Campos and de Campos, 2012). Gulf of California, Baja California Sur, Mexico (no further information) (Felder and Thoma, 2010; Thoma *et al.,* 2014).

New localities. A total of nine new localities are reported herein (Fig. 4), all in the Gulf of California, Mexico.

General distribution. Tropical eastern Pacific from Morro Bay, California, USA, to Golfo Dulce, Costa Rica.

Habitat and bathymetry. In holes on muddy beaches (California; Holmes, 1900). In depths of 11–27 m, sandy mud, crushed shell, mangrove leaves, mud and shell (Garth, 1961). Secondary channel, coastal lagoon, close to mangroves; 1 m depth, brackish water (22 ‰) (Hendrickx, 1984). In burrows in estuaries, muddy substrate (Campos *et al.,* 1995; Campos and de Campos, 2012). From intertidal to 33 m depth (Garth and Abbott, 1980; Wicksten, 2012). Material examined is from intertidal, in a muddy environment, to 110–114 m on the shelf. Environmental conditions associated with the crabs collected on the continental platform were: water temperature, 12.4–27.0°C; dissolved oxygen, 1.9–5.0 ml/l O2; 58–98% sandy sediments, occasionally with significant portion of lime (Table 1). Jensen (2014) considered that *M. californiensis* is virtually extinct in the USA, at least in the intertidal.

Maximum size. Males, CL 16.0 mm, CW 22.6 mm (Rathbun, 1918). Examined material: males, CW 4.6–21.7 mm; females CW 3.3–16.3 mm; ovigerous females, CW 9.4 mm. Males from 4.6 mm CW and females from 3.5 mm CW show early development of sexual appendages. Two small specimens (CW 6.0 and 6.3 mm CW) were infested with Rhizocephala (Fig. 2A) and no information seems to be available on the presence of this parasite in *M. californiensis*.

Remarks. *Malacoplax californiensis* (Fig. 1) appears to be widely distributed in the Gulf of California and

Table 1. Environmental data obtained at bottom level in offshore sampling stations where *Malacoplax californiensis* was collected.

Cruise	Station	Depth (m)	Temp. (°C)	O_2 (ml/l)	Sediments (%) Sand Lime Clay	Sand
CORTES 2	25	110–114	12.4	1.90	96 – –	Fine
CORTES 2	42	33	15.5	5.0	91 – –	Fine
CORTES 2	52	31	15.5	5.0	58 35 06	–
CORTES 3	32	27	27.0	4.0	98 – –	Fine
CORTES 3	42	30	26.0	3.50	80 16 05	–
CORTES 3	49C	23	22.5	3.50	93 – –	Very fine

