

A new species of crayfish (Decapoda: Cambaridae) from Montebello Lakes, Chiapas, Mexico

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ABSTRACT

Procambarus montebelloensis, new species, is described from Montebello lake district in Chiapas, Mexico. The new species can be distinguished from *P. mirandai* by a gonopod with shorter and more slender mesial process apically directed, a less pronounced cephalic shoulder and a shorter central projection. Regarding the external morphology, in the new species the anterior portion of the head is notably directed downwards, and it has a more elongated chela with a distinct dentition.

KEYWORDS

Freshwater, Montebello Lagoons National Park, Neotropical region, *Procambarus*, Tzisco Lake

INTRODUCTION

Currently 60 species of crayfish in the family Cambaridae Hobbs, 1942 have been recorded in Mexico: 47 belong to the genus *Procambarus* (Ortmann, 1905), 12 to *Cambarellus* (Ortmann, 1905), and one species to *Orconectes* (Cope, 1872) (Pedraza-Lara and Doadrio, 2015; Álvarez and Villalobos, 2016). The number of species of Mexican cambarids has steadily been increasing in the last decade (Pedraza-Lara and Doadrio, 2015; Álvarez et al., 2021; Pedraza-Lara et al., 2021), suggesting that there is still a moderate number of new species to be described. Species with large distribution ranges such as *Cambarellus montezumae*, *Procambarus llamasii*, *P. acanthophorus* and *P. pilosimanus*, may in fact be species complexes composed of several cryptic species.

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Six species of *Procambarus* are currently recognized from the state of Chiapas, five of them are native species: *P. llamasi* Villalobos, 1954, distributed in northern Chiapas, around the town of Palenque; *P. mirandai* Villalobos, 1954, distributed in the Central Depression, with the type locality in Cerro Hueco, in the city of Tuxtla Gutiérrez; *P. pilosimanus* Ortmann, 1906, at present widely distributed in southern Chiapas and northern Guatemala; *P. sbordonii* Hobbs, 1977, described from a cave in Bochil; and *P. adani* Álvarez, Torres and Villalobos, 2021, from Sótano de La Lucha, on the border between Chiapas and Oaxaca (Fig. 1); and the introduced *P. clarkii* Girard, 1852 (Torres and Álvarez, 2012), that now occurs in the central portion of the state including localities in “Los Altos de Chiapas” region.

A series of samples from the Montebello Lagoons National Park (PNLM, for its name in Spanish) were examined and among them a group of organisms representing an undescribed species were found. In this paper we describe a new species of *Procambarus* from the PNLM which is morphologically different from the related *P. mirandai*.

MATERIALS AND METHODS

The studied specimens were hand-collected over a 20-year span in the PNLM. All samples were preserved in 70% EtOH and deposited in the Colección Nacional de Crustáceos, Instituto de Biología, Universidad Nacional Autónoma de México (CNCR), Mexico City. Other abbreviations used are: RL, rostrum length; TCL, total carapace length; coll., collector.

The photographs of the external morphology were obtained with an 18 mp digital camera attached to a Leica dissecting scope; the images were processed with ImageView software. To obtain the scanning electron microscope (SEM) photographs the male gonopod was dissected under a dissecting microscope. The gonopods were progressively dehydrated to 100% EtOH. The samples were critical point dried in a Emitech K850 dryer. The samples were then gold coated in a Quorum Q150 R ES coater. We used a Hitachi SU1510 scanning electron microscope at the Laboratorio de Microscopía de la Biodiversidad at Instituto de Biología, Universidad Nacional Autónoma de México (UNAM), to observe and photograph the samples. Photographs were taken in mesial, cephalic, lateral, and caudal views.

