

TT 81-52039

UNIVERSIDAD NACIONAL AUTONOMA DE MEXICO
Facultad de Ciencias Departamento de Biología

THE NATIONAL UNIVERSITY OF MEXICO
Faculty of Sciences Department of Biology

Crayfishes of Mexico (Crustacea: Decapoda)

[*Cambarinos de la Fauna Mexicana: Crustacea Decapoda*]

ALEJANDRO VILLALOBOS, M. en C.B.

Mexico, 1955

Translated from Spanish

Published for the Smithsonian Institution Libraries,
and the National Science Foundation, Washington, D.C.,
by Amerind Publishing Co. Pvt. Ltd., New Delhi

1983

© 1983 Smithsonian Institution

*Published for the Smithsonian Institution Libraries,
pursuant to an agreement with the National Science Foundation,
Washington, D.C., by Amerind Publishing Co. Pvt. Ltd.,
66 Janpath, New Delhi 110001*

Translator: Horton H. Hobbs, Jr.

*Phototypeset by Anil Printers, New Delhi
and printed at Baba Barkhanath Printers, New Delhi, India*

Foreword

Because of the relative inaccessibility of this important, privately printed monograph dealing with the Mexican crayfishes, I have been urged by several of my colleagues to make my translation of it available. The value of this work lies in the fact that it brings together all previously published information concerning the Mexican crayfishes and includes detailed descriptions and excellent illustrations of most of the described Middle American crayfishes. Equally important are the sections devoted to discussions of relationships and distribution that must be taken into account in future studies of the North and Middle American crayfishes and their symbionts.

As Dr. Villalobos has pointed out in the initial sentence of the Introduction, much of the text consists of a compilation of his prior contributions to our knowledge of the Mexican crayfish fauna, and, as might be anticipated, some inconsistencies have resulted. The Spanish text has been adhered to as closely as possible, with occasional bracketed insertions of words or phrases that are intended to clarify interpretations. For the sake of uniformity, the keys and diagnoses are presented in telegraphic style, and descriptions and discussions in complete sentences. Attempts have been made to render the synonymies uniform, and some corrections in typographical errors and page and figure references have been made; inconsistencies in the spelling of scientific names of the crayfishes, however, have been preserved. The page numbers of the Spanish text appear in the left-hand margin.

The translation has been prepared over a period of several years, and, without the invaluable assistance of Isabel Pérez Farfante, a colleague at the Smithsonian Institution, I should not have considered offering the manuscript for publication. To her, I am indeed most grateful, as I am to Margaret A. Daniel who prepared the photocopies of the plates and worked with me in attempting to ferret out inconsistencies and errors in the typescript. I also extend my thanks to Georgia B. Hobbs for her comments on drafts of the manuscript and to C. W. Hart, Jr., another colleague at the Smithsonian, for his part in arranging for its publication. Finally, appreciation is extended to my friend Alejandro Villalobos F. for approving the publication of the translation of his monograph.

Horton H. Hobbs, Jr.



To my parents

Acknowledgment

I wish to express my appreciation to Dr. Enrique Rioja for his wise direction and his scholarly counsel during the preparation of this thesis. Likewise, to all of my teachers in the Faculty of Sciences, to whom I am indebted for the knowledge I acquired in the various areas of my profession, and to my colleagues in the Instituto de Biología who offered me their esteem and affection.

Preface

It is with satisfaction that I devote a few lines to the monograph that Dr. Alejandro Villalobos has dedicated to the Mexican crayfishes; I have observed the development of the study since its inception; the author and I have shared the same laboratory; I have followed his work day by day since the beginning of his scientific investigations; because of this, I have knowledge of his anxieties and satisfactions. These reasons are responsible for my intimate pleasure in seeing this important study published. With this work Professor Villalobos has become an accomplished investigator in the field of Zoology, capable of undertaking other studies, which all anticipate, and I more than any, in a variety of carcinological areas. His scientific rigor and his thoroughness have placed him among the outstanding specialists in his field. We hope that this publication is the first fruit of a full harvest.

Enrique Rioja



Contents

Foreword	v
Preface	vii
Introduction	xi

Introductory Part

Methods of Collection and Preservation	3
Taxonomic Position	8
Distribution of the Parastacids and Astacids in the World	10
Paleontological Origin of the Astacura and Their Possible Emigrations (Plate 1)	15
History of the Study of the Mexican Crayfishes	19
Monographic Study of <i>Cambarellus montezumae montezumae</i> (Saussure) (Plate 2)	26
General Considerations Concerning the Morphological Characters Utilized in the Systematics of Cambarinae	41

Taxonomic Part

Taxonomic Study of the Mexican Genera of Crayfishes	49
Subfamily Cambarinae	49
Genus <i>Procambarus</i>	50
<i>barbatus</i> Section	50
<i>Procambarus simulans regiomontanus</i> Villalobos	51
<i>Procambarus digueti</i> (Bouvier)	58
<i>Procambarus bouvieri</i> (Ortmann)	64
Systematic Discussion of the Mexican Species of the <i>barbatus</i> Section	70
<i>blandingii</i> Section	71
<i>Procambarus blandingii cuevachicae</i> (Hubbs)	72
<i>Procambarus toltecaae</i> Hobbs	81
<i>Procambarus caballeroi</i> Villalobos	86

Taxonomic Discussion of the Mexican Species of the <i>blandingii</i> Section.	93
<i>riojae</i> Section.	94
<i>Procambarus riojae</i> (Villalobos).	95
<i>Procambarus hoffmanni</i> (Villalobos)	100
<i>Procambarus hortonhobbsi</i> (Villalobos).	105
<i>Procambarus teziutlanensis</i> (Villalobos).	112
<i>Procambarus tlapacoyanensis</i> (Villalobos)	119
<i>Procambarus erichsoni</i> Villalobos.	127
<i>Procambarus contrerasi</i> (Creaser)	137
<i>Procambarus zihuatlensis</i> Villalobos.	144
Taxonomic Discussion of the Species of the <i>riojae</i> Section	150
<i>mexicanus</i> Section.	153
<i>Procambarus mexicanus</i> (Erichson)	156
<i>Procambarus aztecus</i> (Saussure).	163
<i>Procambarus rodriguezi</i> Hobbs	170
<i>Procambarus veracruzanus</i> Villalobos	171
<i>Procambarus vazquezae</i> Villalobos	176
<i>Procambarus ruthveni</i> (Pearse).	183
<i>Procambarus ruthveni zapoapensis</i> Villalobos	192
<i>Procambarus mirandai</i> Villalobos	200
<i>Procambarus acanthophorus</i> Villalobos	209
<i>Procambarus llamasi</i> Villalobos.	214
<i>Procambarus pilosimanus</i> (Ortmann).	220
Genus <i>Paracambarus</i>	228
<i>Paracambarus paradoxus</i> (Ortmann).	228
<i>Paracambarus ortmannii</i> Villalobos.	235
Genus <i>Cambarellus</i>	242
<i>Cambarellus montezumae montezumae</i> (Saussure).	243
<i>Cambarellus montezumae zempoalensis</i> Villalobos.	244
<i>Cambarellus montezumae lermensis</i> Villalobos	249
<i>Cambarellus montezumae patzcuarensis</i> Villalobos	252
<i>Cambarellus alvarezii</i> Villalobos	255
<i>Cambarellus montezumae</i> var. <i>tridens</i> (Von Martens)	261
<i>Cambarellus montezumae dugesii</i> (Faxon)	261
<i>Cambarellus montezumae areolatus</i> (Faxon).	262
<i>Cambarellus montezumae occidentalis</i> (Faxon).	262
<i>Cambarellus chapalonus</i> (Faxon)	262
General Considerations Concerning the Present Distribution of the Crayfishes of Mexico	264
Bibliography.	273

Introduction

The present thesis consists of a résumé of the studies made concerning the Mexican crayfishes which have appeared in various volumes of the *Anales del Instituto de Biología de la Universidad Nacional Autónoma de México*. They represent a continuous effort throughout most of 10 years, obtaining systematic collections in the type localities of species previously described and in other areas from which we have obtained new forms. The redescription of some of the species established by other authors, for which it was necessary to describe in more detail and precision, and descriptions of the species and subspecies of new discoveries by me constitute only a small portion of what must be learned concerning the Mexican crayfish fauna, one surely very rich in endemic species.

My task began with the redescription of *Cambarellus montezumae montezumae* and some of its new subspecies, and as the possibilities for collecting arose, the acquisition of crayfishes has been increased and progressively augmented. As a result of this work, at the present time the Mexican crayfish fauna is represented by 37 to 40 known species of which 16 were described by foreign authors.

The crayfishes are freshwater decapod crustaceans which populate a large part of the streams and lacustrine deposits of Guatemala, Mexico, Cuba, and the United States. Some have become adapted to cave life; others dig burrows in wet earth, in which they endure, as a result of their great biological resistance, unfavorable environmental conditions. Almost all of them have nocturnal habits, and in the darkness they crawl about the streams in search of food; during the day, they remain concealed beneath stones or debris, or within the tunnels which they have made.

I must confess that little progress has been made in Mexico in studying their biology and only by analogy with the studies conducted in the United States have I been able to verify many details of their mode of life, but I have had the opportunity to observe some peculiar habits of the Mexican species during my investigations.

In this monographic study, all of the work that has been accomplished since the original investigations of the crayfishes of Mexico has been brought together: their taxonomic relationships and geographic distribution, including moreover descriptions of the species and keys to

them and to the genera to which they belong. It is important to notice that the study of this group in Mexico has not been exhausted; instead, this report forms a base for other colleagues who wish to pursue these studies and who may take into account the information that has been brought together. It would give me much pleasure to know that other persons have become interested in the Mexican crayfishes, and I shall be pleased to place at their disposal the collection of the Institute, my notes, and the experience that I have acquired.

Introductory Part

Methods of Collection and Preservation

The labor of collecting the crayfishes requires a certain knowledge of the habits of these crustaceans. Of course it is important to know that they are never found in large rivers but rather in moderately flowing streams and in standing water. In regard to the lake deposits, these crustaceans prefer banks where there are aquatic plants. On some occasions they are found in tunnels which they have dug, under stones, or among submerged debris.

Three types of habitats may be established in respect to the crayfishes :

- I. The lotic environment.
- II. The lentic environment.
- III. The hypogean environment.

The lotic environment comprises the currents of small streams the waters of which are generally clear, and in which submerged vegetation is represented by *Vallisneria*, *Sagittaria*, *Chara*, and others. Examples of these conditions, in general terms, may be found in the streams in the region of Huachinango, Necaxa, and Villa Juárez, Puebla.

The lentic environment encompasses bodies of water that form small pools, as well as bodies of water in the lake regions. In them there is no current, and the water may be clear or somewhat turbid. Along the shore emergent plants are abundant, such as *Nymphaea*, *Typha*, *Sagittaria*, *Eichhornia*, *Utricularia*, *Lemna*, and others. The submergent vegetation is represented by *Myriophyllum*, *Chara*, *Nitella*, *Potamogeton*, *Pontederia*, *Elodea*, and others. Several localities in Mexico provide such conditions, for example Xochimilco, Texcoco, Pátzcuaro, Lerma, etc.

The hypogean environment is represented by :

- A) The burrows which some species of these crustaceans dig, and
 - B) The grottoes and caves which the crayfishes invade, either occupying them as temporary refuges, or becoming permanently
- 2 established in the dark environment, with the consequent transformations that occur in this special environment.

The burrowing crayfishes are found generally in the coastal plain of the Atlantic slope, for example in Campeche, Tabasco, and Veracruz. Principally, the species of the *mexicanus* Group exhibit this habit. We suppose that they take refuge under ground during the dry period, digging more or less deep tunnels, which may be recognized by small

mounds constructed of material which they dig from the ground. These mounds are conical, and generally an individual constructs two of them for each burrow, each corresponding to an opening as occurs in the case of *Procambarus ruthveni*. The two openings are continuous with the respective tunnel by forming the rami of a Y, which join together to give rise to the principal gallery. We believe that the two openings serve to accumulate on the surface of the soil the material that they remove in the construction of the burrow to the required depth to find sufficient humidity. We assume that remaining in the burrow is a means of enduring dryness and lowering temperature.

The cavernicolous crayfishes are troglonexes or troglobites. The former are those that seek water in the caves where they may live until the dry period ends. We have observed such in Cueva Chica, in San Luis Potosi, and in the cavern of Zapulta, in Chiapas.

As for the troglobites, they include all of those species of crayfishes that have become definitely established in the cave environment such as has happened in Cueva de Ojo de Agua Grande in Córdoba, Veracruz, or in Cerro Hueco, Tuxtla Gutiérrez, Chiapas. It is easy to distinguish one from the other: the former retain their color and exhibit no adaptive characteristics, whereas the latter are whitish in color and have a tendency to lengthen the segments of the legs; their antennae are very long and the eyes greatly reduced, or at least there is a reduction in the pigment of the cornea. We are able to cite two species that are typical cavernicoles: *Procambarus rodriguezii* Hobbs and *Procambarus mirandai* Villalobos.

