

THREE NEW TROGLOBITIC DECAPOD CRUSTACEANS FROM OAXACA, MEXICO

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Among the discoveries made during a recent collecting trip into Oaxaca, México, by James R. Reddell, David McKenzie, Martha Helen McKenzie, and Stuart Murphy were the three albinistic decapod crustaceans described below. One of them is a shrimp, a member of the family Palaemonidae, that is assigned to a new genus. Its affinities with members of other American palaemonid genera, although somewhat obscure, are discussed immediately following the diagnosis of the genus. The other two decapods are crayfishes that are closely allied to the troglobitic *Procambarus (Austrocambarus) rodriguezii* Hobbs (1943:203) which is known from a single locality in Veracruz, México.

Prior to the discovery of these crayfishes, only two others have been described from México since Villalobos (1955) published his "Cambarinos de la Fauna Mexicana": *Procambarus (Ortmannicus) gonopodocristatus* Villalobos (1958:279) from Veracruz, and *Procambarus (O.) villalobosi* Hobbs (1969:41) from San Luis Potosí.

I am most grateful to Mr. Reddell for permitting me to describe these new troglobites and to Fenner A. Chace, Jr., and Isabel Pérez Farfante for their counsel and criticisms of the manuscript. Appreciation is also extended to William R. Elliott for the photographs in Figures 4-7.

FAMILY PALAEMONIDAE

Subfamily Palaemoninae

Neopalaemon, new genus

Diagnosis—Rostrum well developed, compressed, and provided with teeth, ventral margin sometimes

unarmed. Carapace with antennal and hepatic spines, latter situated some distance posterior to anterior margin of carapace. Branchiostegal groove present. Telson with two pairs each of dorsal and posterior spines; plumose setae present between posteromesial pair of spines. Eye without pigment or faceted cornea. Mandible with two-jointed palp. All maxillipeds with exopods. Pleurobranchs present on somites bearing pereopods, and two arthrobranchs on that supporting third maxilliped. Last three pereopods with dactyl simple; posterodistal surface of propodus of fifth pereopod lacking transverse rows of short setae. First pleopod of male without appendix interna.

Type-species—*Neopalaemon nahuatlus*, new species.

Gender—Masculine.

Remarks—Like all except one (*Brachycarpus*, see below) of the genera of the American Palaemoninae, the monotypic genus *Neopalaemon* appears to have no single conspicuous character that distinguishes it from others that are currently recognized. The combination of antennal and hepatic spines on the carapace is shared only with *Brachycarpus*, *Macrobrachium*, and *Pseudopalaemon*. A two-jointed mandibular palp is also typical of members of the genera *Creaseria*, and *Leander*, and occasionally occurs in *Palaemon*. Reduced eyes without pigment is a feature of *Creaseria*, *Troglocubanus*, and some *Palaemonetes*. The absence of one or more transverse rows of setae on the posterodistal surface of the propodus of the fifth pair of pereopods is a feature shared only with *Leander*. None of the characteristics just mentioned are found in the only other American genus, *Cryphiops*.

In spite of the similarities cited, *Neopalaemon* may

be distinguished from the other American genera of the Palaemoninae as follows: *Brachycarpus* and *Leander* have an appendix interna on the first pleopod of the male, and *Brachycarpus* is unique in possessing biunguiculate dactyls on the third through fifth pereopods; in *Macrobrachium*, the mandibular palp is three-jointed, and in *Palaemonetes*, *Pseudopalaemon*, and *Troglocubanus*, the palp is lacking; in the latter four genera, the propodus of the fifth pereopod bears transverse rows of setae posterodistally; *Creeseria* also exhibits the latter characteristic and possesses a branchiostegal spine on the anterior margin of the carapace, lacking a hepatic spine.

Neopalaemon may be included in the generic key presented by Holthuis (1952:1) in his revision of the American Palaemonidae by altering couplet 3 as follows:

- 3. Mandible with two-jointed palp. Propodus of fifth leg lacking transverse rows of setae posterodistally *Neopalaemon*
- 3¹. Mandible without or with three-jointed palp. Propodus of fifth leg with many transverse rows of setae posterodistally .. 3A
- 3A. "Mandible with three-jointed palp
 *Macrobrachium*"
- 3A¹. "Mandible without palp
 *Pseudopalaemon*"

***Neopalaemon nahuatlus*, new species**
 Figs. 1, 2

Description—Rostrum (Fig. 1*f-k*) variable in length and height, its tip reaching between midlengths of penultimate and ultimate podomeres of antennular peduncle; dorsal margin slightly arched or almost straight, bearing four to six teeth, and with or without fine setae in intervals between them; ventral margin with one, two, or no teeth but always with fine setae. Carapace armed with prominent antennal and hepatic spines, latter far removed from cephalic margin; branchiostegal groove distinct.

Abdomen (Fig. 1*l*) with pleura of first two somites rounded, third and fourth somites subangular posteroventrally, and fifth with acute posteroventral spine. Sixth somite about 1.5 times as long as fifth and with prominent acute dorsolateral lobes extending posteriorly over lateral bases of telson and with acute posteroventral extensions at ventrolateral base of uropod; posterior margin of sternum entire. Telson (Fig. 1*m,n*) not including marginal spines, approximately 1.4 times length of sixth somite, bearing two pairs of dorsolateral spines in caudal half; posterior margin tapering toward subacute median apex and bearing

two or three pairs of small dorsal setae, pair of small lateral spines, latter flanked mesially by pair of much heavier longer spines, and five pairs of plumose setae between longer spines.

Eyes rounded distally, lacking faceted cornea and pigment. Antennular peduncle (Fig. 1*a*) not reaching distal extremity of antennal scale. Stylocerite subspiculiform, extending distally to about midlength of basal segment of peduncle. Distolateral spine of basal segment not reaching beyond midlength of penultimate segment of peduncle. Antennular flagella unequal in length: mesial flagellum approximately three times length of carapace; long ramus of lateral flagellum approximately four times length of carapace, and short ramus about 0.5 as long as carapace; latter two rami fused through five to eight articles.

Antennular peduncle (Fig. 1*f*) reaching midlength of penultimate segment of antennular peduncle and slightly beyond midlength of antennal scale; basal segment with prominent distolateral spine; flagellum 5.2 times length of carapace and extending posteriorly beyond telson by little less than 0.33 of its length. Antennal scale (Fig. 1*b*) with lamella distinctly overreaching distolateral spine.

Gnathal appendages as figured (Figs. 1*c-e*, 2*a-c*). Mandible with incisor process bearing three teeth; palp two-jointed with proximal segment distinctly longer than distal, both bearing fine setae. First maxilla with proximal endite arched, its distal end directed toward apex of distal endite; palp with slender distal lobe. Second maxilla with scaphognathite narrowing anteriorly. First maxilliped with exite lobe inflated, rounded, and somewhat tapered apically; lash arising distinctly proximal to distal extremity of endopodite. Second maxilliped in no way remarkable. Third maxilliped reaching base of distal third of antennal scale; exopodite almost attaining distal end of ischium.