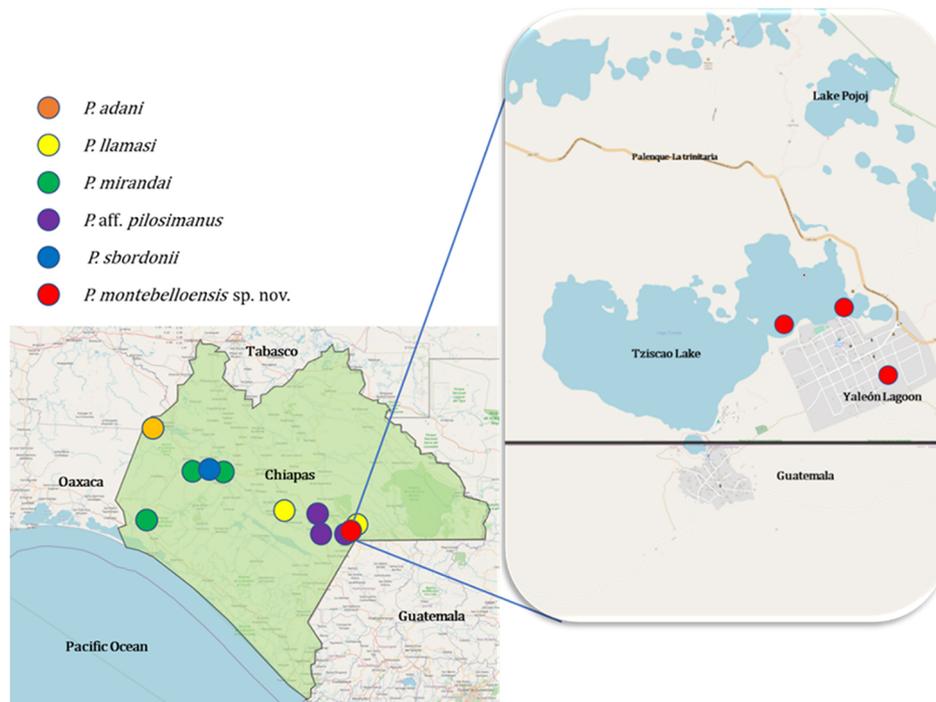


Figure 1. Distribution of the species of *Procambarus* in Chiapas, Mexico, and distribution of the new species.

SYSTEMATICS

Family Cambaridae Hobbs, 1942

Subfamily Cambarinae Hobbs, 1942

Genus *Procambarus* Ortmann, 1905

Procambarus montebelloensis sp. nov.

(Figs. 2–5)

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Diagnosis. Eyes pigmented, well developed, fitting under rostrum. Rostrum short, wide at base, devoid of lateral spines; acumen short, acute, reaching proximal portion of third antennular segment, ranging from 19.2% to 28.3% of RL (\bar{x} = 24.7%). Areola 3.5 to 4.6 times as long as wide (\bar{x} = 3.9), 27 to 36.6% of TCL (\bar{x} = 31.8%), 34 to 45% of postorbital length (\bar{x} = 39.6%), with 3–4 punctuations across narrowest part. Carapace postorbital ridges with anterior small spine, 1 minute cervical spine and 1 branchiostegal spine on each side.

Antennal scale from to 2.09 to 2.33 (\bar{x} = 2.22) times as long as wide, maximum width at midlength. Chelipeds subequal in length, elongate, longer than total body length in adult form I males; surface covered with blunt tubercles; chela not pubescent, elongate, fingers varying from subequal in size to shorter than palm; opposable margin of movable finger finely serrate distally, midportion with 8–10 teeth of similar size, proximally with 2–3 larger teeth; fixed finger with 2–3 large teeth proximally, remaining margin with few irregularly sized teeth. First pair of pereopods, or chelipeds, with all articles covered with blunt tubercles. Third pair of pereopods of form I males with acute hook on ischium, tip slightly overreaching basioischial articulation. Cephalic lobe of epistome approximately hexagonal, margins thickened, apex as distinct triangular tooth separated from lateral margins.

First pleopods of form I male asymmetrical, subequal in length, reaching posterior third of coxae of third pereopods, mesial surface densely covered with long plumose setae. In caudal view, mesial

