HORTON H. HOBBS, JR.

The Entocytherid Ostracods of Mexico and Cuba

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ABSTRACT

Hobbs, Horton H., Jr. A Summary of the Entocytherid Ostracods of México and Cuba. *Smithsonian Contributions to Zoology*, 81:1–55, 1971.—The entocytherid ostracod fauna of México and Cuba comprises four genera and 16 species, 12 of which are endemic to the former and three to the latter. The remaining species, *Ankylocythere sinuosa,* ranges northward from México into the southern part of the United States. Four of the Mexican endemics, *Ankylocythere maya, A. toltecae, A. villalobosi,* and *Uncinocythere zaruri,* have not previously been described. Following a brief historical summary are a cross index to associations between the entocytherids and their hosts, discussions of taxonomic characteristics and entocytherid associates, a resumé of life-history studies, and postulates concerning the origin of the entocytherid fauna. The latter propose that the ostracod stocks reached México passively on crayfish hosts from the southern part of the United States in three major periods of migration: the earliest, prior to the Pliocene, resulted in the colonization of the Central Plateau, the area south of the Cordillera Volcánica Transversal, and Cuba; a Pliocene invasion populated the Gulf slope immediately north of this volcanic mass; and a Recent migration introduced the only non-endemic entocytherid into northeastern México. The treatment of the species includes synonymies, complete bibliographic citations, diagnoses, locations of types, distribution, hosts, entocytherid associates, variations, and relationships.

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Horton H. Hobbs, Jr.

The Entocytherid Ostracods of Mexico and Cuba

The object of this study has been to bring together all available information on the entocytherid fauna of México and Cuba. Following a brief summary of previous work on the members of the family which occur in the region, the entocytherids and their hosts are listed with cross indices to the associations between them. Zoogeographic discussions of the crayfishes and ostracods precede diagnoses, keys, and summaries of the ranges of the family Entocytheridae, its subfamilies, and the Mexican and Cuban genera. The keys to the species of the Mexican and Cuban genera include all the described members together with an indication of the range of each. Presented in the treatment of each species are as complete bibliographic citations as possible, a diagnosis, locations of types, type-locality, hosts, list of other entocytherids sharing the same host species in a single locality, and illustrations. In the citations of locality records, an asterisk has been used to indicate localities from which specimens have been examined during the present study; if the asterisk precedes "Locality Records," specimens from all localities cited have been examined. For those species which have not been described previously, more detailed descriptions are appended to the diagnoses.

For two months, during the late winter and early spring of 1957, I was privileged to work in the laboratories of the late Dr. Enrique Rioja and Dr. Alejandro Villalobos in the Instituto de Biología de la Universidad Nacional Autónoma de México. Most of this report is based on specimens furnished to me by these gentlemen; additional materials were collected, however, in the states of Morelos, Puebla, and Veracruz during my stay in México, and a number of persons have subsequently contributed specimens of crayfishes and ostracods that have furthered our knowledge of the Mexican fauna.

Much to my regret, all the specimens which were prepared for study while I was in México were mounted in Hoyer's Fluid and sealed with lacquer. In spite of sealing the mounts, most of the preparations are crystallizing, and will be of little value within a few years. Fortunately, most of the species are represented among the balsam preparations that were made subsequently. A synoptic series of specimens is deposited in the collection of the Instituto de Biología at the Universidad de México, and except as indicated below, the remaining collection is housed in the Smithsonian Institution.

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Acknowledgments

I should like to acknowledge the encouragement and assistance given me by my late friend, Dr. Enrique Rioja, who during my 1957 visit in México gave unstintingly of his time in introducing me to the Mexican entocytherids.

For the ostracods which were garnered from his crayfish collection, for his invaluable assistance in identifying the hosts, and for his many kindnesses to me during my Mexican sojourn, I am most grateful to Dr. Alejandro Villalobos. He has, moreover, been most helpful in the preparation of this manuscript by carefully checking the locality records of the hosts of the entocytherids and in locating them on the preliminary maps.

I also wish to thank Roger Conant, Oliver S. Flint, Perry C. Holt, Robert R. Miller, James R. Reddell, and Paul J. Spangler for a number of specimens which were utilized in the study.

My gratitude is hereby extended to the following who have offered advice and aid in the preparation of the manuscript: Thomas E. Bowman, Fenner A. Chace, Jr., Roger Conant, Isabel Pérez Farfante, C. W. Hart, Jr., Dabney G. Hart, and Raymond B. Manning. None of them, however, are responsible for the data or conclusions presented.

I wish, also, to express my appreciation to the United States Department of State which made possible through its exchange professorship program, my appointment as Visiting Professor at the Universidad de México as well as to Dr. Roberto Llamas, then Director of the Instituto de Biología, and the members of his staff for the many courtesies extended to me during my tenure there.

Finally, I should like to take this opportunity to rectify an inadvertent omission from the acknowledgments included in *Los Cambarinos de Cuba* by Dr. Villalobos and me (see Literature Cited), for it was my intention there to express similar sentiments to the United States Department of State and to Dr. Llamas.

Historical Summary

The first contribution to our knowledge of the entocytherid fauna of México was that of Rioja (1940a) in which he presented a detailed account of the external skeletal morphology of a new species, *Ankylocythere heterodonta* (= *Entocythere heterodonta*). Later (1940b), he discussed the association of this ostracod and other commensals which infest the crayfish *Cambarellus montezumae*. Rioja (1941a) extended his earlier morphological study to the "internal skeleton" of the same species, and in a second paper (1941b) summarized the available data on the three known species of the genus, *Entocythere cambaria* Marshall, *E. donnaldsonensis* Klie, and *E. heterodonta*; the latter two are now assigned to the genera *Donnaldsoncythere* and *Ankylocythere*, respectively. In the same year, Hobbs (1941) erred in reporting *E. cambaria* from La Cueva Chica, San Luis Potosí, México.

Rioja (1942a) erected two new taxa, *E. claytonhoffi* and *E. heterodonta sinuosa*, for the Cueva Chica ostracods previously reported by Hobbs. Later, he (1942b) presented a summary and a key to the known American entocytherids, proposed a new subgenus, *Donnaldsoncythere*, and elevated *sinuosa* to specific status. Three new entocytherids, *E. mexicana*, *E. dobbini*, and *E. dobbini bicuspide* were described by Rioja (1943a) from two localities in the state of Puebla. A second paper (1943b) included an account of "polimorfismo femenino" in the genus *Entocythere* and revisions of the definitions of the subgenera *Entocythere* and *Cytherites*.

Hoff (1944a) reported the presence of *E. heterodonta* in La Gloria, Camagüey, Cuba. The following year, Rioja (1945) discussed variations in the "pieza copuladora" of *E. dobbini* and described two new subspecies, *E. dobbini cuadricuspide* and *E. dobbini multicuspide*, from the state of Puebla. In 1949, he cited additional localities for several of the Mexican entocytherids, and described the following new species: *E. talirotundi* from Lago Lerma, Lagunas de Zempoala, and Bosque de Chapultepec; *E. bidentata* from three localities in Veracruz; *E. recurvata* from Puebla and Veracruz; and *E. uncinata* from Puebla. Further, he elevated to specific rank two of his previously described subspecies of *E. dobbini*, *E. bicuspide* and *E. cuadricuspide*, and placed his subspecies *E. dobbini multidentata* in synonomy with *E. cuadricuspide*.

In 1951, Rioja described *Sphaeromicola cirolanae*, the only American representative of the genus, from a cave in San Luis Potosí, and briefly referred to the cavernicolous members of the genus *Entocythere*. In 1953, he listed the species that frequent caves.

The most recent contribution by Rioja (1955) was that in which he described *E. ruibali* and *E. heterodonta cubensis* from the province of Camagüey, Cuba. Hobbs (1957) recorded several new locality records for the Cuban forms and described a new species, *E. hamata*, from the province of Las Villas.

In an abstract by Hobbs and Villalobos (1958), they reported the infestation of *Pseudothelphusa lamellifrons* (= *P. veracruzana*), a freshwater crab from Veracruz, with temnocephalids, branchiobdellids, and entocytherids.

The familial revision of Hart (1962) is adopted in this study. Accordingly, the Mexican entocytherids are assigned to two subfamilies, Entocytherinae and Sphaeromicolinae; the former is represented by three genera, *Ankylocythere*, *Entocythere* (sensu stricto), and *Uncinocythere*, and the latter by the genus *Sphaeromicola*. Members of only the two former genera are known to occur in Cuba.

The only other references to the Mexican and Cuban entocytherids of which I am aware, except those having to do with relationships to other species, are that of Hobbs (1966), which consists of an illustrated key and a summary of the ranges of all of the members of the genus *Ankylocythere*, and that of Hart and Hart (1969a) which treats the distribution of the entocytherine genera.

Mexican and Cuban Entocytheridae

Numbers following each species refer to the number of the host in the list immediately below. Hosts, the specific identities of which are unknown, are not included.

Entocytherinae

1. *Uncinocythere bicuspide*—México 10, 17, 20, 22, 23, 28, 39
2. *Uncinocythere cuadricuspide*—México 10, 15, 20, 22, 23, 39
3. *Uncinocythere dobbinae*—México 9, 10, 15, 17, 20, 22, 28, 33, 34
4. *Uncinocythere zaruri*—México 40
5. *Ankylocythere bidentata*—México 14, 24, 25, 26, 27, 29, 30, 31, 36, 37
6. *Ankylocythere cubensis*—Cuba 18
7. *Ankylocythere hamata*—Cuba 13, 18
8. *Ankylocythere heterodonta*—México 3, 4, 5, 6, 7, 8
9. *Ankylocythere maya*—México
10. *Ankylocythere sinuosa*—México and United States 12, 16, 21, 32
11. *Ankylocythere toltecae*—México 35, 38
12. *Ankylocythere villalobosi*—México 24, 27
13. *Entocythere claytonhoffi*—México 12, 14, 24, 25, 27, 31, 35
14. *Entocythere mexicana*—México 15, 20, 22, 23, 28
15. *Entocythere ruibali*—Cuba 13, 18

Sphaeromicolinae

16. *Sphaeromicola cirolanae*—México 1, 2

Hosts of the Mexican and Cuban Entocytherids

Numbers following each species refer to the ostracod commensals listed above. Hosts, the specific identity of which are unknown, are not listed.

Isopoda, Cirolanidae

1. *Speocirolana bolivari* (Rioja, 1953) 16
2. *Speocirolana pelaezi* (Bolívar y Pieltain, 1950) 16

Decapoda, Astacidae

3. *Cambarellus montezumae chapalanus* (Faxon, 1898) 8
4. *Cambarellus montezumae lermensis* Villalobos, 1943
5. *Cambarellus montezumae montezumae* (Saussure, 1857a) 8
6. *Cambarellus montezumae patzcuarensis* Villalobos, 1943 8
7. *Cambarellus montezumae tridens* (Von Martens, 1872) 8
8. *Cambarellus montezumae zempoalensis* Villalobos, 1943 8
9. *Paracambarus ortmanni* Villalobos, 1949 3
10. *Paracambarus paradoxus* (Ortmann, 1906) 1, 2, 3
11. *Procambarus acanthophorus* (Villalobos, 1948) 12
12. *Procambarus acutus cuevachicae* (Hobbs, 1941) 10, 13
13. *Procambarus atkinsoni* (Ortmann, 1913) 7, 15
14. *Procambarus aztecus* (Saussure, 1857b) 5, 13
15. *Procambarus caballeroi* (Villalobos, 1944b) 2, 3, 14
16. *Procambarus clarkii* (Girard, 1852) 10
17. *Procambarus contrerasi* (Creaser, 1931) 1, 3
18. *Procambarus cubensis cubensis* (Erichson, 1846) 6, 7, 15
19. *Procambarus digueti* (Bouvier, 1897) 8
20. *Procambarus erichsoni* Villalobos, 1950 1, 2, 3, 14
21. *Procambarus gonopodocristatus* Villalobos, 1958 10
22. *Procambarus hoffmanni* (Villalobos, 1944a) 1, 2, 3, 14
23. *Procambarus hortonhobbsi* Villalobos, 1950 1, 2, 14
24. *Procambarus llamasi* Villalobos, 1954b 12, 13
25. *Procambarus mexicanus* (Erichson, 1846) 5, 13
26. *Procambarus mirandai* Villalobos, 1954b 5
27. *Procambarus pilosimanus* (Ortmann, 1906) 12, 13
28. *Procambarus riojai* (Villalobos, 1944a) 1, 3, 14
29. *Procambarus rodriguezi* Hobbs, 1943 5
30. *Procambarus ruthveni ruthveni* (Pearse, 1911) 5
31. *Procambarus ruthveni zapoapensis* Villalobos, 1954b 5, 13
32. *Procambarus simulans regiomontanus* Villalobos, 1954a 10
33. *Procambarus teziutlanensis* (Villalobos, 1947a) 3
34. *Procambarus tlapacoyanensis* (Villalobos, 1947b) 3
35. *Procambarus toltecae* Hobbs, 1943 11, 13
36. *Procambarus vazquezae* Villalobos, 1954b 5
37. *Procambarus veracruzanus* Villalobos, 1954b 5
38. *Procambarus villalobosi* Hobbs, 1969 11
39. *Procambarus zihuateutlensis* Villalobos, 1950 1, 2

Decapoda, Pseudothelphusidae

40. *Pseudothelphusa (Tehuana) veracruzana* Rodriguez and Smalley, 1970 4

Taxonomic Characteristics

FIGURES 1, 2

Among the characteristics of the Mexican and Cuban entocytherids that have been found useful in distinguishing species and species groups are (1) the size and shape of the shell, (2) the segmentation and appendices of the distal podomeres of the antenna, (3) the dentition of the mandible, (4) the structure of the genital complex of the female, and, by far the most useful of all, (5) the structure of the copulatory complex of the male.

In general, but not without exception, the shells of the members of the genus *Entocythere* are larger than those of the other genera; only the shells of some individuals of *E. ruibali* are smaller than those of the largest member of some *Ankylocythere*. Too, in the Mexican members of the genus, particularly in *E. claytonhoffi* (Figure 26*d,e*) the anteroventral margin of the shell is flattened rather than being evenly contoured as in the members of other genera. Among the members of the genus *Ankylocythere*, the sizes of the shells of the males of *A. heterodonta* and *A. sinuosa* are larger than those of members of other species of the genus, except for a few of the largest specimens of *A. villalobosi*; while the same is true of the females, the distinction is not so well defined.

Typical of the females of all entocytherids is copulation in the penultimate instar. These "copulating females" (Hoff, 1943:276) or "hembras del tipo biunguis" (Rioja, 1943b:568) have antennae consisting of four (three according to the interpretation of Hart et al., 1967:2) podomeres and two terminal claws. Following copulation and the ultimate molt, the penultimate (ultimate, Hart et al., loc. cit.) podomere of the antenna becomes divided so that there are apparently five (four, Hart et al., loc. cit.) podomeres, and a third claw is added at the distal extremity. These females were termed "gravid females" by Hoff, in token of the fact that most contain large oöcytes, and "hembras del tipo triunguis" by Rioja, alluding to the three apical claws of the antenna. In members of the genus *Entocythere*, but in no others, one or two small pectinate appendices are added at the base of the apical claws of the triunguis females. (Figure 26*f*).

Most members of the genus *Entocythere* bear a mandible of which the distal tooth is not pectinate (Figure 26*g*); however, among the Mexican and Cuban members of the genus, *E. ruibali* has a pectinate distal tooth (Figure 29*e*) as does *E. tyttha* Hobbs and Hobbs, 1970:11.

Again, only in the members of the genus *Entocythere* of the Mexican and Cuban entocytherid fauna have distinctive characteristics of the genital complex of the triunguis females been observed to consist of anything more than a simple tubular prominence in the posterodorsal portion of the body.

The most useful character for distinguishing species among all entocytherids is the copulatory complex of the adult males (Figure 2). This complex consists of a pair of appendages suspended from the posterodorsal portion of the body and is capable of being rotated 180°. Through convention, all descriptions are based on the appendages in their copulatory attitude, that is, with the "fingers" and clasping apparatus directed anteriorly or anteroventrally rather than posteriorly.

Specific determinations of the entocytherid fauna of México and Cuba are, on the basis of our present knowledge, restricted to adult males. Juvenile specimens and biunguis females can seldom be assigned to a genus, and the only adult females the generic identity of which can be recognized with certainty are those of the genus *Entocythere*. It has been assumed, and perhaps correctly so, that a biunguis female found in copula is a member of the same species as the male member of the pair; however, the specific identity of none of the females of the Mexican and Cuban entocytherids can be determined except by association with males in a given locality or by their ranges. The possibility exists that in localities in which two or more species infest the same host animal copulating pairs are not necessarily members of the same species; among the crayfishes interspecific copulating pairs have been observed on several occasions.

Life History

The only studies devoted to the development of entocytherids which include observations of the life histories of members of the subfamilies Entocytherinae, Sphaeromicolinae, and Microsissitrinae are those of Marshall (1903), Paris (1920), Rioja (1940b), Hart, Nair, and Hart (1967), and Roelofs (1968).

The observations of Marshall on the development of *Entocythere cambaria* Marshall (1903) were limited to only a few remarks. The newly hatched young "have the two pairs of antennae and the mandibles fully developed. Well back on the body are a pair of appendages, and near them two long setae which finally disappear. . . . In all of the

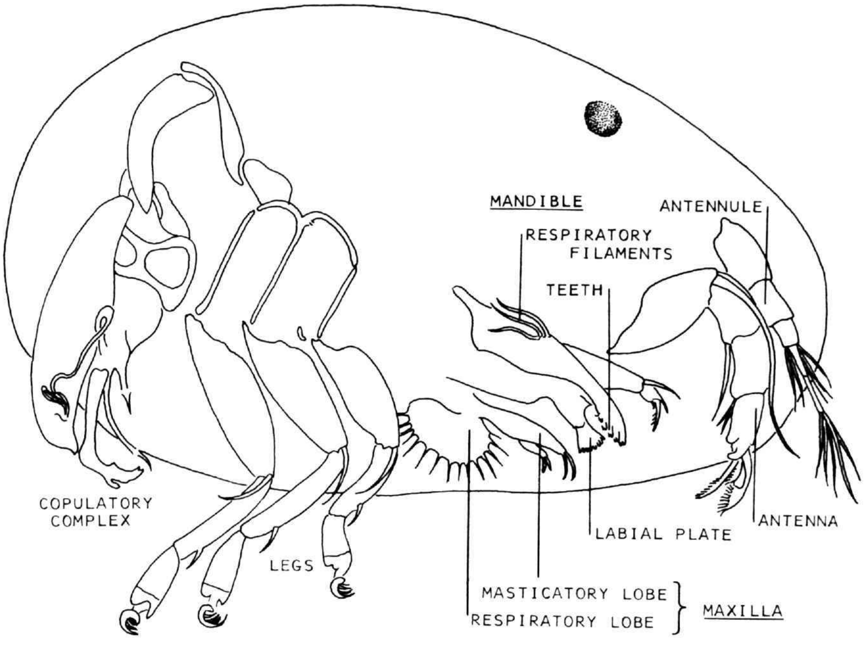

FIGURE 1.—Generalized entocytherid ostracod with right valve of shell removed.

earliest stages of *Entocythere*, . . . I found the first three pairs of appendages similar, except in size, to the appendages of the mature individual. The pair of appendages on the body, the prolegs, disappear but I am unable to say whether they disappear entirely or become changed into the first pair of permanent legs. Their position on the body is not so far forward as that of the first pair of legs."

Paris recognized seven instars preceding the adult stadium in *Sphaeoromicola topsenti* Paris (1920). The first three, referred to as "metanaupliens," are characterized by well-developed antennules, antennae, mandibles, and maxillae; its maxillipeds, the future first pair of feet, consist of styliform, segmented appendages ending in a simple hook. The two following stadia differ from the first only in an increase in size. The fourth through the sixth stadia are designated juveniles, and the fourth differs from the third in that the metanaupliar feet are converted to three-jointed ones which do not differ otherwise from those of the adult. In the fifth stadium, an additional pair of three-jointed feet is added, and the first feet become four-jointed. The sixth stadium is characterized by the addition of a third pair of three-jointed feet; the first two pairs

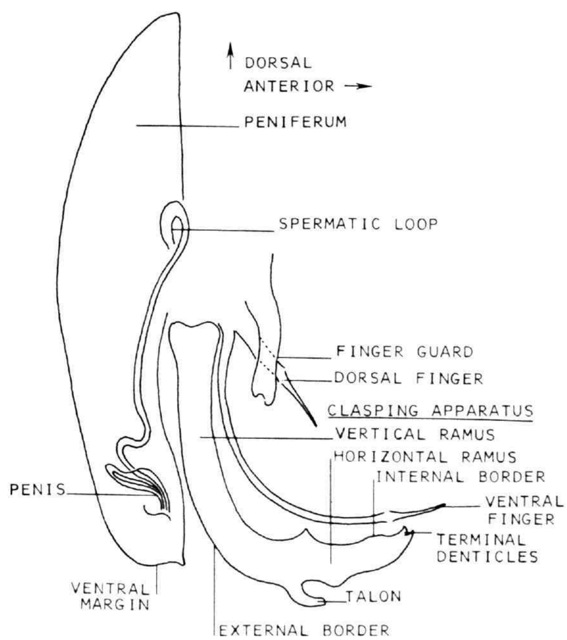

FIGURE 2.—Generalized clasping apparatus of adult male entocytherid.

are now four-jointed. The seventh stadium, of which only the female is mentioned and which Paris termed "nubile," may be recognized by all three pairs of feet consisting of four articles, and the external genital organs are evident. He found one nubile female in which the third pair of legs had only three articles. (I rather strongly suspect that the external genitalia attributed by Paris to the nubile female are actually those of the penultimate instar of the male.)

Rioja found that in *Ankylocythere heterodonta* four stadia precede the attainment of the stage he considered to have reached the adult form. The first is characterized by having antennules of five articles, antennae of three articles with two apical claws, mandibles, maxillae, a single pair of larval feet consisting of two podomeres, the distal one of which is multiarticulate, and the shell bearing a pair of large, conspicuous setae posteroventrally. The second stadium differs from the first chiefly in the acquisition of a second pair of larval feet. The third stadium is characterized by the acquisition of a sixth article in the antennule, the loss of the larval feet, and the development of a single pair of legs resembling those of the adult but having only three podomeres. The fourth stadium differs from the third in possessing two pairs of legs resembling the subadult foot of the third stadium. A fifth stadium, representing the penultimate instar was not described as such by Rioja (1940a), but the female was designated "tipo biunguis" (1940b). This instar may be characterized by the loss of the paired large setae on the posteroventral portion of the shell, the appearance of the third pair of legs, and, in the male, of two pairs of lappets (rudiments of the copulatory complex) projecting posteroventrally slightly posterior to the posteriormost pair of legs. These lappets were apparently misinterpreted by Rioja (1943b:577 and Fig. 31) as constituting the genital apparatus of the biunguis female. The ultimate instar differs from the fifth in the subdivision of the penultimate podomere of the antenna and the addition of a third apical claw; the legs consist of four articles, and the clasping apparatus of the male has become completely differentiated.

Hart, Nair, and Hart (1967) found six instars preceeding the ultimate molt in the development of their *Microsyssitria indica*, the first through the fifth corresponding to those stages in *A. heterodonta*. The sixth apparently is intruded into the development and involves maximum increase in size and the stadium in which the copulatory complex of the male becomes differentiated.

Roelofs (1968) found in her investigation of the development of *Sphaeromicola dudichi* Klie (1938) that the adults are attached to their amphipod host, *Chelura terebrans* Philippi, by a filament produced by the antennal glands. The females deposit 1 to 16 eggs in packets on the gills or oöstegites of the amphipod, each egg being affixed by two filaments. An almost synchronous development occurs in the eggs comprising a packet, and they hatch within a maximum of 15 days at 18° C. The first instar possesses five-segmented antennules and three-segmented antennae, the latter bearing a well-developed flagellum, two terminal, and one subterminal claw; the mandibles and maxillae are well developed; the future first legs consist of a pair of styliform biarticulate appendages with hooked extremities; and the posterior portion of the shell bears several pairs of long hairs. Roelofs did not observe a stage comparable to the second stadium of *Ankylocythere heterodonta*, but did briefly describe and figure one corresponding to the third stage, this characterized by possessing two pairs of triarticulate legs. A third preadult stadium was also found in which three pairs of legs were present, the anterior two pairs consisting of four segments and the posterior with only three.

Despite these excellent contributions, little is known of the life cycle of any entocytherid. No one has expressed an estimate as to the life span of a member of the family; furthermore, no one has determined how many or how frequently eggs are laid, or whether or not a female produces eggs throughout her adult life. Although an occasional entocytherine triunguis female has been observed in copula, as a rule, only those females in the penultimate instar (biunguis females) are paired with males. Yolk deposition in the oöcytes apparently follows the ultimate molt in the entocytherines, and in no individual have more than four or five oöcytes been observed to be markedly enlarged at one time, and no more than three seem to approach maximum size approximately simultaneously.