First pereopod (Fig. 2*d*) overreaching antennal scale by 0.5 length of dactyl; dactyl 1.3 times length of palm; carpus about 1.5 times as long as chela (propodus); and merus only slightly shorter than carpus. Second pereopod (Fig. 2*e-g*) overreaching antennal scale by slightly more than length of propodus; dactyl approximately 1.5 times length of palm; chela 1.6 times as long as carpus; length of carpus 0.94 that of merus. Third pereopod (Fig. 2*h*) overreaching antennal scale by length of dactyl and 0.25 that of propodus; length of dactyl approximately 0.42 that of propodus; propodus 1.7 times as long as merus. Fourth pereopod (Fig. 2*i*) overreaching antennal scale by length of dactyl and 0.5 that of propodus; length of dactyl approximately 0.28 that of propodus;

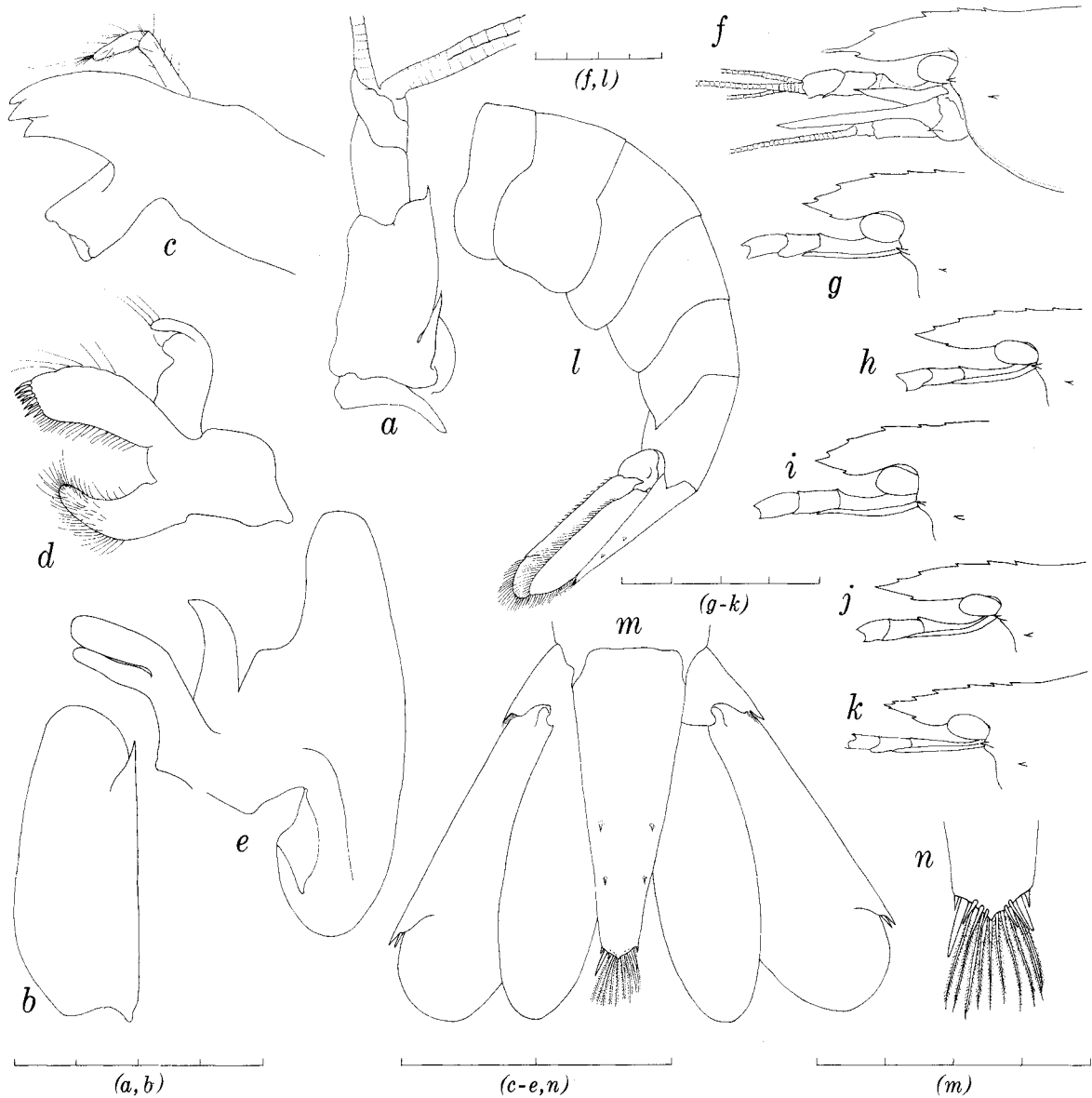


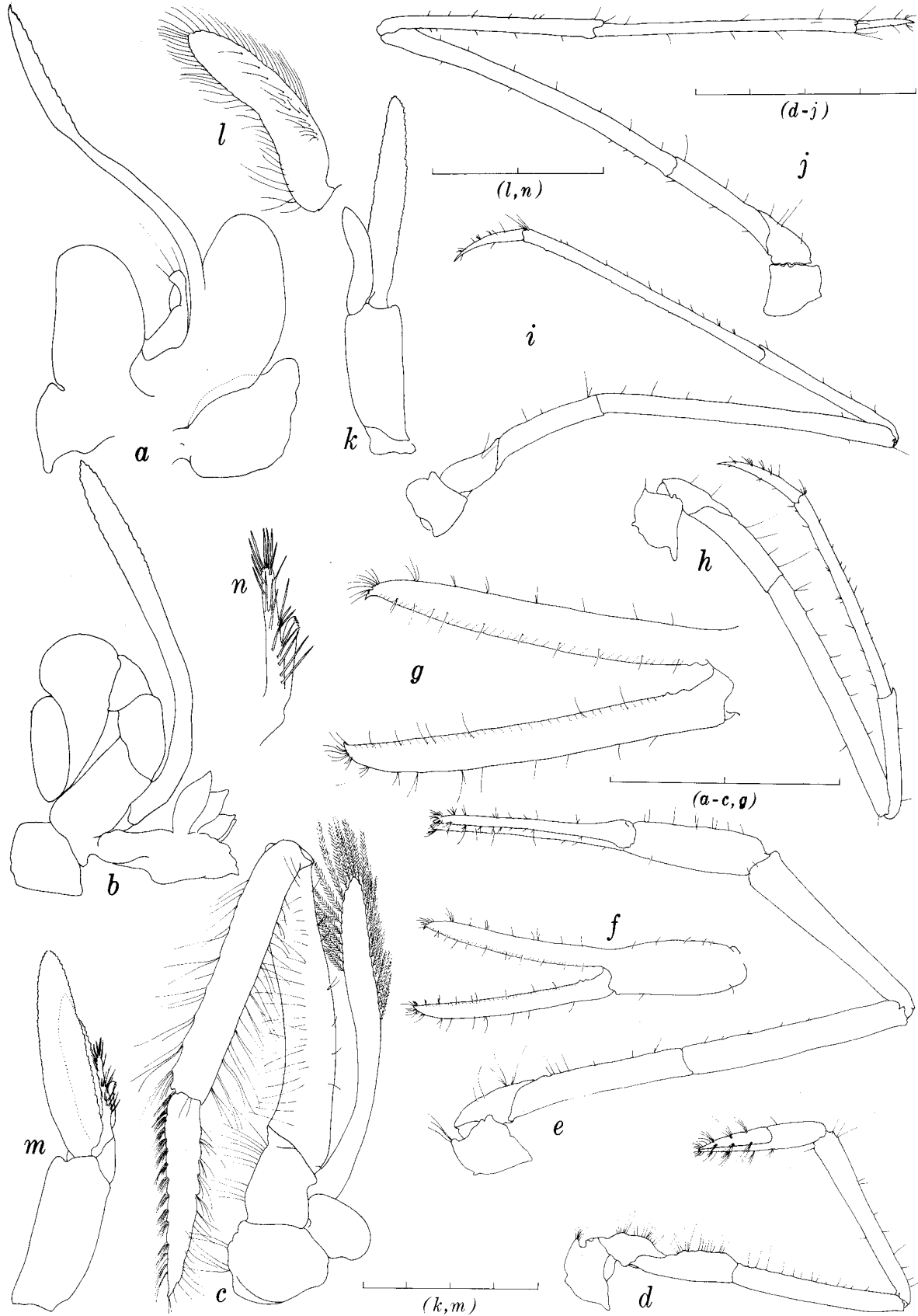
Fig. 1. *Neopalaeomon nahuatlus*, new species. *a-f, l-n*, holotype. *a*, Left antennule; *b*, Left antennal scale; *c*, Left mandible; *d*, Left first maxilla; *e*, Left second maxilla; *f*, Lateral view of cephalic region; *g-k*, Lateral view of cephalic region of paratypes; *l*, Lateral view of abdomen; *m*, Dorsal view of telson and uropods; *n*, Dorsal view of posterior part of telson. (Scales in millimeters.)

propodus 1.6 times longer than carpus and 0.91 length of merus. Fifth pereopod (Fig. 2j) overreaching antennal scale by length of dactyl and about 0.5 that of propodus; length of dactyl about 0.22 that of propodus; propodus 1.1 times longer than carpus and 0.83 length of merus.