The methods of capture vary considerably with the habitat and habits of these crustaceans. If the crayfish live in streams, it is advisable to look for them at night with the aid of a hunting light and a small hand net. Search during the day in such situations is conducted by dragging a strong dip net among the submerged detritus or in the mud or among the vegetation. In the water of lakes, collecting is apparently easiest, because with a net one is able to collect these crustaceans among the plants along the shore. The burrowing crayfishes, as we have said before, dig tunnels in the moist earth; in order to collect them, one looks for those holes which are nearer the water, because there the muddy consistency of the ground makes the operation of digging easier. With the hand one follows the direction of the burrow, removing at the same time the mud in order to enlarge the hole. It is very important in this type of collecting to use the sense of touch of the fingers, because only in this manner is it possible to follow the tunnel to its end and locate the crustacean. We have tried to use a hoe and a shovel, but almost always the tunnel was lost and the results were, in general, unfruitful.

On numerous occasions I have used the technique of baiting which

consists of nothing more than a slender stick, with a piece of meat attached to one of its ends, which is submerged in the water near the cavities among rocks. Soon the crustaceans come to it to eat, and, after a short time, the stick is lifted gently with the animals attached to the meat on which they are feeding; once they are within reach, they can be taken with ease; this operation can be facilitated by using a small hand net.

Traps similar to those that are used in capturing freshwater shrimps have provided favorable results. One should study the way in which the crayfish are able to enter them, because their use would be very profitable to the collector.

On some occasions we had to pump the water out of puddles where we supposed crayfishes occurred, but there are very few opportunities for anyone to use such equipment. The result of using this method is very satisfactory.

The specimens collected are preserved in jars containing 70 per cent alcohol which, although completely removes the original color, leaves the animal perfectly pliable, permitting the manipulations necessary for study. We have abandoned preservation in formalin owing to the hardening of the articulations of the legs and to the decalcification of the integument. Only when we need to preserve the natural color do we use this fixative in a low concentration.

The sediments which remain in the jars have considerable value, because accumulated in them are the epizoites, such as ostracods and branchiobdellids, greatly appreciated by the specialists of such groups.

4 The jars with the collections carry a label on which the following data are recorded :

Common name _____

Scientific name _____

Locality _____

Collector _____

Date _____

Sex _____ Notes _____

In the line of "Notes," the catalogue number is placed.

In order to form the catalogue number, as well as filing the data referring to the collection, we have followed the system established by Horton H. Hobbs. Thus the catalogue number is formed in the following manner: if the material was collected on 11 December 1953, the catalogue number would be 12-1153. The two primary digits correspond to the number of the month; following them, a space is left or a dash inserted, after which there are four digits; the first two

correspond to the day of the month; if the day is a single number, a zero is placed before it; the following numbers correspond to the year in which the collection was made. If several collections are made during the same day, to this catalogue number an ordinal number is added which corresponds to the collection: 1st, 2nd, 3rd, etc. In a few cases we have found two or more species in the same locality; when this happens, the ordinal number of the collection is followed by an (a) or a (b) which is equivalent to the corresponding species.

The data are recorded in the field book in the following manner :

In the upper left margin the catalogue number, and immediately below, the name of the locality. In the right upper margin the data and below it the District, Province, or State, etc., that corresponds to the locality. Detailed below are the location of the locality and its characteristics; those species that were captured and their habits; in addition, any other data that seem pertinent. Finally, the collector who participated in the capture.

For example :

11 - 2450 - 2

Gruta de Zapatula [= Zapaluta]

Friday, 24 November 1950

Comitan, Chiapas.

The cavern is situated 28 to 30 km south of Comitan, Chiapas. It is
5 enormous and clearly corresponds to the subterranean course of a river. Within it, approximately 300 m from the entrance, and in a side stream on the right, we found several specimens of crayfish. Possibly they may be found in all of the situations in which the water is tranquil, but there are difficulties in collecting them due not only to the depth of these pools, but also to the enormous stones under which they hide. Most of our specimens were obtained in the side stream, because there the pools are very small and collecting was relatively easy.

Certainly they approach *Procambarus pilosimanus* (Ortmann), but their identity will be established when they are compared with the collections from Villa Margaritas, Chiapas.

The appearance of the crayfish seems to have no relation to the cavernicolous habitat. Perhaps they were dragged along by the subterranean current, or they sought refuge in this place because the outside stream bed became dry. For that reason, I am able to affirm that they are troglonexes.

Collected by Villalobos

Cataloguing on cards follows more or less the same system. The cards are 3 by 5 inches and are printed in the following manner:

Scientific name		Catalogue Number
Determined by		State
		Town or Municipality
_____ Males I	Number in jar.....	_____
_____ Males II		_____
_____ Females		_____
_____ Immature Females		Collector
_____ Females with eggs		Collection

In order to study the species, the types are selected and placed in a separate jar with the corresponding data. The first pleopods of the first form male and those of the second form are stored in a homeopathic vial with 70 per cent alcohol, and, with their respective label, they are included along with the types.

Taxonomic Position

The crayfishes constitute the subfamily Cambarinae of the family Astacidae.

According to Calman (1909), the suborder Reptantia comprises two Sections: Palinura and Astacura; the latter has the following diagnostic characters: Abdomen extended; exoskeleton thick; pleura and uropods well developed. Cephalothoracic shield not fused with the epistome. Rostrum well developed. Exopodite of maxillipeds with flagellum directed forward. First three pairs of pereopods with chelae or pincers. Without appendix interna on the pleopods. Exopodites of the uropods divided by a suture. Gills numerous.

The same author, according to his taxonomic system, established the tribe Nephropsidea for this Section, and in it proposed the following families:

- I. Nephropsidae.
- II. Parastacidae.
- III. Astacidae.

The closest antecedent of this classification of the Astacura is found in the study by Huxley (1878) on his work concerning the classification and distribution of the "crayfishes," in which he proposed, according to the arrangement of the gills, a separation of these crustaceans into two families, Potamobiidae and Parastacidae.

The parastacids constitute a separate family according to the following characteristics: 1st, by the absence of appendages from the first abdominal somite; 2nd, by the possession of branchial setae terminating in hooks, and 3rd, by the geographic distribution, restricted to the Southern Hemisphere.

Faxon (1898) considers the parastacids as a subfamily (Parastacinae), included in the family Astacidae, but he gives no reason for doing so. Later, the same author (1914) considered the parastacids an independent family while the family Potamobiidae was divided into the Nephropsidae and Astacidae, suppressing the family Potamobiidae, as Calman had done.

7 With regard to the family Astacidae, two subfamilies have been recognized: Astacinae and Cambarinae (Hobbs, 1942b). However, we found a genus of Asiatic Astacidae which occupies an intermediate position between them; it shares characters of the Astacinae and

Cambarinae, and for it we propose the creation of the subfamily Cambaroidinae in which the following diagnostic characters are applicable.

Sixth somite with epipodite lacking branchial filaments. Rudiments of pleurobranchs on somites, X, XI, and XII: Pleurobranch present on somite XIII.

These characters establish the differences in the gill formula in the Astacinae and Cambarinae, [the Cambaroidinae] remaining an intermediate form between these two subfamilies.

In the presence of hooks on the ischiopodites of the second and third pairs of pereopods, as well as by the possession of small dentiform or styliform tubercles on the apical part of the first pair of pleopods of the male, the cambaroidines are near the cambarines. In contrast, the incomplete transverse suture of the telson is a character of the Astacinae of the western part of North America and of the Parastacidae. The first abdominal somite of the female lacks appendages, a characteristic of the parastacids and the astacids of North America.

In summary, the systematic position of the Astacura is as follows:

SECTION ASTACURA

Tribe Nephropsidae

Family Nephropsidae

Family Parastacidae

Family Astacidae

Subfamily Astacinae

Subfamily Cambaroidinae

Subfamily Cambarinae

Distribution of the Parastacids and Astacids in the World

The studies concerning the geographical distribution of the parastacids and astacids made by Huxley (1879), Faxon (1885a), and Ortmann (1902, 1905a, 1906), show that there is an interesting morphological relationship between these crustaceans. In effect, two well-defined distributional areas can be established: one which corresponds to the Southern Hemisphere and the other to the Northern Hemisphere, separated by an equatorial region where until now no species of the two families have been found. In the Northern Hemisphere, species of three subfamilies of Astacidae are found: Astacinae, Cambaroidinae, and Cambarinae; whereas south of the equator there are only species of the family Parastacidae. Among the most outstanding morphological characteristics that can be mentioned as differentiating between the astacurans that populate the two areas, we conclude that the parastacids of the Southern Hemisphere have a more complete branchial apparatus than the astacids of the Northern Hemisphere.

Parastacids of the Southern Hemisphere. The parastacids that inhabit the Southern Hemisphere, with the exception of the Continent of Africa, are considered to constitute an independent family, the genera of which have a complete branchial apparatus (20 to 21 gills), with the exception of *Astacoides madagascariensis* [sic], the gills of which occur in a distinctly reduced branchial formula (12 gills).

The currently known Australian genera and their distribution are :

A) Genus *Astacopsis*. It is distributed in the tributaries of the Murray River and is limited to the southeastern part of Australia. Its species, as a rule, are located in moderate climates and in clear streams. It is not known, in contrast, near the coasts or in bodies of water that are not flowing.

B) Genus *Engaeus*. It is derived from *Astacopsis* and has a branchial complement similar to that of the latter. They are burrowing animals, and hence possess a high degree of specialization. They are found in Victoria, Gippsland, and Tasmania.

C) Genus *Cheraps*. With two tropical and subtropical species which inhabit sluggish rivers and turbid waters. It is dispersed along the west coast and northern Australia, as well as in New Guinea and Aru Island.

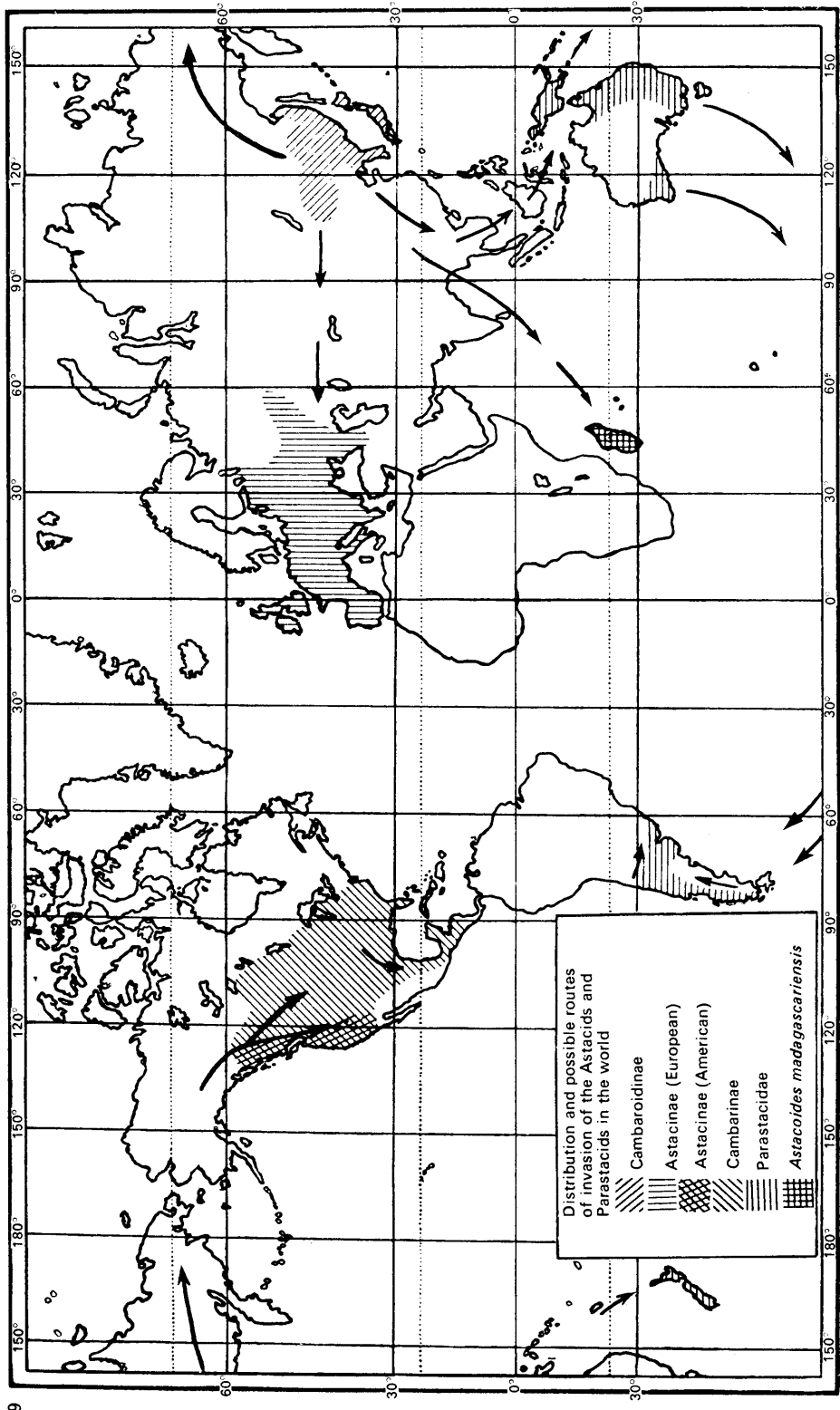


Plate I.

The subgenus *Paracheraps* is adapted to desert conditions which prevail in central Australia.

