# Three New Crustaceans from La Media Luna, San Luis Potosí, Mexico

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and
HORTON H. HOBBS, JR.

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*Alejandro Villalobos Figueroa*
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## ABSTRACT

Villalobos Figueroa, Alejandro, and Horton H. Hobbs, Jr. Three New Crustaceans from La Media Luna, San Luis Potosí, Mexico. *Smithsonian Contributions to Zoology,* number 174, 18 pages, 8 figures, 1 table, 1974.—Representatives of three families of crustaceans are described from La Media Luna, San Luis Potosí, Mexico: *Ankylocythere barbouri* representing the ostracod family Entocytheridae, *Procambarus (Pennides) roberti,* the decapod family Cambaridae, and *Palaemonetes (Palaemonetes) lindsayi* belonging to the decapod family Palaemonidae. All three are known only from the vicinity of the type-locality and seem to have affinities with species occurring in the southeastern part of the United States. A key to the freshwater representatives of the genus *Palaemonetes,* together with a summary of their diagnostic features, is appended.



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## Contents

# Three New Crustaceans from La Media Luna, San Luis Potosí, Mexico

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## Introduction

Three new crustaceans, a crayfish of the genus *Procambarus,* which harbors an entocytherid ostracod of the genus *Ankylocythere,* and a shrimp belonging to the genus *Palaemonetes* may now be added to the faunal list of aquatic animals frequenting the springs and drainage ditches of La Media Luna, San Luis Potosí.

The presence of the crayfish in this headwater tributary of Río Pánuco was discovered by Salvador Contreras on 15 June 1968, and a year later, Clyde D. Barbour collected a single female there, which he sent to the Smithsonian Institution. Being aware of the active fieldwork of Robert R. Miller in Mexico, we asked him to try to get additional specimens for us, should he be collecting in the area. To our delight, he and Kinji Kurawaka obtained seven specimens of the new crayfish, together with two shrimp. Dr. Contreras also secured five additional crayfish in December 1971. After it was realized that the shrimp represented an undescribed species, the senior author visited La Media Luna where, on 14 February 1972, more than 500 additional shrimp were taken in canals and springs of Ejido Las Palomas.

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Miller (1956), in describing the endemic cyprinodontid *Cualac tessellatus* from La Media Luna, presented the following account of the habitat:

> La Media Luna is the name given to an extensive warm-spring area that lies in a broad meadow about seven airline miles south-southwest of the town of Río Verde. A large, constant volume of water rises principally from two rather deep holes in a crescent-shaped pond (laguna) and provides all the water for three municipios. The approximate area of the laguna has been estimated to be 24,800 square meters.... The water is blue, very clear, and has a strong sulfur odor. Water temperatures taken at various stations during different seasons indicate a variation from about 83° to 86.5° F.... The pH varied from 6.9 to 7.3 . . . hardness was recorded as 92 p.p.m. of $CaCO_3$. There was no trace of $CO_2$ and no reaction to phenolphthalein. According to our altimeter, the elevation is 3,580 feet . . . the correct altitude of La Media Luna may be closer to 3,350 feet . . . .
>
> The vegetation of the region is arid, with few trees on the valley floor and a close growth of xerophytic plants on the hills. Mesquite and creosote bush are characteristic, along with large acacias, yuccas, and numerous cacti. Principal crops are sugar cane, corn, beans, citrus fruits, and bananas . . . . Although the vegetation zone of the area is classified in a general way as desert . . . it is markedly different from the other desert areas of northeastern Mexico, and reflects the peculiar position of a depression lying between the relatively low crest (5,500 ft.) of the Sierra Madre Oriental, just to the east and the much higher ranges (8,000 ft.) to the west . . . . The mean annual rainfall of the depression may approach 15 to 20 inches.

In the field notes that accompanied the specimens received from Dr. Miller, he included the following additional information. The ditch (Fig-

ure 1) from which the material was collected was some 8 to 35 feet in width and situated in a cultivated area with few trees and shrubs along the bank. The moderately strong current of clear water (78°F) flowed over a bottom consisting of rocks, boulders, gravel, and deep mud, and supported dense beds of submergent aquatic plants, *Scirpus,* and a few water lilies. The crayfish and shrimp were taken by seine and hand net along the undercut bank at depths of two to three feet. The fishes secured in the same area included *Astyanax fasciatus mexicanus* (de Filippi), *Dionda rasconis* (Jordon and Snyder), *Cichlasoma bartoni* (Bean), *Cichlasoma steindachneri* Jordon and Snyder, *Ataeniobius toweri* (Meek), and the endemic *Cualac tessellatus* Miller. Only two other fishes, *Ictalurus mexicanus* (Meek) and *Cichlasoma labridens* (Pellegrin), are known to occur in the area.

ACKNOWLEDGMENTS.—We wish to thank Clyde D. Barbour, Salvador Contreras, Robert R. Miller, and Kinji Kurawaka for their kindness in collecting many of the specimens on which the descriptions are based. Dr. Miller also provided us with

FIGURE 1.—Ditch from La Media Luna, San Luis Potosí, Mexico, the type-locality of *Procambarus roberti, Palaemonetes lindsayi* and *Ankylocythere barbouri.* (Photo courtesy of Robert R. Miller.)

the photograph of the type-locality and read an early draft of the manuscript. We are also grateful to Isabel Pérez Farfante, Fenner A. Chace, Jr., and Margaret A. Daniel for their criticisms of the manuscript and to Ned E. Strenth for his critical reading of the key.

### *Procambarus (Pennides) roberti*, new species

FIGURE 2

DIAGNOSIS.—Body pigmented, eyes well developed. Rostrum with marginal spines. Areola 31.1 to 34.5 percent of entire length of carapace, and 7 to 10 times longer than wide. Two cervical spines usually present. Suborbital angle rounded and weak. Postorbital ridge with apical spine. Hepatic region tuberculate but lacking spines. Antennal scale approximately 2.3 times longer than wide, broadest near midlength. Ischia of third and fourth pereiopods of first form male with simple hooks overreaching basioischial articulation proximally. First pleopods of male asymmetrical, lacking cephalic shoulder, provided with conspicuous array of subterminal setae, and reaching coxae of third pereiopods; distal extremity bearing (1) slender, caudomesially situated mesial process extending caudodistally and somewhat laterally, slightly beyond other terminal elements; (2) small, curved, platelike, corneous cephalic process on cephalodistal surface; (3) subtriangular, laterally grooved, corneous caudal process on caudodistal surface abutting caudal base of centrally located central projection; and (4) corneous, central projection extending distally about same distance as cephalic process, slightly farther than caudal process, and consisting of subspatulate centrocephalic process and smaller subtriangular centrocaudal process. Annulus ventralis subspindle-shaped, broader than long, with broad median elevated portion marked by sigmoid sinus cutting caudal 0.8 length of annulus. Sternum immediately cephalic to annulus with few low tubercles, but with caudal margin entire.

HOLOTYPIC MALE, FORM I.—Body (Figure 2*c,l*) subovate, somewhat compressed laterally. Abdomen slightly narrower than thorax (10.3 and 11.5 mm). Width of carapace slightly less than height at caudodorsal margin of cervical groove (10.9 and 11.5 mm). Areola 7.4 times longer than broad with 2 punctations across narrowest part. Cephalic section of carapace 2.1 times as long as areola (latter 32.2 percent of entire length of carapace). Rostrum excavate dorsally with unthickened margins slightly convex at base and tapering to marginal spines; dorsal surface with submarginal row of setiferous punctations and others scattered between; spines at base of acumen moderately strong; acumen subtriangular, longer than wide between marginal spines (1.7 and 1.4 mm), and constituting approximately 25 percent of total length of rostrum. Subrostral ridges weak and scarcely evident in dorsal aspect. Postorbital ridges strong, grooved dorsolaterally, with setiferous punctations, and terminating cephalically in corneous-tipped spines. Suborbital angle very weak and rounded. Branchiostegal spine prominent and acute. Carapace punctate dorsally, with conspicuously large pits from base of rostrum posteriorly over most of gastric region; hepatic region mostly tuberculate; branchiostegites granulate laterally and with tubercles ventral to cephalic portion of cervical groove. Two cervical spines on each side of carapace subequal in size. Abdomen slightly longer than carapace (27.4 and 25.2 mm). Cephalic section of telson with 3 spines in each caudolateral corner. Epistome (Figure 2*k*) subcordiform, broader than long; well defined fovea present. Antennules of usual form with prominent spine on ventral surface of proximal segment near midlength. Antennae extending caudally to near midlength of telson. Antennal scale (Figure 2*o*) about 2.4 times longer than broad, broadest near midlength, with broadest lamellar area about 1.6 times wider than thickened lateral portion, latter terminating in strong acute spine.