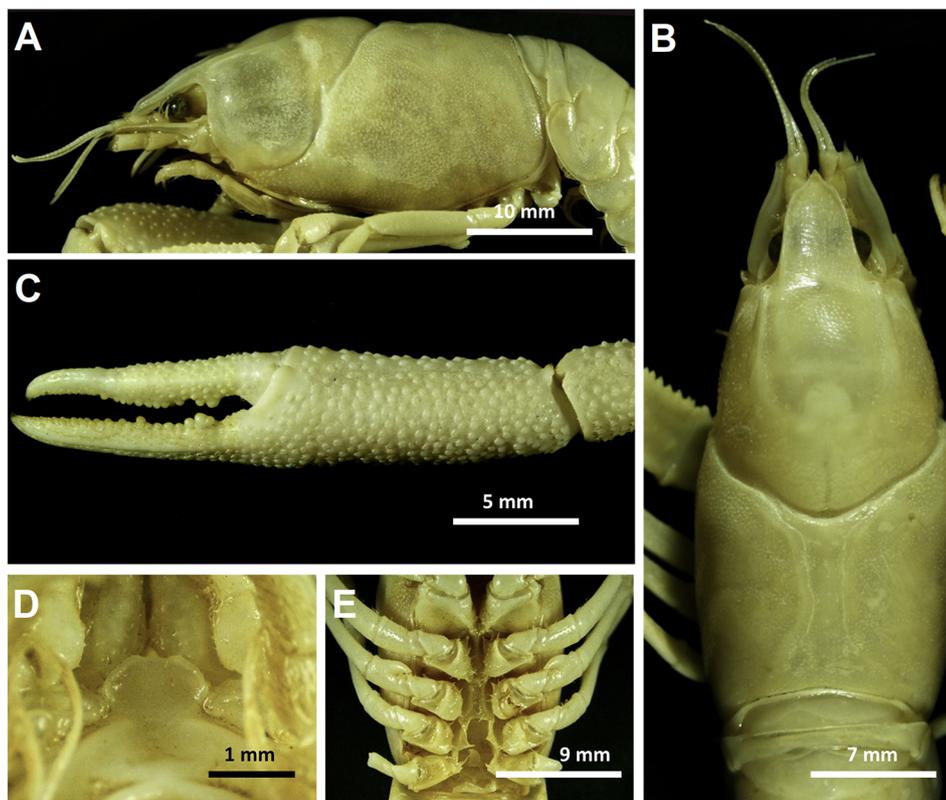


Figure 2. *Procambarus montebelloensis*, new species, holotypic male form I: **A**, carapace, lateral view; **B**, carapace, dorsal view; **C**, right chela (lateral view); **D**, epistome, cephalic lobe; **E**, basal articles of second, third (with developed hooks) and fourth pereopods.