The genus *Paranephrops*, occurring in New Zealand, comprises species that differ considerably from the Australian forms. One species of this genus is found in the Fiji Islands.

Among the fauna of Madagascar we find a parastacid known as *Astacoides madagascariensis*, which as stated above, has 12 gills on each side.

In South America, the parastacids which are represented by the genus *Parastacus*, have close relationships with the parastacids of 10 Australia. The species of *Parastacus* are distributed in northern Argentina, Uruguay, and southern Brazil but have not been observed to occur in waters east of the Andes in the river systems of the Orinoco or of the Amazon. In contrast, they are found on the Pacific slope, west of the Andes, in the fresh waters of Chile.

Faxon has pointed out the occurrence of a parastacid, *Parastacus varicosus*, in Mexico, giving the locality as the State of Colima; at this time, in spite of carefully searching for this species, we have not been able to locate it. We are inclined to believe that the occurrence of a South American genus in such a northern locality in México is impossible. Moreover, we have no reports of collecting species with close affinities even in the southern part of Mexico.

Astacids of the Northern Hemisphere. For geographic distribution, we consider them in five principal groups :

I. The astacines that are found in the western part of the Eurasian Continent from the Ural Mountains and the basin of the Aral Sea to the Iberian Peninsula, Great Britain, and Ireland.

II. The astacines that occur in the northwestern part of the United States from the Rocky Mountains to the Pacific coast.

III. The cambaroidines that live in the Amur Basin, Japan, and Korea.

IV. The cambarines that populate the northeastern part of North America, from the Rocky Mountains to the Atlantic and from the southern part of the Great Lakes in North America to the northern part of Central America and Cuba.

V. The European cambarines [astacines].

I. Eurasian Astacines

They are found in the British Isles and Ireland; on the other hand, they do not occur in Scotland (Huxley). It seems that in England the astacines abound in the Thames, but they have not been collected in the Cam or in the Ouse. In central Europe they frequent the streams that flow into the Baltic, the North Sea, and the Atlantic. In the Iberian

Peninsula, they are found on the Atlantic and Mediterranean slopes, and sometimes in the Cantabrian. They frequent, moreover, the Pontocaspian Basin, occurring in the fluvial systems that empty into the Black and Caspian seas. Also, they are distributed in the brackish waters of the Dnieper and Bug rivers which empty into the Black Sea, as well as
11 in the upper part of the Rion River which descends from the Caucasus and flows into the Black Sea. In Russian Turkistan, they populate the Syr Daria which flows into the Aral Sea.

II. American Astacines

Circumscribed on the western slope of North America (British Columbia, Oregon, and California) are hydrographic systems that empty into the Pacific. Systematically the crayfishes are grouped with the European Astacinae and were considered to be members of the genus *Astacus*. Bott (1950), however, established the genus *Pacifastacus* to encompass these species.

III. Asiatic Cambaroidines

The genus *Cambaroides*, consisting of four species, occurs in the northeastern part of Asia, in the Amur Basin, Korea, and Japan; morphologically they have closer affinities with the astacines of North America than with those of Europe.

It is important to realize that in the central and southern parts of the Asiatic Continent, in the southern part of the Amur, in India, Persia, Arabia, and Syria, no representatives of the astacines are known to exist. Neither have they been reported to occur in any part of Siberia, between Lake Baikal and the Ural Mountains nor in the rivers of northern Asia such as the Obi, Yenisei, and Lena which flow into the Arctic Ocean.

IV. American Cambarines

The astacids of the subfamily Cambarinae occur in the eastern part of the United States, throughout Mexico, and the northern part of Central America. The range is circumscribed by the Great Lakes on the north, the Rocky Mountains on the west, and Guatemala on the south. The island of Cuba is included within this area.

V. European Crayfishes

The presence of a blind species of the genus *Cambarus*, *C. typhlobius* Joseph, similar to the genera which inhabit the Atlantic slope of North

America, in the caves of Carniola is of importance, for this species may be considered as a relict of the cambarines which in other epochs populated Europe.

- 12 Also, it is desirable to note that in the Valley of the Seine, in France, an American species of crayfish has been collected, possibly introduced by man, which has found there a congenial habitat.

Paleontological Origin of the Astacura and Their Possible Emigrations (Plate 1)

Huxley and other zoologists were in accord in believing in the possible existence of an astacuran prototype which in remote epochs lived in a marine habitat and had a broad distribution; it was conceived that this prototype was very similar to a parastacid, and Huxley has designated it *Protastacus*. The fossil remains of a crustacean found in the lower Cretaceous of Westphalia (*Astacus politus* Van der Marck and Schlütter) form a good base to sustain this theory. From this prototype, with its perfectly defined characters, arose two branches, one that gave rise to the northern astacid type, and the other to the southern parastacid type. Later these types took an active part in the invasion of the continents, following the river courses, and becoming established in the hydrographic drainages where they evolved independently. In the meantime it is believed that the *Protastacus* trunk became extinct.

On the other hand, A. E. Ortmann believed that the ancestors of the recent Astacura had a single origin (following Arldt, deriving them from the nephropsids). In order to explain this theory the author dated the event at an earlier time, at the end of which the earth's crust was composed of two large masses, one which formed the continent of Gondwana in the Southern Hemisphere, and the other in the Northern Hemisphere and equivalent to the continent of Angara. The two continents were separated by a central sea (Tethys Sea). The continent of Angara was situated in the Siberian territory embracing the Yenisei and Lena and existed throughout the Mesozoic; Ortmann referred to it as the Sinoaustralian continent and believed that for the duration of the Jurassic it was composed of eastern Asia, the Indomalayan Archipelago, and Australia and that the southern part was in contact with Antarctica. Under such conditions, Ortmann proposed the possibility that an ancestral group of the Astacura existed throughout the lower Cretaceous in some place along the coast of eastern Asia, this being then the area of the earth where these animals first appeared. The cambaroidines of the Amur-Japanese area should be considered then as the most direct descendants of this primitive trunk.

13 With the disappearance of the Tethys Sea, during a very long epoch of the Tertiary there followed the formation of extraordinarily large, freshwater lakes with an accompaniment of small lakes which were situated in a large part of southern Asia, occupying what is now known as the Gobi Desert; in the meantime, a continuous cloak of fresh water covered the entire plain of Turkestan. Such conditions favored without doubt the dispersal of the astacids of Europe.

In the meantime, during the beginning of the Jurassic, the continent of Gondwana, which had existed in toto through the Triassic, began to divide into two parts by the sinking of the Mozambique Channel, forming another continent, the Archihelena which encompassed Brazil and tropical Africa and with a Lenorian peninsula which extended from Madagascar to India. This explains the distinct morphological characteristics of the genus *Astacoides*, which populates Madagascar, the independent evolution of which began in ancient times.

Ortmann thought that two branches arose from the ancestral trunk, one of a southern origin which gave rise to the *Cambaroides* and Parastacidae trunk, and the northern one which gave rise to the *Astacus* group.

The ancestral group of *Astacus* is believed to have given rise to the astacids of Europe and North America by emigrations to the west across central Asia and to the east crossing Bering Strait. This migration occurred during the Eocene.

The ancestral branch of the Parastacidae invaded the southern part of the east coast of the continent of Gondwana, and, in the upper Cretaceous, when the separation of Australia began; this branch remained completely isolated from the rest of the continent, initiating its evolution independently to give rise to the Australian, New Zealand, and South American genera.

The South American *Parastacus* invaded South America across Antarctica which was connected, until the end of the Cretaceous, with Tierra del Fuego on one side and Australia on the other. Therefore, already in the upper Tertiary, the parastacids had extended across Archinotis into Chile, northern Argentina, and southern Brazil.

The American Astacines

As has already been explained, they were located to the west of the Rocky Mountains, in the basins of the rivers that empty into the Pacific. On the basis of their characteristics they are considered very close to the European astacines, and consequently all the species remain grouped within the genus *Astacus*. (*Pacifastacus*, following Bott.)

14 The intercontinental bridge that existed from the Cretaceous until

the mid-Pleistocene and that joined Alaska with Siberia is believed to have been the obligate route of the invasion, across which the astacines, derived from the primitive Asiatic trunk, arrived to populate western North America. The presence of fossil remains which date from the Tertiary, as for example *Cambarus primaevus* Packard located in upper Tertiary deposits of western Wyoming, serves as a base for this theory.

The American Cambarines

At the present time they occupy all of the eastern part of the United States, from the Rocky Mountains to the Atlantic watershed, following moreover all of the territory of the Mexican Republic and the northern part of Central America and Cuba. It is thought that this group was derived from the American astacines, from a type inferior to the present members of the genus *Astacus*, which by losing the single posterior pleurobranch, gave rise to the cambarine form with 17 gills on each side (*Astacus* has 18 gills). Moreover, the male cambarines had perfected the first pair of pleopods for the function of reproduction.

Following the opinion of Ortmann, *Cambaroides* is most closely allied to the genus *Astacus*, and the similarity to the American crayfishes is no more than a phenomenon of convergence. Other authors consider *Cambaroides* as an intermediate form between *Astacus* and the genera of the subfamily Cambarinae.

At the present time, the American crayfishes comprise the following genera: *Procambarus*, *Cambarus*, *Paracambarus*, *Cambarellus*, *Orconectes*, and *Troglocambarus*. The number of species of these genera as now conceived and their distribution in North America, Mexico, and Guatemala take us away from Ortmann's ideas in respect to the migrations that took place between the areas where these species are found. Of course we uphold the idea that there was a continuous migration from north to south, as environmental conditions favored the distribution. Possibly the most primitive species, *Procambarus digueti*, as considered by Ortmann, Faxon, and Hobbs, arrived and became established in the Republic of Mexico between the middle or upper Cretaceous; the same happened with *Procambarus bouvieri*. The genus *Cambarellus* also was able to have migrated to the south approximately during the Senoniano of the upper Cretaceous. With regard to the species that populated the Atlantic watershed, they could only have become established there when this part of Mexico was formed, that is
15 to say, between the Oligocene and the Pliocene of the Cenozoic Era. For such reasons, we consider that the group of species related to *Procambarus mexicanus* are the most modern representatives, and, as we

have proved, they are the ones that have the greatest evolutionary potential.

In the discussion of the geographical distribution of the Mexican crayfishes at the close of this work, a detailed analysis is made in which we sketch the bases of this theory.

History of the Study of the Mexican Crayfishes

The first study of the Mexican crayfishes was conducted by W. F. Erichson in 1846 and in it he described two new species, *Astacus (Cambarus) weigmanni* [sic] and *Astacus (Cambarus) mexicanus*. The locality cited in this work is "Mexico." In the case of *A. (C.) weigmanni* [sic], the collector was Von Deppe, but who collected the second is unknown.

It should be pointed out that the types deposited in the Berlin Museum have disappeared.

In the year 1857, Henri de Saussure described another two species under the names of *Cambarus montezumae*, collected from Chapultepec in the Valley of Mexico, and *Cambarus aztecus*, the locality of which is Tomatlan (without doubt in the State of Veracruz; although it was not specified, he stated that the specimens were collected in the rivulets of the warm areas). According to this author, the latter species shows similarities to *Astacus (Cambarus) mexicanus* Erichson, but on the basis of certain differences it was described as new.

Dr. Herman A. Hagen, in 1870, wrote a magnificent monograph on the North American astacids and the interest which it has for us lies in the attention he gave to Erichson's species, transcribing the original description of *A. (C.) weigmanni* [sic] in Latin; at the same time he assigned to this species a female, collected by Mr. Pearse [Peace], about which he made some observations. Also, he discussed the annotated data by Saussure in the description of *Cambarus montezumae*, adducing that there was an error in the observation of the French author in respect to the position of the hooks on the legs.

After publishing this work, Dr. Hagen visited the Berlin Museum and made certain that the types of the species *mexicanus* and *weigmanni* [sic] described by Erichson were lost; also he had the opportunity to
16 observe the type of *Cambarus montezumae* and recognized that the character of the hooks of the appendages as stated by Saussure was correct.

In 1897, Mr. E. L. Bouvier published a list of the arthropods that Diguët had sent to him from Mexico, and at the same time described a new species, *Cambarus (Procambarus) digueti*, which came from Rio Santiago, in the State of Jalisco.

In 1898, W. Faxon published his observations on the astacids

preserved in the U.S. National Museum and the Museum of Comparative Zoology, describing a new species: *Cambarus carinatus* which proved to be a synonym of *Cambarus (Procambarus) digueti* Bouvier. Also, he recorded new localities for *C. montezumae*. He discussed, moreover, the validity of a variety of the species established by Von Martens on specimens collected in the State of Puebla. *C. montezumae* var. *tridens* Von Martens was established on the basis of the three spines on the rostrum, since in the original description by Saussure one of the specific characters cited was the lack of lateral denticles on the rostrum. Faxon explained that the three rostral denticles occur in the juvenile forms. In a study made of specimens from the type-locality, we found that the rostral denticles seem as well developed in the adult specimens as in the juveniles, males or females, and only occasionally are the rostral borders smooth.

Faxon describes in this work the following subspecies: *Cambarus montezumae dugesi* and *Cambarus montezumae occidentalis*, collected in Guanajuato and Mazatlán, respectively; and a new species *Cambarus chapalanus* obtained from Lake Chapala in the State of Jalisco.