Endopod of first pleopod of male (Fig. 2k,l) almost 0.5 as long as exopod, moderately slender, its least width 0.2 of its total length. Endopod of second pleopod of male (Fig. 2m,n) almost reaching base of distal 0.2 of exopodite; appendix interna only slightly

longer than 0.5 length of appendix masculina; latter extending distally to base of distal two-fifths of endopodite and armed with approximately 20 long spines. Lateral ramus of uropod (Fig. 1m) with conspicuous movable spine situated immediately mesial to spine on lateral margin.

Branchial complement consisting of one pleurobranch on pereopodial somites, two arthrobranchs at dorsal base of third maxilliped, and one podobranch on second maxilliped; epipodite present on first, second, and third maxillipeds.



Size—Carapace length of males, 8.4 to 10.1 mm (holotype, 9.2 mm); of females, 7.6 to 10.8 mm, and of juvenile males or females, 5.2 to 5.7 mm. No females ovigerous.

Color—Lacking pigment.

Type-locality—Cueva del Guano, 10 km NE Valle Nacional, Oaxaca, México. Five males and 11 females were collected in this cave by James R. Reddell, David McKenzie, Martha Helen McKenzie, and Stuart Murphy on 28 December 1972.

Disposition of Types—The holotypic male (no. 143120), two paratypic males, four females, and three juvenile males or females (no. 143121) are deposited in the National Museum of Natural History, Smithsonian Institution. One paratypic male and two paratypic females are deposited in each the Instituto de Biología, Universidad Nacional Autónoma de México, and The Museum, Texas Tech University, Lubbock, Texas.

Relationships—See the remarks following the diagnosis of the genus *Neopalaemon*.

FAMILY ASTACIDAE

Procambarus (Austrocambarus) oaxacae oaxacae, new species

Figs. 3-5

Diagnosis—Body with markedly reduced pigmentation, virtually albinistic but often with slight tan suffusion on abdomen; eyes reduced in size, with or without traces of facets, frequently with few ommatidia bearing reddish purple pigment but with pigmented area not sharply margined. Rostrum with marginal spines. Areola 3.6 to 4.9 times longer than wide, constituting 35.8 to 37.8 percent of total length of carapace (43.7 to 46.1 percent of postorbital length), and with six to eight punctations across narrowest part. Cervical spine and suborbital angle obsolete. Hepatic region lacking spine on cephalic margin. Postorbital ridge provided with small spine or acute tubercle. Antennal scale approximately 2.2 times longer than wide, broadest distinctly distal to midlength. Mesial surface of palm of chela with irregular row of approximately 20 tubercles, and both fingers with longitudinal ridges on dorsal and ventral surfaces. First pleopod with shoulder on cephalic surface convex distally; distal extremity of appendage bearing slender mesial process directed distolaterally,

vestigial cephalic process consisting of very small scalelike lobe at cephalomesial base of mesial process, and corneous acute almost bladelike central projection extending cephalodistally from near distal extremity of cephalomesial surface of slender distal lobe of shaft. Annulus ventralis as figured (Fig. 3f).

Holotypic Male, Form I—Body subovate (Fig. 3a,k), compressed laterally. Abdomen narrower than thorax (12.9 and 13.8 mm). Width of carapace subequal to height at caudodorsal margin of cervical groove. Areola approximately 4.3 times longer than wide with seven or eight punctations across narrowest part. Cephalic section of carapace 1.8 times as long as areola; latter 4.3 times longer than wide and constituting 36.1 percent of total length of carapace and 43.7 percent of postorbital length. Rostrum excavate dorsally, bearing setiferous punctations; convergent margins not thickened and bearing small spines at base of short acumen, latter not quite reaching proximal end of ultimate podomere of antennular peduncle. Subrostral ridge weak and evident in dorsal aspect only in caudal orbital region. Postorbital ridge prominent, grooved dorsolaterally, and with short acute spines cephalically. Suborbital angle obsolete, branchiostegal spine moderately well-developed. Carapace with setiferous punctations except in ventral portion of branchiostegites and in parts of hepatic areas where replaced by small tubercles; cervical spine, or enlarged tubercle replacing it, lacking.

Abdomen longer than carapace (33.5 and 30.8 mm). Cephalic section of telson with two spines in each caudolateral corner, mesial one movable. Proximal podomere of uropod with both lobes bearing distally directed spine, and mesial ramus with distomedian spine not nearly reaching distal margin of ramus.

Cephalic portion of epistome (Fig. 3i) broadly and evenly rounded cephalically, and with short cephalomedian extension; surface subplane; fovea of main body of epistome represented by median longitudinal trough. Antennule of usual form with prominent ventral spine slightly distal to midlength of basal podomere. Antenna extending caudally slightly beyond caudal margin of telson. Antennal scale (Fig. 3o) about 2.2 times longer than wide, greatest width distal to midlength, and with lamellar area distinctly broader than thickened lateral portion; latter terminating in moderately strong acute spine. Third maxilliped with mesial half of ventral surface of ischium

← Fig. 2. *Neopalaemon nahuatlus*, new species. (All appendages from left side of holotype except *j* which is from right.) *a*, First maxilliped; *b*, Second maxilliped; *c*, Third maxilliped; *d*, First pereiopod; *e-g*, Second pereiopod; *h*, Third pereiopod; *i*, Fourth pereiopod; *j*, Fifth pereiopod; *k*, First pleopod; *l*, Endopod of first pleopod; *m*, Second pleopod; *n*, Appendices masculina and interna. (Scales in millimeters.)