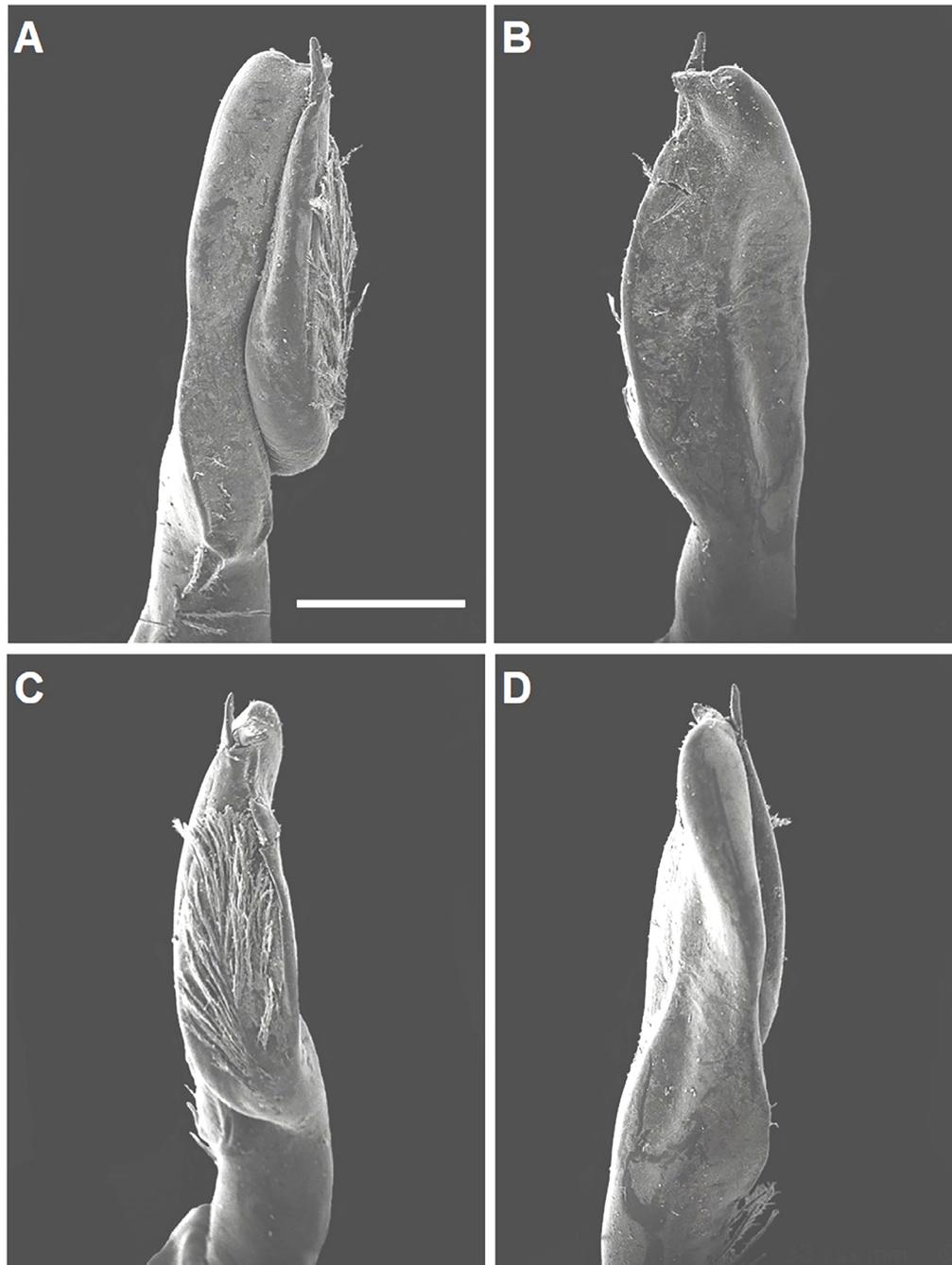


Figure 3. *Procambarus montebelloensis*, new species, holotypic male form I, left gonopod: **A**, caudal view; **B**, cephalic view; **C**, mesial view; **D**, lateral view.

process straight, slender, digitiform, directed distally, reaching beyond all other apical elements; lateral shoulder rounded, surface smooth; central projection triangular, laterodistally directed (Fig. 3A). In cephalic view, lateral shoulder rounded, continued by straight apical margin to form central projection, mesial process straight slightly tapering distally, cephalic surface of gonopod smooth devoid of setae (Fig. 3B). In mesial view, central projection with

inferior narrow opening forming slit, separating centrocaudal and centrocephalic processes, mesial process straight slightly tapering distally, mesial surface oval-shaped, setose, cephalic shoulder incipient (Fig. 3C). In lateral view, lateral shoulder becoming wider distally, apex rounded; central projection subtriangular, cephalically oriented; cephalic shoulder slightly perceptible, mesial process straight (Fig. 3D).