Dr. A. E. Ortmann, in 1902, published a study concerning the geographic distribution of the freshwater decapods and its relationship to ancient geography. In it he gives an interpretation with respect to the crayfishes, within the general concept of the group, of the possible origin and distribution of these crustaceans.

Later, the same author devoted himself to a study of the affinities of the species of the genus *Cambarus (sensu stricto)* and its dispersal in the United States. This memoir was published in April 1905. Both works have served for the modern interpretation of the origin and distribution of the Astacura, but for the very limited number of species of crayfishes known at that time, the interpretation of Ortmann differs from our opinion, as we explained earlier.

In 1905, A. E. Ortmann published the description of a new species, ¹⁷ *Cambarus (Procambarus) williamsoni*, the specimens of which were collected in Guatemala. The importance of this citation lies in the establishment of a new subgenus, *Procambarus*, of the genus *Cambarus* in which the Mexican species *digueti* and *mexicanus* are still placed.

In 1906, the same author revised the Mexican, Cuban, and Central American astacids; in this work he described another new subgenus of the genus *Cambarus*; we refer to the subgenus *Paracambarus* with a single species *Cambarus (Paracambarus) paradoxus*. The specimens were obtained from the Sierra de Zacapoaxtla, Puebla. Moreover, he recorded new localities for *Cambarus (Procambarus) mexicanus* and *Cambarus (Cambarus) weigmanni* [sic] (Erichson).

In the year 1911, the University of Michigan organized an excursion to the State of Veracruz obtaining eleven new species of crustaceans,

among them a crayfish, described by A. S. Pearse as *Cambarus ruthveni*, dedicated to Dr. A. G. Ruthven, director of the expedition. The locality of this species is the Hacienda de Cuatotolapan at the foot of the mountains of San Andres Tuxtla; also collected were other specimens classified as *Cambarus pilosimanus* Ortmann taken from Laguna de Catemaco in San Adrés Tuxtla; this species had been described from Guatemala by Ortmann.

The last revision of W. Faxon, published in *The Mem. of the Mus. of Comp. [Zool.] at Harvard Coll.* in 1914, presents a list in which are included the Mexican crayfishes known at the time, annotated synonymies, and new localities.

Creaser (1931) described a new species of crayfish, *Cambarus (Procambarus) contrerasi*, collected by him during an expedition in the region of Papantla and Villa Juarez in the states of Veracruz and Puebla, respectively. The locality for this species is Agua Fria in the State of Puebla. In his description he indicated that he was not able to collect female specimens, consequently, the female allotype was unknown.

Dr. Enrique Rioja L. published a study in 1940 in which he treated a case of biocenosis observed on *Cambarus (Cambarellus) montezumae* (Saussure). It treats a study of the Branchiobdellidae, *Bdellodrilus illuminatus* (Moore), an oligochaete annelid that lives in the branchial apparatus of this crustacean. Moreover, he related the presence of an epizoic ostracod which resulted in the initiation of a series of interesting works on the subfamily Entocytherinae, the habits of which are linked to the cambarines on which they are found.

18 In the famous expedition of the *New York Aquarium Cave Expedition* to Cueva Chica in San Luis Potosí, interesting specimens of crayfishes were obtained, which later in 1941, H. H. Hobbs studied and described as *Cambarus blandingii cuevachicae*. Although these specimens were found in the cave, Hobbs indicates that there are no characteristics that denote that they are troglobites. Later, we obtained from the vicinity of Valles near the region of Cueva Chica, specimens of the same subspecies, living normally in puddles and streams.

In 1942, Horton H. Hobbs, Jr., published a revision of the astacids of the subfamily Cambarinae. In this there is a historical account of the genera and subgenera previously established, presenting in a table a summary of the generic and subgeneric changes from 1870 to 1941.

The subgenera of Ortmann, *Procambarus*, *Paracambarus*, *Cambarellus*, *Cambarus*, and *Faxonius* are elevated to generic rank. In regard to *Orconectes*, it has come to replace the subgenus *Faxonius*.

From our point of view, this arrangement was made at a propitious moment, because the number of known species up to 1941, as well as the subgenera and the groups established by Hagen, Ortmann, and Faxon, constituted a problem in the taxonomy of these crustaceans.

Summary of the generic and subgeneric changes (1870 - 1941)*

	Hagen 1870	Faxon 1885	Ottmann 1905 - 6	Fowler 1911	Faxon 1914	Creaser 1933	Lyle 1938	Generic names recognized in this work
Group III in part			<i>Procambartus</i>	<i>Procambartus</i>	Group I			
Group III in part	Group I				Group II		<i>Girardiella</i>	<i>Procambartus</i>
Group I in part	Group II		<i>Cambartus</i>	<i>Ottmannicus</i>	Group III			
.....	.....	.....			Group IV			<i>Paracambartus</i>
.....	Group V		<i>Paracambartus</i>	<i>Paracambartus</i>	Group V			<i>Cambarellus</i>
Group II	Group IV		<i>Faxonius</i>	<i>Faxonius</i>	Group VI	<i>Faxonius</i> as a generic name		<i>Oronectes</i>
Group III in part	Group III		<i>Bartolinius</i>	<i>Cambartus</i>	Group VII			<i>Cambartus</i>
.....	.....	.....	.....	.....	.....	.....	.....	<i>Troglocambartus</i>

* Horton H. Hobbs, 1942.

Because of the importance of this table, we include it in its entirety, for in it, it is easy to observe the changes mentioned above and their correspondence to the currently accepted genera.

In 1943, we initiated a study of the crayfishes of our country (Villalobos, 1943). The first contribution consisted of observations on *Cambarellus montezumae* (Saussure), some of its forms, and the description of a new subspecies collected in Lago de Pátzcuaro. With the previous knowledge, that in the original description Saussure described the crayfish collected in Chapultepec with a rostrum lacking spines, we were able to observe that there is a complete series of intermediate forms in lots collected in the same locality, where the majority of them show a tridentate rostrum, and only in a very small percentage does the rostrum lack such structures; other specimens, anomalies without doubt, exhibit a rostrum with a single lateral spine.

Comparing this species of Saussure with specimens from other localities, we found sufficient characters to establish new groups. In this work, moreover, a morphological study of *Cambarellus montezumae* is included.

20 In December 1939 [1940], the University of Florida organized an expedition to Mexico, visiting Tehuacan, Puebla, and Cordoba, Veracruz. In 1943, there appeared a work by Horton Hobbs, a member of that expedition, describing new crayfishes: *Procambarus tolteca* and *Procambarus rodriguez*, of which the latter has special interest because the locality is a cave called Ojo de Agua, in Potrero Viejo, near Córdoba, Veracruz.

In the years 1942 and 1943, we collected specimens of crayfishes in the region of Huachinango, Necaxa, and Villa Juárez, Puebla, the morphological characteristics of which induced us to describe two new species of the genus *Paracambarus*, which until that time had only a single species, *P. paradoxus* (Ortmann). In effect, we considered the presence of hooks on the ischiopodites of only the fourth pair of pereopods sufficient for including *P. riojae* and *P. hoffmanni* (Villalobos, 1944) in this genus.

In the collection of crustaceans of the Instituto de Biología, we have a specimen of crayfish collected in Villa Juárez, Puebla; the interest which it presented compelled us to organize a special expedition to this area, and there we were able to obtain sufficient material to permit us to make a study and describe a new species which was designated *Procambarus caballeroi*; its characteristics indicated that it should be included within the *blandingii* Group (Villalobos, 1944).

The presence of a monotypic genus among the Mexican crayfishes always stimulated us to look for other species of the same genus. Although initially we included *Procambarus riojae* and *P. hoffmanni* in the genus *Paracambarus*, we were dubious concerning their position, since

their characteristics agree better with those of members of the genus *Procambarus*.

A special excursion to the type-locality of *Paracambarus paradoxus* permitted us to obtain abundant material for redescribing it. Moreover, with specimens collected in Teziutlán, Puebla, we described a new species, *Paracambarus teziutlanensis*, in which we found characteristics very similar to those of *P. paradoxus* (Villalobos, 1947).

Another new species of the genus *Paracambarus*, *P. tlapacoyanensis*, was described from Barranca de Tomata near Tlapacoyan, Veracruz, with characteristics similar to those of *Paracambarus teziutlanensis* (Villalobos, 1947).

As we have noted, A. S. Pearse classified a crayfish collected in Catemaco, San Andrés Tuxtla, Veracruz, as *Procambarus pilosimanus* 21 (Ortmann), originally described from Guatemala. In the crustacean collection of the Instituto de Biología, we had a jar containing specimens of crayfish which on the appearance of their chelae, completely covered with hairs, corresponded to *P. pilosimanus*. The only obstacle to the final identification was the absence of first form males.

In 1947, we had the opportunity of leaving for Tuxtepec, Oaxaca, and there collected specimens of cambarines among which we were surprised by the capture of the species to which we are referring.

The careful study of the recently acquired material permitted us to confirm that the specimens, in spite of having the chelae covered with hairs, were very different from *Procambarus pilosimanus*. Given the different characteristics between Ortmann's species and the specimens from Tuxtepec, we decided to establish a new species which we called *Procambarus acanthophorus*, belonging to the *mexicanus* Section.

The excursions to the region of Villa Juárez, Puebla, were always productive for us, to such an extent that we consider it as the "Zone of dispersion."

In the month of February 1949, we visited the region of Zihuateutla, located to the southeast of Villa Juárez, Puebla. The material collected in this locality offered for our study four new species, of which one, designated by us *Paracambarus ortmanni*, clarified the situation of the species which previously we had placed within this genus, since the characteristics of the new species correspond precisely to it. On this basis we decided that *P. riojae*, *P. hoffmanni*, *P. teziutlanensis*, and *P. tlapacoyanensis* should be transferred to form a part of the genus *Procambarus*. The character of the hook on the ischiopodites of the fourth pair of pereopods had to be included in the generic diagnosis of *Procambarus* (Villalobos, 1949).

Regarding the revision of a group of species of the genus *Procambarus* employed in making the change mentioned above, it was published the following year (Villalobos, 1950).

In 1951, we obtained a lot of crayfishes from the state of Nuevo León which proved to be a new species of the genus *Cambarellus*, *C. alvarezii*. With this species, a faunistic connection was established between the crayfishes of Mexico and the United States in the zone existing between the two mountain ranges (Villalobos, 1952).

The first attempt of synthesis concerning the Mexican crayfishes was accomplished in a contribution presented at the Congreso Científico Mexicano, prompted by the IV Centenario de la Fundación de la Universidad Nacional Autónoma de México. In this were included almost all of the data concerning the Mexican crayfishes with a list of the localities from which the species were then known (Villalobos, 1953).

Without doubt, the most important aspect of the Mexican crayfishes is that concerning the assemblage of species related to *Procambarus mexicanus* (Erichson), which, because of the markedly uniform characteristics, forms a Section which we have designated *mexicanus*. The collections, made in more than thirty localities along the Atlantic versant from Jalapa, Veracruz, to Campeche, very near Yucatan, and in Chiapas, have disclosed the existence of a broad zone populated by this interesting group.

The study of this material has been carried on for more than a year, and the results, recently published (Villalobos, 1954), have permitted us to obtain very valuable data on geographic distribution, and at the same time have served as a basis for interpreting the possible immigration of the crayfishes from north to south. Also, because of the variations, we became aware of the fact that the *mexicanus* Section exists in a full state of evolution, a state that we corroborate by finding these crustaceans in diverse environments. In fact, the species that we consider to be completely adapted to cave life belongs to this group. Later, when we treat the species of the *mexicanus* group in this thesis, we shall point out reasons for deeming it important.