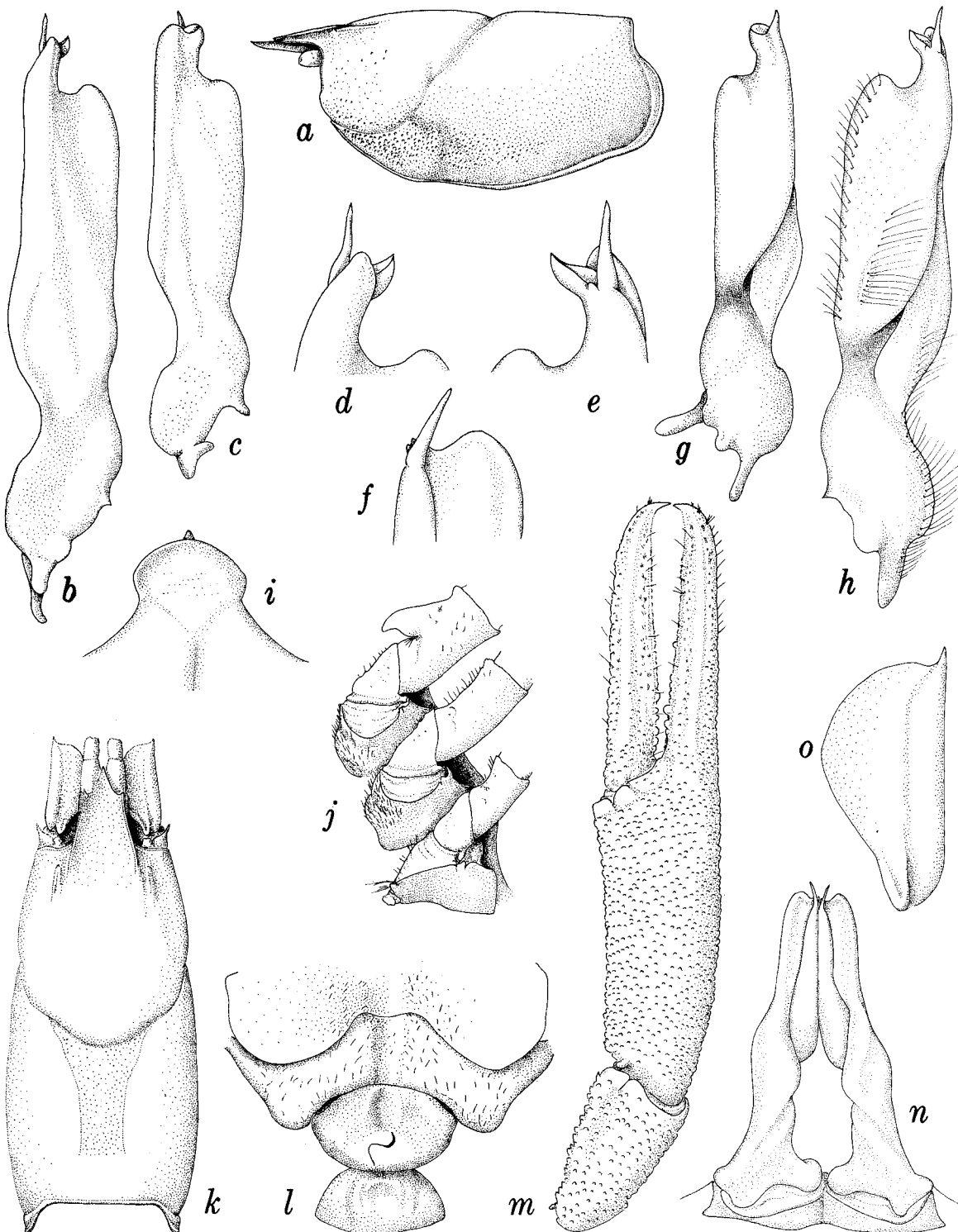


Fig. 3. *Procambarus (Austrocambarus) oaxacae oaxacae*, new species. *a*, Lateral view of carapace of holotype; *b*, Lateral view of first pleopod of holotype; *c*, Lateral view of first pleopod of morphotype; *d*, Lateral view of distal portion of first pleopod of holotype; *e*, Mesial view of same; *f*, Caudal view of same; *g*, Mesial view of first pleopod of holotype; *h*, Mesial view of first pleopod of morphotype; *i*, Cephalic lobe of epistome of holotype; *j*, Basal podomeres of third through fifth pereopods of holotype; *k*, Dorsal view of carapace of holotype; *l*, Annulus ventralis and adjacent sternites of allotype; *m*, Distal podomeres of cheliped of holotype; *n*, Caudal view of first pleopods of holotype; *o*, Antennal scale of holotype.

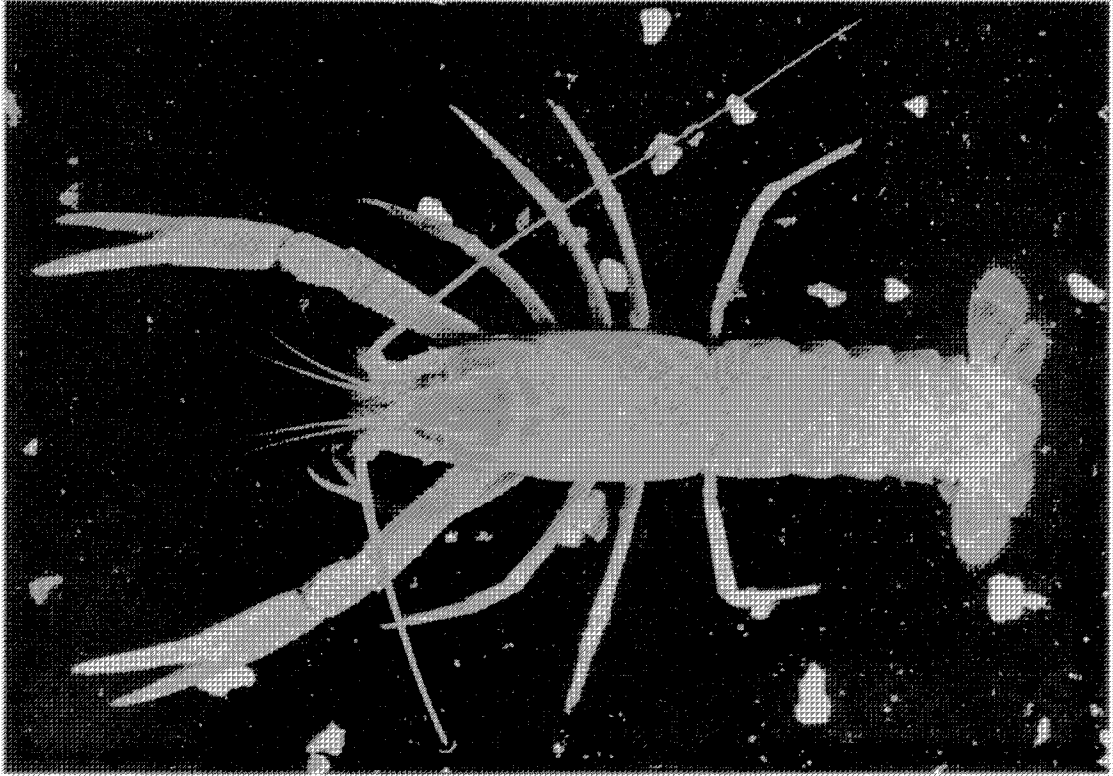


Fig. 4. *Procambarus (Austrocambarus) oaxacae oaxacae*, new species. Female from type-locality (William R. Elliott).

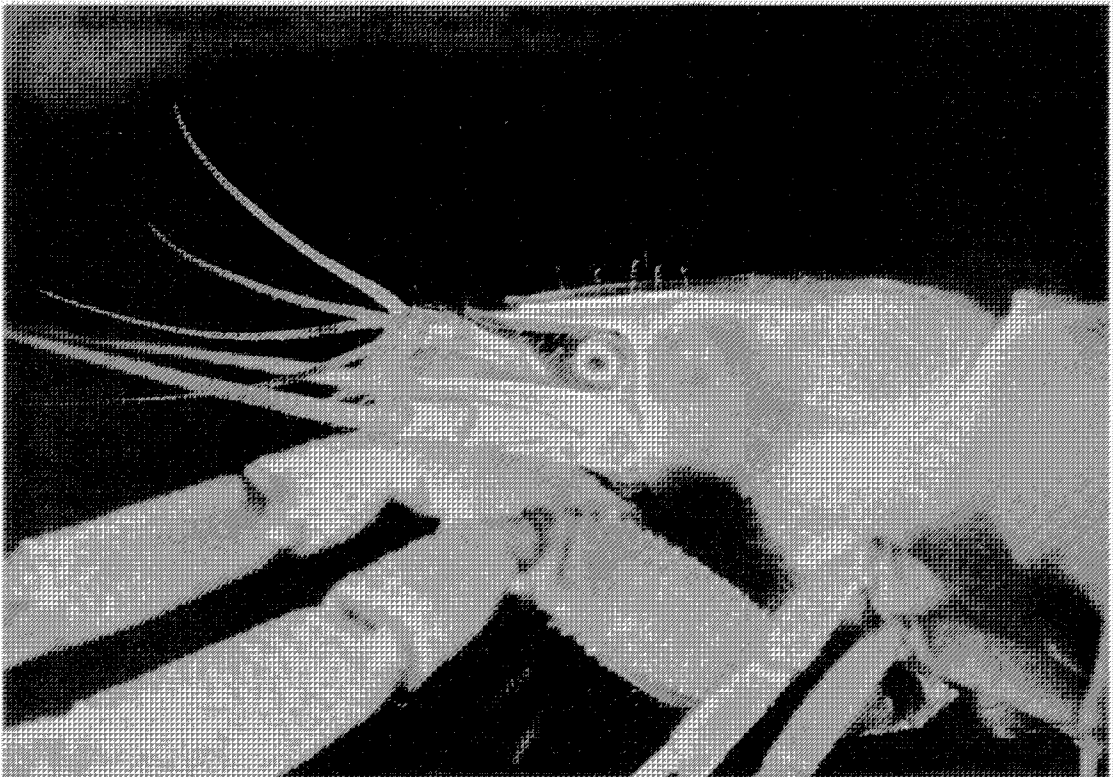


Fig. 5. *Procambarus (Austrocambarus) oaxacae oaxacae*, new species. Female from type-locality (William R. Elliott).

bearing tufts of stiff setae, and lateral half with fine setae.

