JOURNAL OF CRUSTACEAN BIOLOGY, 20(1): 186–194, 2000

MACROBRACHIUM VICCONI, NEW SPECIES, A FRESH-WATER SHRIMP FROM A RAIN FOREST IN SOUTHEAST MEXICO, AND COMPARISON WITH CONGENERS (DECAPODA: PALAEMONIDAE)

Ramiro Román, A. Laura Ortega, and Luis M. Mejía

(RR) Universidad Nacional Autónoma de México (UNAM), Instituto de Ciencias del Mar y Limnología, Laboratorio de Parasitologia Marina, P.O. Box 70-305, Mexico 04510 (e-mail: ramiror@mar.icmyl.unam.mx); (ALO, LMM) Universidad Autónoma Metropolitana, Unidad Xochimilco (UAM-X), Departamento El Hombre y su Ambiente, Lab. PHI, ADEFRNR. Calz. del Hueso 1100, Coyoacán, Mexico 04960 (e-mail: lmmejia@cueyatl.uam.mx)

A B S T R A C T

Macrobrachium vicconi, new species, from a rain forest of southeastern Mexico is described. It is similar to *Macrobrachium quelchi* and *Macrobrachium atabapense* in total length, partially abbreviated larval development, and cornea not reduced. *Macrobrachium vicconi* differs from those species in the size-ratio of the articles of the legs, the spinous ornamentation, and the length of the second pereiopods. *Macrobrachium vicconi* is more closely related to the inland South American complex of *Macrobrachium* in bearing few large eggs, than to other epigean species described in the genus from the Americas. The new species is the first epigean species of *Macrobrachium* with partially abbreviated larval development described from North America, Central America, and the Caribbean.

In a recent compilation of the main groups of Crustacea recorded from México, Villalobos-Hiriart *et al.* (1993) quoted 15 species of *Macrobrachium* inhabiting rivers, creeks, coastal lagoons, ponds, and caves of México; 13 of these species are epigean and two are stygobionts.

Additional species of *Macrobrachium* have been recorded but not named from Mexico by Rodríguez de la Cruz R. (1965), Holthuis (1977), and Alvarez and Villalobos-Hiriart (1997). We describe a new epigean species of fresh-water *Macrobrachium* inhabiting small creeks in the southeast rain forest of the state of Chiapas, México. Morphological characters of the species herein proposed differ from those and other forms already described (Table 1).

ORDER DECAPODA

Family Palaemonidae
Subfamily Palaemoninae
Genus *Macrobrachium* Bate, 1868
Macrobrachium vicconi, new species