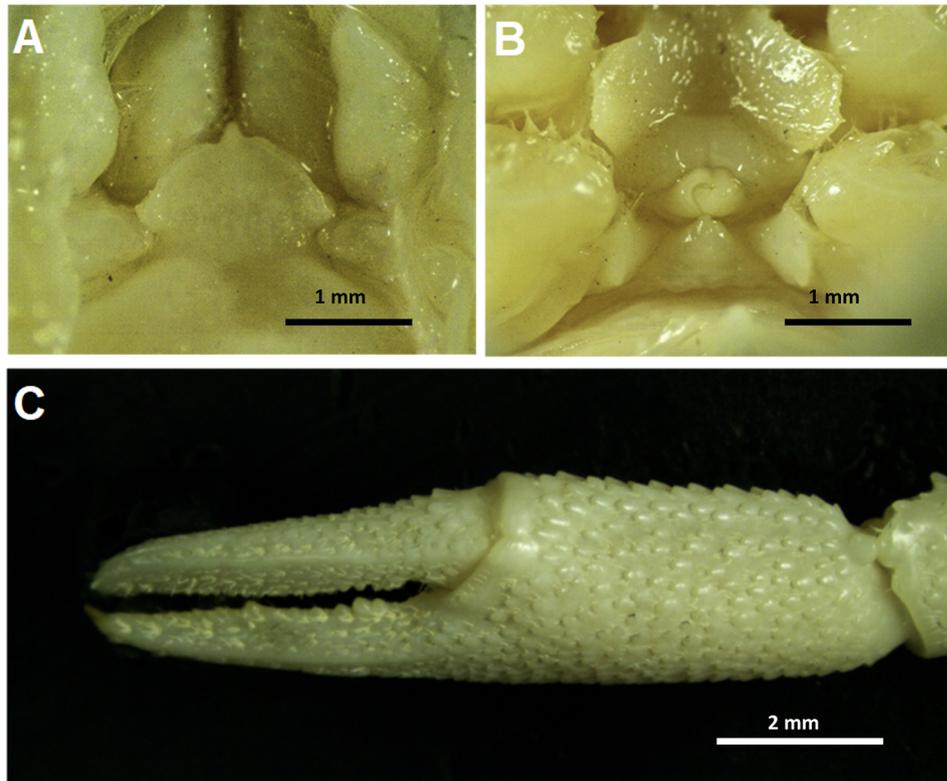


Figure 4. *Procambarus montebelloensis*, new species, allotypic female: **A**, epistome, cephalic lobe; **B**, annulus ventralis; **C**, right chela (lateral view).

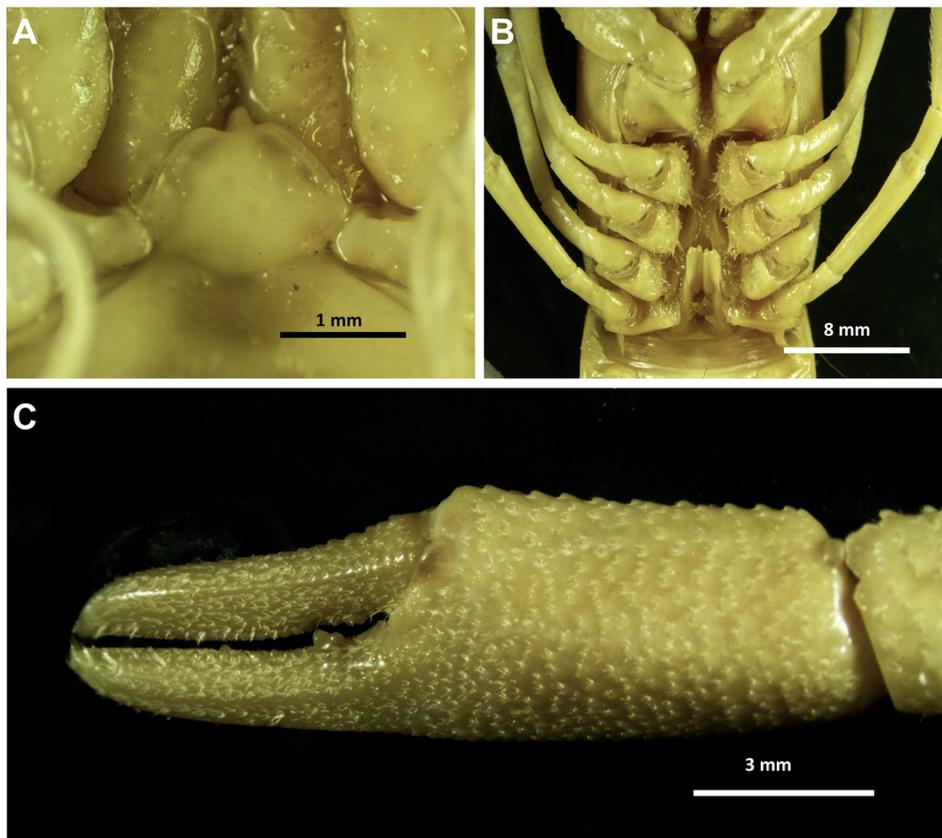


Figure 5. *Procambarus montebelloensis*, new species, morphotypic male form II: **A**, epistome, cephalic lobe; **B**, ventral view of basal articles of pereopods and gonopods; **C**, right chela (lateral view).

Annulus ventralis with preannular plate of constant thickness, bearing shallow incomplete median groove, slightly rounded to receive annulus. Preannular plate and annulus in contact (Fig. 4B). Annulus subcircular; anterior margin slightly bilobed, forming shallow groove; sinus on right side, curved, S-shaped, extending from anterior third to posterior margin (Fig. 4B). Postannular plate triangular, anterior tip touching annulus, margins almost straight.