TABLE 1.—*Entocytherid associations in México and Cuba. Species utilizing the same host species in one or more localities are indicated by X.*

	BICUSPIDE	CUADRICUSPIDE	DOBBINAE	ZARURI	BIDENTATA	CUBENSIS	HAMATA	HETERODONTA	MAYA	SINUOSA	TOLTECAE	VILLALOBOSI	CLAYTONHOFFI	MEXICANA	RUIBALI	CIROLANAE
U. BICUSPIDE	X	X	X											X		
CUADRICUSPIDE	X	X	X											X		
DOBBINAE	X	X	X											X		
ZARURI				X												
A. BIDENTATA					X								X			
CUBENSIS						X									X	
HAMATA							X								X	
HETERODONTA								X								
MAYA									X							
SINUOSA										X			X			
TOLTECAE											X		X			
VILLALOBOSI												X	X			
E. CLAYTONHOFFI					X					X	X	X	X			
MEXICANA	X	X	X											X		
RUIBALI						X	X								X	
S. CIROLANAE																X

Entocytherid Associates

TABLE 1

Within the range of the subfamily Entocytherinae, frequently one host animal is infested with two or more ostracods, and there is evidence that in some instances one species tends to be concentrated on one area of the exoskeleton of the host while another is the predominant form elsewhere on the body (Hobbs, Holt, and Walton, 1967:7). Among the Mexican and Cuban entocytherids, members of the genus *Entocythere* share the same host with a species of the genus *Ankylocythere* or *Uncinocythere,* and occasionally with two species of the latter, but data as to what parts of the hosts they infest are not available. In México, members of the genera *Ankylocythere* and *Uncinocythere* are not known to share the same host, or even host species, despite the fact that in the Tuxtla area of Veracruz *Pseudothelphusa* is infested with *U. zaruri* and *Procambarus ruthveni zapoapensis* with *A. bidentata.*

Of the Mexican and Cuban entocytherids only *U. zaruri, A. cubensis,* and *A. maya* are known from single host species. It is improbable that host specificity of the latter two limits them to the crayfishes they are now known to infest; more probably, it is our lack of knowledge of their ranges or to the unavailability within their ranges of other possible hosts. In contrast, *U. zaruri* has probably had opportunities to gain access to crayfishes within the area it occupies, and it is perhaps noteworthy that it has been found only on the freshwater crab.

Zoogeographic Considerations

THE ENTOCYTHERIDS.—Of the 15 entocytherines occurring in México and Cuba, 3 are endemic in the latter, and, of the remaining 12 which occur in México, 11 are endemic. Only *Ankylocythere* *sinuosa* occurs outside of the Country, and its range extends northeastward along the Gulf Coastal Plain to Louisiana. The single representative of the Sphaeromicolinae is apparently endemic in subterranean waters in the northeastern part of México.

Three genera of entocytherines are represented in the fauna (Figure 3). The Mexican segment of the genus *Uncinocythere* comprises four species which occupy two small, apparently discontinuous areas: one in the Tuxtla area of Veracruz, and the other to the northwest, north of the Cordillera Volcánica Transversal, in Hidalgo, Puebla, and Veracruz. No member of the genus is known to occur between the latter area and Texas.

Ankylocythere, which occurs in both México and Cuba, is represented by five species in the former and two in the latter. In México, it ranges from the Rio Grande westward to Chihuahau and southward to Chiapas and Campeche, and along the Pacific slope from Nayarit to Michoacán.

Three species of the genus *Entocythere* contribute to the Mexican-Cuban entocytherid fauna. One is endemic in Cuba, and the other two are confined to México where their combined ranges extend southward from San Luis Potosí along the gulf slope to Chiapas and Campeche. One of the Mexican species seems to be restricted to the same area as is the northern segment of the genus *Uncinocythere*.

Because of our limited knowledge of the single sphaeromicoline species, which in México is commensal on two sympatrically occurring isopods of the family Cirolanidae, nothing can be offered concerning its advent onto the North American

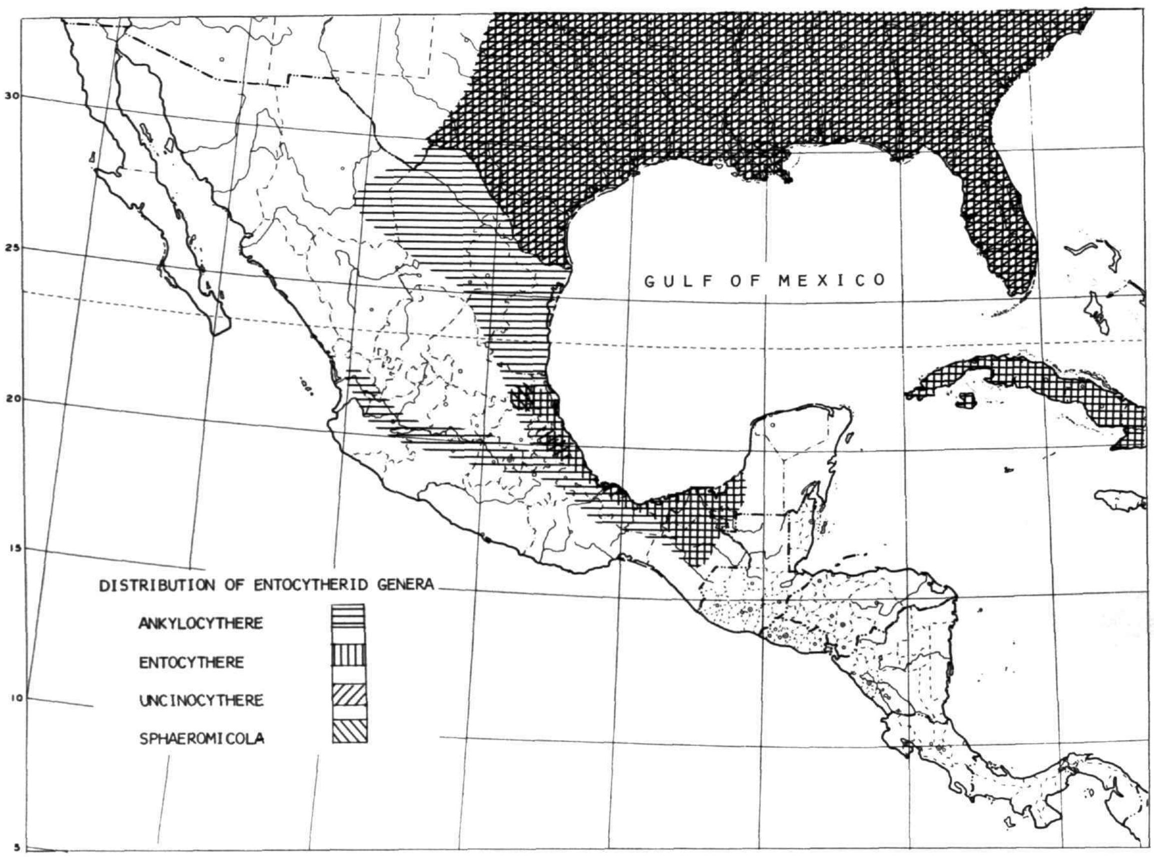

FIGURE 3.—Ranges of the Mexican and Cuban entocytherid genera.

continent. All other members of the genus *Sphaeromicola* occur in and along the southern Atlantic and Mediterranean coast of Europe. That the genus is not known to be represented along the Gulf Coast of México or elsewhere in the western hemisphere is probably due to the fact that no concentrated search for it has been made. Perhaps it is significant in the distribution of the genus, however, that the remaining seven members of the North American troglobitic Cirolanidae (see Bowman, 1964 and 1966, and Cole and Minckley, 1966) apparently do not harbor commensal ostracods.

Whereas the genus *Sphaeromicola* is represented in North America by the single Mexican species, the three entocytherine genera are much richer: *Uncinocythere* with 21 species, *Ankylocythere* with 16, and *Entocythere* with 12. Additional undescribed species of all three genera are known to be present northeast of the Rio Grande.

The only entocytherids which occur west of the Rocky Mountains in the United States belong to the genus *Uncinocythere*. Inasmuch as the Mexican members of the genus are apparently restricted to a small area on the Gulf slope and seem no more closely allied to those species occurring west of the Rocky Mountains than to certain others on the eastern slopes, I do not hesitate to make the general statement that all the entocytherine ancestral stocks, like their crayfish hosts, have migrated into México on the eastern side of the Continental Divide.

Before discussing in more detail the possible origins of the Mexican entocytherines, it seems appropriate to consider the relationships and possible migrations of their hosts. Although Baker

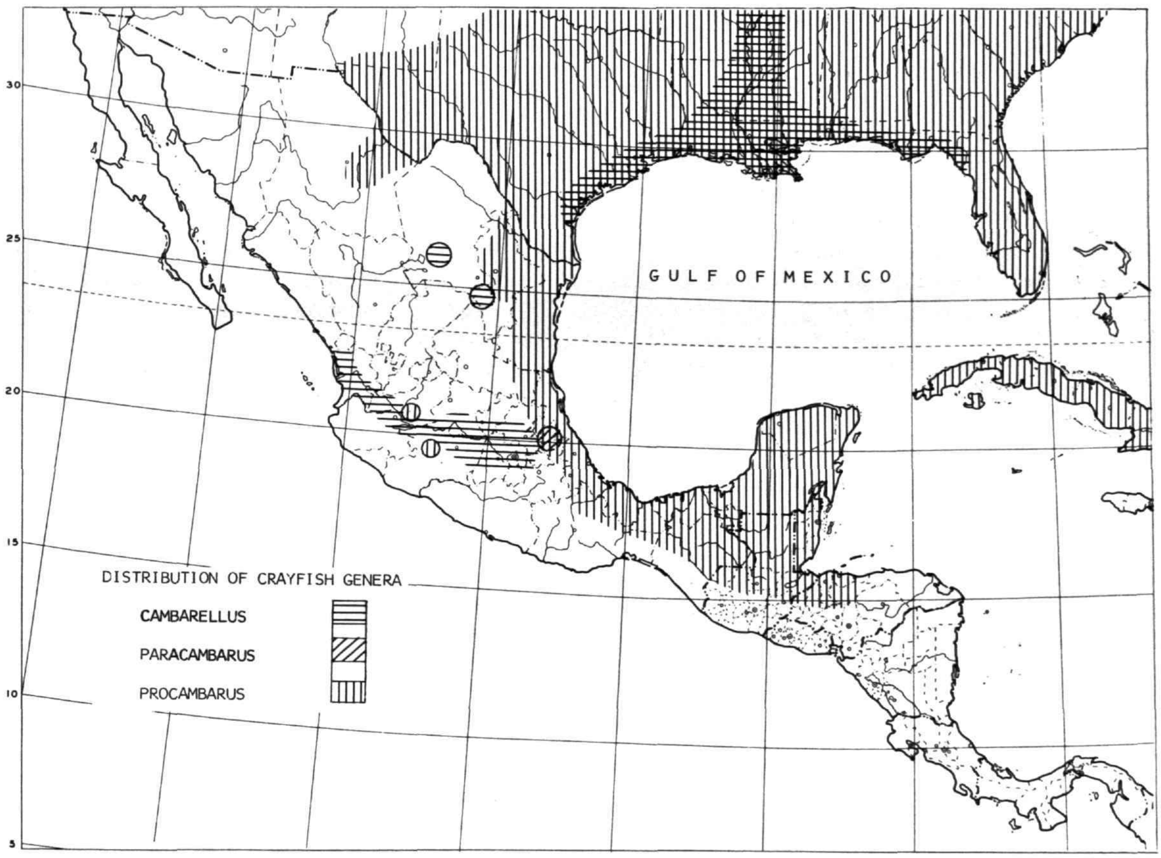

FIGURE 4.—Ranges of the Mexican and Cuban crayfish genera.

(1969) has shown that the entocytherine *Ankylocythere sinuosa* may survive for as long as 10 weeks away from its crayfish host, data are still lacking to indicate that the life cycle can be completed independently of a decapod host. In view of no information to the contrary, it is here assumed that the migrations of entocytherine ostracods are virtually passive—dependent upon the ability of the host to move from one locality to another. Accordingly, a brief summary of the ranges of the hosts of the Mexican and Cuban crayfishes is presented to suggest possible migratory routes along which the ostracods were carried.

THE DECAPOD HOSTS.—Two families of decapod crustaceans serve as hosts to the Mexican and Cuban entocytherines—crayfishes of the family Astacidae and a single species of freshwater crab of the family Pseudothelphusidae.

In view of the fact that there is only a single record of the occurrence of a lone species of the Entocytherinae on a host other than a crayfish, it seems probable that the unique association between *Pseudothelphusa veracruzana* and *Uncinocythere zaruri* is probably one of recent origin and occurred after the ancestral stock reached northern Veracruz. For this reason the following discussion is devoted almost exclusively to the crayfishes.

Among the carcinologists and biogeographers who have considered the origin of the crayfish faunas of México and Cuba are Huxley (1878), Ortmann (1902, 1905), Van Straelen (1942), Villalobos (1955), Croizat (1958), Rhoades (1962), Hobbs and Villalobos (1964), Hobbs (1967b), and Chace and Hobbs (1969). The following brief account draws freely from and modifies the theses of several of these authors (particularly Villalobos) without further reference to them. Suffice it to say that without the excellent contributions of Villalobos (see Literature Cited) all of the hypotheses relative to the dispersal of crayfish stocks to and from México and Cuba that have been proposed by the other authors cited above would have few data to support them.

Of the 43 species and subspecies of crayfishes known from the area, 37 have been found to be infested with entocytherids, and only one of the remaining six, *Procambarus bouvieri* (Ortmann), has been collected in sufficient numbers to indicate that it perhaps does not harbor these commensals. How *P. bouvieri* managed to escape infestation, or has been able to rid itself of entocytherines, poses a question which cannot be answered from available data. This crayfish has no existing close relatives and is apparently isolated, in the area of Uruapan, Michoacán, from other crayfishes.

The crayfishes of México and Cuba are currently assigned to three genera: *Procambarus*, comprising 32 species and subspecies; *Paracambarus*, 2 species; and *Cambarellus*, 9 species and subspecies. The ranges of the genera in México, Cuba, and the southern United States are indicated in Figure 4. Since host specificity on the part of their commensal ostracods does not exist, except as limitations of access to single host species, it seems more appropriate to treat the crayfishes in terms of their occupation of faunistic regions rather than to attempt to reconstruct the migrations of individual phyletic lines. Five such regions are recognized (Figure 5) and designated as follows: (1) the *Central Plateau*, including the Mesa Central, restricted portions of the Mesa del Norte (as outlined by West: 1964:40), and a small segment of the Pacific slope from Nayarit to Michoacán; (2) the *Southern Gulf Slope*, extending southward from the eastern portion and flank of the Cordillera Volcánica Transversal ("Neovolcanic Axis," Maldonado-Koerdell, 1964:19) * to Honduras, thus encompassing the "southern sector" (West, 1964:58) of the gulf coastal lowlands, the Tabasco Plain, the highlands of Chiapas and northern Central America, and portions of the Isthmus of Tehuantepec and Yucatan Platform; (3) the *Interjacent Gulf Slope*, extending from the Río Tuxpan Basin southward to the "immense volcanic salient of the Mesa Central" (ibid.) or easternmost extension of the Cordillera Volcánica Transversal, including the lower slopes and adjacent southern portion of the "northern sector" of the gulf coastal lowlands; (4) the *Northern Gulf Slope* extending from the Rio Grande southward to the Río Tuxpan Basin; and (5) *Cuba*, including Isla de Pinos.

* The effect of this barrier to migrations of inhabitants of freshwater is emphasized in the ranges of the two southern subspecies of the water snake *Natrix rhombifera*, an animal of considerably greater vagility than crayfishes (See Conant, 1969:51).

Dispersal of the crayfishes (Figure 6, Table 2).—The five faunal areas recognized here almost certainly have resulted from no fewer than three major periods of invasions of México from the north, following, at least in part, the easternmost north-to-south route depicted by Maldonado-Koerdell (1964:20). The Southern Gulf Slope probably was invaded by one of the earliest crayfish stocks to venture into México. It is believed to have moved southward along the gulf coastal region (Figure 6*a*–1) and to have reached southern Veracruz by the close of the Miocene, at which time the elevation of the Cordillera Volcánica Transversal formed a barrier to crayfish migration which has persisted to the present time. Later, one segment of this stock reached Cuba, and that which remained on the continental mass migrated southward as far as Honduras. The only trace of the original stock which occurs north of the transverse volcanic ridge in México is a distant relative, *Procambarus simulans regiomontanus,* which is believed to represent a much later, perhaps even a Recent, invasion (see below).

The invasion of the Central Plateau perhaps occurred before or at about the same time as that which resulted in the population of the Southern Gulf Slope, but instead of a single stock, no fewer than three moved southwestward from the United States. Of the three, only one, the *Cambarellus* stock (Figure 6*a*–2), can be considered to have been successful in light of its present distribution. The other two stocks (Figure 6*a*–3 and 4) are each

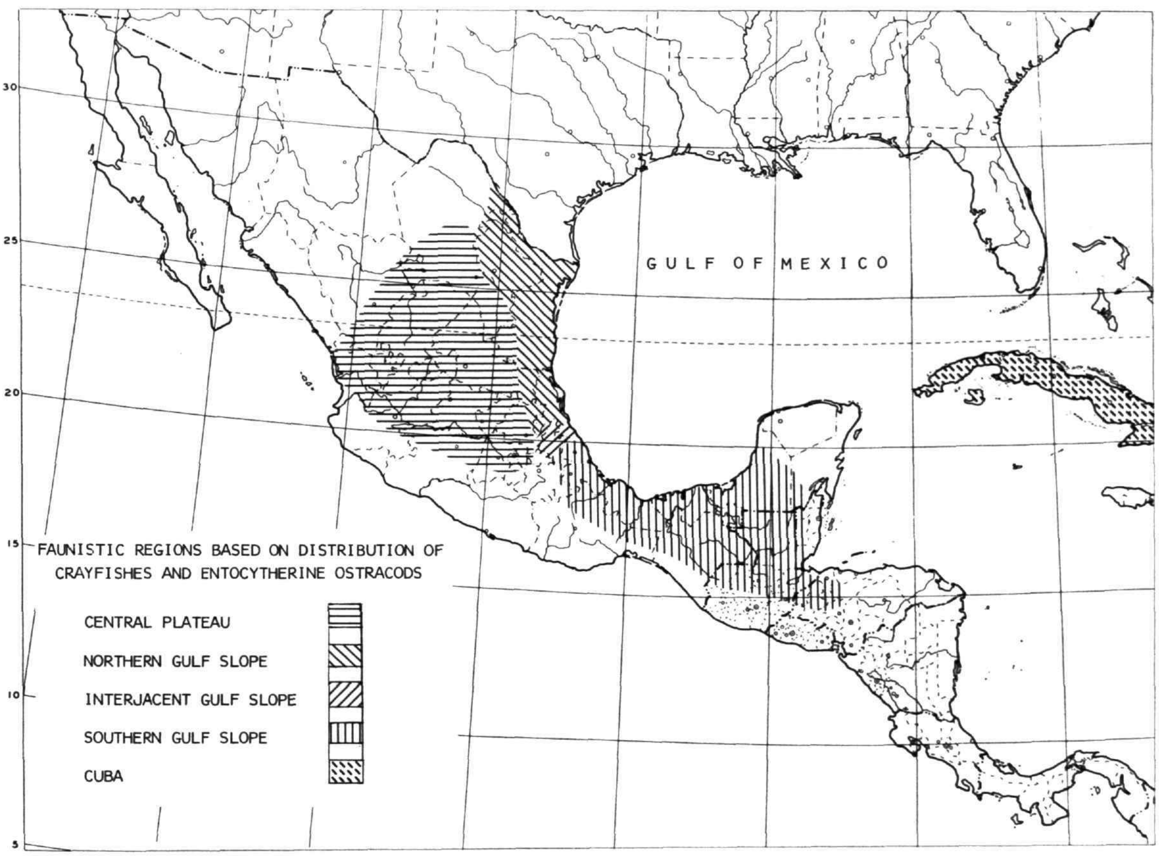

Figure 5.—Faunistic regions of México and Cuba based upon the ranges of entocytherine ostracods and their crayfish hosts.

TABLE 2.—*Summary of crayfish invasions of México and Cuba with listing of present derivatives.*

TIME OF INVASION	PRIMITIVE STOCKS	FAUNISTIC REGIONS: CENTRAL PLATEAU	GULF SLOPE: SOUTHERN	GULF SLOPE: INTERJACENT	GULF SLOPE: NORTHERN
PRE-PLIOCENE	1		PROCAMBARUS ACANTHOPHORUS AZTECUS LLAMASI MEXICANUS MIRANDAI PILOSIMANUS RODRIGUEZI R. RUTHVENI R. ZAPOAPENSIS VAZQUEZAE VERACRUZANUS * SUBSEQUENTLY TO CUBA ATKINSONI C. CUBENSIS C. RIVALIS ** NIVEUS **		
	2	ALL MEXICAN CAMBARELLUS			
	3	P. DIGUETI			
	4	P. BOUVIERI **			
PLIOCENE	5A			PROCAMBARUS CABALLEROI GONOPODOCRISTATUS	
	5B			RIOJAI HOFFMANNI HORTONHOBBSI TZIUTLANENSIS TLAPACOYANENSIS ERICHSONI CONTRERASI ZIHUATEUTLENSIS	PROCAMBARUS VILLALOBOSI TOLTECAE
	5C			PARACAMBARUS PARADOXUS ORTMANNI	
PLEISTOCENE OR RECENT	6 7 8			PROCAMBARUS A. CUEVACHICAE	PROCAMBARUS A. CUEVACHICAE S. REGIOMONTANUS CLARKII

* AND TWO SPECIES IN GUATEMALA AND HONDOURAS
** NOT KNOWN TO HARBOR ENTOCYTHERIDS

represented in the modern fauna by single species, both of which have very limited ranges. One of the latter, *Procambarus bouvieri*, as indicated above, has no close relative in México or elsewhere, and the other, *Procambarus digueti*, has only two rather distant relatives, which are confined to the coastal plain of Texas and western Louisiana, where the ranges overlap that of two of the closest relatives of th Mexican members of the genus *Cambarellus*.

Following the initial stock that moved southward

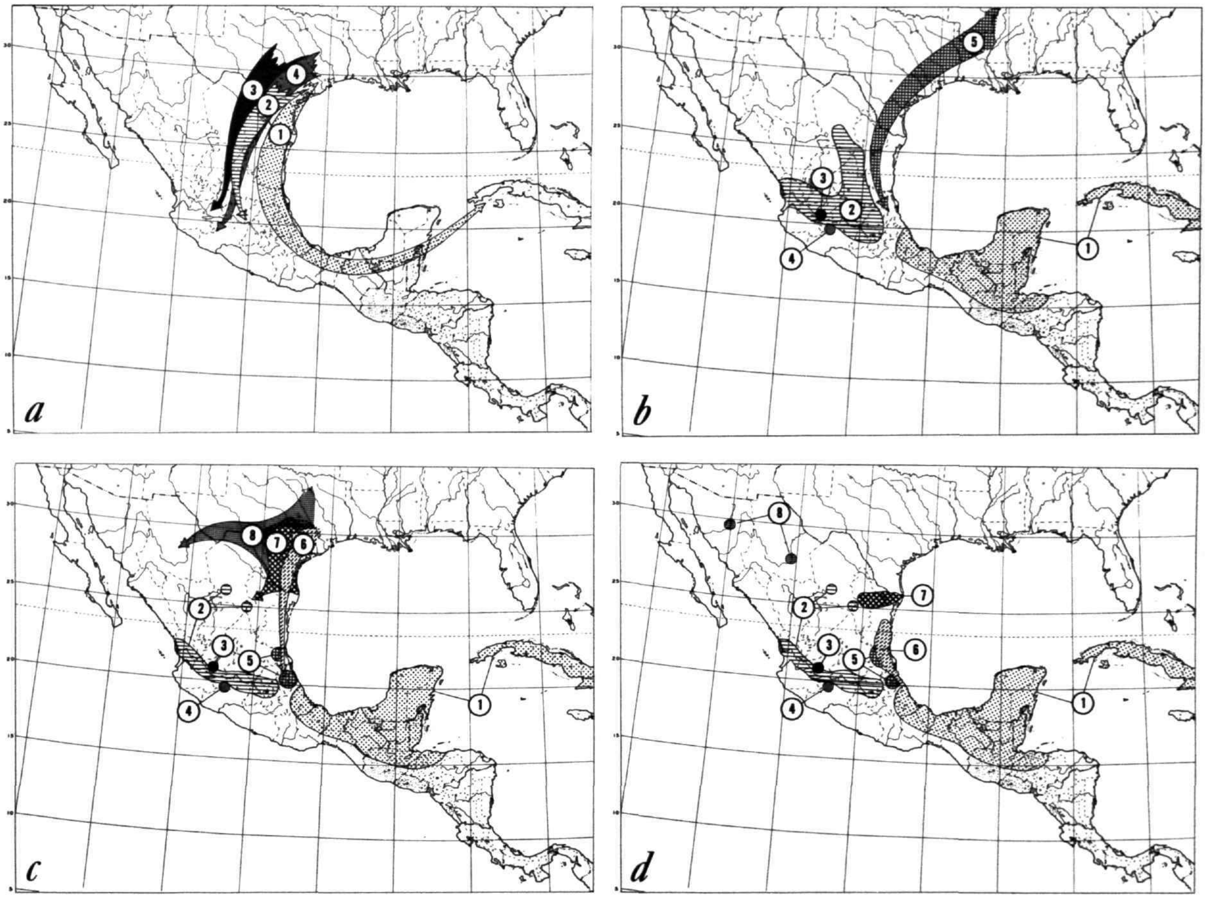

FIGURE 6.—Crayfish migrations: a, Pre-Pliocene; b, Pliocene; c, Pleistocene or Recent; d, present ranges of invading stocks. For correlations with species postulated to have been derived from them, see Table 2. (Ranges in United States not indicated.)

along the Gulf coastal area were three additional ones (Figure 6*b*–5, Table 2) which gave rise to most of the species occurring in the Interjacent Gulf Slope, the most densely populated area in México, in terms of numbers of crayfish species. If remnants of the original stock which moved southward were still there when these three arrived, obviously the former were less successful than the new emigrants, for apparently they have disappeared completely from the area. Perhaps it was the subsequent development of the semiarid region in Tamaulipas, eastern Nuevo León, and adjacent portions of San Luis Potosí and Veracruz that resulted in the disappearance of a major portion (only *P. toltecae* and *P. villalobosi* are known to remain) of these comparatively primitive stocks from the Northern Gulf Slope which now bears evidence of a more recent influx of crayfishes from the north.