Right chela (Fig. 3m) elongate, slender, subovate in cross-section, moderately depressed. Entire surface of palm studded with thickly set small tubercles; mesial surface with sublinear arrangement of 20 tubercles, lateral surface with tubercles extending almost from base to about midlength of finger; ventral surface with only one tubercle, situated opposite base of dactyl, larger than others. Dorsal and ventral surfaces of both fingers with rounded, submedian, longitudinal ridges flanked along proximal half by tubercles and distally by setiferous punctations. Opposable margin of fixed finger with dorsal row of 24 tubercles, third from base largest, extending from basal seventh to base of distal seventh, and ventral row of 6, proximalmost largest, along middle third; minute denticles studding surface between and distal to tubercles. Opposable margin of dactyl with slightly irregular row of 24 tubercles, seventh from base largest, along proximal three-fourths; tubercles interspersed with minute denticles continuing to corneous tip of finger; mesial surface with tubercles, decreasing in size distally, to base of distal fifth of finger.

Carpus of right cheliped entirely tuberculate with only three conspicuously larger than others: one subspiniiform with corneous tip situated on distoventral median margin, another forming ventrolateral articular condyle, and third, smallest of three, on dorsal

mesiodistal margin.

Merus of right cheliped entirely tuberculate; dorsal surface with single subacute subdistal tubercle slightly larger than others; those on mesial and lateral surfaces progressively smaller proximally; tubercles on ventral surface somewhat irregularly arranged with approximately 25 in both mesial and lateralmost rows, two distalmost tubercles in lateral row spikelike with sharp corneous tips; ventrolateral margin of podomere lacking spine. Ischium with dorsal and ventral surfaces tuberculate; five larger, subspiniiform tubercles in linear series ventromesially.

Hook on ischium of third pereopod only (Fig. 3j); hook simple, extending proximally over distal extremity of basis but not opposed by tubercle on latter. Coxa of fourth pereopod, as in other members of subgenus, lacking boss on caudomesial surface, that of fifth with small tuberculiform prominence.

Sternum between second, third, and fourth pereopods moderately shallow, and, while bearing setae, latter fringelike only on ventrolateral margin between coxae of fourth pereopods.

First pleopods (Fig. 3b, d-f, h,n) as described in diagnosis.

Allotypic Female—Differing from holotype in following respects: postcervical groove much more prominent than in holotype; palm of chela with mesial row of only 16 tubercles; opposable margin of fixed finger with dorsal row of 14 tubercles and ventral one rep-

Table 1. Measurements (mm) of *Procambarus (A.) oaxacae oaxacae*

	Holotype	Allotype	Morphotype
Carapace:			
Height	13.9	11.3	10.6
Width	13.8	11.8	10.7
Length	30.8	26.6	24.6
Postorbital length	25.4	21.4	19.7
Areola:			
Width	2.6	2.6	2.5
Length	11.1	9.6	9.0
Rostrum:			
Width	4.8	4.7	4.0
Length	7.3	6.9	6.1
Right Chela:			
Length of mesial margin of palm	13.0	8.1	8.7
Width of palm	6.5	4.9	4.9
Length of lateral margin of propodus	31.8	20.3	21.0(app.)
Length of dactyl	16.9	10.9	11.1
Abdomen:			
Width	12.9	11.1	10.2
Length	33.5	29.5	27.7

resented by only two; tufts of setae near distal extremity of finger more conspicuous than in holotype; opposable margin of dactyl with row of 18 tubercles; carpus of cheliped lacking enlarged tubercle on dorsal mesiodistal margin; merus with mesial row of 20 tubercles much larger than those of lateral row. (See measurements, particularly those of chelae).

Annulus ventralis (Fig. 3/) with median trough cephalically; sinus originating at caudal extremity of trough, curving sharply dextrally before turning caudosinistrally, and cutting caudal margin of annulus slightly sinistral to median line. Preannular plate with median longitudinal trough, lateral swollen areas with many short stiff setae, comparatively few in trough. Postannular plate almost as wide as annulus and more than one-half as long; surface not strikingly ornamented. First pleopod rudimentary.

Morphotypic Male, Form II—Differing from holotype in following respects: palm of chela with mesial row of 15 tubercles; opposable margin of fixed finger with 15 tubercles in dorsal row and three in ventral; opposable margin of dactyl with row of 26 tubercles; carpus without enlarged tubercle on dorsal mesiodistal margin; merus with ventromesial row of 18 tubercles conspicuously larger than those in lateral row of 21; hook on ischium of third pereopod less acute and shorter than those in holotype, not extending proximally so far as distal extremity of basis; tuberculiform prominence on coxa of fifth pereopod almost as well developed as in holotype.

First pleopods (Fig. 3c,g) with cephalodistal extremity of shoulder more truncate than in holotype; mesial process less acute and not bent so strongly laterally; central projection non-corneous and decidedly more bulbous.

Size—The largest specimen available is a female with a carapace length of 30.9 mm (postorbital length 25.4 mm). The largest and smallest first form males have corresponding lengths of 30.8 (25.4) mm and 25.5 (20.8) mm.

Type-locality—Cueva del Guano, 10 km NE Valle Nacional, Oaxaca, México. The specimens were collected on 28 December 1972 by J. R. Reddell, D. McKenzie, M. McKenzie, and S. Murphy.

Types—The holotypic male, form I, allotypic female, and morphotypic male, form II (Nos. 144341, 144342 and 144343, respectively) are deposited together with one paratypic male, form I, and 4 paratypic females, in the National Museum of Natural History, Smithsonian Institution. Two series of paratypes, each consisting of 1 male, form I, and 2 females, are deposited in the Instituto de Biología, Universidad Nacional Autónoma de México, and in The Museum, Texas Tech University, Lubbock, Texas.

Range and Specimens Examined—*Procambarus (Austrocambarus) o. oaxacae* is known only from the type-locality, and the 14 specimens available are all assigned to the type-series. Associated with this crayfish are two entocytherid ostracods: *Entocythere claytonhoffi* Rioja and *Ankylocythere maya* Hobbs.

Variations—The variations noted are primarily those associated with injury and regeneration. Slight differences occur in the numbers of tubercles on the various podomeres of the chelipeds, but none is markedly different from those cited in the above descriptions. Variations are rather marked in the amount of pigment and the size of the pigmented area in the eye. In one specimen, there is not a trace of any pigment; all of the others, however, have a diffusely pigmented spot with concentrations seemingly limited to a few ommatidia. There are also slight variations in the sculpture of the annulus ventralis and the pre- and postannular plates with excavations and prominences more prominent in larger specimens.

Relationships—See the discussion of relationships of *Procambarus (A.) o. reddelli*.