Right chela (Figure 2*p*) moderately depressed, with palm somewhat inflated; lateral margin with row of subsquamous tubercles along proximal half; dorsal and ventral surfaces of palm with ciliated squamous tubercles, mesial margin with irregular row of 6 or 7 tubercles flanked dorsally by irregular row of 8, ventral surface with prominent tubercle opposite base of dactyl. Fixed finger with moderately well-developed median longitudinal ridge flanked by setiferous punctations, and proximomesial surface with several tuberosities; opposable margin with row of 8 rounded tubercles along proximal 0.6 subtended by row of conspicuously setiferous punctations, third and fourth tubercles from base largest, and large tubercle on lower level at base of distal third; crowded minute denticles

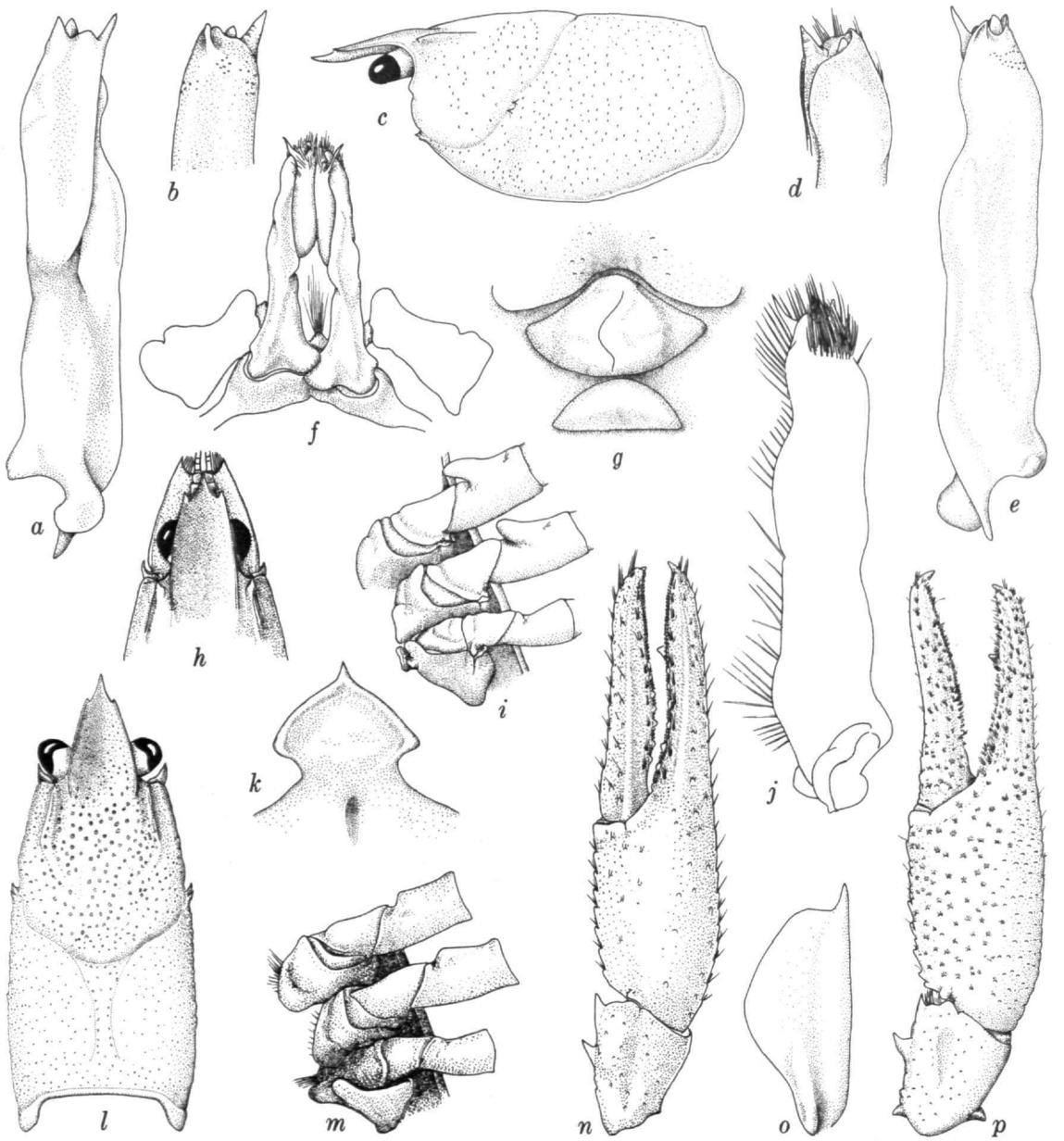


FIGURE 2.—*Procambarus (Pennides) roberti (a, c, e–g, i–l, o, p* from holotypic male, Form I; *b, d, h, m, n* from morphotypic male, Form II): *a,* mesial view of first pleopod; *b,* mesial view of distal part of first pleopod; *c,* lateral view of carapace; *d,* caudolateral view of distal part of first pleopod; *e,* lateral view of first pleopod; *f,* caudal view of first pleopods; *g,* annulus ventralis of allotype; *h,* dorsal view of cephalic region; *i,* basal podomeres of third, fourth, and fifth pereiopods; *j,* lateral view of first pleopod with pubescence; *k,* epistome; *l,* dorsal view of carapace; *m,* ventral view of basal podomeres of third, fourth, and fifth pereiopods; *n,* dorsal view of distal podomeres of cheliped; *o,* antennal scale; *p,* dorsal view of distal podomeres of cheliped.

along almost entire length, sublinearly arranged basally but forming broad band distally; ventral surface with submedian ridge, otherwise with setiferous punctations. Dactyl with low submedian longitudinal ridges dorsally and ventrally, flanked proximally by tubercles and distally by setiferous punctations; mesial surface with tubercles along proximal fourth and setiferous punctations distally; opposable margin with row of 9 low, rounded tubercles along proximal three-fifths, interspersed in band of crowded minute denticles extending almost entire length of finger.

Carpus of right cheliped longer than broad (6.4 and 4.3 mm), with dorsal and dorsomesial surfaces tuberculate and that lateral to oblique furrow punctate; distal dorsomesial surface with prominent spine; mesial surface with 1 very large spine slightly distal to midlength and several small tubercles proximal to it; ventrodistal margin with 2 spines, 1 on ventral articular condyle and other submedian.

Merus of left cheliped mostly punctate; dorsal margin with row of tubercles along proximal half and more irregularly arranged ones distally, two subdistal ones spiniform; ventrolateral margin with row of 10 tubercles proximal to fork and 5 in each ramus of fork; ventromesial margin with row of 16 tubercles; distal tubercles in mesial and lateral rows strongly spiniform; other smaller tubercles present mesial and lateral to 2 rows. Ischium with row of 4 small tubercles on ventromesial margin.

Hooks on ischia of third and fourth pereiopods (Figure 2*i*) simple, and both overreaching basioischial articulation, neither opposed by conspicuous prominence on basis, instead by large pit, bearing tuft of setae; hook on third subconical and longer than somewhat flattened hook on fourth. Coxa of fourth pereiopod with prominent caudomesial boss; that of fifth with slender, rounded, subspatulate prominence on ventral caudomesial margin.

Sternum between second through fifth pereiopods moderately deep and bearing prominent fringe of setae on ventrolateral margins.

First pleopods (Figure 2*a,e,f,j*) as described in diagnosis.

ALLOTYPIC FEMALE.—Differing from holotype in following respects: acumen of rostrum subequal in length and width at base; postorbital spines longer; ventral members of paired cervical spines distinctly larger than dorsal ones; cephalic section of telson with only 2 spines in right caudolateral corner; epistome with paired anterolateral obtuse angles; opposable margin of both fingers of chela with minute denticles reduced to very narrow band, with maximum of 3 denticles in broadest portions; carpus of cheliped with small spiniform tubercle immediately proximal to large spine on dorsal mesiodistal angle, and with additional spiniform tubercles proximal to spine on mesial surface; several tubercles ventral to large spine also spiniform; ventral surface of merus with mesial row of 13 or 14 tubercles and lateral row of 9 or 11, with 2 or 3 in distomesial ramus of lateral row. (See "Measurements.")

Sternum cephalic to annulus ventralis (Figure 2*g*) comparatively shallow, with caudal margin entire; surface of winglike plates between fourth pereiopods with few very low tubercles, otherwise unadorned.

Annulus ventralis freely movable, broader than long, subspindle-shaped in outline, with median portion elevated ventrally and bearing broadly S-shaped sinus, latter beginning on median line, approximately 0.2 length of annulus from cephalic margin, extending caudodextrad, then turning gently caudosinistrad to median line before bending slightly caudodextrad to caudal margin. Median sternite immediately caudal to annulus in form of half-ellipse, with horizontal caudal margin and with transverse elevation, highest medially, slightly cephalic to midlength.

First pleopods uniramous and reaching cephalic margin of annulus when abdomen flexed.