Penetrating far inland into the Northern Gulf Slope in comparatively recent times was *Procambarus clarkii* (Figure 6*c*–8), a species which is widespread in the southern part of the United States. Only two additional crayfishes along the eastern part of the Northern Gulf Slopes are believed to represent such recent invasions into the country:

TABLE 3.—*Summary of entocytherine invasions of México and Cuba with listing of present derivatives.*

TIME OF INVASION	PRIMITIVE STOCKS	FAUNISTIC REGIONS			
		CENTRAL PLATEAU	GULF SLOPE		
			SOUTHERN	INTERJACENT	NORTHERN
PRE-PLIOCENE	1	A. HETERODONTA	A. BIDENTATA A. MAYA A. VILLALOBOSI		A. TOLTECAE
	2		E. CLAYTONHOFFI	E. MEXICANA	E. CLAYTONHOFFI
			SUBSEQUENTLY TO CUBA		
	1		A. CUBENSIS A. HAMATA		
	2		E. RUIBALI		
PLIOCENE	3		U. ZARURI	U. BICUSPIDE U. CUADRICUSPIDE U. DOBBINAE	
PLEISTOCENE OR RECENT	4				A. SINUOSA

Procambarus simulans regiomontanus (Figure 6*c*–7), the range of the species of which extends from Arkansas and Colorado southward, although perhaps not continuously, to the vicinity of Monterrey, Nuevo León; and *Procambarus acutus cuevachicae* (Figure 6*c*–6), a member of a species the range of which is larger than that of any other member of the genus—extending over much of the United States and southward on the Interjacent Gulf Slope into Puebla.

Our knowledge of the single pseudothelphusid (*Pseudothelphusa veracruzana*) which is known to be infested with entocytherids is so limited as to be almost useless in this discussion.

DISPERSAL OF THE ENTOCYTHERINAE (Figure 7, Table 3).—The details of how the invasions of the crayfishes into México governed the dispersal of the entocytherine stocks are not entirely clear; however, a conclusion that certain parallelisms exist in their postulated migrations seems inescapable. That there does not seem to be total congruity in the evolution of the two groups is perhaps in part due to the fact that host specificity is essentially absent among the Mexican entocytherines. Secondly, there is fair evidence that the rate of speciation has been much slower in the ostracods than in their hosts (see below). In spite of a lack of knowledge of many details concerning the migrations of these symbionts, the following hypotheses seem to be supported by the available data.

The pre-Pliocene invasions of México by the crayfishes probably resulted in the introduction of two stocks of entocytherines. One of these, the *Ankylocythere* stock (Figure 7*a*–1), became divided into two segments, one of which was carried by those crayfishes that moved southwestward onto the Central Plateau and which ultimately gave rise to *Ankylocythere heterodonta*. The other segment was transported southward along the Northern and Interjacent Gulf Slopes into southern Veracruz where it spread to Oaxaca, Chiapas, Campeche, and ultimately to Isla de Pinos and the island of Cuba. That segment of the stock which remained in the Southern Gulf Slope of México gave rise to *A. bidentata*, *A. maya*, and *A. villalobosi*, and the remnant in the Northern Gulf Slope, to *A. toltecae*. No trace of it is believed to have remained in the Interjacent area. The stock which reached Cuba

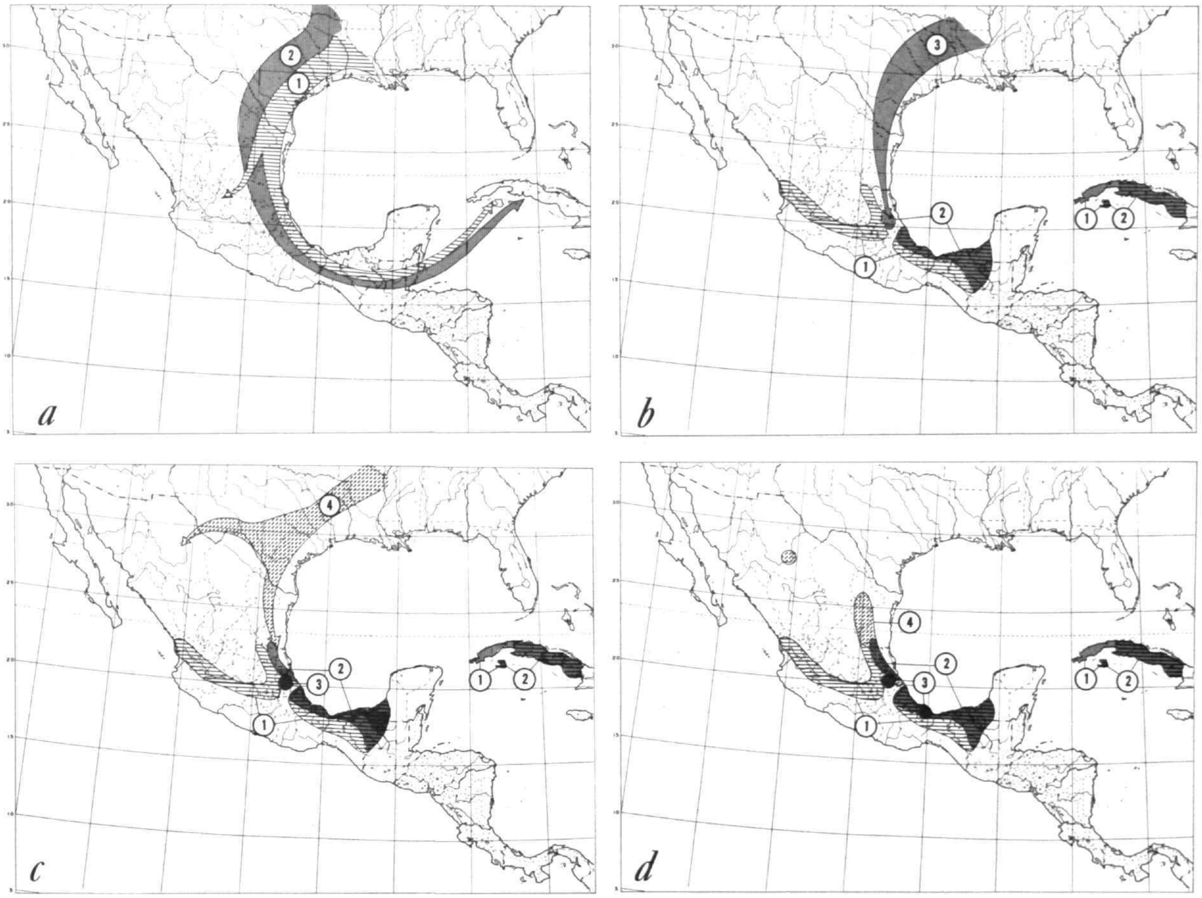

FIGURE 7.—Entocytherine migrations: a, Pre-Pliocene; b, Pliocene; c, Pleistocene or Recent; d, present ranges of invading stocks. For correlations with species postulated to have been derived from them, see Table 3. (Ranges in United States not indicated.)

was ancestral to *A. cubensis* and *A. hamata.* Accompanying the *Ankylocythere* stock in the pre-Pliocene invasion of México was an *Entocythere* stock (Figure 7*a*–2) which might well have already been differentiated into two species, descendants of one of which, *E. ruibali,* are now confined to Isla de Pinos and the island of Cuba, and of the other, represented by two species, *E. claytonhoffi* and *E. mexicana,* having a combined range extending from the southern portion of the Northern Gulf Slope southward in the Interjacent and over most of the Southern Gulf Slope.

A third entocytherine stock, *Uncinocythere* (Figure 7*b*–3), generally considered to be the most primitive of the subfamily, apparently was brought into México during the Pliocene by one or more of the three stocks of crayfishes (one of which is rather primitive) that moved southward across the Northern Gulf Slope to populate the Interjacent area. There, in a very small area encompassing adjacent portions of the states of Hidalgo, Puebla, and Veracruz, thirteen species of crayfishes infested by four species of entocytherids have become established. All except one each of the crayfishes (see

Table 2) and ostracods are believed to have descended from those stocks introduced during the Pliocene; the entocytherines include *U. bicuspide*, *U. cuadricuspide*, and *U. dobbinae* (Table 3).

With this assumed Pliocene invasion, segments of all three basic stocks from which the modern Mexican and Cuban entocytherines have been derived had been introduced into México. Nevertheless there are several peculiarities in the ranges of supposed derivatives from all three which deserve further consideration.

Among the modern Mexican members of the genus *Ankylocythere*, there are two species occurring in the Northern Gulf Slope. *Ankylocythere sinuosa* may be dismissed rather perfunctorily, for it is a common species in the western gulf coastal region of the United States that probably reached México comparatively recently (Figure 7*c*–4), and that owes its large range to the apparently highly vagile host crayfishes *Procambarus acutus* and *P. clarkii*.

In contrast, no convincing hypothesis can be offered concerning the origin of *A. toltecae*, which is restricted to a small area in southern Tamaulipas, eastern San Luis Potosí, and extreme northern Hidalgo.

This ostracod is associated with only two hosts, *P. toltecae* and *P. villalobosi*, both of which are believed to be 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. 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. These two crayfishes, being, in a sense, relicts of the stocks which dominate the region immediately to the south, may well have become infested with a stock of *Ankylocythere* brought into the area by the pioneering ancestors of those crayfishes which now occur south of the Cordillera Volcánica Transversal, a stock that has otherwise disappeared from the area north of this mountain range.

For reasons which will become apparent below, more remote possibilities exist that the entire original *Ankylocythere* stock disappeared from the area north of the transverse volcanic range, and that the stock from which this species was derived was either brought southward with the ancestors of *Procambarus villalobosi* and *P. toltecae* from the United States, or that *A. toltecae* represents a comparatively recent offshoot of *A. sinuosa*. The latter possibility seems less likely, since the range of *A. sinuosa* extends from the United States southward to the Cordillera Volcánica Transversal on both sides of the drainage system frequented by *A. toltecae*. Furthermore, although *A. sinuosa* exhibits considerable variation throughout its range, I am aware of no populations with tendencies toward such a reduced talon as has *A. toltecae*, whereas descendants of two segments of the pioneering *Ankylocythere* stock (*A. heterodonta* and *A. maya*) do exhibit such a reduction, although not to the extent it has become atrophied in *A. toltecae* (cf. Figures 15, 20, 21, and 23). For these reasons, the former hypothesis is favored: that *A. toltecae* is viewed as a relict of the pioneering *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. These hosts are now confined to a small range in headwater tributaries of the Río Moctezuma in the southern part of the Northern Gulf Slope.

Problems concerning the range of the Mexican *Entocythere*, to some degree, parallel those of *Ankylocythere*. It seems probable that both genera reached México prior to the elevation of the Cordillera Volcánica Transversal, and the only evidence that *Ankylocythere* arrived ahead of the *Entocythere* stock is that the latter is not now represented on the Mexican Plateau, whereas *Ankylocythere* occurs both there and along the Gulf Slope. In any case, it seems highly probable that the ancestral *Entocythere* stocks were present in the Southern Gulf Slope before the close of the Miocene.

The most primitive of the three Mexican and Cuban members of the genus is *E. ruibali*, for, among other characters, it has a pectinate distal tooth on the mandible—a character that is universal in the subfamily except in most members of the genus *Entocythere* (see discussion of taxonomic characteristics above)—and it seems a reasonable assumption that its ancestors arrived in Cuba along with those of the two *Ankylocythere* on a common host. This host unquestionably had its closest affinities with the group of Mexican crayfishes which occur in the Southern Gulf Slope. If it could be accepted that the character of the mandible of *E. ruibali* represents the appearance in the Cuban population of an atavistic trait, at least one of the problems related to the origins and relationships of the three members of the genus *Entocythere* in the region could be much more readily explained. The fact, however, that a species in western Kentucky, *E. tyttha* Hobbs and Hobbs (1970:11), which is also considered to be primitive, is small, and has a pectinate distal tooth on the mandible causes me to question such an assumption. The problem of the origins of the three species occurring in the Mexican-Cuban region is made more complex by the fact that *E. claytonhoffi* is the only entocytherid (and there are no crayfishes) which occurs both north and south of the Cordillera Volcánica Transversal; furthermore, the species is so widespread on both sides of this enormous and complex volcanic belt that the occupation of such an area and the establishment of associations with so many hosts could hardly have been accomplished by a Pleistocene or Recent introduction on either side. An alternative suggestion is that two species of the genus, one with a pectinate distal tooth on the mandible, the other with a simpler one, were introduced into México in pre-Pliocene times and that both reached the Southern Gulf Slope before the elevation of the Cordillera Volcánica Transversal. A segment of the more primitive one was rafted to Cuba along with the primitive *Ankylocythere* where it gave rise to *E. ruibali*. That segment of the stock which remained on the continent has apparently become extinct. The descendants of the second species, *E. claytonhoffi*, exhibit extremely few variations throughout its range, and it is thus believed to be an old, stable, Pre-Pliocene species ranging from southern Tamaulipas southward to Chiapas and Campeche.

Entocythere mexicana is almost certainly an offshoot of *E. claytonhoffi*, and whatever factors persisted in the Interjacent Gulf Slope to contain and protect the *Uncinocythere* stock (see below) were probably effective in isolating a segment of the Pliocene *claytonhoffi* stock in the same area, immediately to the north of the Cordillera Volcánica Transversal.

The postulated Pliocene invasion that carried three crayfish stocks, including some of the most primitive of the Mexican species, along the Gulf Slopes also introduced the ancestral *Uncinocythere*, the most primitive of the entocytherine genera. One must assume that, as in the pioneering stocks of the other genera, there was at least originally a temporally continuous range from Texas (where the genus is still represented, although by distantly related species) southward to the Cordillera Volcánica Transversal. Unfortunately, since our knowledge of the crayfishes and entocytherine faunas of the coastal portion of the Northern Gulf Slope (Tamaulipas and northern Veracruz) is distinctly limited, we cannot be sure that there are no members of the genus *Uncinocythere* in the area. Inasmuch as it is apparently absent further inland, and because of the semiarid conditions which exist in the Northern Gulf Slope, it is likely that if an *Uncinocythere* fauna exists, it is a depauperate one. If this gap is real, as I think likely, it is tempting to suggest that the originally continuous range has perhaps been broken by the alteration of the previously more humid conditions that must have existed when the crayfishes were moving southward.

As to the implied divergence of the *Uncinocythere* stock in the Interjacent Gulf Slope, I have considerable reservations. It is possible that the sympatric *U. bicuspide*, *U. cuadricuspide*, and *U. dobbinae* represent variations in a single species—just as *E.d. multicuspide* and *E. uncinata* have been demonstrated to be variants of *U. cuadricuspide* and *U. bicuspide*, respectively. Inasmuch as in the material available to me some localities support only one of the three, and I have no conclusive evidence of interbreeding among them, the three species are recognized here. If, however, they represent three previously geographically isolated stocks, the barriers which separated them no longer exist.

The occurrence of a lone species, *U. zaruri*, on a freshwater crab in a single locality in the Tuxtla area of Veracruz (Southern Gulf Slope) presents a problem which for solution lends itself to an array of guesses, but with almost no knowledge of the habits of the host and whether its range extends on both sides of the Cordillera Volcánica Transversal, no explanation of how its association with the crab originated or how it reached the Tuxtla area can be made with any degree of confidence. Should the crab feed on crayfishes, that would suggest a possible means whereby this ostracod stock might have gained access to it, but it seems equally likely that dislodged ostracods, or ones left on a discarded exuvia of a crayfish, might make their way to a crab hovering in the former lair of a crayfish.

The data on which the above hypothetical reconstruction of the invasions of México and Cuba by crayfishes and entocytherine ostracods seem to be, in general, in accord with the conclusions of Martin and Harrell (1957). Their summary statement that "interpreting the eastern temperate (Arctotertiary) element in the Mexican montane biota exclusively in terms of Pleistocene dispersal raises more distributional problems that it solves," is supported by our present knowledge of the distribution of the crayfishes and ostracods discussed here. Furthermore, there is every reason to believe that the major center of distribution of the cambarine crayfishes and the entocytherine ostracods is located in the southeastern part of the United States and that migration between the center and México has been essentially unidirectional, from north to south. The earliest invasion of México occurred in pre-Pliocene times, followed by the arrival of other stocks in the mid-Pliocene, and by the subsequent, probably Recent, invasion of three comparatively highly vagile crayfish stocks carrying only a single ostracod species. Although migrations in the reverse direction might have occurred, there is little evidence to support such a conclusion; thus, in a sense, one might consider México to have served as a refugium for those stocks which must have at one time occupied parts of Texas and northeastern México only to become extinct in the latter areas during the late Pliocene and Pleistocene with the development of arid conditions. Such a history, although without any fossil evidence to support it, is not at variance with the accounts of Maldonado-Koerdell (1964) and West (1964) treating the geohistory, paleogeography, surface configuration, and associated geology of Middle America.

A statement was made earlier that the rate of speciation among the entocytherine stocks of México and Cuba has not kept pace with that of the crayfish hosts. Perhaps this generalization can best be defended by comparing the numbers of species and subspecies of crayfishes with the numbers of ostracod symbionts inhabiting the five faunal zones here recognized:

Zone	*Number of Crayfish Species and Subspecies*	*Number of Entocytherine Ostracods*
Central Plateau	11	1
Northern Gulf Slope	5	3
Interjacent Gulf Slope	12	5
Southern Gulf Slope	11	5
Cuba	4	3

Along the southern portion of the Central Plateau, which was folded and interrupted by volcanic activity many times during the past, several populations of *Cambarellus* have become isolated and show divergences from the more widespread *C. montezumae montezumae* immediately to the north and east. In contrast, the populations of *Ankylocythere heterodonta* living on them are indistinguishable from those infesting *C. m. montezumae*. Furthermore, whereas we have no evidence to conclude that a population of crayfishes along the Gulf Slopes has remained essentially unchanged since Miocene times, the uniformity of *E. claytonhoffi* on both sides of the Cordillera Volcánica Transversal does seem to offer such a possibility.

Summaries of the zoogeographic discussion presented here are outlined in Tables 2 and 3.

Family Entocytheridae Hoff, 1942

Entocytherinae Hoff, 1942a:63–65, 71; Hoff, 1942b:159, 166; Rioja, 1942a:203; Rioja, 1942b:686; Hoff, 1944b:330; Rioja, 1953:289; Pennak, 1953:421; Howe, 1955:66; Howe (*in* Moore and Pitrat) 1961:300; Howe, 1962:80; Hart, 1962:125.

Entocytheridae Moore (*in* Moore and Pitrat) 1961:96, 98; Howe (*in* Moore and Pitrat), 1961:255, 257, 300; Howe, 1962:80; Hart, 1962:125.

Diagnosis (from Hart, 1962:125).—"A family of the suborder Podocopa. Shell reniform to elliptical, thin, chitinous, laterally compressed; valves slightly unequal in size, with or without protuberances, and hairless to somewhat hirsute. Eyes, when present, fused. Antennules consisting of six or seven podomeres with shortened setae. Antennae with four podomeres, armed distally with two or three claws. Mandible well developed with all podomeres of palp fused except distal one. Thoracic legs similar to one another, each terminating in a large curved claw. Maxilla variable among species; consisting of a palp, and not more than one masticatory process. Copulatory apparatus of males complex;

consisting of a peniferum, penis, clasping apparatus, one or two 'fingers,' and with or without a 'finger guard'."

Four subfamilies of the family Entocytheridae are currently recognized: Entocytherinae, Sphaeromicolinae, Notocytherinae, and Microsyssitrinae. The first two are represented in the Mexican fauna, and the Entocytherinae in Cuba. The subfamily Notocytherinae is currently known to occur only in Australia and Tasmania (Hart and Hart, 1967:9), New Zealand, and New Guinea (Hart and Hart, personal communication), and the Microsyssitrinae in "two estuarine localities in Karala State, India" (Hart, Nair, and Hart, 1967:1).

The family is represented on the continents of Asia (Microsyssitrinae), Europe (Sphaeromicolinae), North America (Entocytherinae and Sphaeromicolinae), and Australia (Notocytherinae).

Key to the Subfamilies of Entocytheridae

1	Dorsal claw of antenna without setae on flexor surface (commensal on crayfishes)	**Notocytherinae**
1′	Dorsal claw of antenna with setae on flexor surface	2
2 (1′)	Maxilla with respiratory plate and well developed masticatory lobes; penis always strongly curved (commensal on crayfishes and freshwater crab)	**Entocytherinae**
2′	Maxilla without respiratory plate or masticatory lobes (occasionally vestigial); penis straight or only slightly curved	3
3 (2′)	Antennule consisting of five podomeres; distal flexor margin of ultimate podomeres of legs with brush of setae on finger-like projection opposing terminal claw (commensal on isopod)	**Microsyssitrinae**
3′	Antennule consisting of six or seven podomeres; distal flexor margin of ultimate podomeres of legs lacking setiferous fingerlike projection opposing terminal claw (commensal on amphipods and isopods)	**Sphaeromicolinae**

Subfamily Entocytherinae Hoff, 1942

Entocytherinae Hoff, 1942a:65; Hart, 1962:125–126.

DIAGNOSIS.—Dorsal claw of antenna with brush of setae on flexor face. Mandible with respiratory filaments. Maxilla with respiratory plate, and masticatory lobe terminating in setae. Peniferum without movable claws; penis always angular, usually bent at right angle.

RANGE.—Continent of North America from the state of Washington to New York, southward (mostly east of the Rocky Mountains) to Florida and Oaxaca, Chiapas, and Campeche, México; also present on the island of Cuba and Isla de Pinos.

HOSTS.—Crayfishes of the family Astacidae and a freshwater crab of the family Pseudothelphusidae, *Pseudothelphusa veracruzana*.

GENERA.—*Ankylocythere* Hart, 1962:126; *Ascetocythere* Hart, 1962:128; *Cymocythere* Hart, 1962:128; *Dactylocythere* Hart, 1962:129; *Donnaldsoncythere* Rioja, 1942b:688; *Entocythere* Marshall, 1903:120; *Geocythere* Hart, 1962:134; *Harpagocythere* Hobbs III, 1965:162; *Hartocythere* Hobbs III, 1970:180; *Litocythere* Hobbs and Walton, 1968:247; *Lordocythere* Hobbs and Hobbs, 1970:15; *Okriocythere* Hart, 1964:243; *Ornithocythere* Hobbs, 1967a:2; *Phymocythere* Hobbs and Hart, 1966:48; *Plectocythere* Hobbs III, 1965:161; *Rhadinocythere* Hart, 1962:135; *Sagittocythere* Hart, 1962:135; *Saurocythere* Hobbs III, 1969:167; *Thermastrocythere* Hobbs and Walton, 1966:7; *Uncinocythere* Hart, 1962:136.

Three genera, *Ankylocythere*, *Entocythere*, and *Uncinocythere*, are represented in the Mexican fauna, and the former two in that of Cuba.

Key to Mexican and Cuban Genera

1	External border of horizontal ramus of clasping apparatus of male with talon or excrescence	***Ankylocythere***
1′	External border of horizontal ramus of clasping apparatus without talon or excrescence	2

2 (1) Distal tooth of mandible pectinate (5 cusps); antenna of triunguis female without comblike appendix at base of terminal claws; ventral portion of peniferum seldom heavily sclerotized; internal border of horizontal ramus of clasping apparatus with distinct gap between distal tooth and apical denticles .... ***Uncinocythere***

2' Distal tooth of mandible pectinate only in the Cuban *E. ruibali;* antenna of triunguis female with comblike appendix at base of terminal claws; ventral portion of peniferum usually heavily sclerotized; internal border of horizontal ramus of clasping apparatus without distinct gap between distal tooth and apical denticles. ***Entocythere***

Genus *Uncinocythere* Hart, 1962

Uncinocythere Hart, 1962:136.

DIAGNOSIS.—Terminal tooth of mandible pectinate. Copulatory complex of male without finger guard or accessory groove; spermatic and prostatic elements of penis contiguous and extending anteroventrally from base. External border of clasping apparatus entire; internal border with one to four teeth; apex with two to five denticles. Females without amiculum or J-shaped rod, and antenna of triunguis female without comblike appendix at base of apical claws.

TYPE-SPECIES.—*Entocythere columbia* Dobbin, 1941; designated by Hart, 1962:136.

RANGE.—On the basis of present knowledge, this genus occupies a discontinuous range: Pacific slope from Washington, Idaho, and Utah to California; Illinois and Missouri, eastward to West Virginia, Tennessee, and Virginia, and southward to Florida; and Hidalgo, Puebla, and Veracruz, México. Of the 21 described species, only 4 endemic ones occur in México, and none in Cuba. (See Hart and Hart, 1969:182–184.)

LIST OF SPECIES.—UNITED STATES (Northwestern): *U. cassiensis* Hart, 1965:191, Idaho; *U. caudata* (Kozloff, 1955:156), Oregon; *U. columbia* (Dobbin, 1941:184), Washington; *U. ericksoni* (Kozloff, 1955:159), Oregon; *U. holti* Hart, 1965:193 (a probable synonym of *U. ericksoni*), Utah; *U. neglecta* (Westervelt and Kozloff, 1959:240), California; *U. occidentalis* (Kozloff and Whitman, 1954:160), Oregon; *U. thecktura* Hart, 1965:192, Idaho.