Description. Form I male — Body and eyes pigmented. Cephalothorax 95.4 length of pleon, posterior half wider. Areola 5.05 times as long as wide, 32.1% of TCL, with 5–6 punctations across narrowest part, suprbranchial grooves well marked. Surface of carapace finely punctate (Fig. 2A, B). Rostrum concave, lateral margins thick, raised, converging anteriorly, devoid of lateral spines, anterior width 2.8 mm, width at base 4.8 mm. Acumen reaching middle portion of third antennular segment, 19.2% of rostrum length. Postorbital ridge as straight thick keel, anterior end with minute spine, not reaching orbital margin; fading posteriorly (Fig. 2A, B). Suborbital margin with superior portion straight, in lateral view forming acute angle with rostrum; inferior portion curving posteriorly to cervical groove. One acute branchiostegal spine, inferior portion of cervical groove widely rounded, appears as divided at level of single cervical spine (Fig. 2A). Pleon slightly longer than cephalothorax. Uropods with protopodite and endopodite bearing 1 distolateral spine; telson with 2 distolateral spines; distal margins setose.

Epistome as described in diagnosis. Chelipeds 1.07 times total length, 2.2 times length of carapace. Chela long, merus ventral surface with ventral row of teeth, carpus 0.54 length of merus, 0.52 length of dactyl; palm 3.2 times longer than wide, slightly longer than dactyl; surface covered with blunt tubercles. Opposable margin of fixed finger with 3 large proximal teeth, followed by 4 small teeth and 1 medium-sized tooth in middle. Opposable margin of movable finger with 2 large teeth proximally, 9 small teeth in central portion (Fig. 2C). Ischium of this pereopod with thick hook, tip slightly surpassing basioischial articulation (Fig. 2E).

First pleopods as described in Diagnosis.

Allotypic female — Similar to holotypic form I male, differing in the following characters. Areola 4.56 times as long as wide; cheliped 1.4 times length of carapace, 0.68 times total length (Fig. C). Uropods with protopodite bearing 3 distolateral spines, endopodite and telson with 2 distolateral spines. Annulus ventralis as described in Diagnosis.

Form II male — Differing from form I male in the following characters. Mesial process of first pleopod shorter, at same level as lateral shoulder. Ischium of third pereopod without hook, appearing as a rounded tubercle (Fig. 5B). Areola 3.7 times as long as wide, 33.3% of TCL. Chelipeds subequal in length, longest one right, 0.78 times total length, 1.57 times TCL. Cephalic lobe of epistome 1.2 times wider than long (Fig. 5A).

Measurements of types. See Tab. 1.

Type locality. Mexico, Chiapas, municipality of La Trinitaria, Montebello Lake District, Southern shore of Lake Tziscaco, 16°04'56"N 91°40'28"W, 1,481 m asl.

Disposition of types. Male holotype form I CNCR 5580; female allotype CNCR 5580; morphotypic male form II CNCR 5580. Paratypes, 1 male form II, 1 female (CNCR 5580).

Additional material examined. *Procambarus mirandai* (type series) — Mexico, Chiapas Tuxtla Gutiérrez (727 m asl), Cerro Hueco Cave: 1 male form I, 1 male form II, 1 female (CNCR 563), 30 Nov 1949, coll. A. Villalobos. *Procambarus mirandai* — Mexico, Chiapas, Tuxtla Gutiérrez (16°43'46"N 93°05'23"W; 727 m asl), creek outside Cerro Hueco Cave: 2 males form I, 3 males form II, 3 females (CNCR 26742).

Etymology. The specific epithet of the new species is derived from “Montebello” the lake district in Chiapas, Mexico, where the new species occurs.

Distribution. The new species occurs in several lakes within the Montebello Lagoons National Park: Tziscaco, Yaleon, and El Carrizal.

Remarks. Over the years some controversy has arisen regarding the identity of *P. mirandai*.

Table 1. Measurements (mm) of type specimens of *Procambarus montebelloensis*, new species.