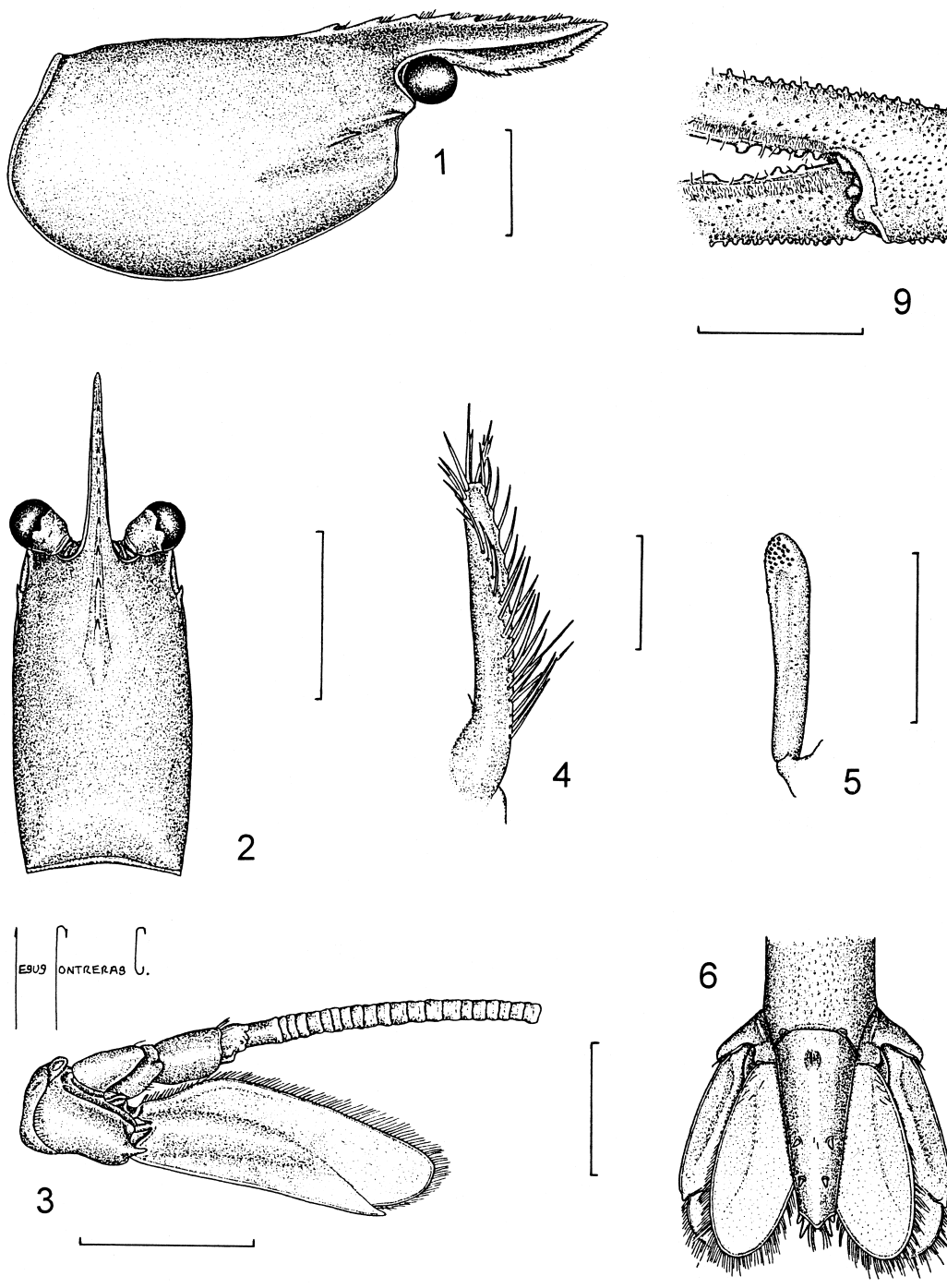
Holotype.—1 ♂: CNCR-17032 (Coleccion Nacional de Crustaceos del Instituto de Biologia, Universidad Nacional Autonoma de México UNAM), 30 November 1996, collected by A. L. Ortega; allotype ♀: CNCR-17033, 10 December 1996, collected by A. L. Ortega.

Paratypes.—8 ♀♀, 6 ♂♂, April 1996, collected by J. Viccon-Pale, F. Rosario, M. Silva, and A. L. Ortega; 5 ♀♀, 5 ♂♂, September 1996, collected by A. L. Ortega; 2 ♂♂, November 1996, collected by A. L. Ortega; 6 ♀♀, 6 ♂♂, December 1996, collected by A. L. Ortega; 5 ♀♀, January 1997, collected by A. L. Ortega.

Deposition of Paratypes.—6 ♂♂, 4 ♀♀: CNCR-17034; 1 ♂, 1 ♀: USNM-285277 (National Museum of Natural History, Smithsonian Institution); 15 ♂♂, 17 ♀♀: ICMyL (Instituto de Ciencias del Mar y Limnología, UNAM).

Type Locality.—Río Perlas, Municipio de Ocosingo, state of Chiapas, México (16°47′78″N, 91°29′29″W).

Description of Holotype Male.—Total length 57.2 mm; cephalothorax length 16.0 mm, rostrum excluded. Rostrum straight, almost reaching distal end of scaphocerite. Upper border bearing 9 teeth including 2 postorbital; 3 teeth on lower margin of rostrum. Cephalothorax smooth, except for gradual depression below hepatic spine (Fig. 1); antennal spine slightly larger than hepatic spine (Figs. 1, 2); scaphocerite almost 2.7 times as long as wide (Fig. 3). Cornea pigmented, not reduced. Abdomen smooth, posteroventral angle of fifth pleuron acute. Sixth abdominal segment 1.7 times length of fifth, 0.7 times as long as telson. Appendix masculina approximately 2 times length of appendix interna; 16 pairs of smooth bristles on inner margins of appendix masculina (Fig. 4); appendix interna smooth, small button-shaped structures on tip (Fig. 5). Telson shorter than uropodal rami, 2 pairs of dorsal spines, distal pair near



Figs. 1–6, 9. *Macrobrachium vicconi,* new species, holotype ♂. 1, carapace, lateral view, scale bar = 5 mm; 2, carapace, dorsal view, scale bar = 9 mm; 3, scaphocerite, scale bar = 6 mm; 4, appendix masculina, scale bar = 1 mm; 5, appendix interna, scale bar = 1 mm; 6, telson, scale bar = 5 mm; 9, teeth on internal margin of second pereiopod, scale bar = 3 mm.

Table 1. Rostral formula and distinctive characters of the second pereiopod for the species of *Macrobrachium* recorded in México. (*) Authors' observations.