UNITED STATES (Eastern): *U. ambophora* (Walton and Hobbs, 1959:115), Florida; *U. clemsonella* (Crawford, 1961:236), South Carolina; *U. equicurva* (Hoff, 1944b:337), Alabama, Florida, and Georgia; *U. lucifuga* (Walton and Hobbs, 1959:118), Florida; *U. pholetera* (Hart and Hobbs, 1961:181), Missouri; *U. simondsi* (Hobbs and Walton, 1960:17), Georgia and Tennessee; *U. stubbsi* Hobbs and Walton, 1966:9, Tennessee; *U. warreni* Hobbs and Walton, 1968:250, Georgia; *U. xania* (Hart and Hobbs, 1961:181), Missouri; *U. zancla* Hobbs and Walton, 1963:456, Tennessee.

MEXICO: *U. bicuspide* (Rioja, 1943a:565), Hidalgo, Puebla, and Veracruz; *U. cuadricuspide* (Rioja, 1945:422), Puebla; *U. dobbinae* (Rioja, 1943a:561), Hidalgo, Puebla, and Veracruz; *U. zaruri*, new species, Veracruz.

Key to the Species of the Genus *Uncinocythere* (Based on Male)

1 Internal border of horizontal ramus of clasping apparatus with four teeth 2

1' Internal border of horizontal ramus of clasping apparatus with fewer than four teeth. 3

2 (1) Apex of clasping apparatus with four denticles .... ***U. columbia***

2' Apex of clasping apparatus with two or three denticles .... ***U. cuadricuspide***

3 (1') Internal border of horizontal ramus of clasping apparatus with three teeth 4

3' Internal border of horizontal ramus of clasping apparatus with one or two teeth ... 15

4 (3) Ventral margin of peniferum entire 5

4' Ventral margin of peniferum cleft 7

5 (4) Apex of clasping apparatus with two or three denticles .... ***U. dobbinae***

5' Apex of clasping apparatus with four denticles 6

6 (5') Vertical ramus of clasping apparatus longer than horizontal ramus .... ***U. clemsonella***

6' Vertical ramus of clasping apparatus shorter than horizontal ramus ...... ***U. columbia***

7 (4′)	Shell with posteroventral spine	8
7′	Shell without posteroventral spine	10
8 (7)	Posteroventral spine arising anterior to posteriormost margin of shell	***U. thecktura***
8′	Posteroventral spine arising at posteriormost margin of shell	9
9 (8′)	Peniferal cleft more than ½ width of peniferum; clasping apparatus with three apical denticles	***U. caudata***
9′	Peniferal cleft less than ½ width of peniferum; clasping apparatus with five apical denticles	***U. cassiensis***
10 (7′)	Apex of clasping apparatus with four or five denticles	11
10′	Apex of clasping apparatus with three denticles	14
11 (10)	Apex of clasping apparatus with four denticles	***U. warreni***
11′	Apex of clasping apparatus with five denticles	12
12 (11′)	Apical portion of peniferum constricted ventrally	***U. neglecta***
12′	Apical portion of peniferum not constricted ventrally	13
13 (12′)	Peniferal cleft almost closed ventrally by posterior curve of anteroventral spine.	***U. ericksoni***
13′	Peniferal cleft not almost closed ventrally	***U. holti***
14 (10′)	Peniferum with simple rounded cleft	***U. pholetera***
14′	Peniferum with shanklike prominence within cleft	***U. stubbsi***
15 (3′)	Ventral margin of peniferum cleft or with anteroventral spine	16
15′	Ventral margin of peniferum entire	20
16 (15)	Horizontal ramus of clasping apparatus with two teeth on internal border and two or four denticles on apex	17
16′	Horizontal ramus of clasping apparatus with one tooth on internal border and three denticles on apex	19
17 (16)	Apex of clasping apparatus with two denticles	***U. zaruri***
17′	Apex of clasping apparatus with four denticles	18
18 (17′)	Clasping apparatus C-shaped; peniferal cleft shallow	***U. occidentalis***
18′	Clasping apparatus L-shaped; peniferal cleft deep	***U. simondsi***
19 (16′)	Peniferal cleft very shallow	***U. ambophora***
19′	Peniferal cleft deep	***U. zancla***
20 (15′)	Clasping apparatus with two teeth on internal border	21
20′	Clasping apparatus with one tooth on internal border	23
21 (20)	Teeth on internal border subequal in size	***U. bicuspide***
21′	Teeth on internal border distinctly unequal in size	22
22 (21′)	Clasping apparatus L-shaped; eye absent	***U. lucifuga***
22′	Clasping apparatus C-shaped; eye present	***U. equicurva***
23 (20′)	Anteroventral angle of peniferum acute, its anterior side simple	***U. lucifuga***
23′	Anteroventral angle of peniferum 90 degrees, its anterior side rolled or thickened.	***U. xania***

Uncinocythere bicuspide (Rioja, 1943)

FIGURES 8*a-e*, 9

Entocythere (Cytherites) dobbini bicuspide Rioja, 1943a:565, 566, fig. 22.—Rioja, 1943b:576.

Entocythere dobbinae bicuspis.—Hoff, 1944b:332 [erroneous spelling].

Entocythere dobbini bicuspide.—Rioja, 1945:419, 420, 422, fig. 1.—Kozloff and Whitman, 1954:162.

Entocythere bicuspide.—Rioja, 1949:322, 323, 326, 328, figs. 17–20.—Crawford, 1959:167.

Entocythere uncinata.—Rioja, 1949:326–328, figs. 27, 28. [Type-locality, "Arroyo de Puendó, a 3 km. E. de Tenango de Doria," and "arroyo que va a El Coyular, distrito de Zihuateutla, Pue.," on *Procambarus contrerasi* (= *P. wiegmanni*?, Rioja). Types no longer extant.]

Uncinocythere bicuspide.—Hart, 1962:136.

DIAGNOSIS.—Shell length (numbers in parentheses represent averages): ♂, 0.29–0.31 (0.30) mm; ♀, 0.34–0.35 (0.34) mm. Shell height: ♂, 0.16–0.19 (0.18) mm; ♀, 0.20–0.22 (0.21) mm. Clasping apparatus comparatively heavy and usually strongly curved with angle formed by extensions of horizontal and vertical rami distinctly less than 90 degrees. Internal border of horizontal ramus with two teeth and with two, rarely three, small denticles at apex of ramus. Penis situated proximal to ventral margin of peniferum by distance no greater than its length. Ventral margin of peniferum always entire but often with anteroventral extremity produced.

TYPE-LOCALITY.—Huauchinango, Estado de Puebla, México, on *Procambarus riojai*; restricted by Hart, 1962:136.

TYPES.—No longer extant.

LOCALITY RECORDS (Figure 9).—MEXICO: Hidalgo: *Arroyo de Puendó, 3 km E of Tenango de Doria (Rioja, 1949:323), on *P. erichsoni* (listed as "*Procambarus weigmanni* ?" by Rioja) [This locality was also cited for *E. uncinata* (Rioja, 1949: 327)]; *Arroyo de San Bartolo, San Bartolo, 23 km NNW of Huauchinango, on *P. erichsoni*; *Arroyo

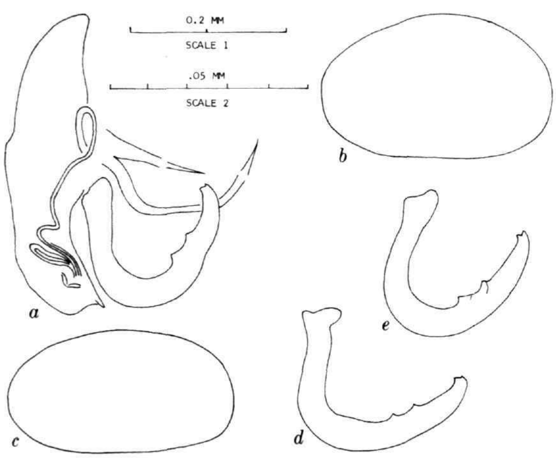

FIGURE 8.—*Uncinocythere bicuspide:* a, copulatory complex of male; b, left valve of female; c, left valve of male; d, e, clasping apparatus of male. Figures a, d, e to Scale 2; b, c to Scale 1. (Source of specimens: México—Zihuateutla, Puebla.)

de Puendó, Mamay y Bojoy, Tenango de Doria (Rioja, 1949:323), 16 km NW of Huauchinango, on *P. erichsoni*.

Puebla: *Tetela de Ocampo, La Cañada (Rioja, 1945:422), on *Paracambarus paradoxus*; Villa Juárez (Rioja, 1949:323), on *P. hoffmanni*; Cumbres de Cuanepixca, 6 km NE of Zihuateutla (Rioja 1949:323), on *P. hoffmanni*; Type-locality (Rioja, 1943a:566), on *P. riojai*; Arroyo de San Diego, 36 km NE of Villa Juárez (Rioja, 1949:323) on *P. contrerasi*; El Coyular, 4 km NE of Zihuateutla (Rioja, 1949:323) on *P. contrerasi* and *P. zihuateutlensis* [These crayfishes were listed as "*Procambarus* sp." by Rioja.]; "Arroyo que va a El Coyular, distrito de Zihuateutla" (Rioja, 1949:327), 29 km NE of Huauchinango, on *P. erichsoni*; *Zihuateutla, on *P. hortonhobbsi*.

?Veracruz: *Two km N of Coyutla, on *P. hoffmanni*; *Tomatlán, on *P. aztecus*; this locality is not shown on map and should be confirmed.

Thus, the range of this species lies on the eastern slopes of the plateau in the states of Hidalgo, Puebla, and Veracruz, and, except for the record on *Procambarus aztecus* at Tomatlán, lies wholly north of the Cordillera Volcánica Transversal.

HOSTS.—The hosts of *Uncinocythere bicuspide* include *Procambarus aztecus* (should be confirmed), *P. contrerasi, P. erichsoni, P. hoffmanni, P. hortonhobbsi, P. riojai, P. zihuateutlensis*, and *Paracambarus paradoxus*.

ENTOCYTHERID ASSOCIATES.—*Uncinocythere dobbinae, U. cuadricuspide*, and *Entocythere mexicana*.

REMARKS.—The subgeneric designation, *Cytherites*, according to Hart (1962:123, 139), should be used only as a generic taxon in combination with Sars' species, *Cytherites insignipes*, which, in turn, was treated as "*incertae sedis*."

Entocythere uncinata Rioja, 1949, is unquestionably a morphological variant of *U. bicuspide*. The only distinction made between them was in the curvature of the clasping apparatus, and a complete series of intermediate forms have been observed among the specimens cited above.

Uncinocythere cuadricuspide (Rioja, 1945)

FIGURES 10*a-f*, 11

Entocythere dobbini cuadricuspide Rioja, 1945:422, fig. 3.—Rioja, 1949:323.

Entocythere dobbini multicuspide Rioja, 1945:422, fig. 4 [Type-locality, "Tetela de Ocampo y La Cañada," Puebla. Types, no longer extant].—Rioja, 1949:325.

Entocythere dobbini multidentata.—Rioja, 1949:325 [erroneous spelling].

Entocythere cuadricuspide.—Rioja, 1949:323, 325, 328, figs. 21–23.—Crawford, 1959:167.

Uncinocythere cuadricuspide.—Hart, 1962:137.

DIAGNOSIS.—Shell length (numbers in parentheses represent averages): ♂, 0.28–0.29 (0.29) mm; ♀, 0.33–0.34 (0.34) mm. Shell height: ♂, 0.17–0.18 (0.17) mm; ♀, 0.21 mm. Clasping apparatus strongly

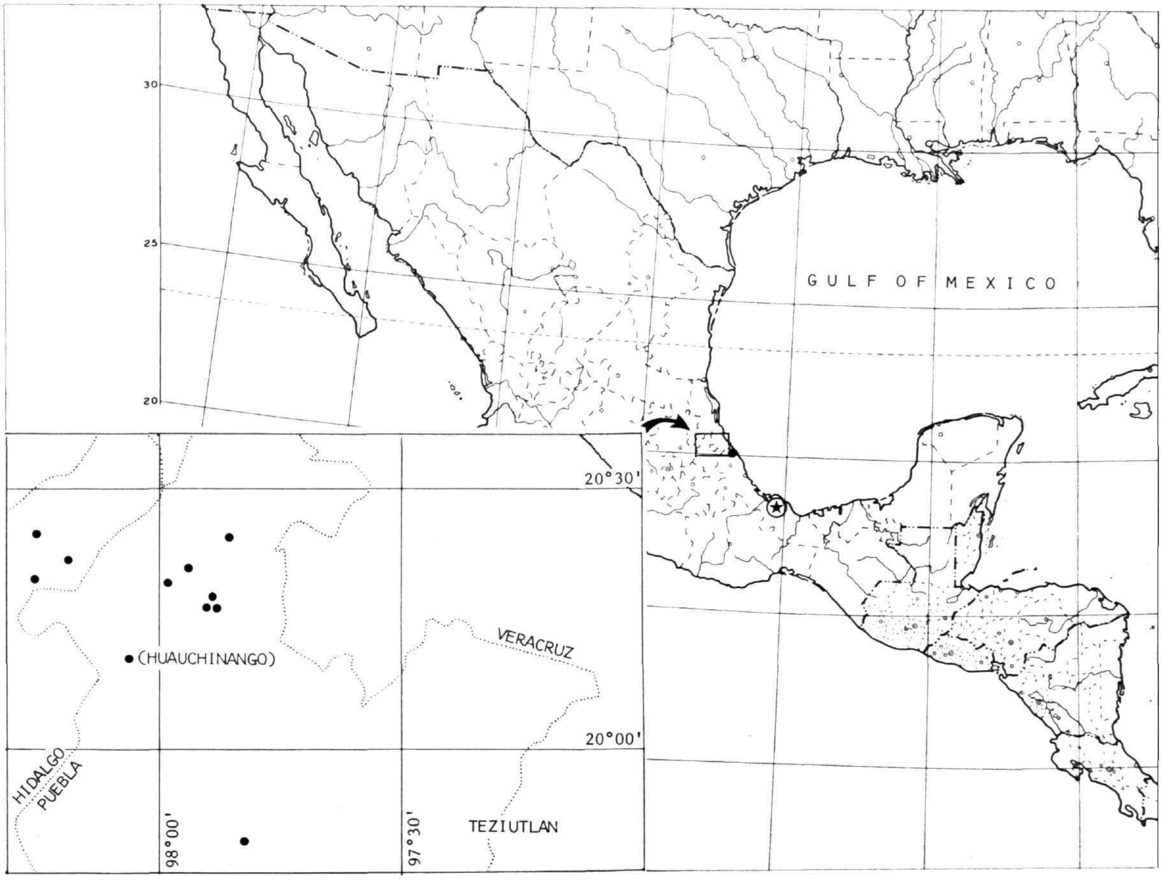

FIGURE 9.—Ranges of *Uncinocythere bicuspide* (●) and *U. zaruri* (★)

curved with angle formed by extension of horizontal and vertical rami highly variable but always less than 90 degrees. Internal border of horizontal ramus with four or more teeth and with two or three denticles at its apex. Ventral extremity of peniferum entire.

TYPE-LOCALITY.—Tetela de Ocampo y La Cañada, Puebla, México, on *Paracambarus paradoxus*.

TYPES.—No longer extant.

LOCALITY RECORDS (Figure 12).—MEXICO: Puebla: *Type-locality; La Magdalena, 3 km N of Zihuateutla (Rioja, 1949:325), on *P. ortmanni* and *P. erichsoni* [not *P. paradoxus* and *P. weigmanni* as indicated by Rioja]; *Los Estajos, 9–10 km E of Villa Juárez, Arroyo de Tlatentiloyan, on *P. hoffmanni*; *Arroyo del Coyular, 7 km NE of La Unión, on *P. hortonhobbsi*; *Las Cumbres de Cuanepixca, Municipio de La Unión, on *P. zihuateutlensis*; *Zihuateutla, on *P. hortonhobbsi*; *Mazacutlán, 16 km NE of Huauchinango, on *P. caballeroi*.

Uncinocythere cuadricuspide, like the sympatric *U. dobbinae*, seems to be restricted to the gulf drainage systems of México north of the Cordillera Volcánica Transversal where it is thus far known to occur only in Puebla.

HOSTS.—Its hosts include the following crayfishes, the ranges of which also occur entirely north of the

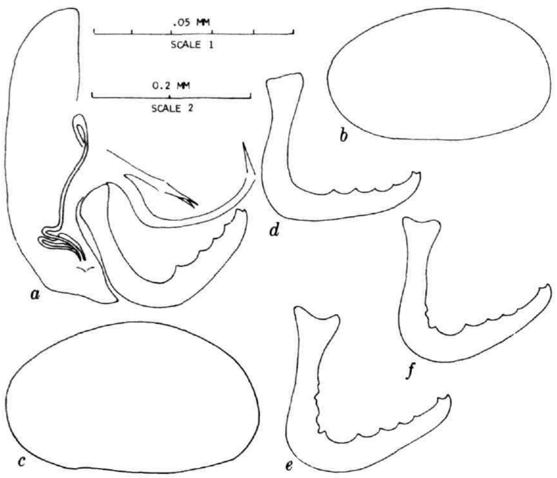

FIGURE 10.—*Uncinocythere cuadricuspide:* a, copulatory complex of male; b, left valve of male; c, left valve of female, d-f, clasping apparatus of male. Figures a, d-f to Scale 1; b, c to Scale 2. (Source of specimens: México—a-d, type-locality; e, f, Zihuateutla, Puebla.)

Cordillera Volcánica Transversal: *Procambarus caballeroi, P. erichsoni, P. hoffmanni, P. hortonhobbsi, P. zihuateutlensis,* and *Paracambarus paradoxus.*

ENTOCYTHERID ASSOCIATES.—*Uncinocythere dobbinae, U. bicuspide,* and *Entocythere mexicana.*

REMARKS.—Although this ostracod was originally described as a subspecies of *U. dobbinae* (= *E. dobbini*) by Rioja (1945), four years later, he elevated it to specific rank and indicated that his subspecies *multicuspide* was nothing more than a variant of *cuadricuspide.* His use of *multidentata* was simply an erroneous substitute for *multicuspide.* That *U. cuadricuspide* should not be considered a subspecies of *U. dobbinae* is evident in that the two occur together in four of the seven localities from which it has been collected.

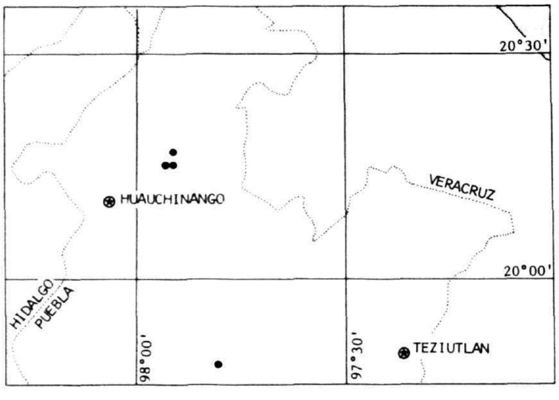

FIGURE 11.—Range of *Uncinocythere cuadricuspide.*

Uncinocythere dobbinae (Rioja, 1943)

FIGURES 12*a-m*, 13

Entocythere (Cytherites) dobbini Rioja, 1943a:560–565, figs. 11–21, 24.—Rioja, 1943b:570, 576, 582, figs. 19, 20.
Entocythere dobbini.—Rioja, 1945:419, fig. 2.—Rioja, 1949: 322, 325, 326, 328, figs. 15, 16.—Kozloff and Whitman, 1954:162.—Kozloff, 1955:161.—Hobbs, 1955:330.
Entocythere dobbinae.—Hoff, 1944b:332, 337, 341—Tressler, 1959:729, figs. 28.187a, b.—Crawford, 1959:167.
Entocythere recurvata Rioja, 1949:325–326, 328, figs. 24–26. [Type-locality, "Los Estajos, a 6 km. NE. de Zihuateutla, Pue." Types, no longer extant.]
Uncinocythere dobbinae.—Hart, 1962:137.

DIAGNOSIS.—Shell length (numbers in parentheses represent averages): ♂, 0.29–0.32 (0.30) mm; ♀, 0.32–0.36 (0.33) mm. Shell height: ♂, 0.18–0.20 (0.18) mm; ♀, 0.20–0.23 (0.21) mm. Clasping apparatus of male curved with angle formed by extension of horizontal and vertical rami distinctly less than 90 degrees. Internal border of horizontal ramus with three denticles that may or may not be well-developed and with two to four small denticles at apex of horizontal ramus. Ventral portion of peniferum entire.

TYPE-LOCALITY.—Huachinango, Estado de Puebla, México, on *Procambarus riojai* and *P. hoffmanni*; restricted by Hart, 1962:137.

TYPES.—No longer extant.

LOCALITY RECORDS.—MEXICO: Hidalgo: *Arroyo Puendó, 3 km E of Tenango de Doria (Rioja, 1949:322), on *P. erichsoni* (listed by Rioja as *P. weigmanni*); *Tenango de Doria, on *P. erichsoni;* *Arroyo de San Bartolo, San Bartolo, on *P. erichsoni;* *Arroyos Puendó, Mamay y Bojoy, Tenango de Doria, on *P. erichsoni.*

Puebla: Type-locality (Rioja, 1943a:566; Rioja, 1945:419) on *P. riojai* and *P. hoffmanni;* *Villa

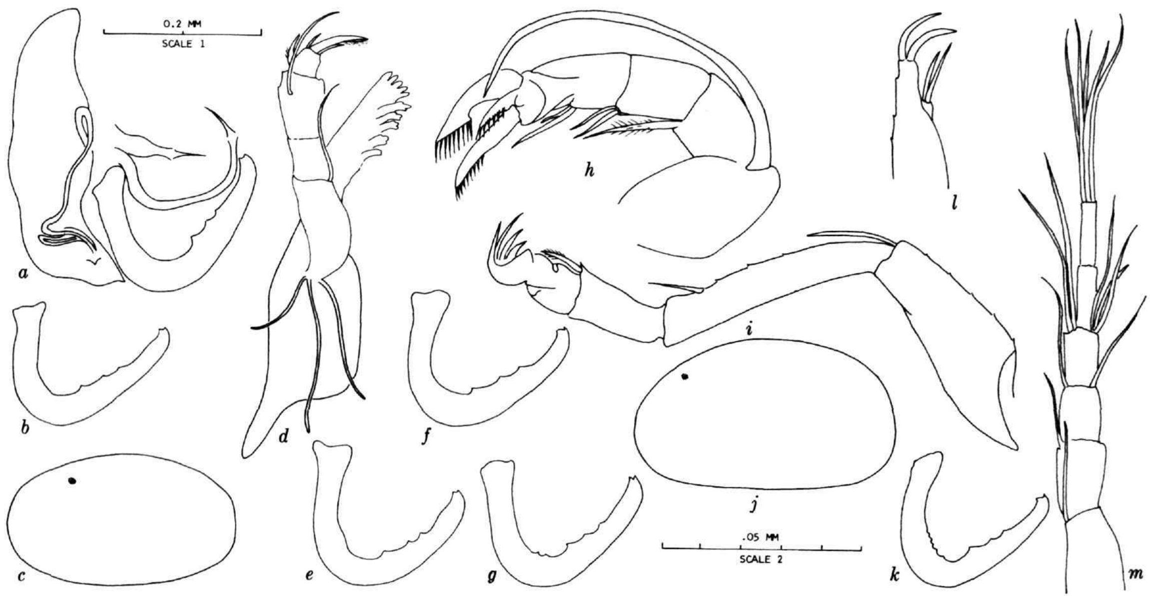

FIGURE 12.—*Uncinocythere dobbinae:* a copulatory complex of male; b, e-g, k, clasping apparatus of male; c, left valve of male; d, mandible of male; h, second antenna of male; i, second leg of male. Figures a, b, d-i, k-m to Scale 2; c, j to Scale 1. (Sources of specimens: México—a-c, e-g, j, k, Villa Juárez, Puebla; d, h, i, l, m, Tuxpan, Veracruz.)

Juárez (Rioja, 943a:565) on *P. hoffmanni* (= "especie no determinada de *Paracambarus*") and *P. caballeroi* (= "*Procambarus* próxima a *P. contrerasi*"); *Los Estajos, 6 km NE of Zihuateutla (Rioja, 1949:322) on *P. hoffmanni*, *P. ortmanni* (= *P.* sp. "próxima a *paradoxus*"), and *P. erichsoni* (= *P.* sp. "próxima a *P. weigmanni*") [*Entocythere recurvata* was recorded by Rioja (1949:326) from the same locality and the same hosts]; La Magdalena, 3 km N of Zihuateutla (Rioja, 1949:322) on *P. erichsoni* (listed by Rioja as *P. weigmanni*); Camino de Villa Juárez a Coyutla, on *P. hoffmanni* (Rioja, 1949:322); *Arroyo del Coyular, 7 km NE of Unión, La Unión, on *P. contrerasi*; *Las Cumbres de Cuanepixa, La Unión, on *P. hoffmanni*; *Mazacuatlán, 16 km NE of Huauchinango, on *P. caballeroi*; *El Agengibre, on *P. contrerasi*; *Arroyo de San Diego, km 260 carretera México a Tuxpán, on *P. contrerasi*; *Chignautla, Teziutlan, on *P. teziutlanensis*; *La Junta, on *P. contrerasi*; *Arroyo de Apatlaco, Villa Juárez, on *P. hoffmanni*; *Barrio San Isidro, Villa Juárez, on *P. caballeroi*; *Lagunillas, Villa Juárez, on *P. caballeroi*; *Curva del Perro, km 172 carretera México a Tuxpán, on *P. hoffmanni*; Tetela de Ocampo, La Cañada (Rioja, 1945:419), on *P. paradoxus* [Specimens examined from this locality by me were all referable to *U. bicuspide* and *U. cuadricuspide*.]; Barranca de Zacatlan, Río Hueyalpan, on *P. riojai*; *Arroyo de San Diego, 36 km NE of Villa Juárez, on *P. contrerasi* [Rioja, 1949:326; lists *E. recurvata* from this locality and host].