	Holotypic male, form I	Allotypic female	Morphotypic male form II
Carapace			
Total length	30.52	26.89	30.37
Postorbital length	25.9	22.47	25.44
Height	14.84	12.5	14.12
Width	14.97	13.24	15.17
Areola			
Length	9.81	8.62	10.12
Width	1.94	1.89	2.72
Rostrum			
Length	7.26	6.63	7.32
Width	4.65	4.31	5.19
Right chela			
Mesial margin length of palm	17.93	9.82	12.92
Width of palm	5.62	3.66	4.72
Lateral margin length	35.32	17.84	23.76
Length of dactyl	17.82	8.89	11.28
Length of carpus	9.29	6.29	7.28
Length of merus	16.91	10.91	12.95
Pleon			
Length	31.34	28.92	34.14
Width	11.41	11.13	12.51

Villalobos (1954) described the species from a cave in Cerro Hueco in the outskirts of Tuxtla Gutiérrez, Chiapas. The cave is formed by a spring which has supplied water to the city of Tuxtla Gutiérrez and has been closed for many years. No additional crayfish collections are known from inside the cave besides the type material collected in 1949 (Villalobos, 1954). Many crayfish have been collected in the creek that forms coming out of the cave, and also in the Sabinal River, in Tuxtla Gutiérrez and other nearby rivers and ponds. All these crayfish have been identified as *P. mirandai* (Álvarez et al., 2011). We examined for this discussion the types of *P. mirandai* (CNCR 563) as well as samples from the creek outside the Cerro Hueco cave (CNCR 26742) to establish with certainty the identity of the new species described herein. The crayfish from inside the cave have somewhat elongated appendages, and had at the time of collection a “depigmented body” and showed a “slight depigmentation of the cornea” (Villalobos, 1983). However, as seen in figure 6 the

gonopod morphology of both the crayfishes from inside the cave versus the ones from outside are very similar.

Procambarus montebelloensis sp. nov. is closely related morphologically to *P. mirandai* but differs in the following characters (Fig. 6): the angle in lateral view of the anterior portion of the cephalothorax is oriented downwards in the new species versus oriented frontwards in the latter; the length of the cheliped in form I males is longer than the total body length in the new species, whereas it is shorter in *P. mirandai*; and the anterior tip of the epistome is acute and distinct of the lateral margins in the new species versus acute and as a continuation of the lateral margins. Regarding the gonopod of form I males, in caudal view, the mesial process of the new species is shorter, straight, directed upwards; in *P. mirandai* it is bent laterally and clearly surpasses the lateral shoulder. In mesial view, the cephalic shoulder of the new species appears as a slight protuberance, whereas it is large and prominent in *P. mirandai*.