MORPHOTYPIC MALE, FORM II.—Differing from holotype in following respects: width of cephalothorax and abdomen 10.3 and 8.5 mm, respectively; width and height of cephalothorax at level of caudodorsal margin of cervical groove 10.3 and 9.5 mm, respectively; areola 4.9 times longer than broad; cephalic section of carapace twice as long as areola and constituting 33 percent of total length of carapace; surface of rostrum (Figure 2*h*) grooved and with fine punctations, marginal spines well defined, acumen triangular, length less than distance between spines (1.3 and 1.6 mm) and constituting 23.2 percent of total length of rostrum; postorbital ridge well defined, terminating anteriorly in spine; branchiostegal spine conical and sharp; only 1 cervical spine present; abdomen

slightly longer than carapace (23.0 and 20.7 mm); antennal scale 2.4 times longer than wide and with greatest width at midlength; right chela (Figure 2*n*) slenderer than that of holotype and with opposable margins of fingers less pubescent, immovable finger with 6 small, somewhat hemispherical teeth along dorsal region of margin and 1 large subconical tubercle situated ventrally at base of distal 0.33 of dactyl, movable finger with 6 denticles; carpus of cheliped with 2 spines on mesial surface, 1 near midlength and other subdistal; ischia of third and fourth pereiopods (Figure 2*m*) with hooks represented by angular prominences.

First pleopod (Figure 2*b,d*) with mesial process conical, broad basally, and maintaining its caudomesial position; cephalic process forming broad plate; central projection consisting of subconical tubercle; caudal process absent.

COLOR.—Mostly bleached after several weeks' preservation in formalin and alcohol; however, palm of chela reddish purple dorsally, reddish orange ventrally; fingers black dorsally and ventrally, with reddish orange tips. Distal half of merus and entire carpus reddish purple.

TYPE-LOCALITY.—"Ditch from La Media Luna, 4.8 miles (6.6 km) south of Río Verde (on highway to Pedro Montoya) and 2.5 miles (4 km) west on dirt road to Mina El Refugio, San Luis Potosí, México" (Miller, in litt.). See Figure 1 and "Introduction" for description.

DISPOSITION OF TYPES.—The holotypic male, Form I, allotype, and morphotypic male, Form II, are deposited in the National Museum of Natural History, Smithsonian Institution, under the catalog numbers of the United States National Museum (USNM), 132345, 132346, and 144826, together with 2 females and 1 juvenile female paratype. The remaining paratypes consisting of 4 males, Form I, 2 females, and 2 juvenile females are in the collections of the Instituto de Biología, Universidad Nacional Autónoma de México.

RANGE AND SPECIMENS EXAMINED.—All of the specimens available are from Laguna de la Media Luna: 2♂I, 9 km southwest of Río Verde, 15 June 1968, Salvador Contreras, coll.; 1♀, type-locality, 9 June 1969, Clyde D. Barbour and R. J. Douglass, coll.; 2♂I, 3♀, 1 juv. ♀, type-locality, 8 March 1971, Robert R. Miller and Kinji Kurawaka, coll.; 1♂I, 1♂II, 1♀, 2 juv. ♀, 7 km southwest of Río Verde, 23 December 1971, F. C., coll.

SIZE AND VARIATION.—The largest specimen available is a paratypic first form male that has a carapace length of 29.6 mm, 4.4 mm longer than the holotype. The largest female, the allotype, has a corresponding length of 27.0 mm.

Most of the variations noted seem rather insignificant and some, at least, are associated with size and/or possible injury. Chief among them is the presence of only 1 cervical spine on each side in the largest male; all of the spines are heavier and more tubercle-like in this specimen than in any of the others. The epistome varies from subcordiform to subtriangular, some specimens having anterolateral angles. The number of tubercles along the mesial margin of the palm of the chela ranges from 6 to 8. The boss on the coxa of the left fifth pereiopod of the largest male consists of a broad plate rather than a subspatulate one as on the right pereiopod and in the holotype. The spines on the caudolateral corner of the cephalic section of the telson vary from 2 to 4. There may be 1 or 2 subdistal spines on the dorsal surface of the merus. The sinus on the annulus ventralis may be a mirrored image of that in the allotype and may also be more strongly curved.

RELATIONSHIPS.—*Procambarus roberti* is a member of the subgenus *Pennides* Hobbs (1972:10) and has its closest affinities with those crayfishes that have formerly been assigned to the Spiculifer Group (Ortmann, 1905:100). Among them (see Hobbs, 1969), it resembles most closely *P. natchitochae* Penn (1953:5), *P. ablusus* Penn (1963:121), *P. elegans* Hobbs (1969:329), and *P. penni* Hobbs (1951:273). In all of them, the first pleopod of the first form male has a full complement of terminal elements, and the central projection is directed distally or subdistally. Too, the sternum immediately anterior to the annulus ventralis is not produced into tuberculiform or fingerlike lobes. It differs from all of the species of the subgenus in possessing an areola that is 7 to 10 times longer than wide; in none of the other members is it more than 6 times longer, and in most less than 5. It is the only member of the subgenus in which the cephalic process is in the form of a curved, corneous plate. This platelike cephalic process and the large punctations on the dorsal surface of the carapace, particularly between the postorbital ridges, are unique in the subgenus *Pennides* and resemble characteristics that are more typical of the members of the

Mexican subgenus *Villalobosus* Hobbs (1972:12) (= "section *riojae*" Villalobos, 1955:94).

ETYMOLOGY.—This species is named in honor of Robert R. Miller, who has contributed greatly to our knowledge of the Mexican crayfishes by sending many collections to the Smithsonian and who made a special effort to obtain specimens of this new Mexican species.

MEASUREMENTS (mm).—

| *Characters* | *Holotype* | *Allotype* | *Morphotype* |
|---|---|---|---|
| Carapace | | | |
| Height | 11.5 | 11.8 | 9.5 |
| Width | 10.9 | 12.2 | 10.3 |
| Length | 25.2 | 27.0 | 20.4 |
| Areola | | | |
| Width | 1.1 | 0.9 | 1.4 |
| Length | 8.1 | 8.8 | 6.9 |
| Rostrum | | | |
| Width | 4.2 | 4.8 | 3.5 |
| Length | 7.0 | 7.7 | 5.6 |
| Left chela | | | |
| Length of mesial margin of palm | 8.0 | 6.7 | 5.3 |
| Width of palm | 6.4 | 5.0 | 3.5 |
| Length of lateral margin | 20.7 | 16.3 | 13.5 |
| Length of dactyl | 11.1 | 8.8 | 7.5 |

## *Ankylocythere barbouri*, new species

FIGURE 3

DIAGNOSIS.—Shell length: ♂, 0.36 mm; ♀, 0.40-0.41 mm. Shell height: ♂, 0.19-0.20 mm; ♀, 0.22 mm.

Clasping apparatus with talon represented by very slight excrescence near midlength of external border of horizontal ramus; internal border with 2 teeth, larger tooth above talon and small one immediately distal to larger; apex with 2 upturned denticles. Ventral portion of peniferum subtruncate with anteroventral angle produced ventrally in short spinelike projection and with short fingerlike thickening at posterior end of truncate ventral extremity.

MALE.—Eye situated at anterodorsal 0.2 of shell. Shell (Figure 3*e*) oblong with greatest height slightly posterior to midlength; ventral margin only slightly curved, lacking concavity; submarginal setae almost evenly spaced except dorsally, and few additional setae on posterolateral surface.

Copulatory complex (Figure 3*a-c*) with peniferum slightly arched posteriorly, subtruncate ventrally, with short spinelike projection anteroventrally supported by elevated flange extending dorsally almost

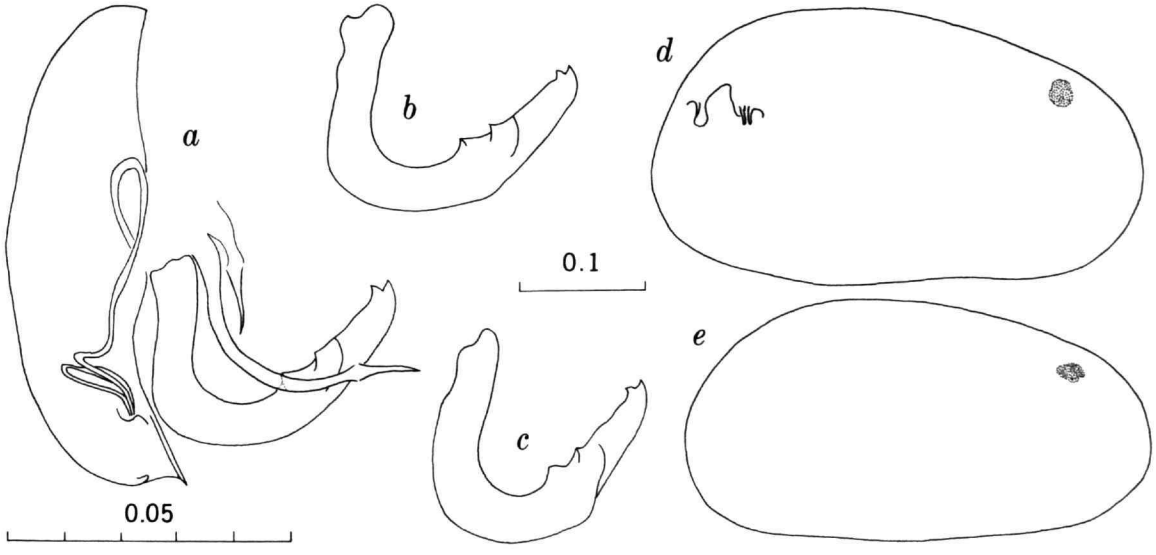


FIGURE 3.—*Ankylocythere barbouri: a*, copulatory complex of paratypic male; *b*, *c*, clasping apparatus of same; *d*, lateral view of shell of allotypic female; *e*, lateral view of shell of holotype. (Scales in mm.)