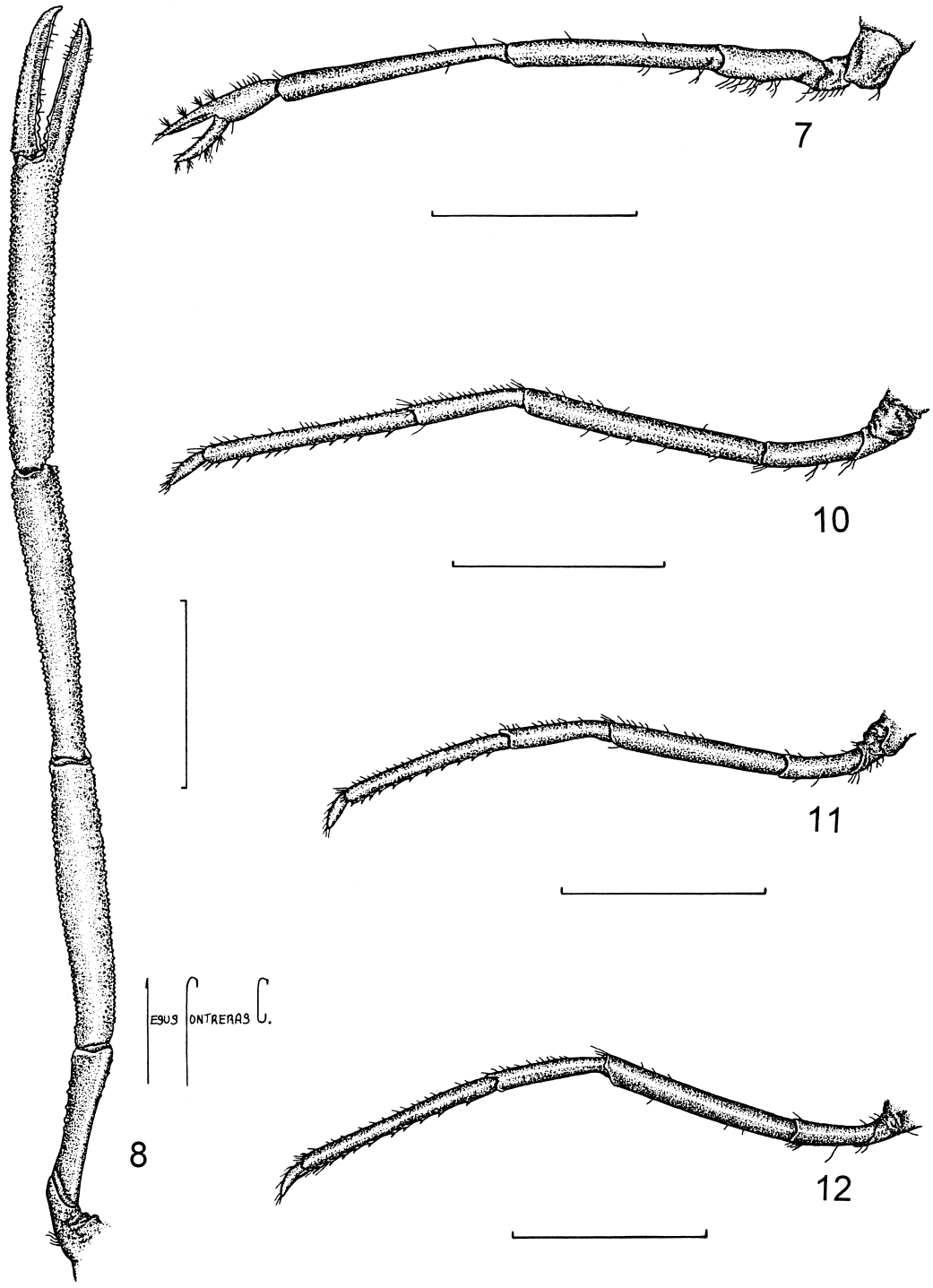
Species	Rostral formula	Second pereiopod					Type locality
		Size	Palm	Space between fingers	Pubescence palm-fingers	Spines on propodus-dactylus	
M. acanthochirus Villalobos, 1966	14 or 15(4–6)/4 or 5	Unequal	Wide and compressed, outer and inner surfaces slightly bulky	Wide	Present, dense on submarginal zone of palm	Present, 31 and 36 dorsal	Río Valdeflores, Oaxaca, México
M. acanthurus (Wiegmann, 1836) (cf., Holthuis, 1952)	9–11(2)/4–7	Equal	Elongate and cylindrical	Absent	Throughout length	Several longitudinal rows of spinules	Brazilian coast
M. acherontium Holthuis, 1977 (stygobite)	8–11(2 or 3)/1	Equal	Cylindrical	Cutting edges entire, except for two very small teeth	Absent	Absent	Gruta de Coconá, Tabasco, México
M. americanum Bate, 1868	11(4)/3*	Equal*	Elongate and compressed*	Absent*	Absent*	Present, larger on internal border*	Lago de Amatitlán, Guatemala
M. carcinus (Linnaeus, 1758) (cf., Holthuis, 1952)	11–14(4–6)/3 or 4	Equal	Elongate, slightly compressed	Present, distinctly gaping proximally	In lower margin	Present, smaller on upper and lower region	Jamaica
M. digueti Bouvier, 1895	13–18(4–7)/2–4	Unequal	Strongly compressed	Present, curved and gaping	Present, on upper surface	On lower margin	Rio Mulegé, B.C.S., México
M. heterochirus (Wiegmann, 1836) (cf., Holthuis, 1952)	10–12(4 or 5)/2–4	Unequal	Elongate	Absent	Present, throughout lower margin of palm	Present on both palm and finger	Gulf of Mexico
M. hobbsi Villalobos and Nates, 1990	14–16(5 or 6)/3 or 4	Unequal	Slightly compressed	Small cutting edges	Present	On dorsal edges, ventral spines of palm smaller than dorsal	Río el Naranjo, Chiapas, México
M. michoacanus Villalobos and Nates, 1990	13–16(4–6)/3–5	Unequal	Compressed	Very small	On dorsal margin	Present, less than four rows	Río Mexcalhuacan, Michoacán, México
M. occidentale Holthuis, 1950 (cf., Holthuis, 1952)	10–12(5 or 6)/2–4	Unequal	Elongate and little compressed	Very wide	Present	Present, on outer surface longer and strong	Río de los Esclavos, Guatemala
M. tenellum (Smith, 1871)	9–11(2)/5 or 6	Equal*	Slender*	Absent*	Present*	Absent*	Polvon, western Nicaragua
M. villalobosi Hobbs, 1973 (stygobite)	9–11(1 or 2)/2	Equal	Slender and smooth	Absent	Absent	Absent	Cueva del Nacimiento del Río San Antonio, Oaxaca, México
Macrobrachium sp. Rodriguez de la Cruz R., 1965	11(4)/2	?	?	Absent	Absent	Present	El Tejar, Veracruz, México