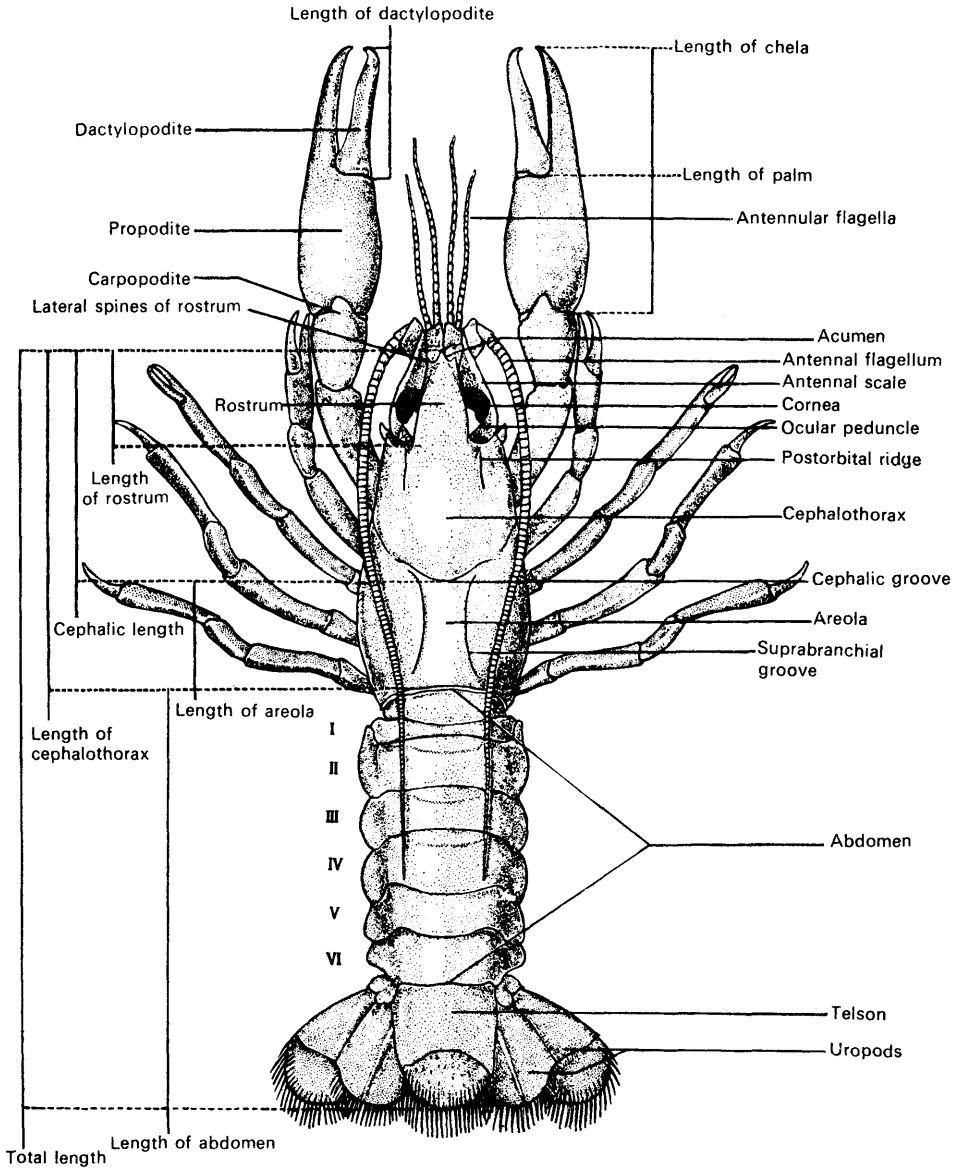
Monographic Study of *Cambarellus montezumae montezumae* (Saussure) (Plate 2)

In relation to the other species of the genus, these crustaceans possess a robust appearance, the carapace of the adult is more firm than that of the young; some are completely hidden by the muddy slime which adheres to its surface; but the normal pigmentation includes two faint, broad stripes, one on each side of the abdomen that extends to the cephalothoracic shield. In addition to these stripes, the pleural regions of the abdomen are also pigmented. Otherwise the chromatophores are evenly dispersed over the entire surface of the body, imparting to it a greenish-brown color.

The females are larger than the males and may be distinguished from them by the abdomen which is much broader and shorter. The proportions between the various body regions are: in the males the length of the carapace is equivalent to the distance from the cephalic end of the abdomen to the sixth somite, and in the females almost to the distal articulation of the anterior part of the telson. In both the males and females, the length of the areola is half that of the cephalic part of the carapace. Also in both sexes, the length of the rostrum is one-fourth that of the cephalothorax.

23 **Cephalothorax.** The cephalothoracic shield is compressed anteriorly, becoming slightly more massive posteriorly. Its surface is smooth but bears very small punctations which are sparse and widely dispersed, most conspicuous on the rostrum.

24 The rostrum is broad, tridentate, subplane, although slightly concave anteriorly; the acumen almost reaches the distal border of the second antennal segment. According to our observations in a large number of individuals, the rostrum exhibits variations that, within certain limits, are related to age and sometimes to the sex of the individual. The various forms that have been observed are the following: the juveniles exhibit a rostrum the lateral borders of which are almost straight, converging anteriorly, and terminating in sharp, slightly divergent marginal spines; the surface is subplane medially, and the lateral borders are elevated above the surface in the anterior region; the anterior part is rather narrow. In some adult females, the



Cambarellus montezumae montezumae (Saussure) 1857

lateral margins of the rostrum are subparallel, the lateral spines are transformed into angular structures, and the acumen is shorter and chitinized.

With regard to the lateral spines of the rostrum, there are few specimens that lack them; we have been able to verify such a condition in only two or three individuals, ones that agree perfectly with the description of the type by Saussure; this gives us an explanation as to why this species was placed in the second part of the work of this author (1858 – 64), including “Especies dont le rostre n’offre pas de dents laterales.”

In resumé, after observing a large number of specimens, we have reached the following conclusions:

I. That the absence of lateral spines on the rostrum is a character that occurs only rarely in the individuals.

II. That between the tridentate state of the rostrum and the unarmed, there exists a series of intermediate forms that may be arranged according to the following scheme (Plate 3); in the first place, we find the rostral form in which the lateral spines are present and sharply pointed; the lateral borders are straight and exhibit setae on the apical portion; such a rostral form is found only in the juvenile individuals (fig. 2). The second stage of the series is that of the rostrum of individuals of intermediate age in which the lateral borders are slightly curved in the posterior third; the lateral spines are obtuse and strongly chitinized (figs. 3 and 4). The third stage corresponds to the rostrum
25 without either the right or left lateral tooth, leaving in its place a rounded angle (fig. 5). Finally, we have the stage at which the rostrum has lost both lateral teeth (fig. 6); such a rostral form agrees completely with the figure accompanying the description given by Saussure. Thus there occurs a sequence of transformation to the form that lacks lateral teeth, but in general, the majority of the specimens of this species, instead of losing the lateral spines of the rostrum, tend to retain them (fig. 7).

Observing the ventral surface of the rostrum, it bears an infromedian keel which begins at the apical spine (fig. 1).

The postorbital ridges are located on the anterior part of the carapace, on each side of the rostrum; they end anteriorly in spines, the presence of which is not invariable, since abrasion transforms them into small, blunt tubercles; in contrast, the juvenile individuals exhibit perfectly developed ones. The postorbital ridges are almost parallel.

The areola is broad, and the branchiocardiac grooves that limit it are parallel except in the anterior and posterior parts where they diverge. Its width is always between 1.75 and 2.0 mm (Plate 2).

The cervical groove forms three very broad undulations dorsally.

The groove that delimits the hepatic region is discontinuous with the former and, moreover, deeper.

There is no branchiostegal spine.

Abdomen. In addition to the difference in width between the male and female, this region of the body has the following characteristics: The pleural margins are provided with short plumose setae. The anterior part of the telson is quadrangular and ends distally in two spines on each side. The ultimate part of the telson is almost semicircular (Plate 1 [2]).

Epistome. This is a broad plate which occurs in front of the mouth. It is triangular and the anterior angle is broadly obtuse. The lateral angles are rounded and the margins of the epistome are provided with setae (Plate 3, fig. 8).

Eyes. They stand out a little from the sides of the rostrum. The ocular peduncle is short and exhibits a contraction in the median part which divides it into two regions, an anterior one where the cornea occurs and a posterior thicker one in which the muscles and the ocular ligaments are inserted.

Cephalic appendages. The first pair of antennae, or antennules, consist of the peduncle and the antennular flagella (Plate 3, fig. 10). The antennular peduncle is composed of three articles. The basal one is in the form of a triangular prism, the edge situated externally and the base internally, it is broad basally; its upper surface is concave and on it rests the ocular peduncle; in the proximal articular region and on the same surface, a row of plumose setae is inserted and reclines on the surface of the article; these setae cover the opening of the auditory sac or otocyst, which is filled with small concretions. This first antennular article bears on its extreme distolateral part a series of six or eight long setae; situated on the lower internal surface near midlength of the article is a small spine which is directed anteriorly (Plate 3, fig. 9). The second and third antennular articles are much more reduced than the first, are flattened dorsoventrally, and the inner margins are provided with plumose setae. In regard to the antennular flagella, the internal one is slightly longer and heavier than the external one.

The second pair of antennae (Plate 3, fig. 11) comprises the protopodite, the exopodite, and the endopodite. The protopodite consists of the coxopodite and the basipodite. The first bears the orifice of the antennal glands on the lower surface. The basipodite is short; its internal border bears a spine which coincides with the external edge of the exopodite; the latter constitutes the antennal scale with its characteristic platelike appearance (Plate 3, fig. 12); its external border is slightly concave and terminates anteriorly in a spine; the internal margin is provided with plumose setae which are longest in the distal

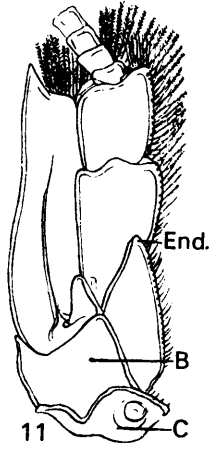
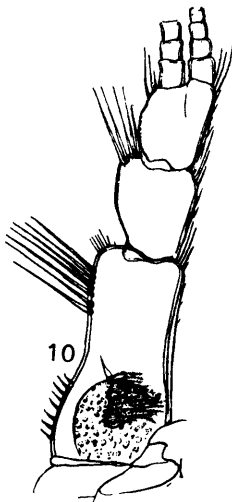
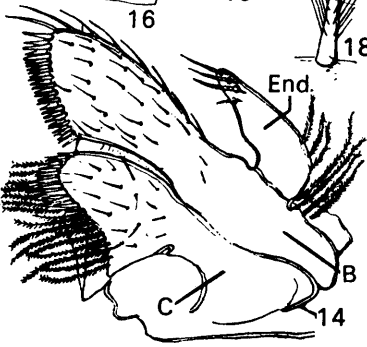
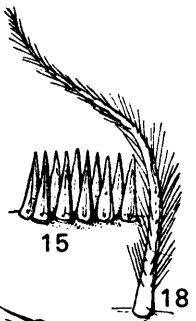
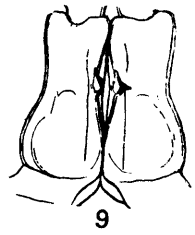
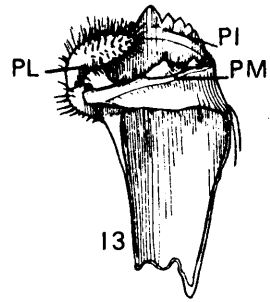
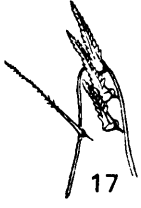
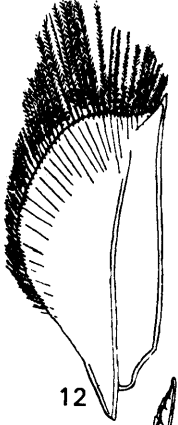
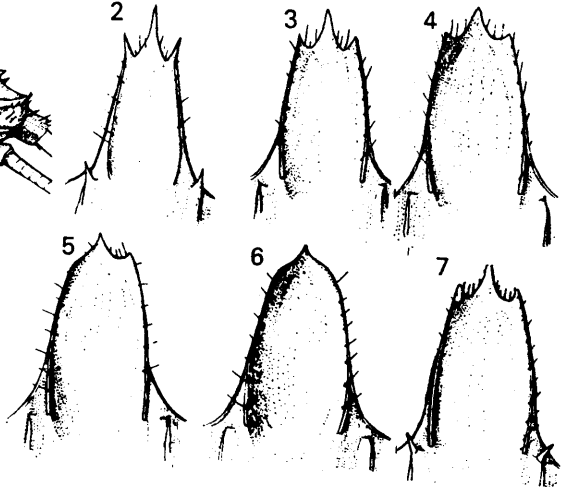
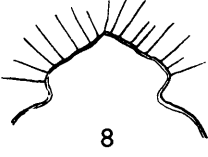
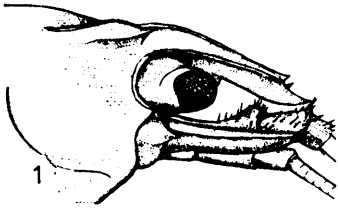
region. The greatest width of the antennal scale is near midlength and is equal to the length of the external margin; the internal surface bears a few striations that coincide with the position where the setae are implanted. The endopodite, on the other hand, consists of three articles of distinct form and size; the distal internal articular region of the basal article is produced into an acute angle that extends over the lower extreme proximal part of the middle article, the distal border of which is undulate. The last antennal article bears the flagellum which is subcylindrical and if bent over the body reaches the fourth abdominal somite.

The mandibles are unequal (Plate 3, fig. 13), consisting of two parts, the protopodite and endopodite. The protopodite, or body of the mandible, exhibits an incisor process formed by a triangular series of teeth (PI); the left mandible has one tooth which is larger than the others and the right, two. The molar process (PM) is perpendicular to the principal axis of the mandible; it bears three prominences, one large and the other two small; all of them are strongly chitinized, especially 28 the largest one. The mandibular palp (PL) or endopodite is triarticulate; the basal and the middle articles are short; the ultimate one is larger and its proximal articular part forms a right angle; all of them are armed with heavy, rigid setae, inserted irregularly on all surfaces; the ultimate article bears the longest and most abundant.

The first pair of maxillae or maxillules (Plate 3, fig. 14) are foliaceous, slightly chitinized, and only when they were cleared with potassium hydroxide could their parts be observed. The masticatory regions possess strong, short spines. The endopodite is small and is provided with three setae which are characteristic in form and are articulated by a broad base (fig. 16). Moreover, near this group, a slender seta with accessory hairs on its sides may be observed (fig. 17). The basipodite is a flat article and larger than the other segments, its masticatory region armed with strong, short spines of chitinous consistency (fig. 15) arranged in several rows. The anterior margin of this segment exhibits setae that are spaced in an almost regular manner, and moreover, on the external part, near the articulation with the endopodite, there is a group of plumose setae of moderate length

Plate 3. *Cambarellus montezumae montezumae* (Saussure).