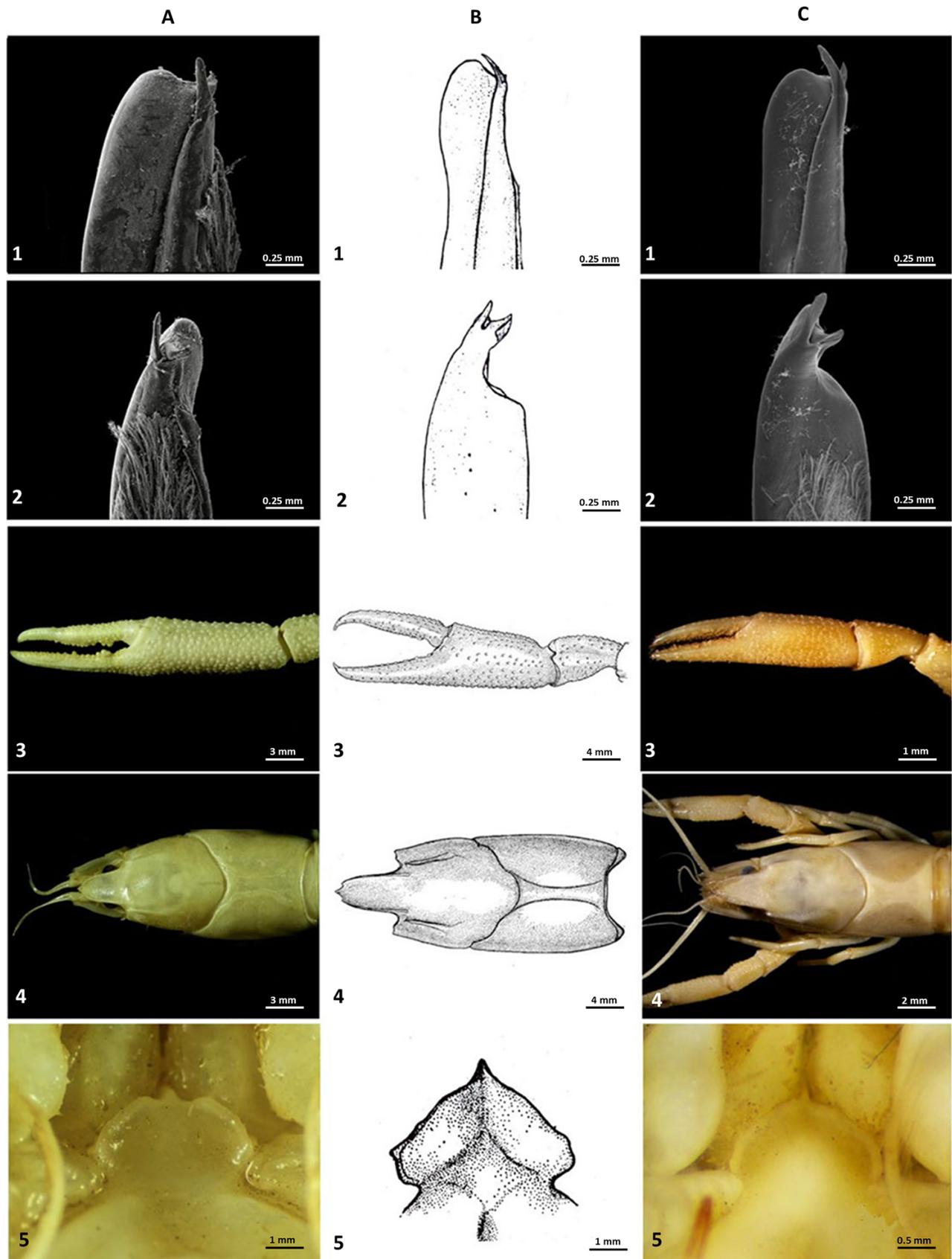


Figure 6. Comparison of important taxonomic characters of: **A**, *Procambarus montebelloensis*, new species; **B**, *P. mirandai*, from Cerro Hueco cave (Villalobos, 1983); **C**, *P. mirandai*, from Sabinal River in Tuxtla Gutiérrez, Chiapas. For the 3 species: **1**, left gonopod caudal view; **2**, left gonopod mesial view; **3**, right chela of form I male lateral view; **4**, dorsal view of carapace; **5**, epistome of form I male.

The distribution areas of *P. mirandai* and *P. montebelloensis* sp. nov. are separated in a straight line by around 165 km of a very rugged territory with numerous mountains, valleys, and rivers, that make any contact among populations unlikely. Other species of *Procambarus* recorded from northern Chiapas, similar to *P. mirandai*, may as well be distantly related to the new species. As Álvarez et al. (2021) noted, two different “morphs” occur in the PNLM, one is the new species described herein, and the second one is related to *P. pilosimanus* exhibiting clear differences in the gonopod morphology, and the chelipeds which have pubescent chelae. Due to the large number of lakes within the PNLM (> 60, Alcocer et al., 2023) several invasions, from populations that occurred along the coastal plain of the Gulf of Mexico, at different times may explain the presence of different species in the same area, and even in the same lake. Forthcoming studies based on molecular analyses will help elucidate the relationships of these species and morphs.

In regard to the ecology of the new species very little is known. It is not clear if the organisms belonging to the new species have a burrowing habit; however, they were all collected in muddy areas with vegetation. Some lakes within the Montebello Lake District have been the subject of intensive limnological studies that describe in detail the main abiotic conditions, including Lake Tzisco. It is from these studies that the conditions in which the new species lives can be drawn (e.g., Alcocer et al., 2016; Cortés-Guzmán et al., 2019).

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ADDITIONAL INFORMATION AND DECLARATIONS

Author Contributions

Conceptualization and Design: FA, FV, JLV. Performed research: FA, FV, JLV. Acquisition of data: FA, FV, JLV. Analysis and interpretation of data: FA, FV, JLV. Preparation of figures/tables/maps: FV. Writing – original draft: FV. Writing – critical review & editing: FA, FV, JLV.

Consent for publication

All authors declare that they have reviewed the content of the manuscript and gave their consent to submit the document.

Competing interests

The authors declare no competing interest.

Data availability

All study data are included in the article.

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Study association

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