Veracruz: Tlapacoyan, on *P. tlapacoyanensis* (This locality and host are cited for *E. recurvata* by Rioja, 1949:326); km 260 carretera México-Tuxpán, on *P. hoffmanni* (this locality and host are cited for *E. recurvata* by Rioja, 1949:326); Sabana de El Poste, Miahuapan, 8–10 km N of Coyutla (Rioja, 1949:322), on *P. hoffmanni* [Rioja (1949:326) also recorded *E. recurvata* from the same locality and host]; *18 km SSE of Martínez de la Torre, on *P. hoffmanni*; *2 km N de Coyutla, on *P. hoffmanni*; 5 km E of Coyutla, Río Necaxa (Rioja, 1949:322) on *P. hoffmanni* [this locality is in Veracruz, not in

Puebla as indicated by Rioja]; *Tuxpán, on *P. contrerasi.*

Uncinocythere dobbinae appears to be restricted to the Gulf Slope in México north of the Cordillera Volcánica Transversal, in the states of Hidalgo, Puebla, and Veracruz.

HOSTS.—Its hosts include the following crayfishes, the ranges of which also occur entirely north of the Cordillera Volcánica Transversal: *Procambarus caballeroi, P. contrerasi, P. erichsoni, P. hoffmanni, P. riojai, P. teziutlanensis, P. tlapacoyanensis, Paracambarus ortmanni,* and *Paracambarus paradoxus.*

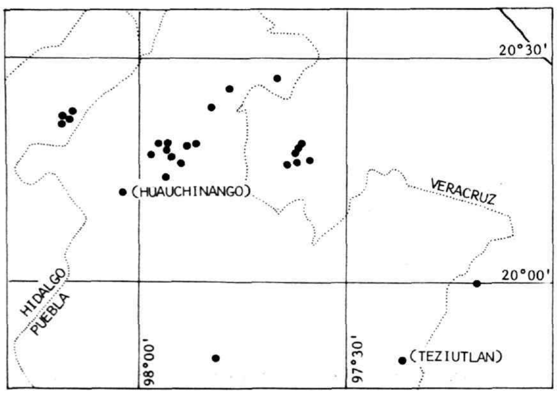

FIGURE 13.—Range of *Uncinocythere dobbinae.*

ENTOCYTHERID ASSOCIATES.—*Uncinocythere bicuspide* and *U. cuadricuspide.*

REMARKS.—*Entocythere recurvata* is here considered to be a morphological variant of *Uncinocythere dobbinae,* for among the available specimens there is a complete series of intermediate forms between the *dobbinae*-type clasping apparatus and the strongly recurved *recurvata*-type (see Figures 12*b, e, f, g, k*). In collections from several localities, both extremes were encountered, and, in addition, there are a number of specimens in which the clasping apparatus is neither strongly recurved nor quite so gently curved as in typical *dobbinae.*

The alteration of the original spelling of the name of this ostracod by Hoff (1944b) is entirely justified by the dedication of the name, "Nos complacemos en dedicar esta especie a la Dra. Catherine N. Dobbin, del Departamento de Zoología de Smith College, Northampton, Mass. . . ." (Rioja, 1943a: 565).

Uncinocythere zaruri, new species

FIGURES 9, 14*a-g*

Entocythere.—Hobbs and Villalobos, 1958:395.

DIAGNOSIS.—Shell length (numbers in parentheses indicate averages): ♂, 0.31–0.33 (0.32) mm; ♀, 0.34–0.36 (0.35) mm. Shell height: ♂, 0.18–0.19 (0.18) mm; ♀, 0.22–0.23 (0.22) mm. Clasping apparatus comparatively slender with vertical and horizontal rami directed at angle of 60 to 80 degrees. Internal border of clasping apparatus with two teeth and with two denticles at apex. Penis situated proximal to ventral margin of peniferum by distance much greater than its length. Ventral margin of peniferum with slight notch immediately posterior to anteroventral angle.

MALE.—Eye pigmented, situated about one-fifth shell length from anterior extremity. Shell (Figure 14*b*) ovate with greatest height almost at midlength; ventral margin gently curved or almost straight; submarginal setae present anteriorly, posteriorly, and ventrally.

Copulatory complex (Figures 14*a, d, f*) with peniferum rounded posteriorly and distal extremity directed anteroventrally, bearing shallow notch just posterior to small acute anteroventral angle. Penis considerably longer than half anteroposterior diameter of peniferum at level of penis and curved with proximal and distal ends disposed at angle of approximately 120 degrees. Dorsal and ventral fingers comparatively stout and both terminating in simple seta; ventral finger somewhat sinuous proximally but strongly curved at end of proximal fourth and more gently in distal half. Clasping apparatus with vertical and horizontal rami disposed at angle of 60 to 80 degrees; vertical ramus about one-tenth longer and wider than tapering horizontal ramus; external border of both rami and internal border of vertical ramus entire; internal border of horizontal ramus with two teeth near midlength; apex with two denticles.

TRIUNGUIS FEMALE.—Eye pigmented, situated as in male. Shell (Figure 14*h*) subreniform, more

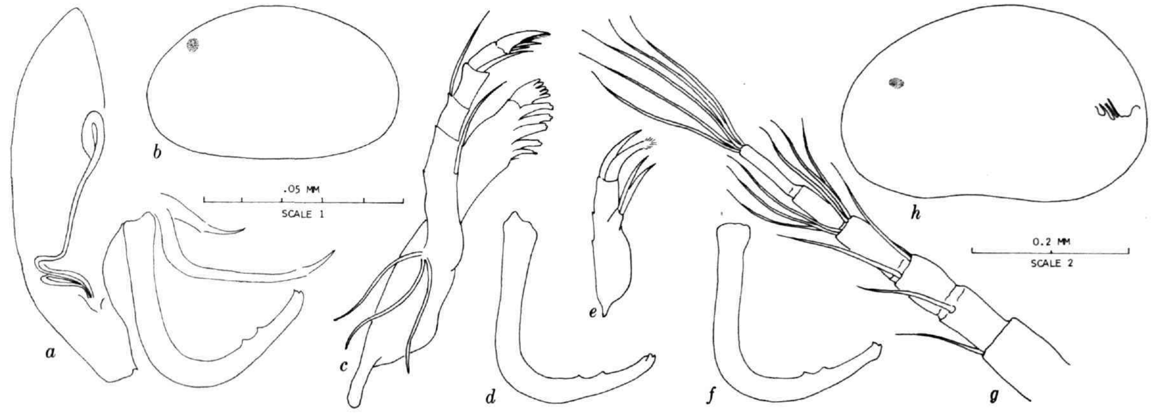

FIGURE 14.—*Uncinocythere zaruri:* a, copulatory complex of male; b, left valve of male; c, mandible of male; d, f, clasping apparatus of male; e, maxilla of male; g, antennule of male; h, left valve of female. Figures a, c-g to Scale 1; b, h to Scale 2. (Sources of specimens: México —Rio Tapalapa, Santiago Tuxtla, Veracruz.)

highly vaulted than in male, highest posterior to midlength, and with distinct concavity anterior to midlength; submarginal setae present except anterodorsally.

Genital complex consisting of prominent, slender, weakly sclerotized papilla projecting posteroventrally between anterior slender lappet and heavier posterior one.

MEASUREMENTS.—Holotype: length 0.31 mm, height 0.18 mm. Allotype: length 0.36 mm, height 0.22 mm. See diagnosis above for ranges and averages of 10 males and 10 females.

TYPE-LOCALITY.—Río Tapalapa, Santiago Tuxtla, Veracruz, on *Pseudothelphusa veracruzana.*

DISPOSITION OF TYPES.—The holotypic male and allotype are deposited in the National Museum of Natural History (Smithsonian Institution) no. 128827. Paratypes are in the collections of the Instituto de Biología, Universidad de México; C. W. Hart, Jr.; H. H. Hobbs III; and the Smithsonian Institution.

RANGE.—Known only from the type-locality.

RELATIONSHIPS.—*Uncinocythere zaruri* is most closely allied to *U. bicuspide* but may be readily distinguished from it by the slenderer clasping apparatus which bears but a single tooth on the internal border of the horizontal ramus, and by the shell which is usually slightly larger.

HOST.—The only positively known host of this ostracod is the freshwater crab *Pseudothelphusa veracruzana.* Specimens were retrieved from sediment in a jar containing specimens of *Atya scabra* collected from Tapalapan, Santiago Tuxtla; however, *P. veracruzana* was present in the same locality, and it is probable that a few individuals of the latter were preserved in the same container with the *Atya.* Consequently, the ostracods could well have been on the crab rather than the shrimp. Examinations of the sediment in other lots of *Atya* in the collections of the Instituto de Biología at the University of México disclosed no entocytherids.

ENTOCYTHERID ASSOCIATES.—None.

ETYMOLOGY.—I am pleased to name this species in honor of my good friend, Sr. Amín Zarur Menez, who extended many courtesies to me while I was in Mexico and who accompanied Dr. Villalobos and me on the collecting trip during which this species was discovered.

REMARKS.—Except for the questionable isolated record cited above of *U. bicuspide* occurring on *Procambarus aztecus* at Tomatlán, Veracruz, *U. zaruri* is the only member of the genus which ranges south of the Cordillera Volcánica Transversal. Furthermore, it is the only member of the subfamily known to be associated with a noncrayfish host.

Genus *Ankylocythere* Hart, 1962

Heterodonta Group Rioja, 1943a:564; Hoff, 1944b:330, 352, 356; Rioja, 1949:327; Rioja, 1955:196; Hobbs, 1957:431; Hart, 1959:201; Crawford, 1959:173.
Ankylocythere Hart, 1962:126.

DIAGNOSIS.—Terminal tooth of mandible pectinate. Copulatory complex of male without finger guard or accessory groove; spermatic and prostatic elements of penis contiguous. External border of clasping apparatus with talon or excrescence; internal border with one to four distinct serrations or teeth, and apex with two or three denticles. Triunguis females without amiculum; antenna lacking comblike appendix at base of terminal claws.

TYPE-SPECIES.—*Entocythere heterodonta* Rioja, 1940b:594; designated by Hart, 1962:126.

RANGE.—Campeche and Chiapas, México to Illinois, and eastward to Maryland and Florida. Also present on the island of Cuba and Isla de Pinos. (See Hart and Hart, 1969:184–185.)

Of the 17 species assigned to this genus, six occur in México and two in Cuba.

LIST OF SPECIES.—UNITED STATES: *A. ancyla* Crawford, 1965:148, Virginia to South Carolina; *A. copiosa* (Hoff, 1942a:69), Illinois to Tennessee; *A. harmani* Hobbs, 1966:71, Arkansas and Louisiana; *A. hobbsi* (Hoff, 1944b:352), South Carolina to Florida; *A. hyba* Hobbs and Walton, 1963:457, Tennessee; *A. talulus* (Hoff, 1944b:349), Florida; *A. sinuosa* (Rioja, 1942a:203), Louisiana to México; *A. telmoecea* (Crawford, 1959:167), South Carolina; *A. tiphophila* (Crawford, 1959:173), South Carolina; *A. tridentata* Hart, 1964:245, Maryland [Hobbs (1966:69) erred in citing this species from the District of Columbia].

MEXICO: *A. bidentata* (Rioja, 1949:320), Chiapas, Oaxaca, and Veracruz; *A. heterodonta* (Rioja, 1940b:594), Distrito Federal, Hidalgo, Jalisco, México, Morelos, Michoacán, Nayarit, Puebla, and ?Tabasco; *A. maya*, new species, Chiapas; *A. sinuosa* (Rioja, 1942a:203), Chihuahua to Veracruz; *A. toltecae*, new species, San Luis Potosí; *A. villalobosi*, new species, Chiapas and Campeche.

CUBA: *A. cubensis* (Rioja, 1955:193), Camagüey and Matanzas; *A. hamata* (Hobbs, 1957:433), Isla de Pinos and Las Villas.

Key to the Species of the Genus *Ankylocythere* (Based on Male)

1	Clasping apparatus with low rounded excrescence 2
1'	Clasping apparatus with well developed talon 10
2 (1)	External border of horizontal ramus of clasping apparatus with single rounded excrescence situated below major tooth on internal border .... ***A. telmoecea***
2'	External border of horizontal ramus of clasping apparatus with one or more excrescences situated on external border; if only one, always situated distal to tooth on internal border 3
3 (2')	External border of clasping apparatus with two or three excrescences 4
3'	External border of clasping apparatus with single excrescence 8
4 (3)	Two excrescences on external border of clasping apparatus subequal in size.. ***A. talulus***
4'	Two excrescences on external border of clasping apparatus unequal in size 5
5 (4')	Clasping apparatus bent to resemble fish-hook and with three to many small teeth (serrations) on internal border .... ***A. hamata***
5'	Clasping apparatus never so strongly bent and seldom with more than one tooth on internal border 6
6 (5')	Clasping apparatus with vertical ramus longer than horizontal .... ***A. hyba***
6'	Clasping apparatus with vertical ramus no longer, often shorter, than horizontal ... 7
7 (6')	Shell length of male greater than 0.34 mm; that of female greater than 0.36 mm. ***A. heterodonta***
7'	Shell length of male less than 0.34 mm; that of female less than 0.36 mm .. ***A. cubensis***
8 (3)	Peniferum truncate or slightly concave distally with acute anteroventral extension .. 9
8'	Peniferum rounded or tapering distally 7
9 (8)	Internal border of clasping apparatus with serrations or small teeth at junction of vertical and horizontal rami .... ***A. maya***
9'	Internal border of clasping apparatus without serrations or small teeth at junction of vertical and horizontal rami .... ***A. toltecae***

10 (1′)	External border of clasping apparatus with two elongate projections (talons).	***A. tridentata***
10′	External border of clasping apparatus with only one elongate talon	11
11 (10′)	Length of talon more than twice least vertical diameter of horizontal ramus	12
11′	Length of talon less than twice least vertical diameter of horizontal ramus	15
12 (11)	Ventral margin of peniferum bifid	13
12′	Ventral margin of peniferum acute or irregular but never bifid	14
13 (12)	Talon extending distally at least to level midway between tooth on internal border and proximal terminal denticle	***A. ancyla***
13′	Talon never extending distally to level midway between tooth on internal border and proximal terminal denticle	***A. copiosa***
14 (12′)	Clasping apparatus tapering from level of tooth on internal border of horizontal ramus to terminal denticles; base of talon entirely proximal to level of tooth on internal border	***A. harmani***
14′	Clasping apparatus expanding between level of tooth on internal border of horizontal ramus and terminal denticles; part of base of talon usually opposite tooth on internal border	***A. hobbsi***
15 (11′)	Ventral margin of peniferum bifid	***A. sinuosa***
15′	Ventral margin of peniferum not bifid, but acute or rounded	16
16 (15′)	Clasping apparatus with three terminal denticles	***A. tiphophila***
16′	Clasping apparatus with two terminal denticles	17
17 (16′)	Gap between upper distal end of talon and horizontal ramus distal to base of talon greater than height of distal portion of ramus	***A. villalobosi***
17′	Gap between upper distal end of talon and horizontal ramus distal to base of talon less than height of distal portion of ramus	18
18 (17′)	Vertical ramus of clasping apparatus distinctly longer than horizontal ramus.	***A. bidentata***
18′	Vertical ramus subequal in length, or shorter than, horizontal ramus	7

Ankylocythere bidentata (Rioja, 1949)

FIGURES 15*a-e*, 16

Entocythere bidentata Rioja, 1949:320, 321, 328, figs. 9–11.—Hobbs, 1956:431.—Crawford, 1959:173.
Entocythere heterodonta.—Rioja, 1949:316 [in part].
Entocythere sinuosa.—Rioja, 1949:322 [in part].
Ankylocythere bidentata.—Hart, 1962:126.—Hobbs, 1966:71, fig. 14.

DIAGNOSIS.—Shell length (numbers in parentheses indicate averages): ♂, 0.30–0.33 (0.32) mm; ♀, 0.34–0.38 (0.35) mm. Shell height: ♂, 0.19–0.20 (0.20) mm; ♀, 0.21–0.24 (0.22) mm. Clasping apparatus of male with well developed talon, latter never projecting distally more than distance equivalent to its own width; internal border of horizontal ramus usually with two teeth (one situated above base of talon and other proximally), occasionally only one, and frequently irregularly serrate along and adjacent to junction of horizontal and vertical rami; vertical ramus distinctly longer than horizontal ramus; apex of horizontal ramus with two upturned denticles. Ventral portion of peniferum entire but with small acute projection anteroventrally.

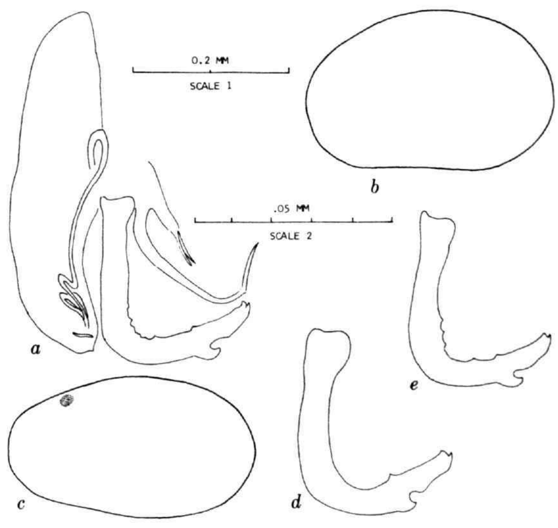

FIGURE 15.—*Ankylocythere bidentata:* a, copulatory complex of male; b, left valve of female; c, left valve of male; d, e, clasping apparatus of male. Figures a, d, e to Scale 2; b, c to Scale 1. (Sources of specimens: México—a, b, three miles south of Coscomatepec, Veracruz; c, d, Catemaco, Veracruz; e, Villa Hermosa, Tabasco.)

TYPE-LOCALITY.—Tomatlán, 14 km SW of Huatusco, Veracruz, on *Procambarus aztecus*.

TYPES.—Not extant.

LOCALITY RECORDS.—MEXICO: Chiapas: *Cerro Hueco, 8 km WNW of Tuxtla Gutiérrez, on *P. mirandai*.

Oaxaca: *Monte Bello, Tuxtepec, on *P. mexicanus*; *Laguna Escondida, Ojitlán, on *P. veracruzanus*.

Tabasco: *Villa Hermosa, on *P. llamasi*.

Veracruz: *Type-locality (Rioja, 1949:321), on *P. aztecus*; *Sinkhole between Huatusco and Jalapa, on *P. aztecus*; ?Coscomatepec (Rioja, 1949:321), on *P. aztecus* [*A. sinuosa* was also reported by Rioja (1949:322) on *P. mexicanus* from the same locality—this is in need of confirmation]; *Mirador de Zacuapan (Rioja, 1949:321) on *P. mexicanus*; *Hacienda Jalapilla, 5 km al SE de Orizaba [reported by Rioja (1949:322) as *E. sinuosa*], on *P. mexicanus*; *Playa Norte de la Laguna de Catemaco, San Andrés, Tuxtla [reported by Rioja (1949:316) as *E. heterodonta*], on *P. vazquezae*; *Zapoapan de Cabaña, 11 km SSE of Catemaco, on *P. ruthveni zapoapensis*; *Cueva de Ojo de Agua Grande, Paraje Nuevo, on *P. rodriguezi*; *32 km carretera a Juan Díez Covarrubias, on *P. ruthveni ruthveni*; *Rincón de la Doncella, Ciudad Mendoza, on *P. mexicanus*; *3 km S of Coscomatepec, on *P. aztecus*; *Zapoapan de Cabaña, Catemaco, on *P. ruthveni zapoapensis*; *El nacimiento de la Laguna Encantada, San Andrés, Tuxtla, on *P. vazquezae*; *Spring at Tlilapan, on *P. mexicanus*; Hacienda de Tenejapa [reported by Rioja (1949:316) as *E. heterodonta*], on *P. mexicanus*; *Ojo de Agua, Tlilapan, on *P. mexicanus*; *Sinkhole between Huatusco and Jalapa, on *P. aztecus*.

Ankylocythere bidentata appears to be confined to the Atlantic slope south of the Cordillera Volcánica Transversal, in Chiapas, Oaxaca, Tabasco, and Veracruz, where the only crayfishes available to

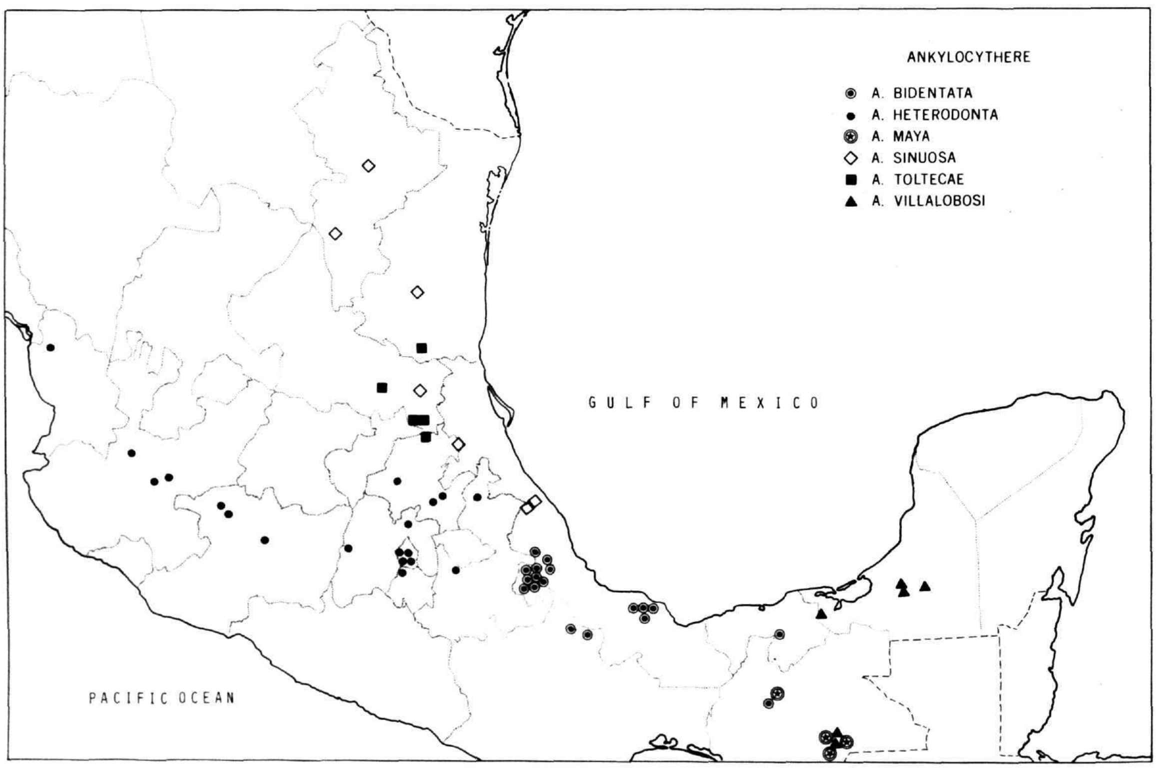

FIGURE 16.—Ranges of Mexican species of the genus *Ankylocythere*.

it are members of the Mexicanus Group of the genus *Procambarus*. It has been found in lentic and lotic habitats, and on one occasion was found on specimens of *P. ruthveni zapoapensis* which were dug from simple burrows in a drying pond.

HOSTS.—The hosts of this ostracod include the following: *Procambarus aztecus, P. mexicanus, P. mirandai, P. rodriguezi, P. ruthveni ruthveni, P. r. zapoapensis, P. vazquezae,* and *P. veracruzanus.*

ASSOCIATES.—Entocytherid associates include only a single species, *Entocythere claytonhoffi.*

REMARKS.—Literature citations in the above synonomy refer to Crawford (1959) who included *bidentata* in a list of the then known members of the Heterodonta group of the genus *Entocythere,* Hart's (1962) assignment of the species to his new genus *Ankylocythere,* and Hobbs (1966) who included *A. bidentata* in his key to the members of the genus *Ankylocythere* and cited its range and hosts.

In the same publication in which Rioja (1949) described *A. bidentata,* he cited two records for *Ankylocythere heterodonta* in Veracruz (p. 316). Specimens from one of the localities, Playa Norte de la Laguna de Catemaco, have been examined in this study, and while they possess only one tooth on the internal border of the clasping apparatus, the vertical ramus is distinctly longer than the horizontal ramus, the peniferum is much more like that of the more typical members of *A. bidentata* than that of *A. heterodonta,* and they are smaller than any known specimens of the latter. Rioja's record for Hacienda Tenejapa is also probably based on specimens similar to those mentioned above, for *A. heterodonta* is not otherwise known to occur south of the Cordillera Volcánica Transversal.

Ankylocythere cubensis (Rioja, 1955)

FIGURE 17*a-e*

Entocythere heterodonta.—Hoff, 1944a:370.
Entocythere heterodonta cubensis Rioja, 1955:193, 194, fig. 1. —Hobbs, 1957:431–433, 435, 436, fig. 7.
Ankylocythere heterodonta cubensis.—Hart, 1962:127.
Ankylocythere cubensis.—Hobbs, 1966:67, 68, 71, fig. 15.

DIAGNOSIS.—Shell length (numbers in parentheses indicate averages): ♂, 0.32–0.33 (0.32) mm; ♀, 0.34–0.35 (0.34) mm. Shell height: ♂, 0.20–0.22 (0.21) mm; ♀, 0.21–0.22 (0.21) mm. Clasping apparatus of male with well developed or adnate talon, latter never projecting distally more than distance equivalent to its own width; internal border with single tooth above talon and with or without irregular serrations in area of junction of vertical and horizontal rami; apex with two upturned denticles. Ventral portion of peniferum rounded with very small acute anteroventral projection.