1. lateral view of the anterior part of the cephalothorax; 2 - 7, different forms of the rostrum; 8, epistome; 9, ventral view of the basal article of the antennular peduncle; 10, antennular peduncle showing the otocyst; 11, antenna (C, coxopodite; B, basipodite; End., endopodite); 12, antennal scale; 13, mandible; (PL, palp; PI, incisor process; PM, molar process); 14, maxillule; 15, spine on the internal border of the basipodite of the maxillule; 16, dentate setae of the endopodite of the maxillule; 17, endopodite of the maxillule; 18, plumose setae of the maxillule.



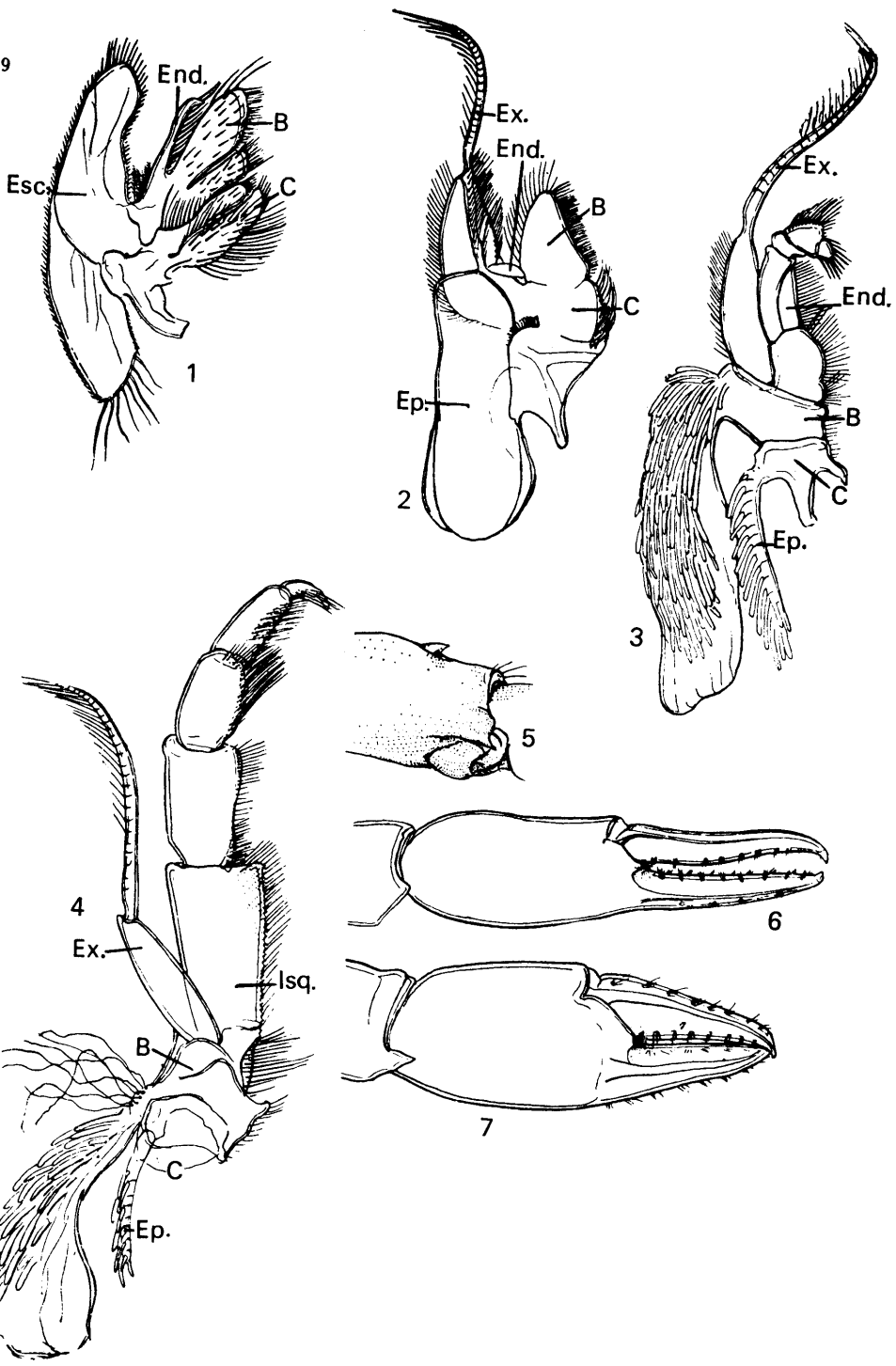
(fig. 18). The lower surface of the basipodite, as on the coxopodite, bears spines or small hairs, all directed toward the internal part. The coxopodite is shorter than the basipodite; the anterior part of the internal border possesses spines of the same type as that of the basipodite, but, in addition, some plumose setae; in contrast, the posterior part bears plumose setae but no spines. The upper surface of the maxillule is connected with the hypostome.

The second pair of maxillae (Plate 4, fig. 1) are appendages which also are platelike with four lobes on the internal part; two of them belong to the coxopodite, of which the posterior is broader and bears numerous setae; the anterior lobule is smaller and the division between the coxopodite and basipodite is marked by a chitinous thickening armed with setae which are arranged along its entire length. The other two lobules correspond to the basipodite; they are well developed, particularly the anterior one. The lobules of the coxopodite as well as those of the basipodite exhibit a masticatory surface provided with spiniform setae. The endopodite is a narrow prolongation, which is borne on the anteroexternal border of the first lobule of the basipodite and possesses long, naked setae on one of its margins. The external part
30 of this appendage bears a more or less rectangular plate, the scaphognathite, convex ventrally, which, after having been slightly cleared, shows a chitinous support that runs diagonally from one side to the other, delimiting two portions: an anterior which is associated with the basipodite and which may represent the exopodite; and a posterior part associated with the coxopodite and which corresponds to the epipodite. All of the free margins of the scaphognathite bear small hairs, the size of which increases toward the anterior and posterior extremities; in the latter, the hairs are longer and assume the form of flexible setae.

Maxillipeds. The first pair of maxillipeds (Plate 4, fig. 2) maintain the platelike form, and the internal borders of the basipodite and coxopodite are provided with thick rigid setae. The internal border of the coxopodite exhibits longer setae than that of the basipodite and they are directed toward the anterior part. The coxopodite also has an epipodite in the form of a mastigobranch. The basipodite is triangular with its vertex directed anteriorly, and the base articulated with the coxopodite. The endopodite is small, consisting of two segments, articulating posteriorly with the basipodite. The exopodite is flagelliform and is multiarticulate; it is provided with two rows of setae on the external border; at the base of the flagellum of the exopodite there is a

Plate 4. *Cambarellus montezumae montezumae* (Saussure).

1, maxilla; 2, first maxilliped; 3, second maxilliped; 4, third maxilliped (B, basipodite; C, coxopodite; End., endopodite; Ep., epipodite; Ex., exopodite; Isq., Ischiopodite); 5, distal region of meropodite; 6, chela of the male; 7, chela of the female.



broad emargination which decreases the width of the exopodite; from this notch, the exopodite broadens, assuming the form of a triangular pyramid, with setae on the external margin; on the internal region, it exhibits another series of setae arranged in a row very close to the internal surface.

The second pair of maxillipeds (Plate 4, fig. 3) have an appearance somewhat different from the first; the coxopodite bears a mastigobranch; the lateral side of the basipodite exhibits a large gill the anterior part of which articulates with the exopodite and endopodite. The former is arranged in the same manner as that of the first maxilliped; the endopodite, in contrast, is multiarticulate, consisting of five articles typical of an appendage; all of them bear setae, but the dactylopodite exhibits rigid spines.

The third pair of maxillipeds (Plate 4, fig. 4) are subpediform in appearance due to the strong development of the endopodite which consists of five segments, of which the basal, or ischiopodite, bears a series of small teeth on the internal border. An epipodite in the form of a gill is inserted on the coxopodite. The basipodite bears a well developed gill, and moreover exhibits a hemispherical process on the surface of which arise many long, flexible setae. The exopodite consists of two parts: a broad basal one and a flagellum that does not differ from those of the first and second maxillipeds.

First pair of pereopods. The coxopodite is short and bears a podobranch and two arthrobranches. The basipodite and ischiopodite are united by an immovable articulation, but the two articles are distinct; the ischiopodite bears an emargination proximolaterally which serves as a hinge with a protuberance of the coxopodite; it is flattened dorsoventrally and trapezoidal in outline; its length is one-third that of the external border of the meropodite. The meropodite is flattened proximolaterally while distally it is thickened; the upper border exhibits a small spiniform process which is directed subterminally at the extreme distal end of the segment (Plate 4, fig. 5); the lower margin exhibits a series of very small spines, of which one large one, situated at the end of the second third near the articular ridge, is conspicuous. The carpopodite is shaped like a truncate cone, with the base directed distally; its surface is smooth without a groove on the upper part and without spiniform processes on the anterior articular border; only an angular emargination occurs on the lower external articular margin. The propodus is subcylindrical and slightly depressed in the palmar portion. The dactylar portion is sharply pointed. The entire surface of the chela is smooth with tufts of setae on the cutting border. The dactylopodite and the immovable finger are very slender and straight; the cutting borders are devoid of dentiform tubercles, although on the lower surface of the movable finger there is a rudimentary tubercle

situated at the level of the proximal third. The length of the dactylo-
podite is equal to that of the palm and one third that of the carpopodite
(Plate 4, fig. 6).

The chela or pincer of the female (Plate 4, fig. 7) is quite distinct in
form from that of the male; it is broader, shorter, and more depressed,
the latter particularly conspicuous in the distal half. The fingers are
broad basally, short, and both are marked by a rib or ridge which
extends the entire length; each ridge is flanked externally and internally
by a groove which makes it more prominent. The length of the
dactylopodite is slightly greater than that of the palmar region.

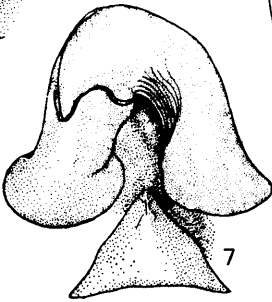
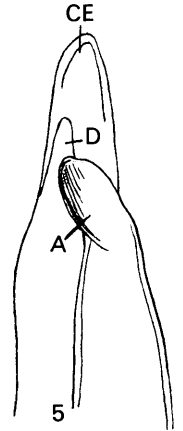
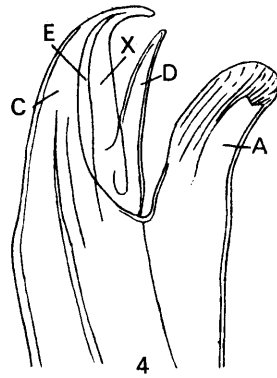
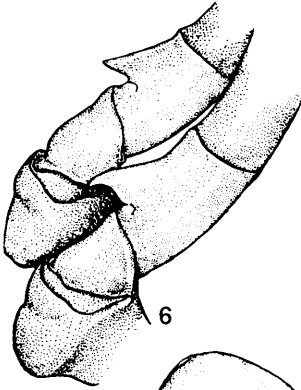
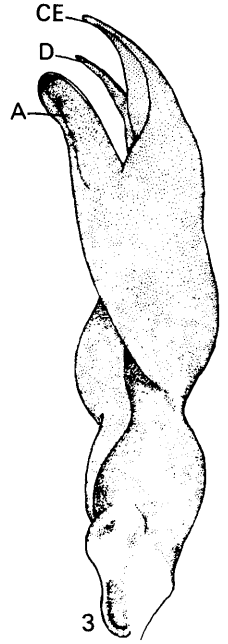
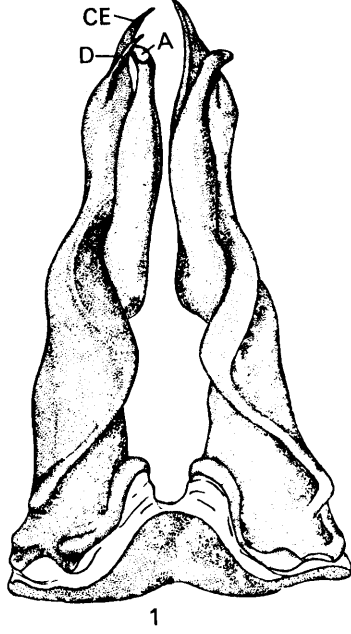
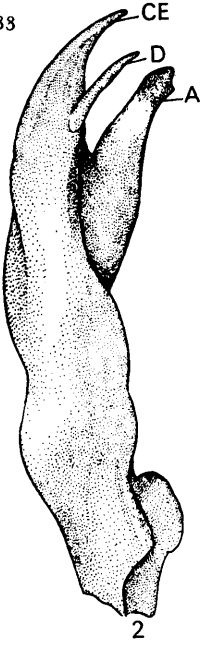
32 **Remaining pereopods.** The ischiopodites of the second and
third pairs of pereopods bear hooks, which are thornlike. Although the
hooks of both pairs of pereopods are similar in form, that of the third
pair is larger and its internal border is quite concave owing to the fact
that the apical extremity is bent (Plate 5, fig. 6).