Table 1. Continued.

Species	Rostral formula	Second pereiopod					Type locality
		Size	Palm	Space between fingers	Pubescence palm-fingers	Spines on propodusdactilus	
Macrobracium sp. Holthuis, 1977	9(2)/2	Equal	Cylindrical, less slender than in *M. acherontium*	Absent	Absent	Absent	El Azufre, Tabasco, México
Macrobrachium vicconi, new species	9(2)/3	Equal	Slender, elongate, and subcylindrical	Present	Absent	Present	Río Perlas, Chiapas, México

0.5 times length of telson, second pair approximately 0.7 times length from base; posterior margin broadly triangular, bearing 2 pairs of lateral spines, outer pair 4 times smaller than inner pair; plumose setae between inner spines (Fig. 6). Uropods normal. First pereiopods subequal, more slender than second pair, smooth; scarce isolated hairs on surface, tufts of hairs on palm and fingers. Tip of fingers overreaching scaphocerite; palm slightly compressed, 1.1 times length of dactyl; carpus 3.4 times length of palm, and 1.1 times that of merus (Fig. 7). Second pair of pereiopods equal in size, relatively strong, with small, abundant spinules covering surface (Fig. 8); and overreaching distal border of scaphocerite with proximal half of merus; few short hairs on inner margins; narrow gap over length of chela, 4 small teeth on inner borders (Fig. 9). Palm subcylindrical, 6.5 times longer than high, 1.9 times length of dactyl. Carpus 0.9 times length of palm, and 1.0 times that of merus. Propodus and dactyl of third pair of pereiopods sparsely pilose; 2 rows of 6 and 10 movable spines on inner margin of propodus, 1 pair distally. Propodus 3.4 times length of dactyl, 1.7 times that of carpus (Fig. 10). Fourth pair of pereiopods slender and sparsely pilose; propodus 4 times length of dactyl, and 1.6 times that of carpus; 9 and 10 rows of movable spines on inner border of propodus, 1 pair distally (Fig. 11). Fifth pair of pereiopods almost reaching scaphocerite with tip of dactyl. Propodus and carpus pilose; 2 longitudinal rows of 9 and 11 movable spines on inner margin of propodus, 1 distally; propodus 4.2 times length of dactyl, 1.6 times that of carpus (Fig. 12).