***Procambarus (Austrocambarus) oaxacae reddelli*,
new subspecies
Figs. 6, 7, 8**

Diagnosis—Body without pigment or with tan suffusion on abdomen; eyes reduced in size, but with small distinct black pigmented faceted area. Rostrum with marginal spines. Areola 3.4 to 5.3 times longer than broad, constituting 33.2 to 35.7 percent of total length of carapace (42.0 to 44.4 percent of postorbital length), and with seven to nine punctations across narrowest part. Cervical spine present, often small and occasionally absent on one side. Hepatic region lacking spine on cephalic margin. Suborbital angle obsolete. Postorbital ridge provided with well developed spine. Antennal scale approximately twice as long as wide, broadest distinctly distal to midlength. Mesial surface of palm of chela with irregular row of approximately 20 tubercles, and both fingers with longitudinal ridges dorsally and ventrally. First pleopod with shoulder on cephalic surface convex distally; distal extremity of appendage bearing terminal elements markedly similar to those of *P. (A.) oaxacae oaxacae*. Annulus ventralis and accompanying sternites as figured (Fig. 8/).

Holotypic Male, Form I—Body subovate (Fig. 8a,k) compressed laterally. Abdomen narrower than thorax (14.1 and 16.4 mm). Width of carapace slightly greater than height at caudodorsal margin of cervical

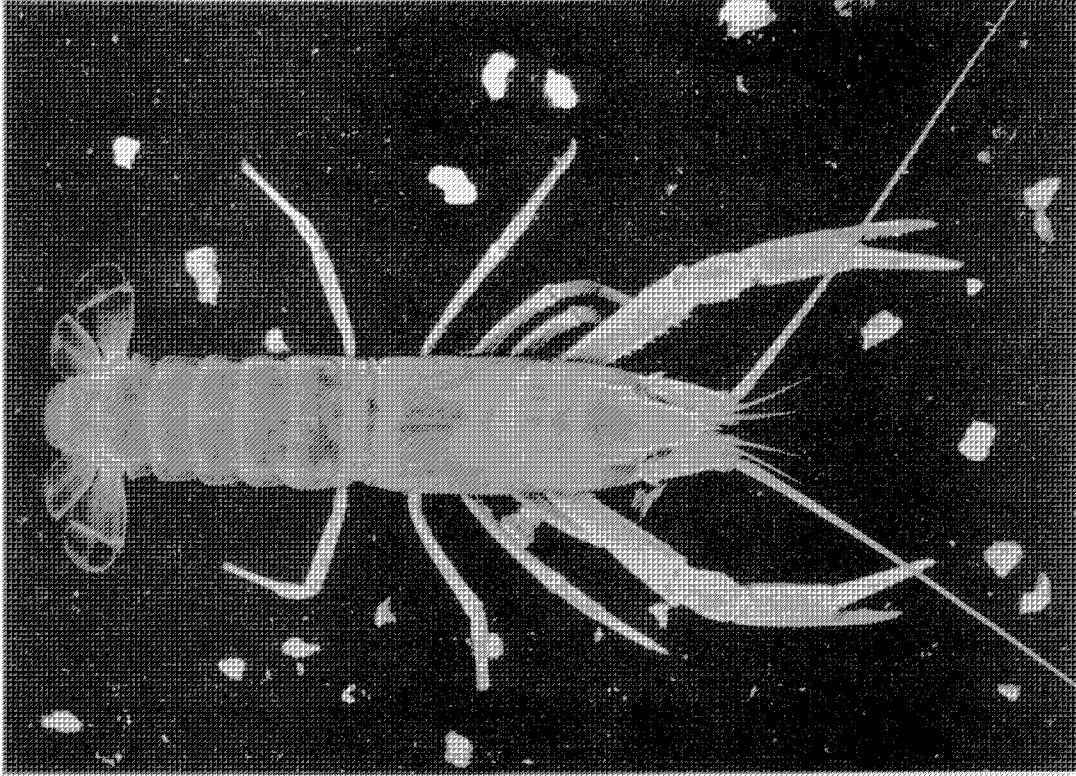


Fig. 6. *Procambarus (Austrocambarus) oaxacae reddelli*, new subspecies. Female from type-locality (William R. Elliott).

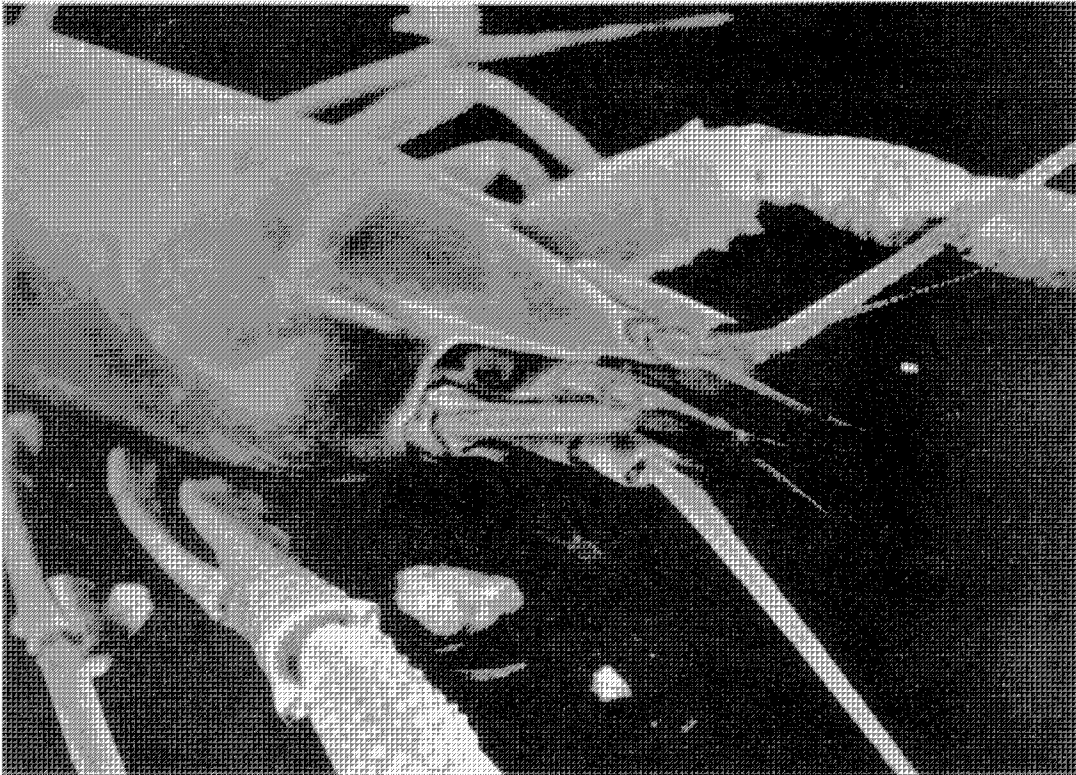


Fig. 7. *Procambarus (Austrocambarus) oaxacae reddelli*, new subspecies. Female from type-locality (William R. Elliott).

groove. Areola 5.8 times longer than wide with eight punctations across narrowest part. Cephalic section of carapace approximately 1.8 times as long as areola and constituting 35.6 percent of total length of carapace and 43.7 percent of postorbital length. Rostrum excavate dorsally, bearing setiferous punctations; convergent margins not thickened and bearing prominent spines at base of acumen, latter almost reaching midlength of ultimate podomere of antennular peduncle. Postorbital ridge prominent, grooved dorsolaterally, and with acute tubercle cephalically. Suborbital angle obsolete, branchiostegal spine rather well developed. Carapace with setiferous punctations except in ventral portion of branchiostegites and in parts of hepatic areas where replaced by small tubercles; cervical spine present.

Abdomen subequal in length to carapace (37.3 and 37.1 mm). Cephalic section of telson with three prominent spines in each caudolateral corner, mesial two movable. Proximal podomere of uropod with both lobes bearing distally directed long spine, and mesial ramus with strong distomedian spine not nearly reaching distal margin of ramus.