Pleopods. The apical region of the first pair of pleopods of the first
form male (Plate 5, fig. 1) reaches the posterior part of the coxopodites
of the third pair of pereopods; this apical region is turned toward the
caudal extremity and ends in three distinct parts (Plate 5, figs. 2 and 3).
The mesial process (figs. 1, 2, 3, and 4A) is spatulate and resembles a
rolled plate in the form of a trough; its length does not exceed that of the
other apical structures, and it is inclined at an angle of approximately
140° to the principal body of the appendage. The caudal process (figs.
1, 2, 3, and 4D) is slender, spiniform, borne on the external side of the
base of the central projection, and its length does not exceed the apical
part of the projection or that of the mesial process. The latter structure
[central projection] (figs. 1, 2, and 3CE) is broad at the base, its end
pointed and recurved toward the caudal part of the body. Viewing the
appendage mesially, the relationship that exists between the caudal and
centrocaudal process (fig. 4C) of the central projection may be clearly
observed. The centrocephalic process (fig. 4E) is scarcely evident as a
uniformly slender, chitinous reinforcement along its entire length. The
central projection, moreover, exhibits a membranous sheath situated
between the processes [centrocephalic and centrocaudal] comprising it
(fig. 4X).

The first pair of pleopods in the male, form II, are almost straight,
and their apical structures are poorly defined. The mesial process
already shows its spatuliform end (fig. 5A), whereas the caudal process
(fig. 5D) resembles a small tubercle. The central projection (fig. 5CE) is
the most apical structure of the appendage; its tip is recurved and gently
inclined toward the caudal end of the body, and the separation of the
caudal process and centrocephalic process is hardly noticeable.

The *annulus ventralis* of the female (fig. 7) is shaped like an inverted
U, the rami of which are directed caudally. A slight twist of one of its

38



rami makes it asymmetrical; the other ramus bears a transverse groove very near the arc. It is important to observe that the groove at times appears on the left side and at others on the right. Between the fifth pereopods, there is a spiniform process with a broad base, the vertex of which coincides with the lower part of the two rami, nearer the ramus which lacks the groove. The females carry 30 or 40 small eggs on the pleopods during reproduction; each egg measures approximately 1.5 mm in diameter.

Measurements in millimeters

	Male, Form I	Male, Form II	Female
Total length	31.3	23.2	37.0
Length of carapace	16.6	10.7	16.9
Anterior part of carapace	9.0	7.0	11.0
Length of areola	4.6	3.7	5.9
Width of areola	1.5	1.1	2.0
Length of abdomen	17.7	12.5	20.1
Posterior width of rostrum	1.9	1.6	2.2
Anterior width of rostrum	0.9	0.7	1.0
Length of chela	9.4	5.5	9.0
Length of movable finger	4.8	3.0	4.9

Distribution. *Cambarellus montezumae montezumae* is found throughout the Valley of Mexico (Plate 6), occupying residual lakes which were left from the enormous body of water that covered a large portion of it. The type-locality is Lago de Chapultepec, which now encompasses a small area with a series of canals that run through the Bosque de Chapultepec [Chapultepec Forest]. This locality has been completely transformed, making Chapultepec, at the present time, a place for recreation for the inhabitants of the Federal District. The last collection which was obtained had to be made in a canal near the Museo de la Flora y Fauna, since recently the other canals had been drained. There resulted a complete modification of the aquatic vegetation. Previous studies of this type of flora indicate the normal existence of *Typha angustifolia* and *Sagittaria mexicana* in the emergent vegetation; among the submergent plants there are *Potamogeton pectinatus*, *Myriophyllum hippuroides*, and *Ceratophyllum demersum*; the floating vegetation consists of

Plate 5. *Cambarellus montezumae montezumae* (Saussure).

1, caudal view of first pair of pleopods of the male, Form I; 2, lateral view; 3, mesial view; 4, view of the apical part of the same; 5, view of the apical part of a pleopod of the first pair of the male, Form II (A, mesial process; D, caudal process; CE, central projection); 6, ischiopodites of the second and third pairs of pereopods of the male, Form I; 7, *annulus ventralis*.

Nymphaea ampla, *N. mexicana*, *Lemna minor*, *Limnobium stoloniferum*, *Eichhornia crassipes*, *Wolffia oblonga*, and *Aster axillis*. Among the aquatic cryptogams may be cited *Azolla caroliniana*, *Oedogonium* sp., *Vaucheria* sp., *Volvox*, and possibly a rhodophyte, *Batrachospermum* sp. (Plate 7).

Of the species of animals that live on *C. montezumae montezumae* as epizooites, according to the data contributed by Rioja (1940), there are large colonies of vorticellids, *Opercularia plicatilis* Stokes, which may measure up to 5 mm when completely extended. According to Rioja, the relationship between the protozoan and the crustacean is no more than that of a simple lodger. Also he has observed the occurrence of colonies of acinetids of the genus *Tokophyra*, at times *T. lemnae* (Stern), on the crustacean, and in the gill chamber were nematodes which Rioja presumed to be *Rhabditis cambari* described by Allen.

It is also probable that a rotifer, *Embata parasitica* Giglioglio, occurs on *Cambarellus montezumae montezumae*; this rotifer was also observed by Allen.

Likewise confirmed is the occurrence of an annelid of the family Branchiobdellidae, *Bdellodrilus illuminatus* (Moore), which may be considered an ectoparasite by its position on the body of the crayfish and by its adaptation to this type of life.

Of tremendous interest was the discovery of an ostracod, *Entocythere heterodonta*, which lives all over the body but principally in the branchial chamber, and which clings to the setae of the crayfish by means of the greatly modified claws of its three pairs of legs. Rioja considers *E. heterodonta* to be an epizooite instead of a parasite.

The most important localities in the Valley of Mexico, apart from the type-locality, are:

A) Canals of Xochimilco, SSW of the capital (Plate 6, locality 2).

B) Five km from Mexico on the Mexico-Puebla highway, southern shore of Lago de Texcoco (Plate 6, locality 3).

C) Canals of Chimalhuacán in the western part of the same Lake (Plate 6, locality 4).

D) El Caracol de Texcoco, northern part of the Lake (locality 5).

E) Laguna de Zumpango, 40 km N of the capital (locality 6).

Without doubt, other nearby localities exist, but they are probably similar to those just mentioned.

Relationships. The affinities of *C. montezumae montezumae* with the nearby subspecies may be deduced from the previous geological events of the Valley of Mexico.

Jorge L. Tamayo (1949) considers that initially the Valley of Mexico was dehiscent, that is, a well defined valley which was open on the south and emptied into the Balsas System. Later, with the formation of the Serranía del Ajusco, the waters of this valley took a course toward the Lerma River, a belief based upon the occurrence of the same

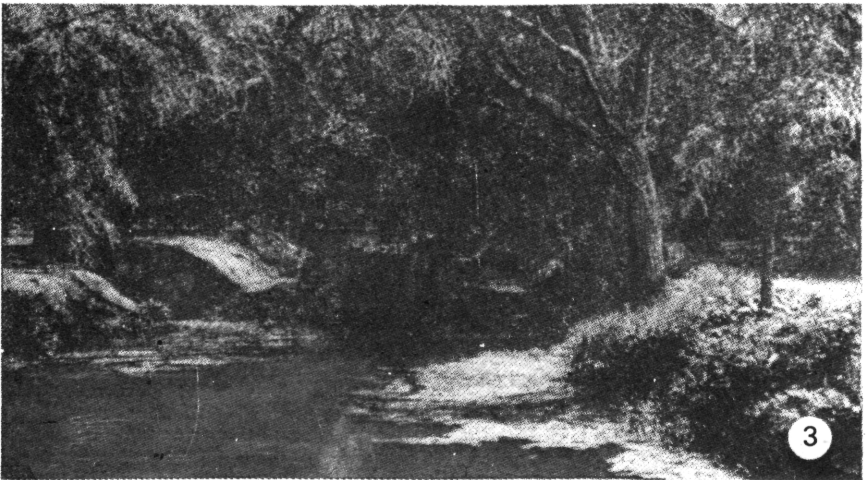
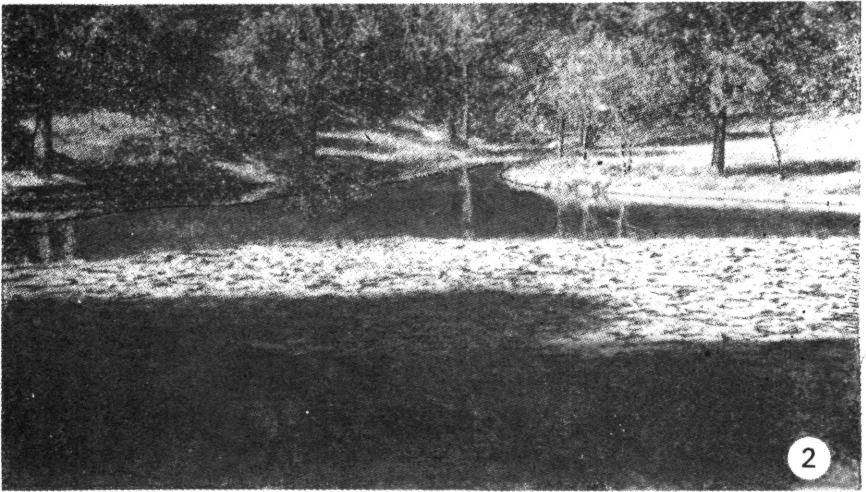
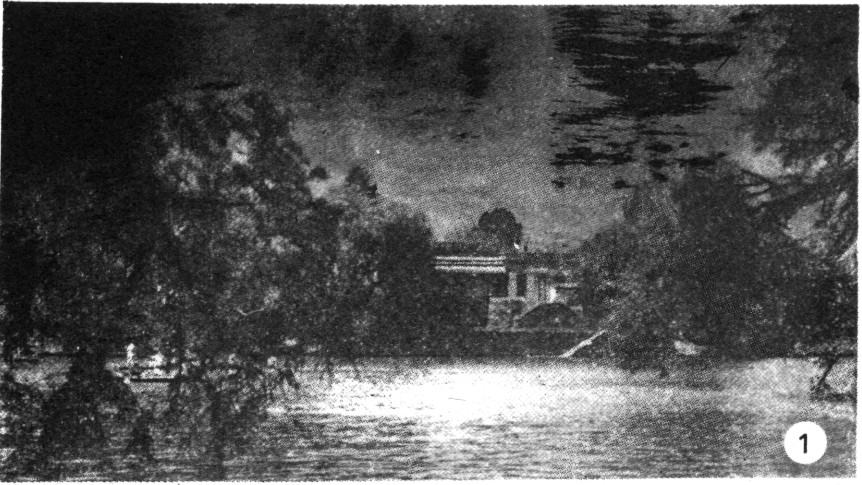
BASIN OF MEXICO

GEOGRAPHIC DISTRIBUTION OF

Cambarellus montezumae montezumae (Sauss.)



1. CHAPULTEPEC
2. XOCHIMILCO
3. 5 km CARRETERA MEXICO-PUEBLA
4. CHIMALHUACAN
5. EL CARACOL
6. LAGUNA DE ZUMPANGO



37 Plate 7. Three views of the type locality of *Cambarellus montezumae montezumae*.
1, general view of the lake below the Instituto de Biología; 2, Lago de las *Nymphaea*;
3, Canal del Invernadero.

ichthyological species in the Valley as exist in the valley of Lerma River. It is presumed that this connection existed up to the beginning of the Pliocene, and afterward the Valley was left isolated by volcanic eruptions which formed the Serrania de la Cruces. The presence of fossil remains of teeth of ruminants and pachyderms along the
38 northern border of the Valley, however, permits the supposition that the connection with the Lerma River was not to the west, rather directly with the Tula River when it was a tributary of the Lerma.

According to this explanation, the affinity of *C. montezumae montezumae* and *C. montezumae lermensis* is considered to be very close.

On the other hand, the Valley of Mexico has a connection on the north with Pachuca across the Avenidas de Pachuca River, and it would not be very unlikely that it has been a route of invasion toward the State of Hidalgo, hence the identity of the crayfish collected in Tulancingo and San Miguel Regla of the same State with the species of Saussure.

General Considerations Concerning the Morphological Characters Utilized in the Systematics of Cambarinae

As new species of crayfishes have been encountered, it has been necessary to look for more definite morphological characters that permit the establishment of distinct differences between them.

If we judge the descriptions made by Erichson and Saussure, we find that the data given by them pertain to very general morphological characters, and now there are several species to which such descriptions apply. To this we should add the absence of a pattern [for descriptions] or the loss of types, as has happened in the case of the Mexican species which were described by Erichson, has given rise to considerable confusion with respect to the identity of certain species in our country.

Hagen, Ortmann, Faxon, and others have considered the hooks on the pereopods as a principal base for the formation of groups and subgenera in the subfamily Cambarinae. The character has certain value without doubt, but the variability in number and position in known species is indicative of the fact that it should be used with care. Already, Hobbs has pointed out the variability that exists in *Procambarus pubischaelae* [sic] and the very notable difference between *Procambarus geodytes* and *P. advena* in regard to which the first species has hooks on the third pair of pereopods and the second on the third and fourth pairs, notwithstanding the great similarity that exists in the other characteristics. We also have found that in some species, for example *P. mirandai*, specimens exist with hooks on the second and third pairs of pereopods, 39 when the normal condition is their presence only on the third pair, as is characteristic of all of the species of the *mexicanus* Section to which *P. mirandai* belongs.