Allotype Female.—Total length 40.0 mm; cephalothorax length 11.0 mm, rostrum excluded, slightly curved downward, shorter than scaphocerite; upper border bearing 8 teeth including 2 postorbital and 2 teeth on lower margin. Carapace smooth, except for antennal and hepatic spines, and hepatic groove; posteroventral angle of fifth pleuron of abdomen acute. First pair of pereiopods overreaching tip of scaphocerite with palm; palm ovoid, 0.5 times length of dactyl. Carpus 3.2 times length of palm, and 1.1 times that of merus; tufts of hairs on dactyl. Second pair of pereiopods equal in length, proportionally shorter than that of males, reaching tip of scaphocerite with proximal part of



Figs. 7, 8, 10–12. *Macrobrachium vicconi,* new species, holotype ♂. 7, first pereiopod, scale bar = 6 mm; 8, second pereiopod, scale bar = 10 mm; 10, third pereiopod, scale bar = 8 mm; 11, fourth pereiopod, scale bar = 9 mm; 12, fifth pereiopod, scale bar = 8 mm.

carpus. Fingers thin, gap over entire length of fingers, conspicuous teeth absent, pubescent, sparse tufts of hairs on surface. Small spines on surface of carpus, merus, and dactyl. Palm cylindrical, 3.3 times longer than high, 1.2 times length of dactyl. Carpus 1.1 times length of palm, and 1.0 times that of merus. Third pair of pereiopods overreaching slightly distal border of scaphocerite with tip of finger. Propodus with longitudinal row of small spines on inner margin, 2.8 times length of dactyl, and 1.6 times that of merus. Fourth pair of pereiopods failing to reach distal tip of scaphocerite with tip of dactyl. Propodus with longitudinal row of 7 or 8 small spines on inner margin, 3.3 times length of dactyl, 2.0 times that of carpus. Fifth pair of pereiopods failing to reach tip of scaphocerite with tip of dactyl. Propodus with longitudinal row of 7 small spines on inner margin, 3.7 times length of dactyl and 1.9 times that of carpus.

Variation in Males.—Specimens of *M. vicconi* exhibit variation in the number of rostral teeth, ranging from 8–11 dorsally, and from 1–5 ventrally. The highest frequency is given by the formula 9/3 teeth on upper and lower border, respectively, including the postorbital teeth. A small subapical tooth is present in 68% of males, but it is absent in the holotype. Analysis of the second pereiopod in 15 males showed variation in the palm length–dactyl length (0.97–1.7), palm length –carpus length (0.71–1.35), palm length–palm width (3.6–6.26), propodus length–dactyl length (1.9–2.78), and dactyl length–carpus length (0.54–0.79). Ratios annotated for males varied in 11 females as follows: from 1.08–1.41, 0.68–1.06, 3.14–4.89, 1.86–2.74, and 0.49–0.79, respectively. Additional variation was observed in the number of bristles on the border of the appendix masculina, with sometimes 18 units present.

Variation in Females.—Greater variation is present in the rostral formula of females than in males. The rostral formula of females varies from 7–11 teeth in the upper border, including 2 or 3 postorbital, and 2–5 teeth on the lower margin.

Fecundity.—Ovigerous females of *M. vicconi* have an average of 25 eggs. The number of eggs per female varies from 14–44 in females from 32.2–46.6 mm as minimal and maximal total length, respectively. Egg measurements were 2.0–2.8 mm largest diameter, according to the stage of development.

Larval Development.—In agreement with the classification of Jalihal *et al.* (1993), larval development of *M. vicconi* is partially abbreviated. Individuals emerge from the eggs as larvae 0.70–0.72 in total length, straight rostrum, two or three teeth on upper border, sessile eyes, and first and second pereiopods chelate. The species undergoes two molts to become juveniles (Ortega Mendoza, unpublished data). No other species has been described from México with such a larval development.

Color in Life.—Coloration in living organisms varies from light brown to strong gray.

Habitat.—Fresh-water riffle, small ponds with 0.40–1.5-m depth, water temperature 20–23°C, and pH 7.6–7.9; bottom sandy or rocky with abundant vegetal debris; border of riffle with submerged roots of trees, Gramminae, and shrubs serving as refuge to specimens.

Etymology.—The specific name is given in honor of Dr. José A. Viccon-Pale (UAM-X), for his encouragement in this study.

Remarks.—Among the known American species of *Macrobrachium,* based on morphological characters, *M. vicconi* can be compared with *M. quelchi* (de Man) and *M. atabapense* Pereira. It is probable that Rodriguez de la Cruz R. (1965) collected *M. vicconi* and confused it with *M. quelchi* because of the noteworthy morphological similarities with this species, and the relative proximity of the collection areas of the material analyzed by Rodríguez de la Cruz R. and that of *M. vicconi.* However, we were unable to compare the material cited by this author.