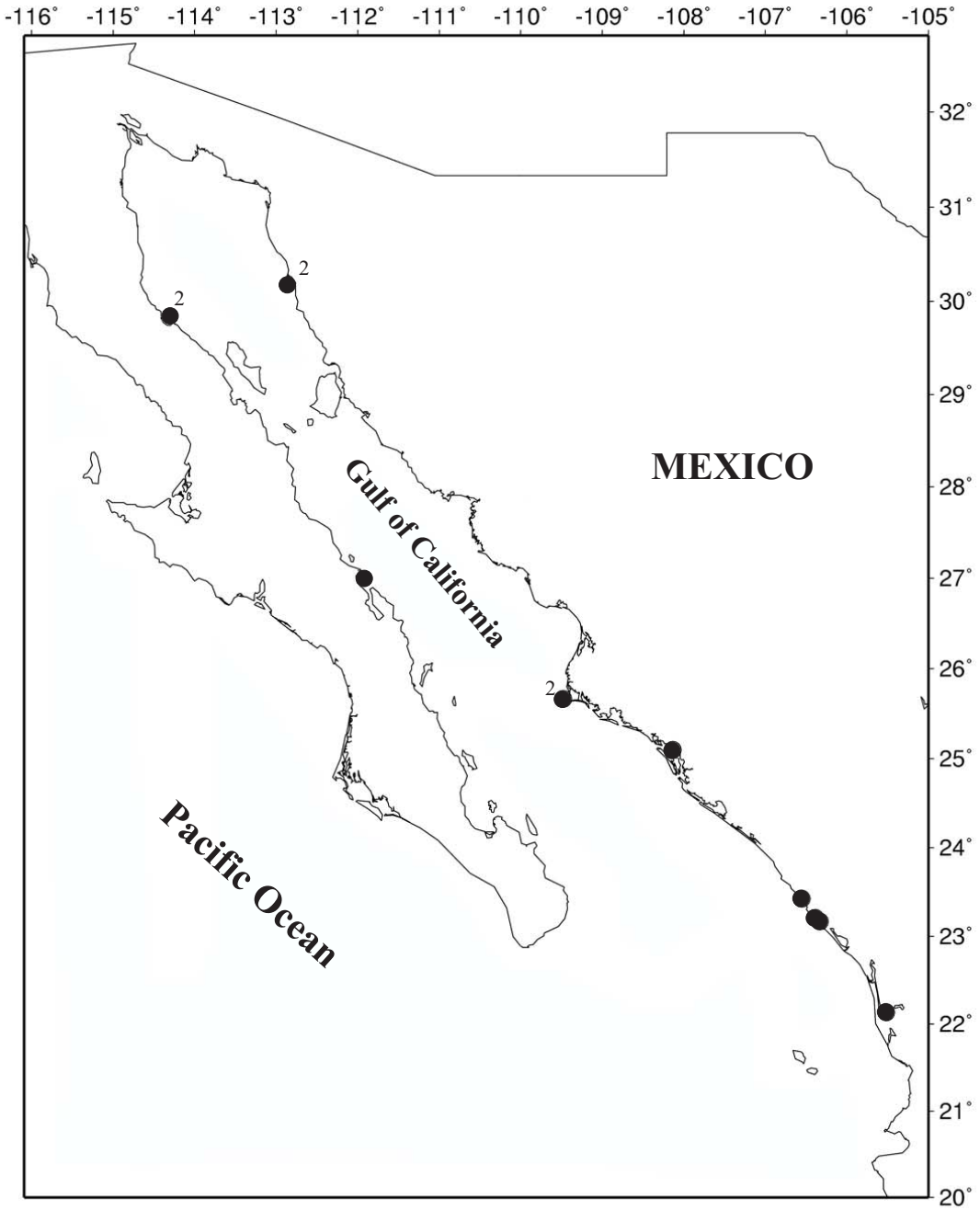

Figure 4. Localities in the Gulf of California where *Malacoplax californiensis* was found. Number 2 indicates that two samples were collected at very close localities.

occurs in both shallow and deep (> 100 m depth) environment. Consequently, it occurs in a wide range of water temperature considering that high water temperature are common in the intertidal environment in tropical-subtropical regions.

Guinot (1969a) considered the affinities of the monospecific genus *Malacoplax* to be close to the Panopeidae, particularly because of the shape and structure of the first gonopods (*i.e.*, distinctly trilobed). Although drawn at a slightly different angle, the illustrations provided by Guinot (1969a, fig. 27b) for the first gonopod of a male 14 mm CW closely resembles the typical, trilobed panopeid-like gonopod of two males (CW 11.1 and 11.9 mm) examined herein (Figs. 2B, 3). The series of long spines near the tip (some missing in the larger specimen examined) (Fig. 3) and the row of six subterminal, blunt spines (Figs. 2B, 3) were illustrated by Guinot (1969a: fig. 27) and partly reproduced by Martin and Abele (1986: fig. 4G).

Guinot (1978: 276) considered *Malacoplax* to be part of the Eucratopsinae. While reviewing the affinities of American mud crabs based on nuclear and mitochondrial markers, however, Thoma *et al.* (2014: 93) considered *M. californiensis* to be included in a moderately well-suported Panopeidae *s.s.* clade together with *Tetraplax quadridentata* (Rathbun, 1898), *Cyrtoplax spinidentata* (Benedict, 1892) and four species of *Eurytium* Stimpson, 1859, the later four species forming a better-supported clade by their own. According to Thoma *et al.* (2014: 96), the former three species are included in a well-supported monophyletic clade and appear to be united by structure of the thoracic sternum, although the same authors (Thoma *et al.*, 2014: 99) later considered this clade (*Malacoplax*, *Tetraplax*, *Cyrtoplax*) as "unsupported" without further comments. Although they emphasized that these three taxa share a similar general morphology and feature a greater exposure of penis between sternites 7 and 8 than in other taxa, they leave their affinity within the panopeids as an open question.

Environmental issues. California records of *M. californiensis*, a species originally described from San Diego, are scarce and mostly previous to 1960 (Holmes, 1900; Rathbun, 1918; Schmitt, 1921; Garth, 1960). According to Wicksten (2012), *M. californiensis* is uncommon and might represent an endangered species. Jensen (2014) considered it to be extinct in the area. Coastal habitats where this species has been recorded (*e.g.*, the muddy bottom in the San Diego and San Pedro areas) have been strongly modified due to population increase and constructions leading to habitat loss (Anonymous, 1992; UCAIC, 2009; M.K. Wicksten pers. comm., August 2018). Southern California has been particularly affected by habitat loss (80% of wetlands have been lost since 1990) (Suchanek, 1994; Anonymous, 2018). Human actions are significantly more impactful and persistent, and protecting (or restoring) entire coastal habitat is considered one of the best way to keep marine life healthy.

Although the type locality of *M. californiensis* is in southern California, it might represent one of these tropical-subtropical species that extends its distribution north of the Magdalena Bay area (on the west coast of the Baja California Peninsula), taking advantage of temporary coastal increases of water temperature to the north during El Niño events (see Garth, 1960), a process that might be strongly enhanced by global warming. Our study shows that there are more records of *M. californiensis* in the Gulf of California than previously thought, thus favoring the hypothesis of a tropical-subtropical origin for dispersion.

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