to level of penis; small fingerlike thickening directed anteriorly on posteroventral extremity. Penis much longer than half anteroposterior diameter of peniferum at level of penis and curved with proximal and distal ends directed at angle of approximately 130 degrees. Dorsal and ventral fingers moderately heavy and both terminating in simple setiform tips; ventral finger gently curved throughout its length. Clasping apparatus with indistinctly delimited horizontal and vertical rami disposed at angle of approximately 50 degrees. Pre- and postaxial borders of vertical ramus entire; postaxial border of horizontal ramus with slight excrescence near midlength (excrescence more clearly defined, with horizontal ramus directed somewhat laterally); preaxial border of horizontal ramus with 2 teeth: proximal one larger and situated opposite excrescence, smaller tooth located slightly distal to larger one and with distinct curved ridge extending proximoventrally from apex; distal extremity of ramus with 2 denticles directed somewhat dorsally.

TRIUNGUIS FEMALE (Figure 3*d*).—Eye situated anterodorsally at anterior 0.17 of shell length. Shell oblong, slightly higher in posterior half than in anterior, greatest height distinctly posterior to midlength; submarginal setae as in male.

Genital complex consisting of 2 posterodorsally situated elements: posterior one subdigitiform, hyaline, and grooved laterally; anterior sclerotized and cylindroid.

MEASUREMENTS.—Holotype: length 0.36 mm, height 0.20 mm. Allotype: length 0.41 mm, height 0.22 mm. See "Diagnosis" for ranges.

TYPE-LOCALITY.—Ditch from La Media Luna, 4.8 miles (6.6 km) south of Río Verde (on highway to Pedro Montoya) and 2.5 miles west on dirt road to Mina El Refugio, San Luis Potosí, Mexico. (See Figure 1 and "Introduction" for description).

DISPOSITION OF TYPES.—The type-series, consisting of the holotypic male, USNM 149159, allotypic female, USNM 149160, a dissected paratypic male, a paratypic female, and 6 juvenile specimens, is deposited in the National Museum of Natural History, Smithsonian Institution, under the catalog numbers of the United States National Museum (USNM). No other specimens are available.

RANGE AND HOST.—Known only from the type-locality, where it is the sole entocytherid infesting the crayfish *Procambarus (Pennides) roberti,* described above.

ETYMOLOGY.—This ostracod is named in honor of its discoverer, Clyde D. Barbour, who has contributed a number of Mexican crayfishes to the Smithsonian Institution.

RELATIONSHIPS.—*Ankylocythere barbouri* exhibits characteristics that indicate its close relationships with two geographic neighbors currently assigned to different genera: *Ankylocythere toltecae* Hobbs (1971:36) from the states of Hidalgo, San Luis Potosí, and Tamaulipas, and *Uncinocythere bicuspide* (Rioja, 1943:565) from Hidalgo, Puebla, and Veracruz. It differs most strikingly from the former in possessing two teeth on the preaxial border of the horizontal ramus of the clasping apparatus of the male and from the latter in bearing a rudimentary talon (excrescence) on the postaxial border of the ramus (see Hobbs, 1971, for summaries of our knowledge of both species). Whereas the excrescence in *A. toltecae* is markedly reduced in size as compared with that of many members of the genus, it is even more rudimentary in *A. barbouri.* The latter differs from both in being larger; for example, its shell length in the male is 0.36 mm, whereas the corresponding lengths in *A. toltecae* and *U. bicuspide* range from 0.29 to 0.31 mm in both species. The penifera of the three are markedly similar, and the clasping apparatus are basically similar, differing essentially only in the characteristic pointed out immediately above.

Those of us concerned with the interrelationships of entocytherids have been aware of the fact that as additional species were added to the two genera, their distinctness became less well defined. With the discovery of *Ankylocythere barbouri* (linking the Mexican species assigned to the genus *Uncinocythere* with *Ankylocythere toltecae,* and it, in turn, through the various *"talirotundi"* forms of *A. heterodonta,* to those members of *Ankylocythere* having a well-developed talon on the clasping apparatus of the male), the advisability of maintaining the two genera does indeed become questionable. Nevertheless, the divergence that has occurred within the two is so great that uniting them does not seem fully justified. Furthermore, the two genera may still be recognized on the basis of the presence or absence of a talon or excrescence on the horizontal ramus of the clasping apparatus of the male.

In reference to the assumed relationships with members of the genus *Uncinocythere,* it is note-

worthy that the presence of only two apical denticles on the clasping apparatus is limited to the three Mexican species [*U. bicuspide, U. cuadricuspide* (Rioja, 1945:422), and *U. dobbinae* (Rioja, 1943:560)] and two [*U. equicurva* (Hoff, 1944) and *U. lucifuga* Walton and Hobbs, 1959] from the southeastern part of the United States [within the range of the crayfish subgenus *Pennides,* and the former occurring on *Procambarus (Pennides) spiculifer* (LeConte, 1956)]. Perhaps it is significant that the peniferum of *U. lucifuga* is remarkably similar to that of *A. barbouri,* and, in some individuals of both *U. equicurva* and *U. lucifuga,* there are two teeth on the preaxial border of the horizontal ramus of the clasping apparatus that are arranged much as they are in *A. barbouri,* thus differing from the latter chiefly in lacking an excrescence on the horizontal ramus of the clasping apparatus.

### *Palaemonetes (Palaemonetes) lindsayi,* new species

FIGURES 4–7, 8*e*

DIAGNOSIS.—Rostrum dentate: $\frac{1)\ 6\ -\ 7;}{2\ -\ 4}$ in general reaching extremity of antennal scale. Telson with 4 dorsal spines; distal margin with 4 spines and 2 setae, none of which exceeding distal end of uropod. Ventral ramus of lateral flagellum of antennule with 3 or 4 free articles. Antennal scale 3.5 times longer than wide. Endopodite of first maxilla with 3 spines. First maxilliped with unilobulate gill. Second maxilliped with mesial border of branchial ramus entire. Third maxilliped with 2 podobranchs, proximal one very small. Appendix masculina as long as endopodial ramus of pleopod and bearing 4 apical and 2 (including distal member of row) subapical spines.

DESCRIPTION.—Rostrum gently curved and reaching extremity of antennal scale in 39.3 percent of individuals examined, in others (24.4 percent) projecting beyond scale, and in remaining specimens (36.3 percent) rostrum not quite reaching distal end of scale; dorsal margin armed with 6 or 7 teeth, latter number predominant; ventral margin with 2, more usually 3, or rarely 4, teeth; single dorsal tooth situated posterior to orbit (Figures 4, 5). Antennal and branchiostegal spines quite long and sharp, former implanted submarginally, latter on margin. Hepatic groove extending to anterior border of carapace, slightly above antennal spine.

Pleuron of second abdominal somite rounded both antero- and posteroventrally, its width in females equal to length of tergum of third somite, and in males 0.75 length of latter. Tergal length of sixth somite equal to that of telson not including distal spines (Figure 4).

Telson with 2 pairs of dorsal spines in posterior 0.25 somewhat asymmetrically arranged, but posterior pair situated about midway between anterior pair and posterolateral angle; posterior margin, prolonged in median acute angle, provided with pair of short posterolateral spines, pair of longer more median ones, and pair of plumose setae inserted mesial to long spines (Figure 6*a-e*).

Eye well developed, cornea and peduncle together pyriform (Figure 6*f*).

Antennular peduncle with apex of stylocerite reaching midlength of first article. Lateral flagellum of antennule bifurcate at thirteenth to fifteenth article from base; ventral ramus, consisting of 3 or 4 free articles, about 0.33 length of basal undivided portion of flagellum (Figure 6*g, h*).

Antennal scale 3.5 times longer than wide; lateral border weakly concave, free portion of scale, from base of spine to distal margin, 0.2 total length of scale; length of distal article of antennal peduncle equal to greatest width of scale (Figure 6*i, j*).

First maxilla (Figure 6*l, m*) with bifurcate palp; distal margin of lateral lobe lacking setae or spines, that of mesial, or more proximal, lobe armed with 3 spines bent at angle. Gnathal lobules as illustrated.

Second maxilla (Figure 6*n*) with extremities of scaphognathite rounded, its width almost uniform. Palp with distal half naked. Gnathal lobules as illustrated.