Macrobrachium vicconi is similar to *M. quelchi* in that in the second pereiopods of the former species, the palm–dactyl ratio is 1.9, and the carpus–merus ratio is 1.0 (1.8 and 1.2 in *M. quelchi*). However, these two species may be distinguished by differences in their carpus–palm and width–height ratios, which are 0.75 and 3.8 in *M. quelchi* (see Pereira, 1985), and 0.94 and 6.5 in *M. vicconi,* respectively.

Other differences between *M. vicconi* and *M. quelchi* are found in the rostral formula, which is 9 (8–11) rostral teeth on the upper border with 2 behind the orbit, and 3 (1–5) on the lower margin of *M. vicconi*; in *M. quelchi* there are 6–8 regularly distributed teeth on the upper border, one behind the orbit, and 2 or 3 (commonly 2) on the lower margin (Pereira, 1985). Additional differences are the dorsal spines on the telson of *M. quelchi,* which are situated at 0.67 and 0.40 of the length from the base, and at 0.5 and 0.7 of the length from the base in *M. vicconi.* The posterior margin of the telson in *M. quelchi* bears 18–20 plumose setae between the inner spines; the number of plumose setae in *M. vicconi* is 12–14. The second pair of pereiopods of *M. quelchi* are subequal in shape and length, whereas the pereiopods of *M. vicconi* are of the same size and are similar in shape. Adult males of *M. quelchi* have a background pale green color, with nonuniform dark green spots scattered around the body in no definite pattern (Pereira, 1985); *M. vicconi* has no obvious coloration pattern, the color varying from light brown to strong gray in live specimens, although some specimens are translucent or slightly pink.

Macrobrachium vicconi is similar to *M. atabapense* in that the palm–dactyl and carpus–palm ratios of the second pereiopods are equal (1.9 and 0.9, respectively). Two pairs of dorsal spines on the telson are situated near 0.5 and 0.75 times the length from the base in both species. The second pair of pereiopods are spiny and subequal in *M. atabapense,* whereas they are equal in *M. vicconi.* There are 9 plumose setae between the inner spines in the telson of *M. atabapense,* whereas there are 12–14 in *M. vicconi.* The carpus–merus ratio is 1.0 in *M. vicconi* and 1.8 in *M. atabapense.* The palm length–width proportion is 6.5 in *M. vicconi* and 3.0 in *M. atabapense.* The scaphocerite is 2.7 times as long as wide in *M. vicconi* and 3.0 times as long as wide in *M. atabapense*; the fingers have conspicuous teeth on *M. atabapense* and very small teeth in *M. vicconi.* The largest male and female *M. atabapense* were 31.4-mm and 26.0-mm total length, respectively (Pereira, 1986), and 57.2 mm in males of *M. vicconi.* The ground color is violaceous with salmon pink in *M. atabapense* (Pereira, 1986), but the color varies from light brown to strong gray in *M. vicconi.* Pereira (1986) observed similarities between *M. atabapense* and *M. quelchi.* We agree with Pereira's observations and conclude that *M. vicconi* is more closely related to these species than to other American species of epigean *Macrobrachium.*

Although neither the appendix masculina nor the appendix interna have been used traditionally as taxonomic characters in the genus *Macrobrachium,* they differ according to the species, and can be useful to differentiate species, as proposed by Fleming (1969) for the genus *Palaemonetes* and by Pereira (1993) in *Macrobrachium depressimanum* Pereira, 1993.

Notes on Other Species Named from México

Previous to the number of species of *Macrobrachium* inhabiting the fresh waters of México cited by Villalobos-Hiriart *et al.* (1993), Guzmán *et al.* (1977) annotated 11 native species, and included *M. rosenbergii* (de Man, 1900) as an introduced species in México. Villalobos-Hiriart *et al.* (1993), based on Rodriguez de la Cruz R. (1965), included the presence of *M. nattereri* (Heller, 1862) and *M. quelchi* in their revision. Other species from México have been named later but not described.

For *M. nattereri,* Holthuis (1952) noted that "the various records in the literature of this species must be considered with great reserve," because they can be confused with other species. Rodríguez (1982) and Kensley and Walker (1982) agreed that the species is exclusively known from the Amazon basin and French Guyana.

Holthuis (1952) included *M. quelchi* from the Upper Mazaruni River, British Guyana. Pereira (1985) confirmed the presence of the species in these localities, and in the State of Bolivar, Venezuela, noting that the species has not been collected since the original description being the distribution of *M. nattereri* and *M. quelchi,* in agreement with those authors, restricted to South America.