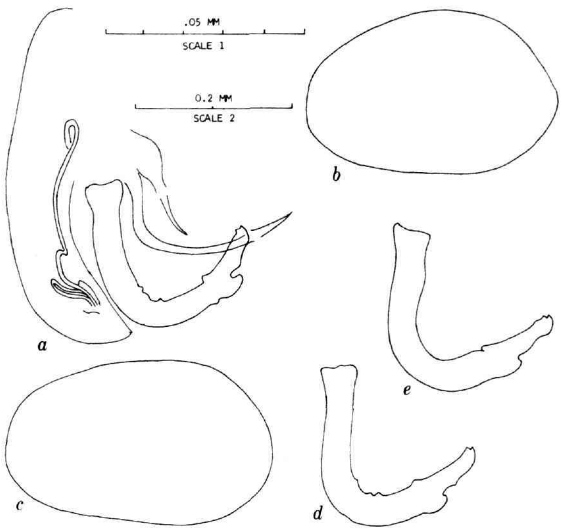

FIGURE 17.—*Ankylocythere cubensis:* a, copulatory complex of male; b, left valve of male; c, left valve of female; d, e, clasping apparatus of male. Figures a, d, e to Scale 1; b, c to Scale 2. (Sources of specimens: Cuba—a, d, 14 miles east of Camagüey, provincia de Camagüey; b, c, e, La Gloria, provincia de Camagüey.)

TYPE-LOCALITY.—14 km W of the city of Camagüey, Camagüey, Cuba, on *Procambarus cubensis cubensis.*

TYPES.—Not extant.

LOCALITY RECORDS.—CUBA: Camagüey: •Type-locality, on *Procambarus cubensis cubensis;* •Arroyo pequeño en La Gloria (Hobbs, 1957:432), on *P. c. cubensis.*

La Habana: Isla de Pinos—•La Ceiba, Los Indios, and Nueva Gerona (Hobbs, 1957:432), on *P. atkinsoni* and *P. c. cubensis.*

Matanzas: •Unión de Reyes (Hobbs, 1957:432), on *P. c. cubensis.*

HOSTS.—*Procambarus atkinsoni* and *P. cubensis cubensis.*

ENTOCYTHERID ASSOCIATE.—*Entocythere ruibali.*

REMARKS.—As Hobbs (1966:67) has pointed out, "The subspecific designation of *A. heterodonta cubensis* proposed by Rioja (1955:193) is not in keeping with the treatment accorded the other members of the genus, and is here elevated to specific status." To be sure, the differences between *A. cubensis* and *A. heterodonta* are slight but they are almost as great as those between the latter and *A. bidentata.*

To my knowledge, no additional information of any kind has been obtained on this species since the brief review of it by Hobbs (1957).

Ankylocythere hamata (Hobbs, 1957)

FIGURES 18*a-d*

Entocythere hamata Hobbs, 1957:431, 433–436, 6 figs.
Ankylocythere hamata.—Hart, 1962:127.—Hobbs and Walton, 1963:459.—Hobbs, 1966:67, fig. 1.

DIAGNOSIS.—Shell length (numbers in parentheses indicate averages): ♂, 0.28–0.31 (0.29) mm; ♀, 0.32–0.42 (0.36) mm. Shell height: ♂, 0.17–0.18 (0.18) mm; ♀, 0.20–0.25 (0.23) mm. Clasping apparatus of male resembling fish hook without barb and with broad, adnate, only slightly produced talon rendering distal fourth of external border of clasping apparatus triscalloped; internal border with one moderately well developed tooth above talon and with irregular serrations proximally along horizontal ramus; apex with two dorsally directed denticles. Ventral portion of peniferum rounded with subacute anteroventral, ventrally directed, projection.

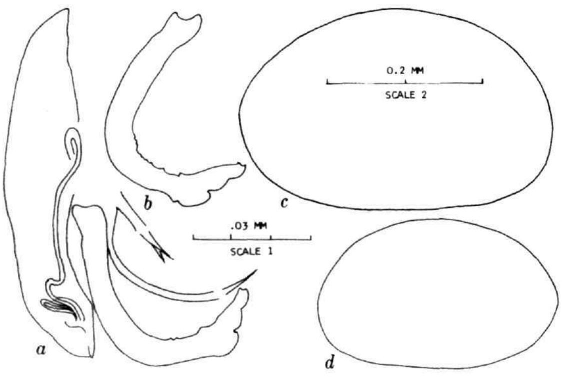

FIGURE 18.—*Ankylocythere hamata:* a, copulatory complex of holotypic male; b, clasping apparatus of paratypic male; c, left valve of allotypic female; d, left valve of holotypic male. Figures a, b to Scale 1; c, d to Scale 2. (Source of specimens: Cuba—Central Soledad, Cienfuegos, provincia de Las Villas.)

TYPE-LOCALITY.—"Un arroyo pequeño cerca del laboratorio de investigación del Jardín de Atkins en Central Soledad, Cienfuegos, Provincia de las Villas, Cuba."

TYPES.—Syntypes (1♂, 1♀) [The second female cited by Hobbs as deposited in the National Museum of Natural History (Smithsonian Institution) no. 100938, is mounted on the same slide but is a specimen of *Entocythere ruibali.*]; Smithsonian Institution (un-numbered, formerly in Hobbs collection) 1♀. All other specimens lost or destroyed.

*LOCALITY RECORDS.—CUBA: Las Villas: Type-locality, on *Procambarus cubensis cubensis.*

Isla de Pinos: La Ceiba, on *P. atkinsoni.*

REMARKS.—No additional specimens of this species have been reported since it was originally described.

HOSTS.—*Procambarus cubensis cubensis* and *P. atkinsoni.*

ENTOCYTHERID ASSOCIATE.—*Entocythere ruibali.*

Ankylocythere heterodonta (Rioja, 1940)

FIGURES 16, 19*a-g*

Entocythere, "nueva especie" Rioja, 1940a:57.
Entocythere heterodonta Rioja, 1940b:593, 594-609, 33 figs.—Rioja, 1941a:177–191, pl. 1, figs. 1–6, pl. 2, figs. 1–3.—Rioja, 1941b:193–197, figs. 1c, d.—Hoff, 1944b:330, 332, 352, 356.—Rioja, 1949:315–321 [in part], 327, 328, fig. 1.—Rioja, 1951: 176.—Rioja, 1955:194, 196.—Hobbs, 1957:431.—Tressler, 1959:731, figs. 28.191a, b, c.—Crawford, 1959:173, 178.
Entocythere (Cytherites) heterodonta.—Rioja, 1942b:688, 689, 694–696, fig. 21.—Hoff, 1943:280.—Rioja, 1943a:553, 554, 562–564, 566.—Rioja, 1943b:567–570, 572, 575, 576, 580, 582, figs. 1–4, 7–14, 22–25.
Entocythere talirotundi Rioja, 1949:316–320, 321, 328, figs. 2-8 [Type-locality, Lago Lerma and Lagunas de Zempoala, México. Types no longer extant].—Hobbs, 1956:431, 435, 436.
Entocythere heterodonta heterodonta.—Rioja, 1949:193 [by implication].
Entocythere talirotunda.—Crawford, 1959:173 [erroneous spelling].
Ankylocythere heterodonta.—Hart, 1962:127.—Hobbs, 1966: 67, 68, 69, 71, figs. 2, 3.

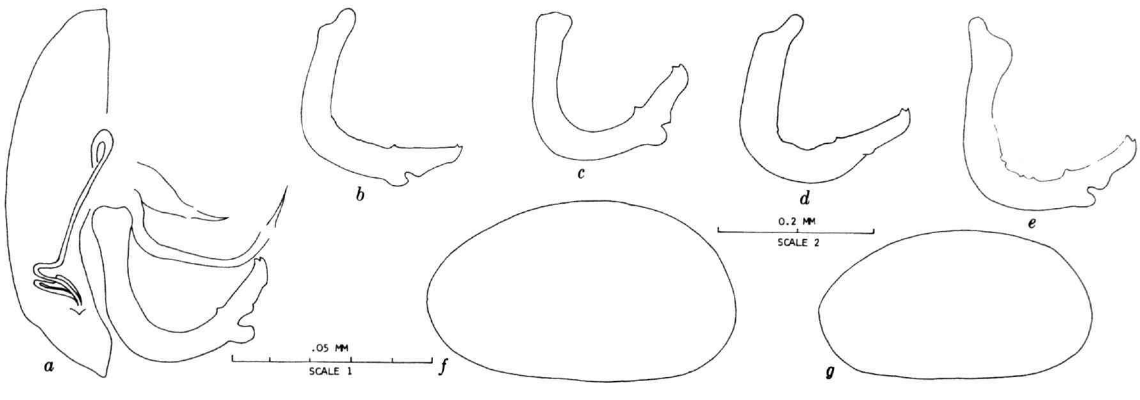

FIGURE 19.—*Ankylocythere heterodonta:* a, copulatory complex of male; b-e, clasping apparatus of male; f, left valve of female; g, left valve of male. Figures a-e to Scale 1; f, g to Scale 2. (Sources of specimens: México—a, b, f, g, Chapultepec, D. F.; c, e, Toluca, Estado de México; d, Largo Lerma, Estado de México.)

Ankylocythere talirotunda.—Hart, 1962:127-128.—Hobbs and Walton, 1963:359.—Hart, 1964:246.—Hobbs, 1966:67, 69, 73, fig. 2 [erroneous spelling].

DIAGNOSIS.—Shell length (numbers in parentheses represent averages): ♂, 0.34–0.38 (0.36) mm; ♀, 0.39–0.43 (0.42) mm. Shell height: ♂, 0.20–0.21 (0.20) mm; ♀, 0.22–0.27 (0.24) mm. Clasping apparatus of male with well developed, broadly rounded talon or with talon reduced to small rounded excrescence, if strongly developed never projecting distally so much as distance equivalent to its own width; internal border with single tooth situated above or proximal to base of talon and sometimes irregularly serrate in vicinity of junction of horizontal and vertical rami; vertical ramus seldom longer than horizontal ramus; apex of horizontal ramus with two upturned denticles. Ventral portion of peniferum entire and tapering.

TYPE-LOCALITY.—Tlalpan, México, D.F., México; restricted by Hart (1962:127).

TYPES.—Not extant.

LOCALITY RECORDS.—MEXICO: Distrito Federal: Type-locality, on *Cambarellus montezumae montezumae*; *Chapultepec (Rioja, 1941b:197), on *C. m. montezumae*; *Xochimilco (Rioja, 1940a:608), on *C. m. montezumae.*

México: *Laguna de Lerma (Rioja, 1940a:608), on *C. montezumae lermensis.* *Laguna Zumpango, on *C. m. montezumae*; *Río San Joaquín. km 125 carretera México a Toluca, on *C. m. montezumae.*

Hidalgo: *Ixmiquilpan, on *C. m. montezumae*; *Pachuca, estanque en el km 135, de la carretera México a Tuxpán, on *C. m. montezumae*; San Miguel Regla (Rioja, 1949:316), on *C. m. montezumae.*

Jalisco: *Lagunas de Magdalena, near Magdalena, on *C. m. chapalanus*; *Tizapán, on *C. m. chapalanus*; *4 miles N of Jocotepec, on *C. montezumae* subsp.; *13 miles N of Chapala, on *C. m. chapalanus.*

Michoacán: *Jacona, on *Procambarus digueti*; *Lago de Pátzcuaro (Rioja, 1940:608), on *C. montezumae patzcuarensis*; *Zamora, on *C. m. chapalanus.*

Morelos: *Legunas de Zempoala (Rioja, 1941b: 197; not "Cempoala" as indicated by Rioja), on *C. m. zempoalensis.*

Nayarit: *Acaponeta, on *Cambarellus* sp.

Puebla: *Cholula, on *C. m. tridens*; Necaxa (Rioja, 1943a:566), on *Procambarus hoffmanni* (= *Paracambarus* sp.) [a doubtful record, see below].

Ankylocythere heterodonta seems to be confined largely to the Mexican plateau and its western slopes where it is associated with the members of the crayfish genus *Cambarellus* and a single member of the genus *Procambarus*, only one of two which seems positively not to have been introduced along the Pacific slope. Rioja's record for Coscomatepec, Veracruz, which is here questionably cited for *A. bidentata*, and the Necaxa, Puebla, record cited above are probably based on misidentifications. About the latter record, he states, op. cit., p. 566, "Todos los ostrácodos observados tenían la apariencia de estar degenerados por una afección patológica cuya naturaleza no hemos podido determinar. . . ."

HOSTS.—*Cambarellus m. chapalanus, C. montezumae montezumae, C. m. lermensis, C. m. patzcuarensis, C. m. tridens, C. m. zempoalensis*, and *P. digueti* are the only identified species of crayfishes which are known to be infested with this ostracod.

ENTOCYTHERID ASSOCIATES.—None.

REMARKS.—Rioja has contributed essentially all of the information available concerning *Ankylocythere heterodonta* except for some of the locality records cited above. His study of the skeletal morphology (1940a, 1941a, and 1943) of this species is the most complete existing for any entocytherid. Despite the number of bibliographic citations, most are concerned with relatives, inclusion in keys, or nomenclatural discussions, and do not add appreciably to our knowledge of the species.

Hobbs (1966:67) indicated that Rioja's *E. talirotundi* (= *A. talirotunda*) should be considered a synonym of *A. heterodonta*. The only difference between the two lies in the relative development of the talon on the horizontal ramus of the clasping apparatus—in typical *A. heterodonta* it is comparatively large, whereas, in *A. talirotundi* it is reduced to a rounded tumescence. In the series of specimens now available, almost every conceivable intermediate condition between the two extremes has been observed, and in one specimen the clasping apparatus on one peniferum is typical of *A. heterodonta* and that on the other, of *A. talirotundi*. Furthermore, in localities from which several males have been observed, both forms of the clasping apparatus, together with intermediate ones, exist.

Among the Mexican and Cuban species of *Ankylocythere*, the most distinctive feature of this ostracod is its greater length. It is doubtful whether or not some specimens assigned to *A. bidentata* could be distinguished from *A. heterodonta* except for the shorter shells of both sexes.

Ankylocythere maya, new species

FIGURES 16, 20*a-h*, 21*a-c*

DIAGNOSIS.—Shell length (numbers in parentheses represent averages): ♂, 0.27–0.32 (0.29) mm; ♀, 0.29–0.32 (0.31) mm. Shell height: ♂, 0.15–0.22 (0.17) mm; ♀, 0.19–0.22 (0.21) mm.

Clasping apparatus with small, low, almost completely adnate talon on external border of horizontal ramus, internal border with single tooth

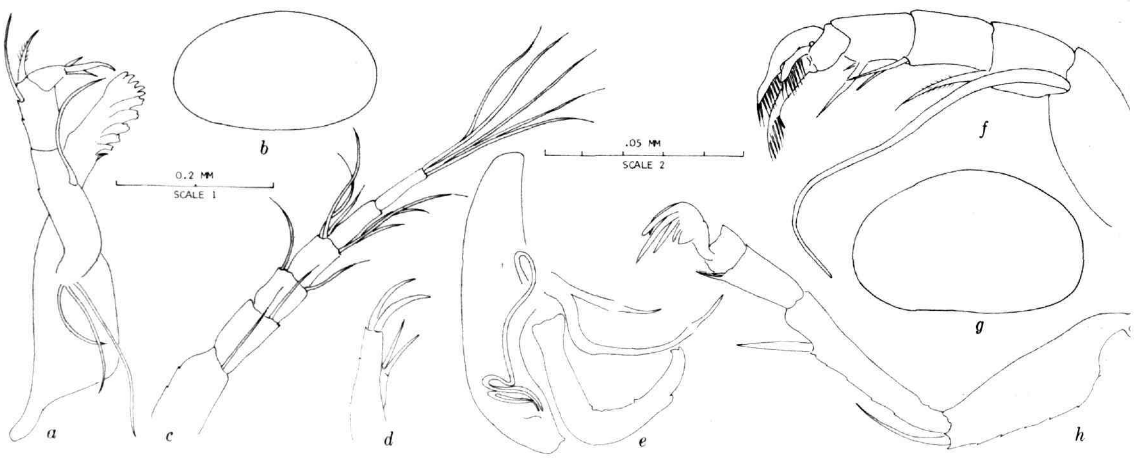

FIGURE 20.—*Ankylocythere maya:* a, mandible; b, left valve of male; c, first antenna of male; d, maxilla of male; e, copulatory complex of male; f, second antenna of male; g, left valve of female; h, second leg of male. Figures a, c-f, h to Scale 2; b, g to Scale 1. (Source of specimens: México—8 km SSW of Simojovel, Chiapas.)

above or proximal to base of talon and with irregular serrations at and distal to junction of horizontal and vertical rami; apex with two upturned denticles. Ventral portion of peniferum subtruncate with anteroventral angle bearing small subacute projection directed anteriorly or ventrally.

MALE.—Eye completely bleached in all available specimens. Shell (Figure 20*b*) ovate with greatest height at midlength; ventral margin gently curved and lacking concavity. Submarginal setae present except dorsally; in addition, irregular row of setae anterodorsally somewhat removed from shell margin and others scattered over shell surface.

Copulatory complex (Figures 20*e*, 21*a*) with peniferum curved anteroventrally, subtruncate distally with small, subacute projection at anteroventral angle. Penis much longer than half anteroposterior diameter of peniferum at level of penis and curved with proximal and distal ends disposed at angle of approximately 130 degrees. Dorsal and ventral fingers only moderately heavy and both terminating in simple setiform tips; ventral finger with one conspicuous bend slightly distal to end of proximal fourth and gently curved distally. Clasping apparatus bent with ends directed at angle of approximately 80 degrees and rather clearly divisible into horizontal and vertical rami. External and proximal three-fourths of internal border of vertical ramus entire, distal fourth with irregular serrations extending onto proximal fourth or half of internal border or horizontal ramus; internal border of latter with one tooth situated between midlength and base of proximal third; external border of horizontal ramus with adnate talon or marked excrescence distal to or opposite tooth on internal border; apex of ramus with two dorsally directed denticles.

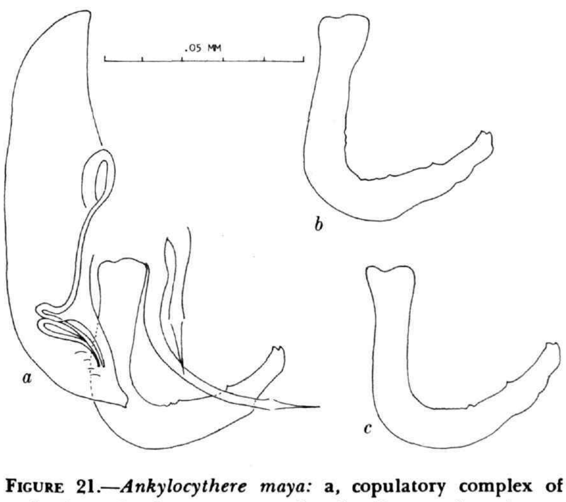

FIGURE 21.—*Ankylocythere maya:* a, copulatory complex of male; b, c, clasping apparatus of male. (Source of specimens: México—Pojsoch, Región de las lagos de Monte Bello, Chiapas.)

TRIUNGUIS FEMALE.—Eye bleached in all available specimens. Shell (Figure 20*g*) ovate with greatest height at midlength and ventral margin shallowy concave slightly anterior to midlength. Submarginal setae as in male.

Genital complex consisting of simple, short, slightly sclerotized cylindroid projection.

MEASUREMENTS.—Holotype: length 0.27 mm, height 0.16. Allotype: length 0.30 mm, height 0.19 mm. See diagnosis above for ranges and averages of 12 males and 13 females.

TYPE-LOCALITY.—Eight km SSW of Simojovel, Chiapas, México, on *Procambarus* n. sp.

DISPOSITION OF TYPES.—The holotypic male and allotype are deposited in the National Museum of Natural History (Smithsonian Institution) no. 128822. Paratypes are in the collection of the Instituto de Biología, Universidad de México; C. W. Hart, Jr.; H. H. Hobbs III; and the Smithsonian Institution.

LOCALITY RECORDS.—MEXICO: Chiapas: *Hacienda San José del Arco, Comitán, on *Procambarus* n. sp.; *Pojsoch, Región de los lagos de Monte Bello, on *Procambarus* n. sp. *Finca La Esperanza, 46 km NE of Tuxtla, Gutiérrez, on *Procambarus* sp.

RELATIONSHIP.—*Ankylocythere maya* has its closest affinities with *A. bidentata* (Rioja) but may be distinguished from it by the adnate talon of the clasping apparatus of the male.

HOST.—*Procambarus* sp.

ENTOCYTHERID ASSOCIATES.—None.

Ankylocythere sinuosa (Rioja, 1942)

FIGURES 16, 22*a-d*

Entocythere cambaria.—Hobbs, 1941:4[in part].

Entocythere (Cytherites) heterodonta sinuosa Rioja, 1942a: 203-204, figs. 5, 6.—Rioja, 1953:287.

Entocythere (Cytherites) sinuosa.—Rioja, 1942b:688, 689, 695–696, fig. 20.—Roja, 1943a:564—Rioja, 1943b:576, figs. 15.–17.

Entocythere sinuosa.—Hoff, 1944b:330, 332, 356.—Rioja, 1949: 321, 322 [in part], 328, figs. 12–14.—Rioja. 1951:170.—Rioja, 1953:291-292.—Hobbs, 1956:431.—Tressler, 1959:731, fig. 28.190.—Crawford, 1959:173, 178.

Ankylocythere sinuosa.—Hart, 1962:127.—Hart, 1964:246.—Crawford, 1965:149.—Hobbs, 1966:70, fig. 18.—Baker, 1969: 293.

DIAGNOSIS.—Shell length (numbers in parentheses represent averages): ♂, 0.34–0.37 (0.35) mm; ♀, 0.36–0.43 (0.39) mm. Shell height: ♂, 0.19–0.22 (0.20) mm; ♀, 0.23–0.27 (0.24) mm. Clasping apparatus with well developed, comparatively narrow talon projecting posteroventrally; internal border with single tooth situated distal to base of talon, otherwise entire; apex with two upturned teeth. Ventral portion of peniferum deeply cleft but without ventrally directed prominences.

TYPE-LOCALITY.—La Cueva Chica, 3 km SE of Ciudad Valles and 609 m SE of pueblo de Pujal, San Luis Potosí, México.

TYPES.—Not extant.

*LOCALITY RECORD.—MEXICO: Chihuahua: Laguna Toronto, 27.4 km SE of Ciudad Camargo, on *Procambarus clarkii*.

Hidalgo: km 267 carretera de México a Tuxpán (Rioja, 1949:322) [no host was cited; this record should be confirmed].

Nuevo León: Arroyo de la Cruz, km 296 carretera Monterrey a México, on *P. simulans regiomontanus*; Río San Juan at San Juan, on *P. simulans regiomontanus*.

San Luis Potosí: Type-locality, on *P. acutus cuevachicae*.

Tamaulipas: Acequia, km 34 carretera a Ciudad Victoria, on *P. simulans regiomontanus*.

Veracruz: María de la Torre, km 407 carretera de México a Nautla, on *P. gonopodocristatus*; Paso Largo, 16 km NE Martínez de la Torre, on *P. gonopodocristatus*.

UNITED STATES: Texas and Louisiana, on *P. s. simulans*, *P. clarkii*, and *P. natchitochae*.

In México, *Ankylocythere sinuosa* appears to be confined to the watershed of the Gulf of Mexico north of the Cordillera Volcánica Transversal but is absent on the plateau.

HOSTS.—*Procambarus acutus cuevachicae*, *P. clarkii*, *P. gonopodocristatus*, *P. natchitochae*, *P. simulans regiomontanus*, and *P. s. simulans*.

ENTOCYTHERID ASSOCIATES.—*Entocythere claytonhoffii* in only the type-locality.

REMARKS.—Not until some twenty-four years after the description of *Ankylocythere sinuosa* from La Cueva Chica was an extension of its range recorded. Hobbs (1966:70) reported it from most of the states cited above and from all of the hosts except *P. gonopodocristatus*. Except for a few additional remarks concerning its morphology, and relationships to other entocytherids, no other additions to our knowledge of the species were made until Baker (1969:293) observed living individuals which were maintained for a period of some ten weeks away from their host *Procambarus simulans simulans*. He concluded "It would appear that the entocytherid ostracod *Ankylocythere sinuosa* does not require the presence of a crayfish in order to survive. Apparently, when it is associated with the crayfish it feeds upon algae extracted from the water or adhering to the gills and body parts of the crayfish. Thus it would seem that *A. sinuosa* is a facultative commensal, but whether or not it is able to reproduce or to complete its life cycle away from the crayfish host has not been demonstrated."

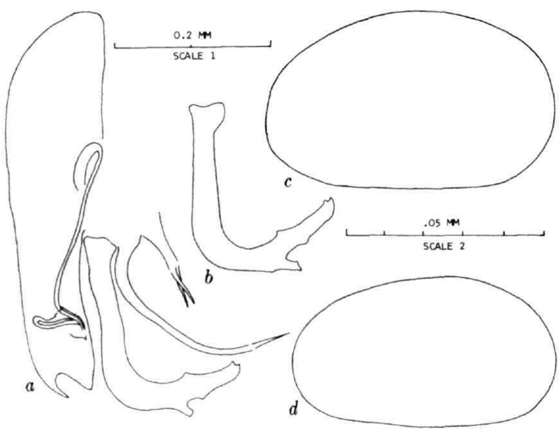

FIGURE 22.—*Ankylocythere sinuosa*: a, copulatory complex of male; b, clasping apparatus of male; c, left valve of female; d, left valve of male. Figures a, b to Scale 2; c, d to Scale 1. (Source of specimens: México—La Cueva Chica, San Luis Potosí.)