First maxilliped (Figure 7*a*) with branchial epipodite bearing slight lateral emargination. Second maxilliped (Figure 7*b*) with branchial epipodite bilobed, one lobe entire, other with digitiform processes. Third maxilliped (Figure 7*c*) with 2 podobranchs, large distal one with digitiform processes, and proximal one small with irregular margins.

First pair of pereiopods reaching base of distal third of antennal scale. Carpus and merus subequal in length (Figure 7*d*). Setiferous organs present on ventrodistal part of carpus, ventroproximal region

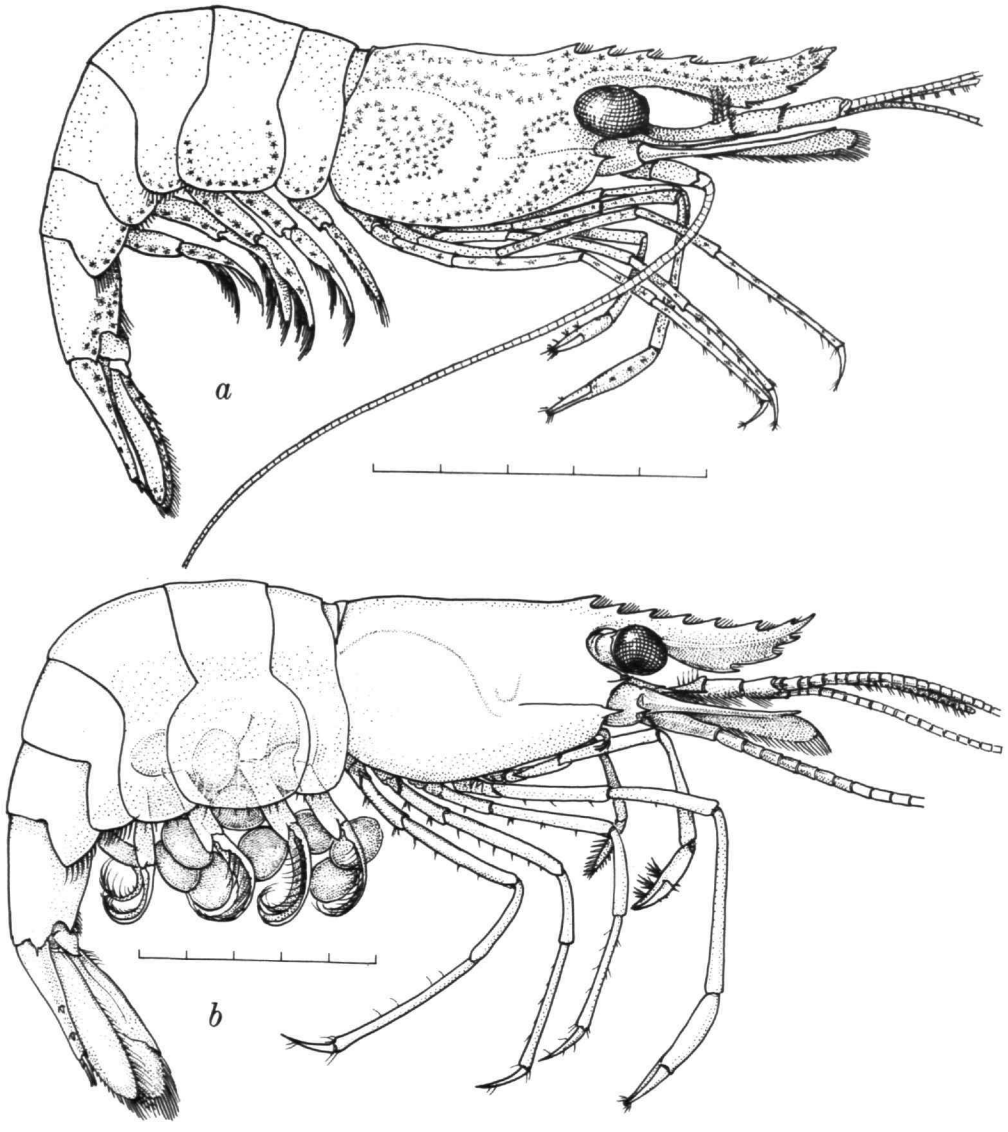


FIGURE 4.—*Palaemonetes (Palaemonetes) lindsayi: a,* lateral view of holotypic male; *b,* lateral view of ovigerous paratypic female. (Scale in mm.)

of propodus, and on dactyl of chela (Figure 7*e*); length of palm equal to that of dactyl; opposable margin of fingers without teeth, single marginal row of setae on both sides of margin in each finger.

Second pair of pereiopods overreaching rostrum by length of distal third of carpus and chela; merus equal in length to chela, and dactyl shorter than palm (Figure 7*f,g*); opposable margins of fingers without teeth.

Third pair of pereiopods (Figure 7*h*) with 3 spines on ventral margin of propodus and 1 spine at ventrodistal extremity. Fourth pair of pereiopods with 4 spines on ventral margin of propodus and another ventrodistally (Figure 7*i*), and, in addition, series of lateral spines on lateral surface. Fifth pair of pereiopods (Figure 7*j*) with 6 spines on ventral margin of propodus; ventrodistal portion of latter with setiferous organ as depicted (Figure 7*l*). Ventral border of dactyl of third through fifth pereiopods in females regularly curved, in males with subdistal, almost angular excavation (Figure 7*k*).

Second pleopod of male (Figures 7*n,o,* 8*e*) with appendix masculina as long as endopod and provided with row of spines along almost its entire length; distal extremity with group of 4 apical spines and 2 (including distal member of row) subapical spines.

MEASUREMENTS (mm).—

| *Characters* | *Holotypic male* | *Paratypic males* | | | | | *Paratypic females* | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Carapace length, including rostrum | 7.0 | 8.4 | 8.2 | 7.3 | 7.9 | 2.6 | 10.0* | 11.2* | 11.0* | 7.4 | 7.2 |
| Telson length | 2.1 | 3.7 | 2.5 | 2.6 | 2.6 | 2.1 | 3.0 | 3.4 | 3.5 | 2.4 | 2.2 |
| Pereiopod length | | | | | | | | | | | |
| First | 6.0 | 6.3 | 5.8 | 6.3 | 5.8 | 4.8 | 7.6 | 8.1 | 9.8 | 5.5 | 5.4 |
| Second | 8.5 | 10.2 | 9.0 | 8.2 | 9.5 | 7.2 | 12.5 | 13.5 | 11.6 | 8.2 | 7.6 |

* Ovigerous

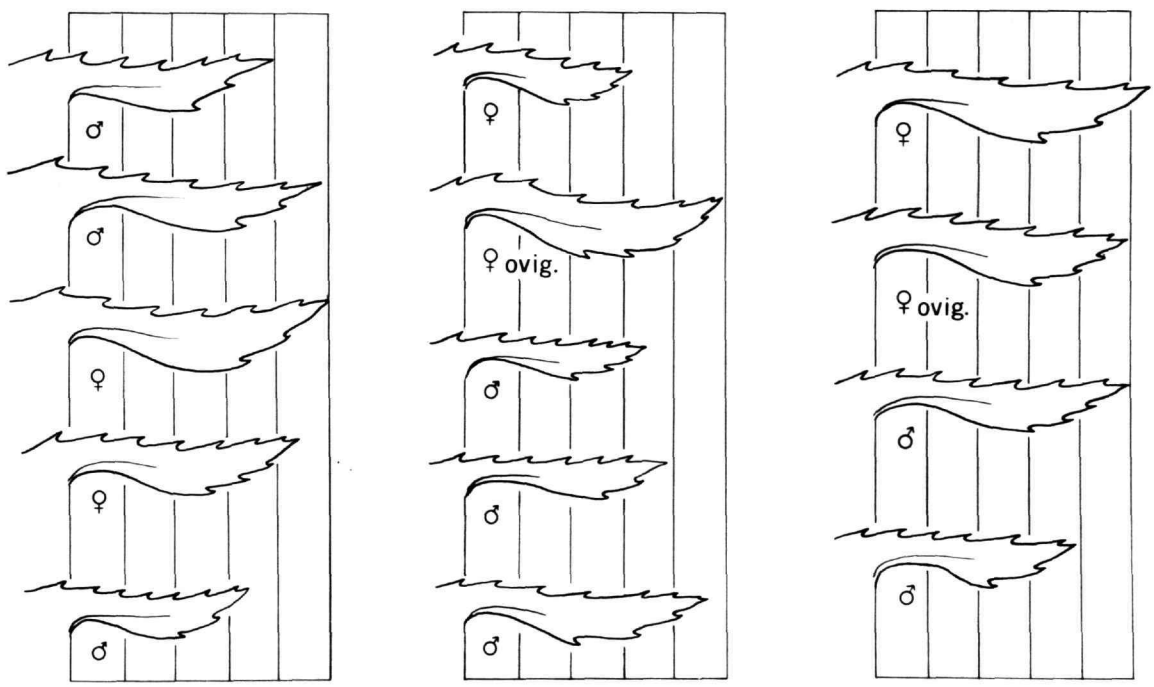


FIGURE 5.—*Palaemonetes (Palaemonetes) lindsayi:* variation in rostrum. (Grid in mm.)