Neither *M. nattereri* nor *M. quelchi* has been cited later by other authors for México besides Rodriguez de la Cruz R. (1965) and Villalobos-Hiriart (1993), despite the abundant published literature for the genus *Macrobrachium* in the country. We agree with Holthuis (1952) in that the records of *M. quelchi* for México must be considered du-

bious; therefore, the species was not included in Table 1.

An additional species of *Macrobrachium* was diagnosed by Rodríguez de la Cruz R. (1965: 88) from El Tejar, Veracruz, México, as having a smooth carapace, the telson with the first pair of spines behind the distal half, and the second pair between the former and tip of the telson; the telson with two pairs of spines, the inner larger than the outer and seven pairs of setae. The palm of the second pair of pereiopods is 1.5 times the length of the fingers; the carpus is 0.75 times that of the palm, and the merus slightly larger than the carpus. There are five teeth on the dactyl, the third larger than the others, the propodus with four teeth, the distal one the largest. There are 11 teeth on the upper border of the rostrum, including four behind the orbit, and two teeth on the lower border. The only specimen observed was apparently an ovigerous female 55 mm in total length.

The rostral formula and size of this species are different from *M. vicconi,* although highly variable in females; there are eight and two teeth on the upper and lower borders, respectively. Similarly, the length of the ovigerous female described by Rodríguez de la Cruz R. is longer than that of *M. vicconi.* Females are smaller than males in both species.

Like former authors, Holthuis (1977) reported *Macrobrachium* sp. from Tabasco, México. This resembles *M. acherontium* Holthuis in many aspects, and although the rostral formula of *M. vicconi* is similar to this species "the fact that only a single, probably immature specimen is available makes it impossible to conclude whether it is a new species or just an epigean form of *M. acherontium*" (Holthuis, 1977).

Streets described *Macrobrachium fluviale* (Streets, 1871) from a tributary of the Coatzacoalcos River, México, but Holthuis (1952) quoted that the specimens of Streets "may prove to be juveniles of a species which has not yet been discovered in adult stage." This places the validity of the species in doubt.

More recently, Alvarez and Villalobos-Hiriart (1997) figured an ovigerous female of *Macrobrachium* sp. from Los Tuxtlas, Veracruz, México, but did not name nor diagnose the specimen.

To date 15 species of *Macrobrachium* must be considered as valid species from México (Table 1), with the exception of *M. quelchi, M. nattereri,* and *M. rosenbergii,* although other species may be discovered and described in the near future.

The relatively small size, length, rostral formula, epigean habitat, no reduced cornea, partially abbreviated larval development, and few large eggs of *M. vicconi* resemble more the inland South American complex of species of *Macrobrachium* than other species of the genus recorded up to date from North America, Central America, and the Caribbean.

ACKNOWLEDGEMENTS

Thanks are given to Mario Martínez Mayén for his technical assistance and to Jesus Contreras for the art work.

LITERATURE CITED

Alvarez, F., and J. L. Villalobos. 1997. Decapoda.—*In:* E. González Soriano, R. Dirzo, and R. C. Vogt, eds., Historia natural de los Tuxtlas. Pp. 433–438. Instituto de Biología-UNAM, Instituto de Ecología-UNAM y CONABIO, México D. F.

Bate, C. S. 1868. On a new genus, with four new species of freshwater prawns.—Proceedings of the Zoological Society of London: 363–368.

Bouvier, E. L. 1895. Sur les palémons recueillis dans les eaux douces de la Basse-Californie par M. Diguet.—Bulletin du Muséum d'Histoire Naturelle, Paris 1: 159–162.

de Man, J. G. 1900. Crustacea. Report on a collection made by Messrs. F. V. McConnell and J. J. Quelch at Mount Roraima in British Guiana.—Transactions of the Linnean Society of London, Zoology, Series 2, 8: 57–64.

Fleming, L. E. 1969. Use of external genitalic details as taxonomic characters in some species of *Palaemonetes* (Decapoda, Palaemonidae).—Proceedings of the Biological Society of Washington 82: 443–452.

Guzmán, M., J. Cabrera, and C. Kensler. 1977. Notes on *Macrobrachium* species in México.—*In:* J. A. Hanson and H. L. Goodwin, eds., Shrimp and prawn farming in the Western Hemisphere. Pp. 207–209. Dowden, Hutchinson & Ross, Stroudsburg, Pennsylvania.

Heller, C. 1862. Beiträge zur näheren Kentniss der Macrouren.—Sitzungsberichte Akademie der Wissenschaften in Wien 45: 389–425.