Cephalic portion of epistome (Fig. 8*i*) broadly rounded cephalically, although slightly undulating sinistrally, with slight cephalomedian concavity and cephalic dorsomedian projection; surface subplane with weakly elevated cephalic margin; fovea of main body of epistome represented by broad shallow longitudinal depression. Antennule of usual form with prominent ventral spine slightly distal to midlength of basal podomere. Antenna broken but probably extending caudally distinctly beyond midlength of abdomen. Antennal scale (Fig. 8*o*) 2.1 times longer than wide, greatest width distal to midlength, and with lamellar area distinctly broader than thickened lateral portion; latter terminating in long acute spine. Third maxilliped with mesial half of ventral surface of ischium bearing tufts of setae, and lateral half with fine plumose setae.

Right chela of paratypic male (Fig. 8*m*) (both chelae regenerated in holotype) rather slender, subovate in cross-section, moderately depressed. Entire surface of palm studded with small subsquamous tubercles; mesial surface with poorly delineated row of approximately 18 tubercles, lateral surface with tubercles extending from base to about midlength of finger; ventral surface with two tubercles opposite base of dactyl slightly larger than others. Dorsal and ventral surfaces of both fingers with low, rounded, submedian ridges flanked proximally by tubercles and distally by setiferous punctations; dorsal and ventral opposable halves of both fingers with conspicuous plumose setae. Opposable margin of fixed

finger with dorsal row of 12 tubercles, third from base largest, along proximal two-thirds, and ventral row of two tubercles near midlength; minute denticles present between and distal to tubercles. Opposable margin of dactyl with row of 12 tubercles along proximal three-fourths, third from base only slightly larger than others nearby, all interspersed with minute denticles continuing to corneous tip of finger; mesial surface with tubercles, decreasing in size distally, extending from base slightly beyond midlength of finger.

Carpus of right cheliped entirely tuberculate with one large tubercle on mesial surface distal to midlength and another on dorsodistal mesial angle; ventral surface with one prominent tubercle on distoventral median margin, another immediately proximal to it and third on ventrolateral articular condyle.

Merus of right cheliped entirely tuberculate; dorsal surface with prominent acute subdistal spine; tubercles on mesial and lateral surfaces progressively smaller proximally; ventral surface with lateral row of 16 spikelike tubercles, and mesial row of about 20 of which those on distal half much more conspicuous than more proximal ones; ventrolateral angle of podomere with strong spine. Ischium with dorsal and ventral surfaces tuberculate; sublinear series of six tubercles ventromesially.

Hook on ischium of third pereopod only (Fig. 8*j*); hook simple, extending proximally over distal extremity of basis but not opposed by tubercle on latter. Coxa of fourth pereopod lacking boss on caudomesial surface, that of fifth with slight elevation caudomesially.

First pleopods (Fig. 8*b,d-f,h,n*) differing only slightly from those of nominate subspecies.

Allotypic Female—Differing from holotype in following respects: epistome with both cephalolateral margins undulating; telson with only two spines in caudosinistral corner of cephalic section. Cheliped differing from that of paratypic male, form I, as follows: opposable margin of fixed finger with dorsal row of 20 tubercles and ventral of five, with third in dorsal row and two proximal ones in ventral row larger than others on opposable surface; opposable margin of dactyl with 22 tubercles, second and fourth from base largest; tubercles on opposable margins of both fingers extending from base almost to corneous tips; merus with five corneous-tipped spines on subdistal dorsal surface, ventral surface with mesial row of 18 tubercles and lateral row of about 23 with spikelike members interspersed with smaller ones. (See measurements.)

Annulus ventralis (Fig. 8*l*) with median trough cephalically; sinus originating at caudal extremity of trough, curving caudodextrally and making hairpin

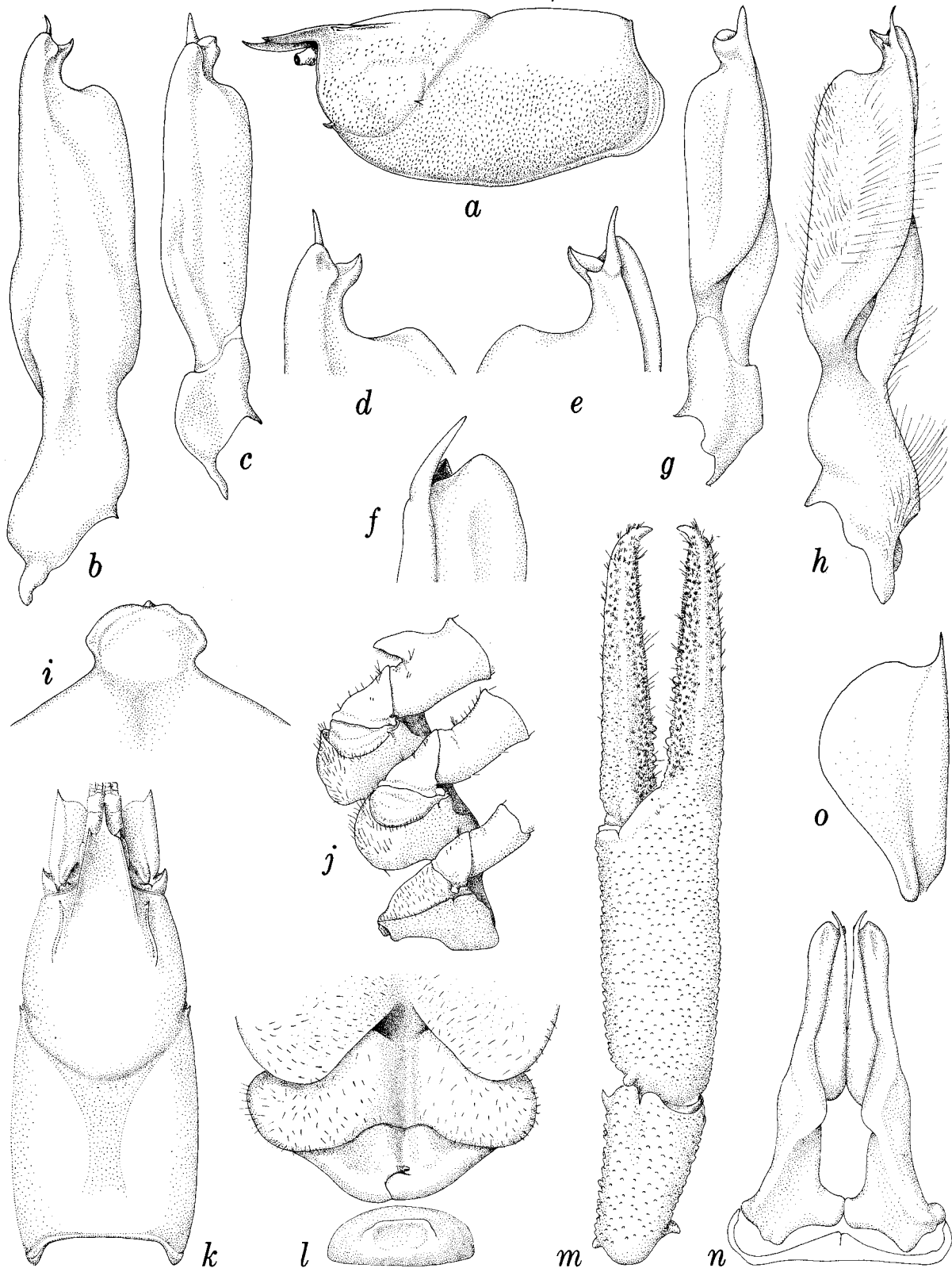


Fig. 8. *Procambarus (Austrocambarus) oaxacae reddelli*, new subspecies. *a*, Lateral view of carapace of holotype; *b*, Lateral view of first pleopod of holotype; *c*, Lateral view of first pleopod of morphotype; *d*, Lateral view of distal portion of first pleopod of holotype; *e*, Mesial view of same; *f*, Caudal view of same; *g*, Mesial view of first pleopod of morphotype; *h*, Mesial view of first pleopod of holotype; *i*, Cephalic lobe of epistome of holotype; *j*, Basal podomeres of third through fifth pereopods of holotype; *k*, Dorsal view of carapace of holotype; *l*, Annulus ventralis and adjacent sternites of allotype; *m*, Distal podomeres of cheliped of paratypic male, form I; *n*, Caudal view of first pleopods of holotype; *o*, Antennal scale of holotype.

turn before bending sharply caudally to submedian caudal margin of annulus. Preannular plate with median longitudinal trough, lateral swollen areas with short stiff setae. Postannular plate almost as wide as annulus and more than half as long; ventral surface with distinct concavity in elevated central area. First pleopod rudimentary.