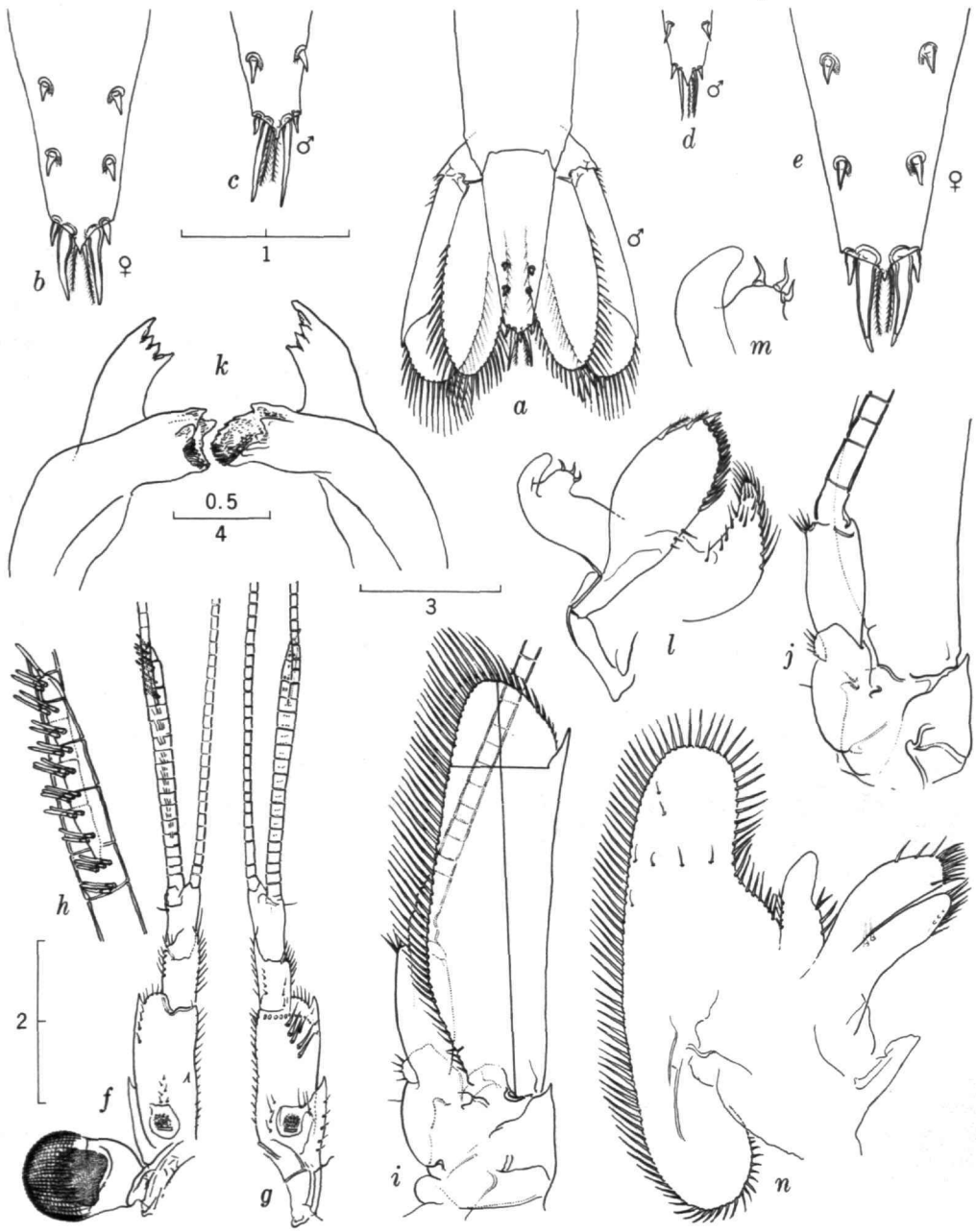


FIGURE 6.—*Palaemonetes (Palaemonetes) lindsayi: a,* telson and uropods of male; *b, e,* telson of adult females; *c, d,* telson of adult males; *f,* dorsal view of antennule and eye; *g,* ventral view of antennule; *h,* ventral view of external and accessory flagella of antennule; *i,* dorsal view of basal portion of antenna; *j,* ventral view of same; *k,* mandibles; *l,* first maxilla; *m,* details of palp of same; *n,* second maxilla. (*a–e* to scale 1; *f, g* to scale 2; *i, j* to scale 3; *k, l, n* to scale 4; scales in mm.)

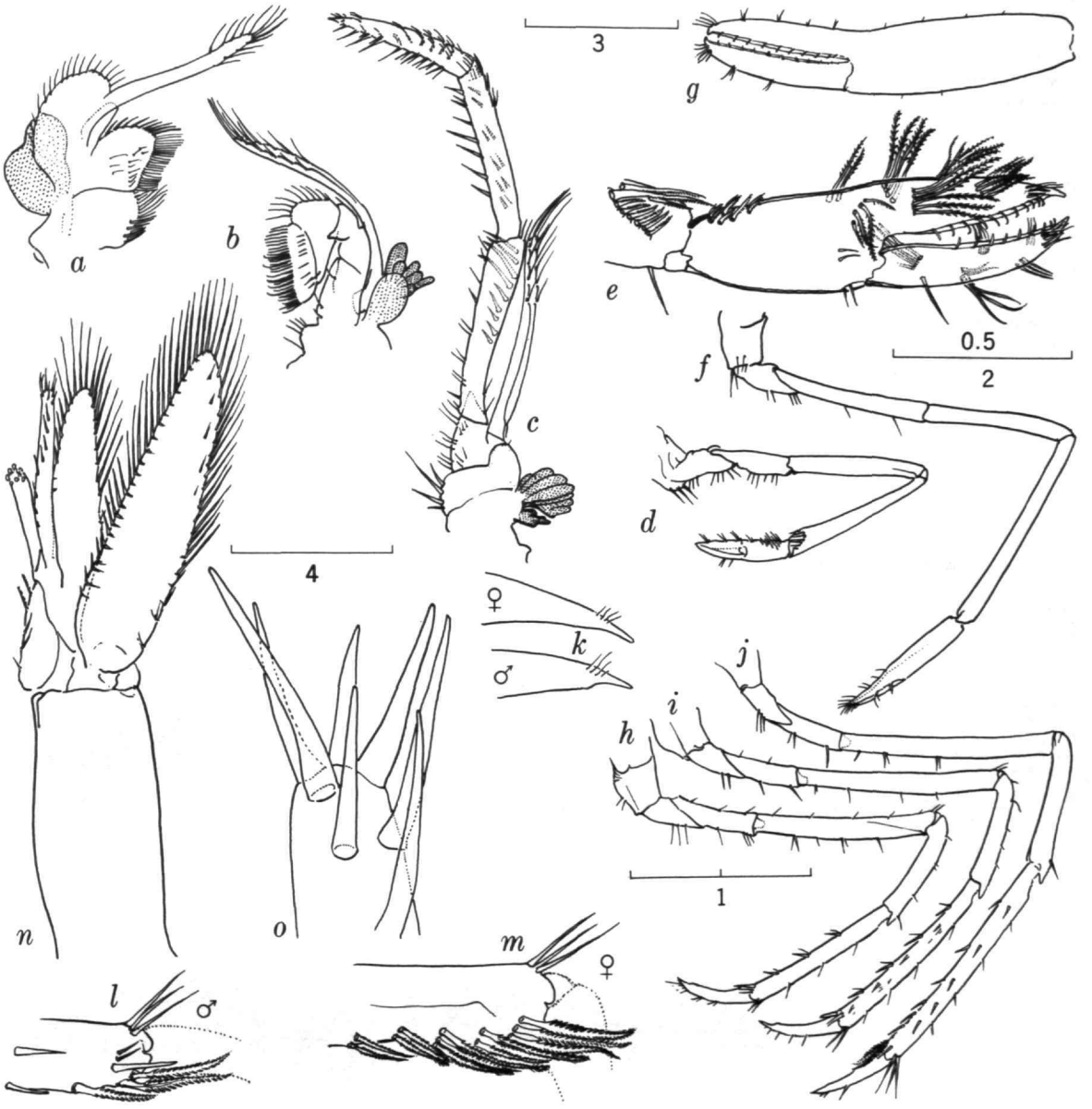


FIGURE 7.—*Palaemonetes (Palaemonetes) lindsayi: a,* first maxilliped; *b,* second maxilliped; *c,* third maxilliped; *d,* first pereiopod; *e,* chela of first pereiopod; *f,* second pereiopod; *g,* chela of second pereiopod; *h, i, j,* third, fourth, and fifth pereiopods; *k,* distal extremity of dactyl of pereiopods 3–5; *l,* distal extremity of propodus of fifth pereiopod of male; *m,* same of female; *n,* second pleopod of male; *o,* distal portion of appendix masculina. *(a–d, f, h–j* to scale 1; *e, k–m* to scale 2; *g* to Scale 3; *n* to scale 4; scales in mm.)