Ankylocythere toltecae, new species

FIGURES 16, 23*a–e*

DIAGNOSIS.—Shell length (numbers in parentheses represent averages): ♂, 0.29–0.31 (0.30) mm; ♀, 0.29–0.35 (0.33) mm. Shell height: ♂, 0.17–0.19 (0.18) mm; ♀, 0.18–0.22 (0.20) mm. Clasping apparatus without distinct talon but with two obliquely disposed emarginations delimiting low round lobe on horizontal ramus; internal border with single tooth situated above or slightly proximal to lobe on external border; apex with two upturned denticles. Ventral portion of peniferum shallowly excavate with anteroventral subacute projection.

MALE.—Eye present or absent, if present situated approximately a fifth shell length from anterior margin. Shell (Figure 23*c*) subovate, comparatively highly vaulted with greatest height slightly posterior to midlength; ventral margin almost straight. Submarginal setae present except dorsally, other setae widely scattered over surface of shell.

Copulatory complex (Figure 22*a, d, e*) with ventral portion of peniferum bent anteroventrally, shallowly excavate, and with conspicuous subacute projection at anteroventral angle. Penis longer than half anteroposterior diameter of peniferum at level of penis and curved apically, with ends disposed at angle of approximately 150 degrees. Dorsal and ventral fingers moderately heavy, and both

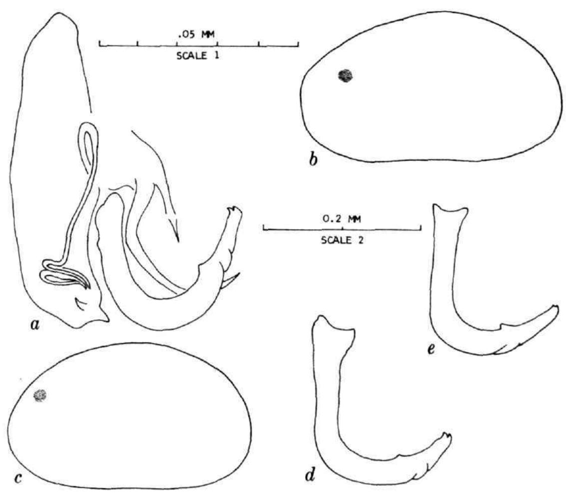

FIGURE 23.—*Ankylocythere toltecae:* a, copulatory complex of male; b, left valve of female; c, left valve of male; d, e, clasping apparatus of male. Figures a, d, e to Scale 1; b, c to Scale 2. (Source of specimens: México—a-c, Cueva del Agua, San Luis Potosí; d, e, Cave, five miles north of Xilitla, San Luis Potosí.)

terminating in simple setiform tip; ventral finger with conspicuous bend slightly distal to end of proximal fourth and another less prominent immediately proximal to subterminal inflated area. Clasping apparatus bent with ends directed at angle ranging from 30 to 70 degrees, usually with horizontal and vertical rami rather clearly defined. Both borders of vertical ramus usually entire, occasionally with one or two minor prominences proximally; external border of horizontal ramus with two emarginations, demarcating rounded lobe, extending obliquely dorsodistally on lateral surfaces as grooves; internal border with single tooth situated above or slightly proximal to lobe on external border; serrations absent on internal border proximal to tooth; apex with two recurved denticles.

TRIUNGUIS FEMALE.—Eye, if present, situated approximately a fifth of shell length from anterior end. Shell (Figure 23*b*) ovate with greatest height posterior to midlength and with ventral margin shallowly concave slightly anterior to midlength. Submarginal setae as in male, setae on remaining surface of valve less numerous.

Genital complex consisting of simple, short, slightly sclerotized cylindroid projection.

MEASUREMENTS.—Holotype: length 0.31 mm, height 0.18 mm. Allotype: length 0.34 mm, height 0.20 mm. See diagnosis above for ranges and averages of 10 males and 10 females.

TYPE-LOCALITY.—Cueva del Agua, 75 km W of Ciudad Valles, San Luis Potosí, México.

DISPOSITION OF TYPES.—The holotypic male and allotype are deposited in the National Museum of Natural History (Smithsonian Institution) nos. 128823, 128824. Paratypes are in the collections of the Instituto de Biología, Universidad de México; C. W. Hart, Jr.; H. H. Hobbs III; and the Smithsonian Institution.

*LOCALITY RECORDS.—MEXICO: Hidalgo: Cueva de El Tenango, approximately 6.4 km SW of Municipio de Chapulhuacán, on *Procambarus toltecae*.

San Luis Potosí: Type-locality, on *P. villalobosi*; 3 km NE of Xilitla, on *P. toltecae*; Sótano de Huitzmolotitla, approximately 8.3 km N of Xilitla, on *P. toltecae*.

Tamaulipas: La Cueva de San Nicolás, about 2 km SE of El Panchón, on *P. toltecae*.

Thus, the known range of this species is restricted to tributaries of the Río Moctezuma in the states of Hidalgo, San Luis Potosí, and Tamaulipas in the Northern Gulf Slope.

RELATIONSHIPS.—*Ankylocythere toltecae* probably has its closest affinities with *A. bidentata* and *A. heterodonta* but has paralleled, in its evolution, *A. hamata*, *A. maya*, and the *talirotundi* form of *A. heterodonta* in developing a reduced talon on the clasping apparatus of the male. It may be distinguished from all of these species, by having its talon reduced to a slight rounded prominence, accentuated by a pair of oblique grooves extending onto the side of the horizontal ramus of the clasping apparatus.

HOSTS.—*Procambarus toltecae* and *P. villalobosi.*

ENTOCYTHERID ASSOCIATE.—*Entocythere claytonhoffi.*

REMARKS.—The variations which have been noted in this species are included in the description above. None seems to be correlated with a limited portion of its range.

Ankylocythere villalobosi, new species

FIGURES 16, 24*a-i*, 25*a-c*

DIAGNOSIS.—Shell length (numbers in parentheses represent averages): ♂, 0.32–0.35 (0.34) mm; ♀, 0.36–0.40 (0.39) mm. Shell height: ♂, 0.19–0.21 (0.19) mm; ♀, 0.24–0.27 (0.25) mm. Clasping apparatus with talon well developed, more than twice as long as least width; internal border with single tooth situated above talon and with or without irregular serrations proximal to tooth and sometimes extending onto vertical ramus; apex with two upturned teeth. Ventral portion of peniferum tapering or curved, if evenly curved, anteroventral extremity with slender, short projection.

MALE.—Eye present, situated between a fifth and a quarter of shell length from anterior margin. Shell (Figure 24*g*) subovate with greatest height at approximate midlength; ventral margin almost straight or slightly convex. Submarginal setae present except dorsally, other setae widely scattered over surface of shell.

Copulatory complex (Figures 23*a*, *i*, 24*a*) with ventral portion of peniferum tapering or evenly rounded, if latter, with anteroventral angle produced into short subacute prominence. Penis much longer than half anteroposterior diameter of peniferum and curved apically with ends disposed at angle of 100 to 130 degrees. Dorsal finger moderately heavy, terminating in one or two setiform tips; ventral finger slenderer, with major bend near end of proximal fourth followed by slightly curved middle section and more strongly curved near base of distal fourth. Clasping apparatus bent with main axes of rami directed at angle ranging from 50 to

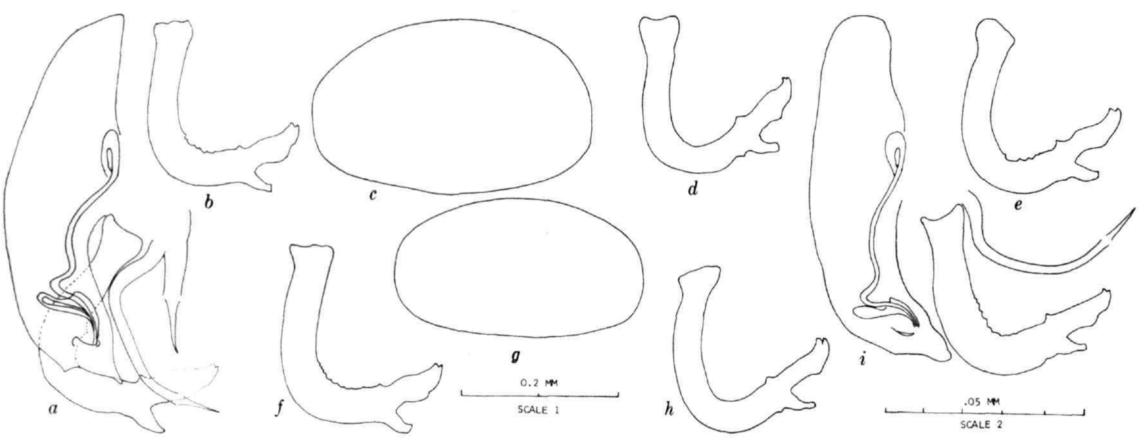

FIGURE 24.—*Ankylocythere villalobosi:* a, i, copulatory complex of male; b, d-f, h, clasping apparatus of male; c, left valve of female; g, left valve of male. Figures a, b, d-f, h, i to Scale 2; c, g to Scale 1. (Sources of specimens: México—a, b, f, Palizada, Campeche; c, g, i, Villa Margaritas, Chiapas; d, e, Estación Rita, Campeche; h, Escárcega, Campeche.)

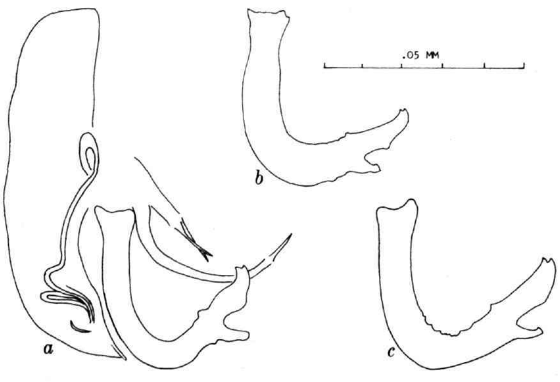

FIGURE 25.—*Ankylocythere villalobosi:* a, copulatory complex of male; b, c, clasping apparatus of male. (Sources of specimens: México—a, Estácion de Haro, Escárcega, Campeche; b, Villa Margaritas, Chiapas; c, Palizada, Campeche.)

80 degrees; rami comparatively well defined, subequal in length or with vertical ramus longer; vertical ramus with external border entire, internal border entire or with as much as distal third irregularly serrate; horizontal ramus with external border bearing prominent talon near midlength, often flanked proximally by small angular prominence and distally by conspicuous concavity; talon always at least as long as twice its least width and directed posteriorly or posteroventrally at 25 to 65 degrees from main axis of horizontal ramus; internal border of latter with single tooth near midlength, situated above base of talon, and often with irregular serrations proximally; apex with two upturned denticles.

TRIUNGUIS FEMALE.—Eye situated as in male. Shell (Figure 24*c*) subovate but more highly vaulted than in male; ventral margin convex with only slight trace of shallow concavity anterior to midlength. Submarginal setae around circumference of shell with others scattered over surface of valves.

Genital complex consisting of simple, short sclerotized cylindroid projection.

MEASUREMENTS.—Holotype: length 0.33 mm, height 0.20 mm. Allotype: length 0.40, height 0.27 mm. See diagnosis above for ranges and averages of 15 males and 10 females.

TYPE-LOCALITY.—Palizada, Campeche, México.

DISPOSITION OF TYPES.—The holotypic male and allotype are deposited in the National Museum of Natural History (Smithsonian Institution) nos. 128825, 128826. Paratypes are in the collections of the Instituto de Biología, Universidad de México; C. W. Hart, Jr.; H. H. Hobbs III; and the Smithsonian Institution.

*LOCALITY RECORDS.—MEXICO: Campeche: Type-locality, on *Procambarus llamasi*; Santa Rita, on *P. llamasi*; Escárcega, on *P. llamasi*; Estación de Haro, Escárcega, on *P. llamasi*.

Chiapas: Villa Margaritas, on *P. pilosimanus*; Gruta de Zapaluta, 30 km S of Comitán, on *P. pilosimanus*.

The known range of this species encompasses portions of three biogeographical regions (Depresión de Chiapa, Llanura del Grijalva-Usumacinta, and the Península de Yucatán) between Río Mezcalapa and Río Champotón.

RELATIONSHIPS.—*Ankylocythere villalobosi* is more closely related to *A. bidentata* and *A. heterodonta* than to any other species, sharing with the more typical members of each a well-developed talon on the clasping apparatus of the male. It may be distinguished from both by the longer, more ventrally directed talon, and from the former by its usually longer shell; its shell is usually shorter than that of *A. heterodonta*.

HOSTS.—*Procambarus llamasi* and *P. pilosimanus*.

ENTOCYTHERID ASSOCIATE.—*Entocythere claytonhoffi*.

ETYMOLOGY.—In token of his invaluable assistance to me in my study of the Mexican entocytherids, the gift of numerous specimens, and his friendship, it is a pleasure to name this species in honor of Dr. Alejandro Villalobos Figueroa.

REMARKS.—There is a tremendous amount of variation in this species; for example, if the clasping apparatus of a specimen from Escárcega, Campeche (Figure 25*a*) is compared with that of one from Palizada (Figure 24*f*), they are so different that one might assume that two species are represented, but most of the differences, except the comparatively slenderer shaft in the central Campeche specimens, are not constant even in the same population. The illustrations in Figures 24 and 25 include most of the variations observed.

Genus *Entocythere* Marshall, 1903

Entocythere Marshall, 1903:120.
Cambaria Group Rioja, 1943a:560; Crawford, 1959:149, 152.
Illinoisensis Group Rioja, 1943a: 560; Rioja, 1949: 327; Rioja, 1955: 196; Hobbs, 1956:431; Hart, 1959:201; Hart, 1962:133.
? Group Hoff, 1944b:330.

DIAGNOSIS.—Terminal tooth of mandible with single cusp or with cusps of unequal size, pectinate only in *E. ruibali* and *E. tyttha*. Copulatory complex without finger guard; peniferum without accessory groove; spermatic and prostatic elements of penis contiguous; external border of clasping apparatus entire; internal border with three or more teeth and apex with three to six denticles. Triunguis female without amiculum or J-shaped rod; antenna with comblike appendix at base of distal claws.

TYPE-SPECIES.—*Entocythere cambaria* Marshall, 1903:120.

RANGE.—Campeche and Chiapas, México to Wisconsin, Virginia, and Florida, and on the Island of Cuba. (See Hart and Hart, 1969:185, 186.)

Of the 12 species that have been assigned to the genus *Entocythere*, 2 are endemic in México and 1 on the island of Cuba and Isla de Pinos.

LIST OF SPECIES.—UNITED STATES: *E. cambaria* Marshall, 1903:120, Wisconsin; *E. dentata* Crawford, 1965:151, North Carolina; *E. dorsorotunda* Hoff, 1944b:341, Florida and Georgia; *E. elliptica* Hoff, 1944b:345, Florida, Georgia, and South Carolina; *E. illinoisensis* Hoff, 1942a:67, Illinois to Georgia and Virginia; *E. internotalus* Crawford, 1959:152, Georgia and South Carolina; *E. kanawhaensis* Hobbs and Walton, 1966:6, Virginia; *E. reddelli* Hobbs and Walton, 1968:243, Texas; *E. tyttha* Hobbs and Hobbs, 1970:11, Kentucky.

MEXICO: *E. claytonhoffi* Rioja, 1942a:201, Campeche, Chiapas, San Luis Potosí, Tabasco, and Veracruz; *E. mexicana* Rioja, 1943a:553, Puebla and Veracruz.

CUBA: *E. ruibali* Rioja, 1955:194, Matanzas, Pinar del Río, and Isla de Pinos.

Key to the Species of the Genus *Entocythere*

1 Mesial surface of clasping apparatus with angular projections or teeth at or near junction of horizontal and vertical rami 2

1′ Mesial surface of clasping apparatus without angular projections or teeth at or near junction of horizontal and vertical rami 3

2 (1) Mesial surface of clasping apparatus with two teeth, neither extending above level of upper margin of horizontal ramus .... ***E. internotalus***

2′ Mesial surface of clasping apparatus with two angular projections extending above level of upper margin of horizontal ramus .... ***E. reddelli***

3 (1′) External border of clasping apparatus at junction of horizontal and vertical rami produced posteriorly in subacute angle .... ***E. illinoisensis***

3′ External border of clasping apparatus at junction of horizontal and vertical rami never produced posteriorly in angle 4

4 (3′) Distal tooth of mandible pectinate 5

4′ Distal tooth of mandible terminating in large median denticle with smaller lateral ones, or tapering without denticles 6

5 (4) Major axes of clasping apparatus directed at angle of 90 degrees or less; vertical ramus with longitudinal groove .... ***E. tyttha***

5′ Major axes of clasping apparatus directed at angle of more than 90 degrees; vertical ramus without longitudinal groove .... ***E. ruibali***

6 (4′) Internal borders of vertical and horizontal rami of clasping apparatus disposed at angle less than 90 degrees .... ***E. elliptica***

6′ Internal borders of vertical and horizontal rami of clasping apparatus disposed at angle of at least 90 degrees 7

7 (6′) Internal borders of vertical and horizontal rami of clasping apparatus disposed at angle distinctly greater than 90 degrees 8

7′ Internal borders of vertical and horizontal rami of clasping apparatus disposed at angle of approximately 90 degrees 9

8 (7) Internal border of horizontal ramus of clasping apparatus with five teeth subequally spaced; three apical denticles .... ***E. dorsorotunda***

8′ Internal border of horizontal ramus of clasping apparatus with three teeth subequally spaced; six apical denticles .... ***E. kanawhaensis***

9 (7′) Teeth on internal border of horizontal ramus of clasping apparatus blade-like. ***E. claytonhoffi***

9′ Teeth on internal border of horizontal ramus of clasping apparatus acute 10

10 (9′) External border of clasping apparatus subangular at junction of horizontal and vertical rami .... ***E. cambaria***

10′ External border of clasping apparatus rounded at junction of horizontal and vertical rami 11

11 (10′) Shells of both sexes oblong-ovate .... ***E. dentata***

11′ Shells of both sexes strongly convex dorsally and concave ventrally ......***E. mexicana***

Entocythere claytonhoffi Rioja, 1942

FIGURES 26*a-i*, 27

Entocythere cambaria.—Hobbs [not Marshall], 1941:4 [in part; see synonomy for *Ankylocythere sinuosa*].
Entocythere (Entocythere) claytonhoffi Rioja, 1942a:201-204, figs. 1-4.—Rioja, 1942b:687, 689, 690–696, figs. 4–13, 15–17. —Hoff, 1943:280.—Rioja, 1943a:558–560.—Rioja, 1943b:567, 570, 572, 573, 577, 579, 580, 582, figs. 5, 6, 27.
Entocythere claytonhoffi.—Hoff, 1944b:330, 331, 345, 349.—Rioja, 1949:327 [in part].—Rioja, 1953:287, 291, 292.—Rioja, 1955:194–196, fig. 9.—Hobbs, 1956:431, 433.—Tressler, 1959:727, figs. 28.181a, b, c.—Crawford, 1959:152.—Hart, 1962:133.
Entocythere claytohoffi.—Rioja, 1949:32 [erroneous spelling].

DIAGNOSIS.—Shell length (numbers in parentheses represent averages): ♂, 0.46–0.48 (0.47) mm; ♀, 0.55–0.59 (0.56) mm. Shell height: ♂, 0.25–0.26 (0.25) mm; ♀, 0.32–0.39 (0.35) mm. Shell with pronounced concavity ventrally, almost angular anteriorly, and with anteroventral margin almost straight. Distal tooth of mandible simple. Clasping apparatus with external junction of horizontal and vertical rami broadly rounded and junction not conspicuously thickened; external border of horizontal ramus curved, internal border with four teeth, proximal three broad and bladelike; apex with four denticles.

TYPE-LOCALITY.—La Cueva Chica, 3 km SE Ciudad Valles and 609 m SE of pueblo de Pujal, San Luis Potosí, México, on *Procambarus acutus cuevachicae*.

TYPES.—No longer extant.

LOCALITY RECORDS.—MEXICO: Campeche: *Palizada, on *Procambarus llamasi*; *Santa Rita, 50 km E of Escárcega, on *P. llamasi*; *Estación de Haro, Escárcega, on *P. llamasi*.

Chiapas: *Villa Margaritas, on *P. pilosimanus*; *Gruta de Zapaluta, 30 km S of Comitán, on *P. pilosimanus*.

San Luis Potosí: *Type-locality, on *P. acutus cuevachicae*; *Sótano de Huitzmolotitla, 8 km N of Xilitla, on *P. toltecae*; *3 km N of Xilitla, on *P. toltecae*.

Tabasco: *37 km N of Villa Hermosa, on *P. llamasi*.

Tamaulipas: *La Cueva de San Nicolás, about 3 km SE of El Pachón, on *P. toltecae*.

Veracruz: *El Mirador de Zacuapan, about 10 km NE of Huatusco (Rioja, 1949:327), on *P. mexicanus*; *Hacienda de Jalapilla, about 5 km SE of Orizaba (Rioja, 1949:327) on *P. mexicanus*; *3 km S of Coscomatepec (Rioja, 1949:327) on *P. aztecus* [listed as *P. mexicanus* by Rioja]; *Rincón de la Doncella, Ciudad Mendoza, on *P. mexicanus*; *Zapoapan de Cabaña, Catemaco, on *P. ruthveni zapoapensis*; *El nacimiento de la Laguna Encantada, San Andrés Tuxtla, on *P. vazquezae*; *Tres Puentes, Col. Emiliano Zapala, Jalapa, on *P. mexicanus*; *El Tular, San Simón, N. of San Andrés Tuxtla, on *P. ruthveni zapoapensis*; *Tomatlán, on *P. aztecus*; *Cuitlahuac, on *P. aztecus*.

Except for the three localities in San Luis Potosí and Rioja's record for La Magdalena, about three kilometers north of Zihuateutla (1949:327), which in all probability is for *E. mexicana*, this species is known only from the southeastern states of México, south of the Cordillera Volcánica Transversal, in Campeche, Chiapas, Tabasco, and Veracruz.

HOSTS.—The hosts of *Entocythere claytonhoffi* include *Procambarus acutus cuevachicae*, *P. aztecus*, *P. llamasi*, *P. mexicanus*, *P. pilosimanus*, *P. ruthveni zapoapensis*, *P. toltecae*, and *P. vazquezae*.

ENTOCYTHERID ASSOCIATES.—*Ankylocythere bidentata*, *A. sinuosa*, *A. toltecae*, and *A. villalobosi*.

REMARKS.—Hart and Hobbs (1961:175) omitted *Ankylocythere sinuosa* and *Entocythere claytonhoffi* from the list of those entocytherids having been

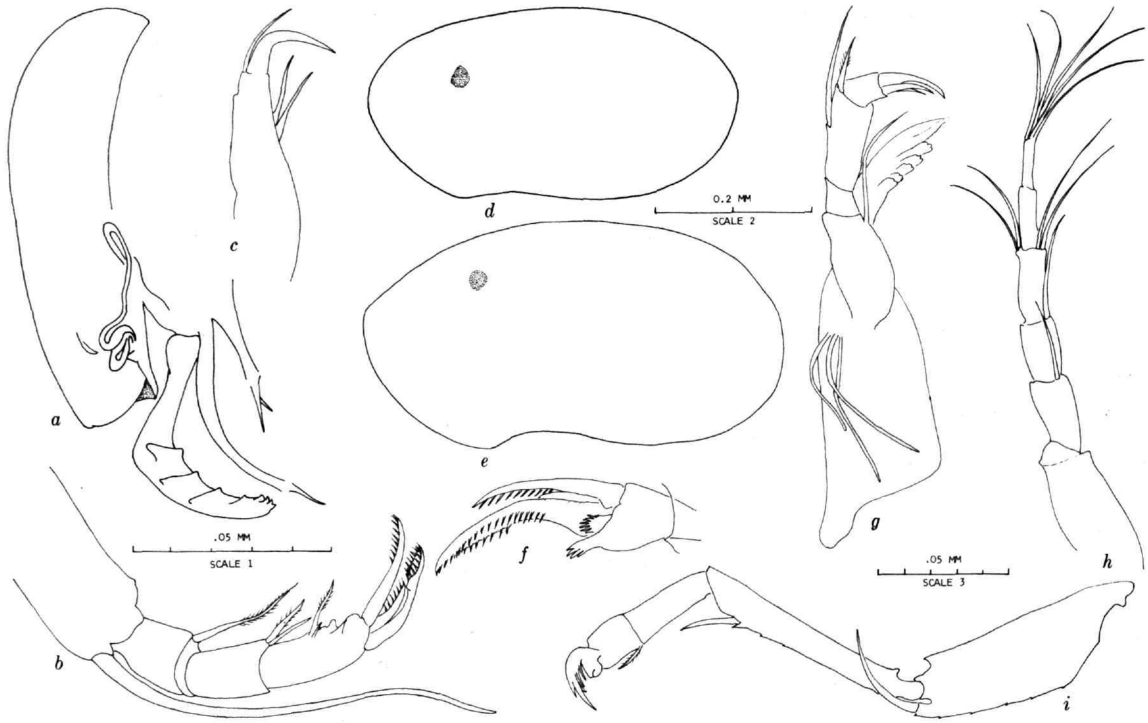

FIGURE 26.—*Entocythere claytonhoffi:* a, copulatory complex of male; b, second antenna of male; c, maxilla of male; d, left valve of male; e, left valve of female; f, distal podomere and comb-like appendices of triunguis female; g, mandible of male; h, first antenna of male; i, second leg of male. Figures a, c, f, g to Scale 1; b, h, i to Scale 3; d, e to Scale 2. (Source of specimens: México—La Cueva Chica, San Luis Potosí.)

described from caves. Both ostracods, however, have been collected in epigean habitats, and, at most, must be considered to be trogloxenic.