Hobbs, Jr., H. H. 1973. Two new troglobitic shrimps (Decapoda: Alpheidae and Palaemonidae) from Oaxaca, México.—Bulletin of the Association for Mexican Cave Studies 5: 73–80.

Holthuis, L. B. 1950. Preliminary descriptions of twelve new species of palaemonid prawns from American waters (Crustacea, Decapoda).—Proceedings Koninklijke Nederlandse Akademie van Wetenschappen 53: 93–99.

———. 1952. A general revision of the Palaemonidae (Crustacea, Decapoda, Natantia) of the Americas. II. Subfamily Palaemoninae.—Allan Hancock Foundation Publications. Occasional Paper 12, University of Southern California, 1–396.

———. 1977. Cave shrimps (Crustacea Decapoda, Natantia) from Mexico. Subterranean fauna of Mexico.—Accademia Nazionale dei Lincei, Quaderno 171: 172–195.

Jalihal, D. R., K. N. Sankolli, and S. Shenoy. 1993. Evolution of larval developmental patterns and the process of freshwaterization in the prawn genus *Macrobrachium* Bate, 1868 (Decapoda, Palaemonidae).—Crustaceana 65: 365–376.

Kensley, B., and I. Walker. 1982. Palaemonid shrimps from the Amazon Basin, Brazil (Crustacea: Decapoda: Natantia).—Smithsonian Contributions to Zoology 362: 1–28.

Linnaeus, C. 1758. Systema naturae per regna tria naturae, secundum classes, ordines, genera, species, cum characteribus, differentiis, synonymis, locis. 10th edition, 1: 1–824.

Ortega Mendoza, A. L., and G. Signoret Poillon B. 1998. Partially abbreviated larval development in an undescribed species of the genus *Macrobrachium* from Chiapas, Mexico.—*In:* Proceedings and abstracts of the 4th international crustacean congress. P. 188. Amsterdam, The Netherlands. 20–24 July 1998.

Pereira, G. 1985. Freshwater shrimps from Venezuela III: *Macrobrachium quelchi* (de Man) and *Euryrhynchus* n. sp.; (Crustacea: Decapoda: Palaemonidae) from La Gran Sabana.—Proceedings of the Biological Society of Washington 98: 615–621.

———. 1986. Freshwater shrimps from Venezuela I: seven new species of Palaemoninae (Crustacea: Decapoda: Palaemonidae).—Proceedings of the Biological Society of Washington 99: 198–213.

———. 1993. A description of a new species of *Macrobrachium* from Perú, and distributional records for *Macrobrachium brasiliense* (Heller) (Crustacea: Decapoda: Palaemonidae).—Proceedings of the Biological Society of Washington 106: 339–345.

Rodríguez de la Cruz R., M. C. 1965. I. Contribución al conocimiento de los Palemónidos de México. II. Palemónidos del Atlántico y Vertiente Oriental de México con descripción de dos especies nuevas.—Anales del Instituto Nacional de Investigaciones Biológico-Pesqueras 1: 72–112.

Rodríguez, G. 1982. Fresh-water shrimps (Crustacea, Decapoda, Natantia) of the Orinoco Basin and the Venezuelan Guayana.—Journal of Crustacean Biology 2: 378–391.

Smith, S. I. 1871. List of Crustacea collected by J. A. McNiel in Central America.—Reports of the Peabody Academy of Sciences for the years 1869–1870: 87–98.

Streets, T. H. 1871. Descriptions of five new species of Crustacea from Mexico.—Proceedings of the Academy of Natural Sciences of Philadelphia, part I: 225–227.

Villalobos, F. A. 1966. Estudio de los Palaemonidae de México. I. *Macrobrachium acanthochirus* n. sp., del suroeste de México.—Anales del Instituto de Biología, Universidad Nacional de México 37: 167–173.

Villalobos-Hiriart, J. L., and J. C. Nates Rodríguez. 1990. Dos especies nuevas de camarones de agua dulce del género *Macrobrachium* Bate, (Crustacea, Decapoda, Palaemonidae), de la vertiente occidental de México.—Anales del Instituto de Biología, Universidad Nacional Autónoma de México, Ser. Zoología, 61: 1–11.

———, A. Cantú Díaz-Barriga, and E. Lira-Fernández. 1993. Los crustáceos de agua dulce de México.—Revista de la Sociedad Mexicana de Historia Natural, special volume, 44: 267–290.

Wiegmann, A. F. A. 1836. Beschreibung einiger neuen Crustaceen des Berliner Museums aus Mexico und Brasilien.—Archiv für Naturgeschichte 2: 145–151.

RECEIVED: 6 December 1998.
ACCEPTED: 5 May 1999.