HABITAT.—Margins of irrigation canals, among the submerged vegetation where the current is more sluggish.

TYPE-LOCALITY.—Springs and canals in the watershed of Laguna de la Media Luna, 4.8 miles (6.6 km) south of Río Verde (on the road to Pedro Montoya) and 2.5 miles (4 km) to the west on a road to the Mina El Refugio, San Luis Potosí, Mexico.

DISPOSITION OF TYPES.—The type-series consists of the holotypic male, USNM 149161, the allotypic female, USNM 149162, and 25 males and 25 females, all deposited in the National Museum of Natural History, Smithsonian Institution; the remaining paratypes are in the collection of Crustacea in the Instituto de Biología, Universidad Nacional Autónoma de México, and the collection of Crustacea of the Facultad de Ciencias Biológicas, Universidad Nacional Autónoma de Nuevo Léon, Mexico.

DISTRIBUTION.—Known only from the type-locality.

ETYMOLOGY.—This species is dedicated to George E. Lindsay, eminent student of cacti and director of the California Academy of Sciences.

RELATIONSHIPS.—Our knowledge of the genus *Palaemonetes* in Mexico is so fragmentary, and that of the limits of variations in the four freshwater representatives in the United States so inadequately known, the affinities of the species described here cannot be properly assessed. Overlooking the lack of pigment in *P. (P.) cummingi* Chace, 1954, all five of the known species belonging to the nominate subgenus are remarkably similar, and few charac-

TABLE 1.—*Diagnostic features of North and Middle American freshwater* Palaemonetes

| *Shrimp* | *Rostral length** | *Branchiostegal spine* | *Posterodorsal spines of telson* | *Spines on lateral ramus of uropod* | *Setae on palp of first maxilla* | *Appendix masculina* |
|---|---|---|---|---|---|---|
| *P. antrorum* | not reaching level of spine | posterior to margin and ventral to branchiostegal groove | nearer to posterior than to antero-dorsal spines | 1 | 0 | 12 setae: 4 apical and 1 subapical (counting distal member of lateral row); apical setae not reaching apex of endopod |
| *P. cummingi* | reaching level of spine | marginal and adjacent to branchiostegal groove | nearer to posterior than to antero-dorsal spines | 2 | 3 | 8 setae: 5 apical and 2 subapical (counting distal member of row); apical setae not reaching apex of endopod |
| *P. kadiakensis* | reaching or slightly overreaching level of spine | usually posterior to margin and ventral to branchiostegal groove | usually much nearer posterior than to antero-dorsal spines | 2 | 0 | 11 setae: 3 apical and 1 subapical; apical setae not reaching apex of endopod |
| *P. paludosus* | overreaching level of spine | marginal or submarginal and adjacent to branchiostegal groove | almost midway between antero-dorsal spines and posterior spine | 2 | 2 | 11 setae: 4 apical and 1 subapical (counting distal member of row); 1 or more apical setae reaching apex of endopod |
| *P. lindsayi* | reaching level of spine | marginal or submarginal and adjacent to branchiostegal groove | almost midway between antero-dorsal spines and posterior spine | 1 | 3 | 16 setae: 5 apical and 2 subapical (counting distal member of row); apical setae reaching or slightly overreaching apex of endopod |
| *P. suttkusi* | reaching or almost reaching level of spine | marginal or submarginal and adjacent to branchiostegal groove | almost midway between antero-dorsal spines and posterior spine | 1 | 0 | 15 setae: 6 apical and 2 subapical (counting distal member of row); apical setae almost reaching apex of endopod |

*In relation to distal spine on antennal scale.

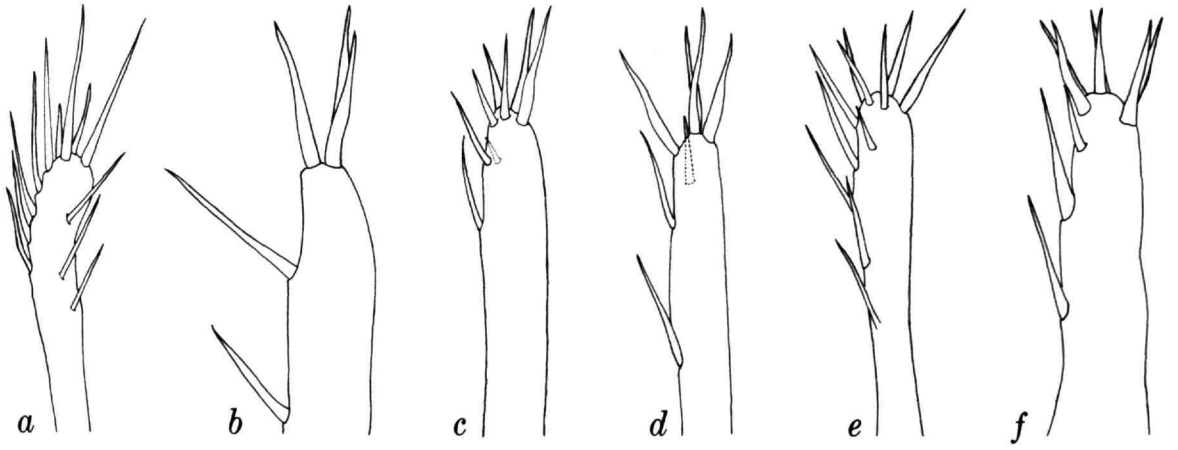


FIGURE 8.—Distal portions of appendices masculinae in postaxial view: *a, Palaemonetes (Alaocaris) antrorum; b, Palaemonetes (Palaemonetes) kadiakensis; c, P. (P.) cummingi; d, P. (P.) paludosus; e, P. (P.) lindsayi; f, P. (P.) suttkusi.* (Not drawn to same scale.)

ters have been found that serve to separate them.

Holthuis (1952), in monographing the American Palaemoninae, summarized the ranges of the three known freshwater species and used spination of the carapace, telson, and uropods as the primary characters for distinguishing between the two epigean members. Subsequently, some specimens from the southeastern part of the United States could not, on the basis of those characters, be identified. Fleming (1969), investigating the secondary sexual characters of certain members of the genus, found that a reliable characteristic for distinguishing between *P. (P.) paludosus* (Gibbes, 1850) and *P. (P.) kadiakensis* Rathbun, 1902, exists in the number and distribution of the setae of the apical region of the appendix masculina.

The characteristics presented in Table 1 include most of those that we have found to be useful in assessing probable relationships and in distinguishing between the six known freshwater species of the genus occurring in North America and Middle America. The overlap in most of the other characters that we have investigated is such that one must conclude that, excluding *P. (Alaocaris) antrorum,* Benedict, 1896, the remaining species comprise a closely allied group. Of the previously described species, adequate series are available of only *P. (A.) antrorum, P. (P.) kadiakensis,* and *P. (P.) paludosus.* There are only 4 specimens of *P. (P.) cummingi* known to us, and only 13 specimens of *P. (P.) suttkusi* Smalley, 1964, have been reported.

Utilizing the limited data available, and perhaps emphasizing the resemblance existing between the appendices masculinae (Figure 8*a-f*), we believe that the closest relatives of *P. (P.) lindsayi* are *P. (P.) suttkusi* (Coahuila Province, Mexico) and *P. (P.) paludosus* (New Jersey to Florida).

The key on page 16 will assist in recognizing the species mentioned above.

## Discussion

As has been pointed out in the sections devoted to relationships of the three crustaceans, the affinities of the crayfish, *Procambarus roberti,* seem clearly to be with species occurring principally in the southeastern part of the United States, and the discovery of the geographically disjunct member of the stream-dwelling subgenus *Pennides* in a stream within the Sierra Madre Oriental, so far south in Mexico, came as a great surprise.