This species was mistakenly recorded by Hobbs (1941) as *Entocythere cambaria* when he mentioned its association with *Procambarus acutus cuevachicae* (= *Cambarus blandingii cuevachicae*), an error which was corrected when Rioja (1942a) recognized it as a previously undescribed species. The remaining references are concerned with its range and relationships to other entocytherids.

Entocythere mexicana Rioja, 1943

FIGURES 27, 28*a-d*

Entocythere (Entocythere) mexicana Rioja, 1943a:553–560, 564, figs. 1–10, 23.—Rioja, 1943b:572, 573, 577, 580, 582, figs. 26, 28, 31–39.

Entocythere mexicana.—Hoff, 1944b:330, 331, 345, 349.—Rioja, 1949:327.—Rioja, 1955:195.—Hobbs, 1956:431.—Tressler, 1959:729, figs. 28.185a, b, c.—Crawford, 1959:152.—Hart, 1962:134.—Crawford, 1965:153.

? *Entocythere claytonhoffi*.—Rioja, 1949:327 [in part].

DIAGNOSIS.—Shell length (numbers in parentheses represent averages): ♂, 0.49–0.52 (0.50) mm; ♀, 0.57–0.58 (0.57) mm. Shell height: ♂, 0.27–0.28 (0.27) mm; ♀, 0.33–0.34 (0.34) mm. Shell with or without broad shallow concavity ventrally and with anteroventral margin gently curved. Distal tooth of mandible simple. Clasping apparatus with external junction of horizontal and vertical rami not produced into angular "heel" but rounded and not conspicuously thickened; external border of horizontal ramus not strongly curved, occasionally concave or straight from base almost to apex, internal

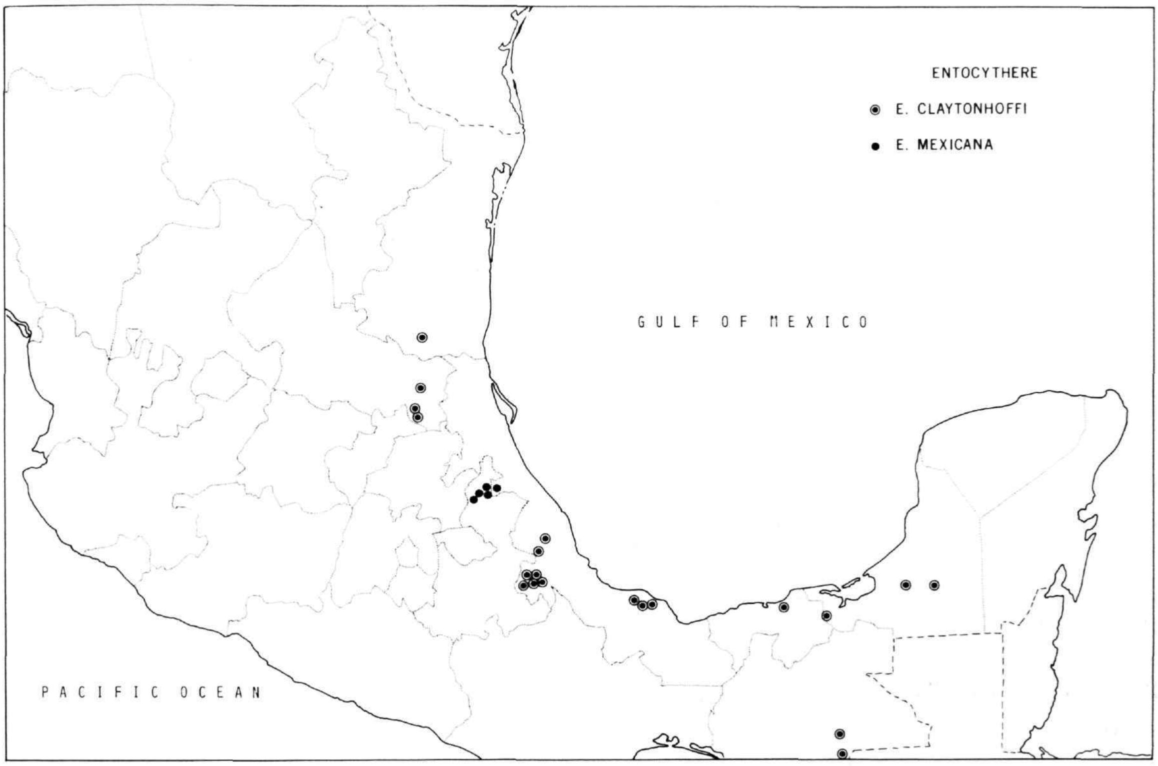

FIGURE 27.—Ranges of Mexican species of the genus *Entocythere*.

border with five or more simple teeth, and apex with four denticles.

TYPE-LOCALITY.—Villa Juárez, Puebla, on *Procambarus hoffmanni* and *P. caballeroi*.

TYPES.—No longer extant.

LOCALITY RECORDS.—MEXICO: Puebla: *Type-locality, on *Procambarus hoffmanni* and *P. caballeroi*; Huauchinango (Rioja, 1943a:560), on *P. riojai*; *Zihuateutla, on *P. hortonhobbsi*; ? La Magdalena, about 3 km N of Zihuateutla (Rioja, 1949:327), on *P. erichsoni* [listed by Rioja as "*E. claytonhoffi* on *P. weigmanni*?"; the specimens are no longer extant and this record is in need of confirmation].

Veracruz: Sabana de El Poste, Miahuapan, 8–10 km N of Coyutla (Rioja, 1949:327), on *P. hoffmanni*.

As indicated by the locality records cited above, *Entocythere mexicana* is known from only five localities in the northern parts of the states of Puebla and Veracruz, in the headwaters of the Río San Marcos and Río Tecolutla, all north of the Cordillera Volcánica Transversal.

HOSTS.—The hosts of *Entocythere mexicana* include *Procambarus caballeroi*, *P. erichsoni* (if the Puebla record for *E. claytonhoffi* cited above is correctly assigned), *P. hoffmanni*, *P. hortonhobbsi*, and *P. riojai*.

ENTOCYTHERID ASSOCIATES.—*Uncinocythere bicuspide*, *U. cuadricuspide*, and *U. dobbinae*.

REMARKS.—Should the La Magdalena record questionably cited above prove to have been for *E. claytonhoffi*, as indicated by Rioja, then this is the only Puebla record for the species and would place it within the range of *E. mexicana*, a close relative, and one which presumably vicariates for *E. claytonhoffi* in the area immediately north of the Cordillera Volcánica Transversal.

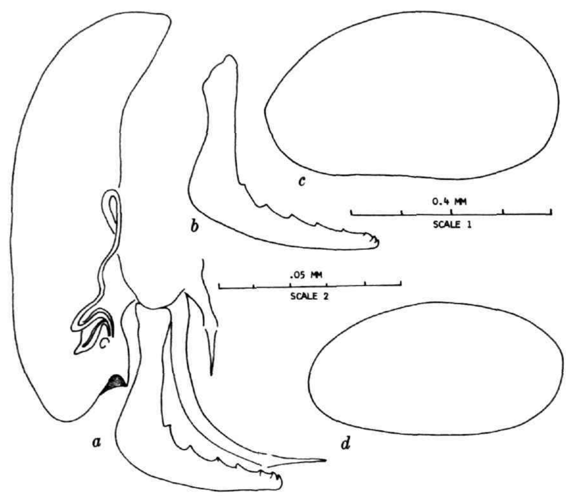

FIGURE 28.—*Entocythere mexicana:* a, copulatory complex of male; b, clasping apparatus of male; c, left valve of female; d, left valve of male. Figures a, b to Scale 2; c, d to Scale 1. (Source of specimens: México—a, Zihuateutla, Puebla; b-d, Villa Juárez, Puebla.)

Entocythere ruibali Rioja, 1955

FIGURE 29*a-e*

Entocythere ruibali Rioja, 1955:194–196, figs. 2–8.—Hobbs, 1957:431–433, fig. 8.—Hart, 1959:201.—Hart, 1962:134.

DIAGNOSIS.—Shell length (numbers in parentheses represent averages): ♂, 0.36–0.43 (0.39) mm; ♀, 0.39–0.45 (0.41) mm. Shell height: ♂, 0.24–0.25 (0.24) mm; ♀, 0.24–0.30 (0.26) mm. Shell with ventral margin straight and with anteroventral margin gently curved. Distal tooth of mandible with cusps. Clasping apparatus with external junction of horizontal and vertical rami broadly rounded and junction of rami only slightly thickened; external border of horizontal ramus curved; internal border with proximal two teeth sometimes truncate (blade-like) but never with third and fourth truncate; apex with four denticles.

TYPE-LOCALITY.—Fourteen km W of Camagüey, Camagüey, Cuba, on *Procambarus cubensis cubensis.*

TYPES.—Not extant.

LOCALITY RECORDS.—CUBA: Camagüey: Type-locality, on *Procambarus cubensis cubensis.*

Isla de Pinos: *La Ceiba (Hobbs, 1956:432), on *P. atkinsoni*; *Nueva Gerona (Hobbs, 1956:432), on *P. cubensis cubensis.*

Matanzas: Unión de Reyes (Hobbs, 1956:432) on *P. cubensis cubensis.*

Pinar del Río: *Guane (Hobbs, 1956:432) on *P. cubensis cubensis.*

This species is known from only the five localities cited above in Cuba.

HOSTS.—*Procambarus atkinsoni* and *P. cubensis cubensis.*

ENTOCYTHERID ASSOCIATES.—*Ankylocythere cubensis* and *A. hamata.*

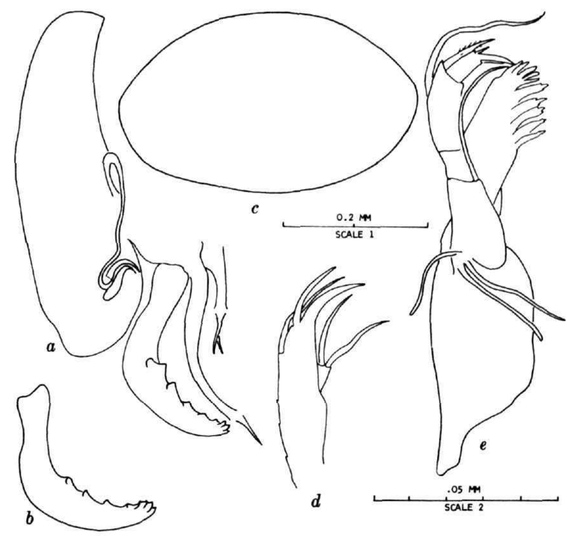

FIGURE 29.—*Entocythere ruibali:* a, copulatory complex of male; b, clasping apparatus of male; c, left valve of male; d, maxilla of male; e, mandible of male. Figures a,b,d, e to Scale 2; c to Scale 1. (Source of specimens: Cuba—Guane, Pinar del Río.)

Subfamily Sphaeromicolinae Hart, 1962

Subfamily Sphaeromicolinae Hart, 1962:139.

DIAGNOSIS.—Dorsal claw of antenna with brush of setae on flexor face; mandible without respiratory filaments; maxilla without respiratory plate, and masticatory lobe reduced or absent; penis straight or angular.

RANGE.—France, Italy, Yugoslavia, and México, in marine or freshwater habitats.

HOSTS.—Isopods of the family Sphaeromatidae, and an amphipod of the family Cheluridae, *Chelura* *terebrans* Philippi in Europe, and isopods of the family Cirolanidae in México.

Genus *Sphaeromicola* Paris, 1916

Sphaeromicola Paris, 1916:307.

DIAGNOSIS.—Same as that for subfamily.

TYPE-SPECIES.—*Sphaeromicola topsenti* Paris, 1916:307.

RANGE AND HOSTS.—Same as that for subfamily.

LIST OF SPECIES.—All the members of the subfamily are assigned to the genus *Sphaeromicola*: *S. cebennica* Remy, 1948:129, France; *S. cirolanae* Rioja, 1951:170, México; *S. dudichi* Klie, 1938:317, coast of France and Italy; *S. hamigera* Remy, 1946: 7, France; *S. sphaeromidicola* Hubault, 1938:12, Yugoslavia; *S. stammeri* Klie, 1930:273, Italy; and *S. topsenti* Paris, 1916:307, France.

Key to the Species of the Genus *Sphaeromicola*

(Based on Copulatory Complex of Male)

1	Clasping apparatus (crochet) with vertical and horizontal rami disposed at angle of 90° or less, its internal border with one or two teeth	2
1′	Clasping apparatus (crochet) with rami (if at all distinct) disposed at angle much greater than 90° or curved throughout, its internal border lacking teeth	4
2 (1′)	Ventral finger (flagellum) of copulatory complex with single setiform tip	***S. cirolanae***
2′	Ventral finger (flagellum) of copulatory complex with two setiform tips	3
3 (2′)	Ventral surface of peniferum (masse pyriformis) with anteroventrally directed prominence	***S. hamigera***
3′	Ventral surface of peniferum (masse pyriformis) with posteriorly directed prominence	***S. cebennica***
4 (1′)	Anterior base of ventral finger (flagellum) naked; apex of clasping apparatus (crochet) entire; ventral surface of peniferum (masse pyriformis) with acute posteriorly directed process	***S. dudichi***
4′	Anterior base of ventral finger with two setiform processes; apex of clasping apparatus serrate or with several denticles; ventral surface of peniferum never with acute posteriorly directed process	5
5 (4′)	Ventral surface of peniferum tapering, without acute or spiniform processes.	***S. stammeri***
5′	Ventral surface of peniferum with one or more spiniform or acute processes	6
6 (5′)	Clasping apparatus with 6 apical denticles; ventral surface of peniferum bearing long slender anteroventrally directed process and shorter acute projections	***S. topsenti***
6′	Clasping apparatus with 5 apical denticles; ventral surface of peniferum lacking long slender anteroventrally directed process but with acute projection.	***S. sphaeromidicola***

Sphaeromicola cirolanae Rioja, 1951

FIGURES 30a-i, 31a-f

Sphaeromicola cirolanae Rioja, 1951:170–179, 16 figs.—Rioja, 1953:290–292. — Levinson, 1959:259. — Hart, 1962:139. — Nicholas, 1962:168.

DIAGNOSIS.—Shell length (numbers in parentheses represent averages): ♂, 0.29–0.31 (0.30) mm; ♀, 0.28–0.31 (0.29) mm. Shell height: ♂, 0.16–0.18 (0.17) mm; ♀, 0.17–0.20 (0.18) mm. Clasping apparatus (crochet) strongly bent with rami forming angle of less than 90 degrees with external border of bend rounded or produced in acute angle; internal border of horizontal ramus with one or two teeth and distal extremity with five or six denticles. Ventral surface of peniferum produced in retractable fingerlike lobe bearing small, variable, subterminal projection. Ventral finger (flagellum) with two setiform processes at base, variously curved, and terminating in single setiform tip.

TYPE-LOCALITY.—La Cueva de los Sabinos, 14 km NNE of Ciudad Valles, San Luis Potosí, México.

TYPES.—The only extant types are paratypes which were donated to me by Dr. Rioja in the spring of 1957. Originally mounted in Hoyer's fluid, they have now been remounted in balsam and

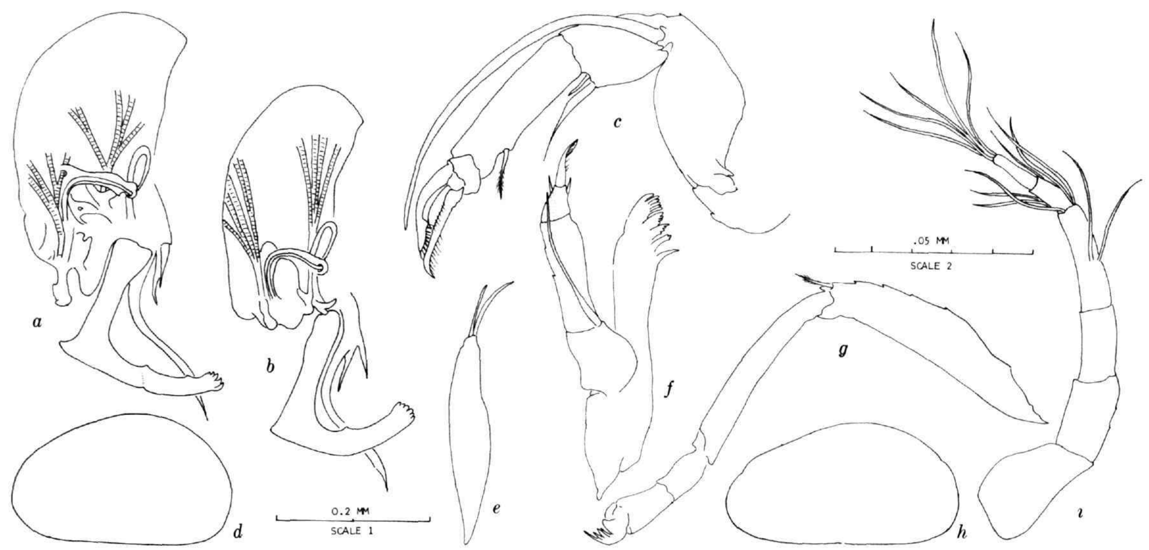

FIGURE 30.—*Sphaeromicola cirolanae:* a, copulatory complex of male with ventral portion of peniferum extended; b, copulatory complex of male with ventral portion of peniferum retracted; c, second antenna of male; d, left valve of female; e, maxilla of male; f, mandible of male; g, second leg of male; h, left valve of male; i, first antenna of male. Figures a-c, e-g, i to Scale 2; d, h to Scale 1. (Source of specimens: México—Cueva de Quintero, San Luis Potosí.)

deposited in the National Museum of Natural History (Smithsonian Institution) no. 128952.

*LOCALITY-RECORDS.—MEXICO: San Luis Potosí: Type-locality, on *Speocirolana pelaezi* Bolívar; La Cueva de Lagunita, 24 km NE of Ciudad de Maíz, on *S. pelaezi*; Sótano del Arroyo, about 1.5 km SE of Los Sabinos, on *S. pelaezi*; Sótano de Pichijumo, about 9 km NE of Ciudad Valles, on *S. pelaezi*; Sótano del Tigre, about 15 km NE of Ciudad Valles, on *S. pelaezi*.

Tamaulipas: Grutas de Quintero (= Cuevas de Quintero, Rioja, 1953:178) about 11 km SW of Ciudad Mante, on *S. pelaezi* and *S. bolivari* Rioja; Cueva de la Florida, about 15 km SW of Ciudad Mante, on *S. pelaezi*.

Thus the known range of *Sphaeromicola cirolanae* is restricted to subterranean waters along the western flank of La Sierra de El Abra in the southeastern part of San Luis Potosí and southern Tamaulipas.

HOSTS.—*Speocirolana pelaezi* (Bolívar) and *S. bolivari* (Rioja).

ENTOCYTHERID ASSOCIATES.—None.

REMARKS.—Specimens of *Sphaeromicola* from Sótano del Arroyo possess a clasping apparatus identical to that of *S. cirolanae*, but because the ventral surface of the peniferum is so different from that of topoparatypes of the latter, they were originally believed to represent an undescribed species. When additional specimens from other localities became available, it was obvious that the differences observed were due to the retracted ventral fingerlike projection which in all of Rioja's specimens was presumably extended (cf. Figure 30*a*, *b* and 31*a*). The observed extreme state of retraction (Figure 31*a*) results in the exhibition of a flaplike flange which abuts the projecting penis.

Another rather surprising variation in the species was encountered in some specimens from Cueva de Lagunita, Sótano de Pichijumo, Sótano del Tigre, and Cueva de Florida. In this variant, the clasping apparatus is vastly different from that of the typical form of the species described and illustrated by Rioja. Instead of the clasping apparatus being bent at an angle, with the external border of the bend produced into an angular prominence, in this form, the bend is rounded (cf. Figure 31*a–f*). Furthermore, in none of the individuals possessing the rounded clasping apparatus is the ventral portion of the peniferum extruded. The combination of the rounded bend of the clasping apparatus and the retracted ventral extremity of the peniferum led me to conclude that two sympatric species, with apparently identical shell dimensions, were infesting the cirolanids of the region. The discovery of one specimen in which the dextral copulatory complex bore a clasping apparatus with a rounded bend and the sinistral one, an angular bend with a produced angular projection, indicated that *S. cirolanae* has a clasping apparatus which exists in two quite different forms, and that the variations noted in the ventral portion of the peniferum reflect nothing more than different degrees of its extension or retraction.

In only two localities, Sótano de Pichijumo and Sótano del Tigre, (from each of which I have only a single male) is the typical form not known to occur.

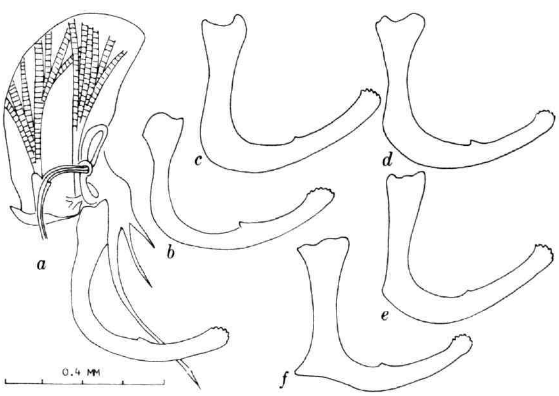

FIGURE 31.—*Sphaeromicola cirolanae:* a, copulatory complex of male; b-f, clasping apparatus of male. (Source of specimens: México—a, b, d, e, Cueva de Lagunita, San Luis Potosí; c, f, Cueva de La Florida, Tamaulipas.)

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Index

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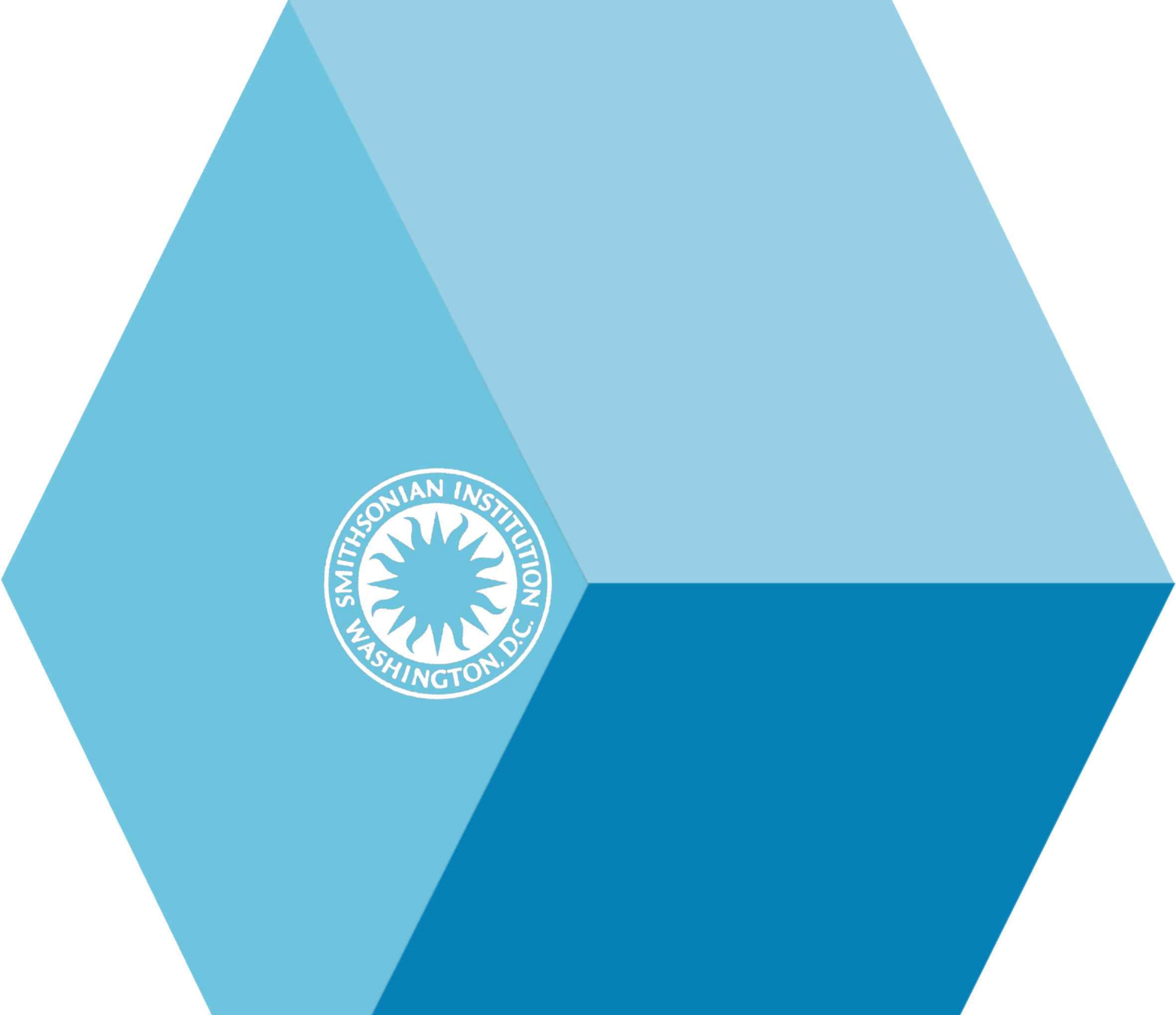
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