Morphotypic Male, Form II—Differing from holotype in following respects: postcervical groove somewhat more clearly defined than in holotype and allotype; epistome without cephalomedian excavation; cephalic section of telson with four spines in dextral and three in sinistral caudolateral corners; hook on ischium of third pereopod much reduced and not nearly reaching distal margin of corresponding basis. Cheliped differing from that of paratypic male, form I, as follows: mesial margin of palm with row of 17 tubercles; opposable margin of fixed finger with dorsal row of six tubercles, second from base largest, along proximal one-third; ventral row of three tubercles on opposable margin of fixed finger situated near midlength; proximal two-thirds of opposable margin of dactyl with row of nine tubercles; merus with ventrolateral row of 14 tubercles and ventromesial row of 13.

First pleopod (Fig. 8c,g) with all elements more inflated and less sharply defined than in holotype;

shoulder on cephalic surface sloping cephalically, and oblique juvenile groove prominent in proximal half.

Size—The largest specimen available is the allotypic female which has a carapace length of 37.4 mm (post-orbital length of 30.5 mm). The largest and smallest first form males have corresponding lengths of 37.3 (30.2) mm and 28.6(23.1) mm.

Type-locality—Cueva del Nacimiento del Río San Antonio, 10 km SSW Acatlán, Oaxaca, México. The specimens were collected on 26 December 1972 by J. Reddell, D. and M. McKenzie, and S. Murphy.

Types—The holotypic male, form I, allotypic female, and morphotypic male, form II (Nos. 144346, 144347, and 144348, respectively) are deposited in the National Museum of Natural History, Smithsonian Institution. Of the paratypes, one male, form II, and one female are in the Instituto de Biología, Universidad Nacional Autónoma de México, one male, form II, and one female are in The Museum, Texas Tech University, Lubbock, Texas, and one male, form I, one male, form II, two females, one juvenile male, and four juvenile females are in the Smithsonian Institution.

Range and Specimens Examined—*Procambarus (A.) oaxacae reddelli* is known with certainty only from the type-locality, and the 16 available specimens from this cave constitute the type-series. A collection of

Table 2. Measurements (mm) of *Procambarus (A.) oaxacae reddelli*

	Holotype	Allotype	Morphotype
Carapace:			
Height	15.5	15.6	10.4
Width	16.4	15.8	10.9
Length	37.3	37.4	25.8
Postorbital length	30.2	30.5	20.0
Areola:			
Width	2.6	3.1	2.2
Length	13.2	13.1	8.5
Rostrum:			
Width	5.5	5.3	3.5
Length	8.7	8.8	6.5
Right Chela:			
Length of mesial margin of palm	9.2*	13.1**	6.0
Width of palm	6.1*	7.5**	3.9
Length of lateral margin of propodus	23.3*	32.1**	16.3
Length of dactyl	12.3*	17.4**	8.5
Abdomen:			
Width	14.1	14.4	10.1
Length	37.3	38.0	29.9

*Holotype with regenerated chelae, measurements are of paratypic male, form I.

**Left chela of allotype; right chela regenerated.

four first form males, two females, one juvenile male, and two juvenile females from Cueva del Guayabo, 12 km NE of Valle Nacional, Oaxaca, taken by the same collectors on 29 December 1972, is tentatively assigned to this subspecies. On the basis of the proximity of this and the locality from which the nominate subspecies was described, one might anticipate that the crayfish in Cueva del Guayabo would be more closely allied to *P. (A.) oaxacae oaxacae*, particularly in as much as both serve as hosts to the same two species of ostracods, *Entocythere claytonhoffi* and *Ankylocythere maya*. In the type-locality of *P. (A.) oaxacae reddelli* this crayfish harbors *E. claytonhoffi* and *Ankylocythere bidentata* (Rioja).

Variations—As in the nominate subspecies, the most conspicuous variations among the specimens from the type-locality are those associated with injuries and regeneration. Numbers of tubercles on the podomeres of the cheliped, except in regenerated appendages, vary little from the range expressed in the above descriptions. While the size of the pigment spot in the eye is slightly variable, the spot is always sharply defined. In comparing the specimens comprising the type-series with those from Cueva del Guayabo and the type-series of the nominate subspecies, the following were noted. In Cueva del Guano (nominate subspecies), the areola constitutes from 35.8 to 37.8 (Average 36.5) percent of the carapace length and 43.7 to 46.1 (Av. 44.8) percent of the postorbital length. In Cueva del Nacimiento del Río San Antonio (*P. o. reddelli*), the corresponding ranges are 32.9 to 35.6 (Av. 34.3) and 42.0 to 43.7 (Av. 43.0) percent. In Cueva del Guayabo (Atypical *P. o. reddelli*), the ranges are 34.1 to 35.7 (Av. 35.1) and 42.5 to 44.4 (Av. 43.5). In Cueva del Guano, the telson has from one to three (usually two) spines in the caudolateral corner of the cephalic section; none of the individuals has cervical spines; and the reddish purple eye pigment may be absent to moderately abundant, but never is the pigmented area sharply delimited. In contrast, the specimens from Cueva del Nacimiento del Río San Antonio have three spines in at least one of the caudolateral corners of the cephalic section of the telson, a cervical spine is present on at least one side, and the black eye-pigment is sharply margined. Among the specimens from Cueva del Guayabo, only one has three spines in the caudolateral corner of the cephalic section of the telson (usually there are two); two of the specimens lack cervical spines; in all of them, however, the black pigment spot in the eye is sharply outlined.

In view of the intermediate nature of the characters exemplified in the specimens from Cueva del

Guayabo between those observed in the specimens from the other two localities, it seems highly probable that the populations in the latter two are capable of interbreeding, if indeed there does not exist a gene-flow between them. Because of the characteristics of the specimens from Cueva del Guayabo, subspecific rank is assigned to these new troglobites.

Relationships—*Procambarus (A.) oaxacae* is more closely allied to *Procambarus (A.) rodriguezii* Hobbs (1943) than to any other described species, and as the troglobitic crayfish fauna in the karst area of Veracruz and Oaxaca becomes better known, it is possible, if not probable, that intergradation will be discovered between all three of the taxa recognized here. The characters that serve to separate the two subspecies of *P. (A.) oaxacae* have been discussed under variations above, and those that serve to distinguish these subspecies from *P. (A.) rodriguezii* are the absence of a prominent corneous caudomesial boss on the fifth pereopod and the decidedly less flattened mesial process of the first pleopod in the first form male; in the female the annulus ventralis is less protruding, more gently rounded posteroventrally, and the postannular plate does not have a simple transverse row of tubercles. In addition, in the nominate subspecies, there is no cervical spine, and, in *P. (A.) oaxacae reddelli*, there are several distinguishing characteristics: the spines on the cheliped are distinctly more strongly developed, and there is one strong one on the mesial surface of the carpus and another on the distolateral extremity of the merus that are absent in *P. rodriguezii*; furthermore, three spines in the caudolateral corner of the cephalic section of the telson have not been observed in the latter species.

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