Certain resemblances of *P. roberti* to members of the subgenus *Villalobosus* (a group of crayfishes confined to a relatively small area north of the Cordillera Volcánica Transversal in the states of Hidalgo, Puebla, and Veracruz) were noted above. Both the morphological similarities and geographic

## Key to the North and Middle American Freshwater Species of the Genus *Palaemonetes*

1. Pigmented; lateral ramus of antennule with mesial free portion longer than basal fused portion ..... Salt and brackish water species
   Pigmented or albinistic; lateral ramus of antennule with mesial free portion distinctly shorter than basal fused portion except in *P. (A.) antrorum* ..... Freshwater species.... 2
2. Body and eyes without pigment; rostrum short and lacking teeth on ventral margin; chela of first and second pereiopods subequal in size ..... ***Palaemonetes (Alaocaris) antrorum*** Benedict, 1896
   Body and eyes with or without pigment; rostrum long and with teeth on ventral margin; chela of second pereiopod distinctly longer than that of first ..... 3
3. Lateral ramus of uropod with small movable spine at mesial base of lateral spine ..... 4
   Lateral ramus of uropod lacking small movable spine at mesial base of lateral spine .... 6
4. Body and eyes without pigment; mesial lobe of palp of first maxilla with 3 setae ..... ***Palaemonetes (Palaemonetes) cummingi*** Chace, 1954
   Body and eyes with pigment; mesial lobe of palp of first maxilla without or with 2 setae . 5
5. Branchiostegal spine marginal or only slightly posterior to margin and adjacent to branchiostegal groove; posterodorsal pair of spines on telson situated almost midway between anterodorsal pair and posterolateral angle of telson; appendix masculina (Figure 8*d*) with 4 apical and 1 subapical setae; mesial lobe of palp of first maxilla with 2 curved setae ..... ***Palaemonetes (Palaemonetes) paludosus*** (Gibbes, 1850)
   Branchiostegal spine never marginal and somewhat removed ventrally from branchiostegal groove; posterodorsal pair of spines on telson usually situated much closer to posterior margin of telson than to anterodorsal spines; appendix masculina (Figure 8*b*) with only 3 apical and 1 subapical setae; mesial lobe of palp of first maxilla lacking setae ..... ***Palaemonetes (Palaemonetes) kadiakensis*** Rathbun, 1902
6. Rostrum extending distinctly beyond level of spine on antennal scale; appendix masculina (Figure 8*e*) with 5 apical and 2 subapical setae (counting distal member of row of setae); mesial lobe of palp of first maxilla with 3 curved setae ..... ***Palaemonetes (Palaemonetes) lindsayi,*** new species
   Rostrum extending only to level of spine on antennal scale; appendix masculina (Figure 8*f*) with 6 apical and 2 subapical setae (counting distal member of row of setae); mesial lobe of palp of first maxilla without setae ..... ***Palaemonetes (Palaemonetes) suttkusi*** Smalley, 1964

position of *P. roberti* suggest that it was derived from the ancestral stock that was the forerunner of *Villalobosus*. If Hobbs' views concerning the invasion of Mexico by crayfish stocks from the north prove to be admissible (Hobbs, 1971:12, 13; see summary table and Figure 6*b*), then *P. roberti* represents a relict of one of the three stocks ("5B") migrating southward into Mexico during the Pliocene.

With the assumed passive migration (Hobbs, 1971:10) of the ostracod on crayfish hosts, and if the suggested relationships of the hosts, as pointed out above, are valid, one might assume that the ostracods occurring on *P. roberti* would show affinities with those ostracods infesting members of the subgenus *Villalobosus,* and this is precisely what we believe has been found. *Ankylocythere barbouri* indeed is markedly similar to *Uncinocythere bicuspide* (Rioja, 1943), which infests six crayfishes belonging to the subgenus *Villalobosus.* Its importance in linking the previously recognized genus *Uncinocythere* with *Ankylocythere* has been discussed in the paragraphs devoted to its relationships.

In discussing the origin of the Mexican entocytherid fauna, Hobbs (1971:15-17) stated that the *Uncinocythere* stock, "generally considered to be the most primitive of the subfamily [Entocytherinae], apparently was brought into Mexico during the Pliocene by one or more of the three stocks of crayfishes (one of which is rather primitive [*P. roberti* is believed to be a descendant of that stock]) that moved southward across the Northern Gulf Slope [1971:10-11] to populate the interjacent area." He further indicated that *Ankylocythere toltecae,*

which is restricted to a small area in southern Tamaulipas, eastern San Luis Potosí, and extreme northern Hidalgo . . . is associated with only two hosts, *P. toltecae* and *P. villalobosi* . . . remnants of the Pliocene crayfish migration passing through the Northern Gulf Slope southward. In fact, these two represent the only suspected traces of the Pliocene crayfish stock that have remained in that area [*P. roberti* is the third]. Why they should harbor a member of the genus *Ankylocythere* while their close relatives to the south are infested by members of the genus *Uncinocythere* poses a problem in itself.

After exploring possible explanations, he "favored" the hypothesis, "that *A. toltecae* is viewed as a relict of the pioneering [pre-Pliocene] *Ankylocythere* stock which, before the extinction of its original hosts, managed to gain access to certain members of the Pliocene crayfish invaders as alternative hosts."

With the discovery of *A. barbouri* in the Northern Gulf Slope, linking *A. toltecae* to *U. bicuspide*, one could hardly overlook the possibility of an independent acquisition of the excrescence on the clasping apparatus by their immediate ancestors from the Pliocene *Uncinocythere* stock that gave rise to the Mexican members of *Uncinocythere*. While this would suggest at least a diphyletic origin of *Ankylocythere* from the more primitive *Uncinocythere*, it would permit a strong parallel with the assumed migrations of the host stocks, and, in addition, it would provide an explanation for the marked similarities betwen *A. barbouri* and the two members of *Uncinocythere (U. equicurva* and *U. lucifuga)* occurring in the southeastern part of the United States. Even though such an explanation is in keeping with our present knowledge, until more conclusive evidence for the di- or polyphyletic origin of *Ankylocythere* becomes available, recognition of the two generic groups does not seem inappropriate.

As pointed out above, there are so few data on the range of the genus *Palaemonetes* in Mexico, and one of the American species is so poorly known, there is little to suggest the source of the stock from which this new species was derived. If our tentative conclusion—that *Palaemonetes (P.) lindsayi* is most closely allied to *P. (P.) suttkusi* and *P. (P.) paludosus*—proves to be tenable, then there exists a similar pattern of relationships (Mexico and the southeastern part of the United States) parallel to that postulated for the crayfish and entocytherid frequenting the waters of La Media Luna.

It seems highly probable to us that the crayfish and its ostracod commensal (also possibly the shrimp), in contrast to most of the fish fauna (see Miller, 1956:15), have affinities with the nearctic faunas rather than with tropical ones.

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*Copy* must be typewritten, double-spaced, on one side of standard white bond paper, with 1½″ top and left margins, submitted in ribbon copy with a carbon or duplicate, and accompanied by the original artwork. Duplicate copies of all material, including illustrations, should be retained by the author. There may be several paragraphs to a page, but each page should begin with a new paragraph. Number consecutively all pages, including title page, abstract, text, literature cited, legends, and tables. The minimum length is 30 pages, including typescript and illustrations.

The *title* should be complete and clear for easy indexing by abstracting services. Taxonomic titles will carry a final line indicating the higher categories to which the taxon is referable: "(Hymenoptera: Sphecidae)." Include an *abstract* as an introductory part of the text. Identify the *author* on the first page of text with an unnumbered footnote that includes his professional mailing address. A *table of contents* is optional. An *index,* if required, may be supplied by the author when he returns page proof.

Two *headings* are used: (1) text heads (boldface in print) for major sections and chapters and (2) paragraph sideheads (caps and small caps in print) for subdivisions. Further headings may be worked out with the editor.

In *taxonomic keys,* number only the first item of each couplet; if there is only one couplet, omit the number. For easy reference, number also the taxa and their corresponding headings throughout the text; do not incorporate page references in the key.

In *synonymy,* use the short form (taxon, author, date:page) with a full reference at the end of the paper under "Literature Cited." Begin each taxon at the left margin with subsequent lines indented about three spaces. Within an entry, use a period-dash (.—) to separate each reference. Enclose with square brackets any annotation in, or at the end of, the entry. For *references within the text,* use the author-date system: "(Jones, 1910)" and "Jones (1910)." If the reference is expanded, abbreviate the data: "Jones (1910:122, pl. 20: fig. 1)."

Simple *tabulations* in the text (e.g., columns of data) may carry headings or not, but they should not contain rules. Formal *tables* must be submitted as pages separate from the text, and each table, no matter how large, should be pasted up as a single sheet of copy.

Use the *metric system* instead of, or in addition to, the English system.

*Illustrations* (line drawings, maps, photographs, shaded drawings) can be intermixed throughout the printed text. They will be termed *Figures* and should be numbered consecutively; however, if a group of figures is treated as a single figure, the components should be indicated by lowercase italic letters on the illustration, in the legend, and in text references: "Figure 9*b*." If illustrations (usually tone photographs) are printed separately from the text as full pages on a different stock of paper, they will be termed *Plates,* and individual components should be lettered (Plate 9*b*) but may be numbered (Plate 9: figure 2). Never combine the numbering system of text illustrations with that of plate illustrations. Submit all legends on pages separate from the text and not attached to the artwork. An instruction booklet for the preparation of illustrations is available from the Press on request.

In the *bibliography* (usually called "Literature Cited"), spell out book, journal, and article titles, using initial caps with all words except minor terms such as "and, of, the." For capitalization of titles in foreign languages, follow the national practice of each language. Underscore (for italics) book and journal titles. Use the colon-parentheses system for volume, number, and page citations: "10(2):5-9." Spell out such words as "figures," "plates," "pages."

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