In the recent works devoted to the crayfishes, the principal characters used in descriptions are the following:

1. The first pair of pleopods of the male which furnishes the most important characters in the identification of the genera and species. In accord with Horton H. Hobbs, who has systematized the different parts of such appendages, the pleopods are considered in normal position, that is, folded beneath the thorax; that portion lying against the sternum he considered the cephalic surface, thus the ventral

portion of the pleopod corresponds to the caudal surface; the internal part of the pleopods is the mesial surface, and the opposite, the lateral surface.

The nomenclature of the apical structures proposed by Hobbs (1942a, c; 1945a) is based on a pleopod with four distinct parts in its apical region which are designated in the following manner : (Plate 8, figs. 1 and 2).

Mesial process (A) is that which is borne by the internal ramus of the pleopod, or more precisely, that which is generally located in the caudomesial part of the apical region of the appendage.

Cephalic process (B), which corresponds to the apical structure which is implanted in the cephalomesial region.

Caudal process (D), implanted in the caudolateral margin, or in the caudal or caudomesial margin of the appendage.

Central projection (CE) corresponds to a double process the parts of which are almost always closely united; each one of them has a name centrocephalic process (E), and centrocaudal process (C), following their relation to the cephalic process or to the caudal process, respectively.

The relations between these different processes of the apical part of the pleopods may be easily understood if we consider that the appendage is a plate rolled in a spiral, from left to right, and the processes are arranged on its apical border in the following manner: from the outside, the first tooth is the mesial process, followed by the cephalic process, and next the centrocaudal process, followed by the caudal process, and finally in the center, the centrocephalic process (Plate 8, figs. 3 and 4 [1 and 2]).

40 Considerable variation exists between the genera and species of crayfishes with respect to the apical structures of the pleopods. Sometimes certain processes, such as the mesial, are very strongly developed, as in the case of *Paracambarus paradoxus*, *Procambarus teziutlanensis*, *P. hortonhobbsi*, and *P. tlapacoyanensis*. At other times it is the central projection that attains a great size, as in *Cambarellus montezumae montezumae*. The particular characters of each species will be treated in the respective descriptions.

The schematic representation of the first pair of pleopods of the male, form I, includes a general drawing of the appendages in caudal view; a representation of one of the pleopods in lateral view, and another in mesial view; finally, a detailed illustration of the apical structures. Also included is a representation of the first pair of pleopods of the male, form II, in order to show the state of development of the apical structures.

2. The rostrum constitutes the anterodorsal part of the carapace which projects forward as a depressed plate; its form varies greatly from

one species to another. The features that are taken into consideration are the disposition of the rostral margins and the surface of the rostrum in relation to its margins. The lateral spines and the acumen on the anterior part of the rostrum are of utmost importance; the former are two more or less sharp processes that terminate on the anterior part of the rostral margins; sometimes the lateral spines of the rostrum are not present and are represented only by rounded angles. The acumen is the anteromedian terminal part of the rostrum which may be more or less sharp; its length is customarily related to the articles of the antennular peduncle. We have paid certain attention to the ventral keel of the rostrum which may be smooth or provided with small dentiform tubercles.

The form of the rostrum is included in the general drawing of the dorsal view of the carapace. As for measurements, the following are considered: the length of the rostrum is taken from the acumen to a transverse line which runs from one side to the other at the anterior ends of the postorbital ridges; furthermore, measurements are made of the anterior and posterior width of the rostrum; the former, from one lateral spine to the other, and the posterior one is taken at the posterior extremity of the rostrum, from one margin to the other.

3. The characteristics of the carapace are considered to be of taxonomic value, if the following are taken into account: the appearance of the surface, the postorbital ridges, the areola, the lateral spines of the carapace, the branchiostegal spines, the proportions between the different regions, and the measurements.

The surface of the carapace generally exhibits punctations or small tubercles which are arranged in a distinct manner for the species.

41 The postorbital ridges are two longitudinal elevations that flank the posterior part of the rostrum. They terminate anteriorly in a spine, but in certain species the spine is not present and the end is blunt.

The areola is an area located on the dorsal part of the thoracic region of the carapace, limited laterally by the suprbranchial grooves, anteriorly by the cephalic groove, and posteriorly by the margin of the carapace. Hobbs considers it as an adaptive character; consequently its width is related to the greater or lesser development of the branchial chamber, and that, in turn, with the concentration of oxygen of the environment in which the crayfishes live. The characters of the areola that are taken into account are: the appearance of the surface; the width, considered in the narrowest part; and the length, measured from the
42 cephalic groove to the posterior margin of the carapace.

The lateral spines of the carapace are generally located on the upper part of the groove that limits the hepatic region posteriorly; the number varies from one to three, or they may be absent.

The branchiostegal spines are found on the lower anterior border of

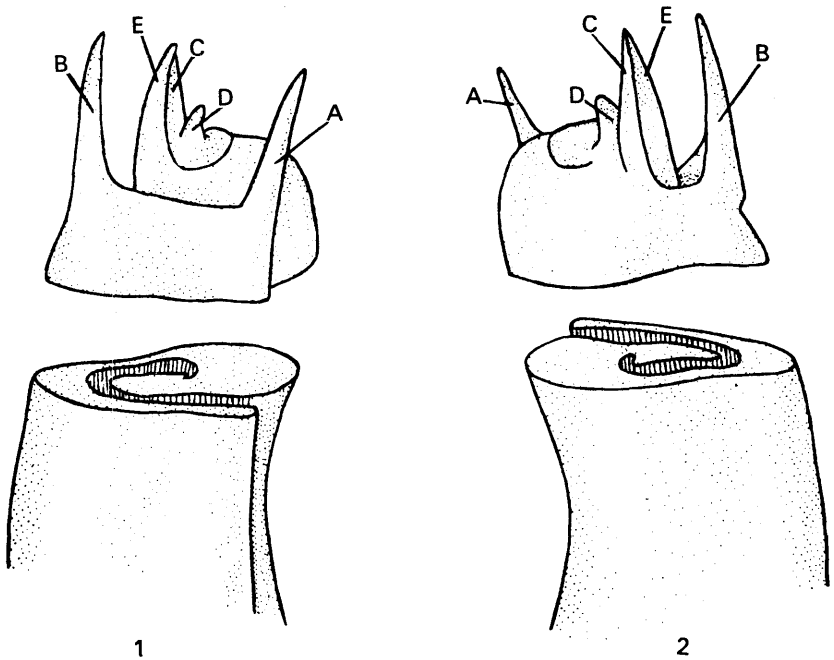


Plate 8. Schematic representation of the first pair of pleopods of the male, Form I (after Hobbs).

1, mesial view; 2, lateral view (A, mesial process; B, cephalic process; C, centrocaudal process; D, caudal process; E, centrocephalic process; CE = Z, central projection).

the cephalothorax, almost always adjacent to the end of the part of the groove that limits the hepatic region; usually there is one on each side, but there may be two or three, or they may be absent.

In my descriptions, I have customarily taken into account the proportions between the different parts of the carapace; for example, the length of the rostrum in relation to the total length of the carapace, and the latter with the length of the abdomen; the width of the rostrum and the length of the areola in relation to the carapace, etc.

The carapace is schematically represented in dorsal and lateral view. The measurements include the total length (from the acumen to the posterior margin), the length of the cephalic part (from the acumen to the cephalic groove), the length of the areola (from the cephalic groove to the posterior margin of the carapace), and the width of the areola in its narrowest part. Occasionally, when the character merits it, the greatest height of the carapace is measured.

4. The abdomen furnishes few specific differences. Of course its size in comparison to that of the thorax is considered, taking into

account the fact that the abdomen of the females, because of its reproductive function, is broader than that of the males, also taking into account the spines of the distolateral angles of the first part of the telson.

The length of the abdomen is taken from the posterior border of the carapace to the posterior margin of the telson.

5. The epistome is a plate that occurs in the anteroventral region of the cephalothorax in front of the mouth. Its contour is more or less constant in individuals of the same species. We have found some variability which makes us consider this structure with certain reservations. Among the drawings accompanying the descriptions, a schematic representation of the epistome is included.

6. Antennules. The first pair of cephalic appendages is taken into account only in respect to the length of the rostrum, that is to say the tip of the acumen may reach the second or third article of the antennular peduncle.

43 7. The antennae are considered only in relation to the antennal scale, taking into account its form, the spine of the scale, and its major width. In the descriptions, a sketch of the scale should be included.

8. The buccal appendages are hardly mentioned in the descriptions. I believe that the different morphological characters that they may offer to the specialists have been overlooked. It would be advisable to make a minute study of these appendages, because from it valuable data for the separation of the genera and species may result.

9. The maxillipeds, especially the third pair, have been taken into account by Horton H. Hobbs for separating his interesting genus *Troglocambarus* from the other genera of crayfishes. Similarly, the masticatory appendages, if one considers the constancy of certain features of the maxillipeds, may be of auxiliary value to the taxonomists.

10. In regard to the pereopods, several specific characteristics of those of the first pair have been considered. In the chela, the sculpture of the surface is pointed out; the form of the fingers; the dentiform tubercles of the cutting edges; the proportions of the different parts of the chela, etc.

The carpopodite also exhibits differential features either by appearance of the surface or by the spiniform structures exhibited, principally on the distal articular margin.

The meropodite may exhibit spiniform tubercles that are generally taken into account by the specialists.

In reference to the illustrations, it is customary to make a drawing of the chela of the male and another of that of the female, including in them the carpopodite. The measurements referring principally to the chela are the following: the length of the chela, the length of the palmar region, that of the dactylopodite, and sometimes the greatest width of the chela.

11. Of the remaining pereiopods, only those that exhibit a hook on the ischiopodite which is used in copulation is taken into account: the hook may be situated on the second and third pairs (*Cambarellus*), on the third pair (*Cambarus*, *Orconectes*, *Procambarus*), on the third and fourth pairs (*Procambarus*, *Troglocambarus*), or on the fourth pair (*Procambarus*, *Paracambarus*).

The value of the hooks on the ischiopodites has already been considered in another part of this work. However, they are an important help in the separation of the genera.

44 It is customary to show schematically the pereiopods that exhibit hooks, more important in the male, form I, than in the male, form II, because in the latter these structures are less well developed.

12. In the females, among the sexual characters that are customarily presented, the *annulus ventralis*, which is located on the sternum between the fourth pair of pereiopods, is of greatest importance. It is considered to be an organ in which the spermatozoa are left following copulation. Its characteristics vary greatly between the species, and, in general, give us an indication of the relationships that may exist among the species of the same genus. It is represented by a drawing.

13. Between the fifth pereiopods of the female there may be a tubercle which at times assumes the form of a spine, as occurs in *Cambarellus* and *Paracambarus*. Some specialists consider it to be of importance, above all in the genus *Paracambarus*. Because of its proximity to the *annulus ventralis*, both structures are represented together in the same illustration.

Aside from the characteristics noted above, the specialist always is absolutely free to take into consideration others that he believes to be useful in order to give greater security of taxonomic stability of the species.

Taxonomic Part

Taxonomic Study of the Mexican Genera of Crayfishes

Subfamily Cambarinae

Definition (Hobbs, 1942b). The first abdominal segment of the male possesses a pair of appendages of variable form with two to five terminal elements, one of which always serves as a sperm conduit (the corresponding appendages in the female are absent). The podobranchs of the second and third pairs of maxillipeds and the first three pairs of pereopods possess a broad and bilobed plate; the epipodite of the third maxilliped is devoid of branchial filaments; the setae of the coxopodite are sharp without a hook at the extremity; the telson is generally more or less completely divided by a transverse suture. Gills are absent from the last thoracic somite and there is no bilobed lamina on the podobranch of the fourth pair of pereopods.

45

KEY TO THE GENERA OF THE SUBFAMILY CAMBARINAE

(Hobbs, 1942b, modified by Villalobos)

- 1 First pleopod of first form male terminating in three or more distinct parts; strong shoulder may or may not be present on cephalic margin near apex 2
- 1' First pleopod of first form male terminating in only two distinct parts; never with well developed shoulder on cephalic margin near apex 5
- 2 (1) Ischiopodite of third pair of maxillipeds with teeth along internal margin 3
- 2' Ischiopodite of third pair of maxillipeds without teeth along internal margin *Troglocambarus*
- 3 (2) Hooks present on ischiopodites of third, third and fourth, or fourth pairs of pereopods only, never on those of second pair 4
- 3' Hooks present on ischiopodites of second and third pairs of pereopods *Cambarellus*
- 4 (3) Process between fifth pereopods of female present or absent; if present, never compressed laterally *Procambarus*

- 4' Process always present between fifth pereopods of female and compressed laterally *Paracambarus*
- 5 (1') Two terminal structures on first pleopod generally short and strongly recurved; appendage short and robust *Cambarus*
- 5' Terminal structures on first pleopod short or long, never strongly recurved, if recurved slender and usually setiform *Orconectes*

At the present time, only three of these genera have been found in Mexico: *Cambarellus*, *Procambarus*, and *Paracambarus*.

46 **Genus *Procambarus* Ortmann, 1905 b (S. Hobbs, 1942b)**
 (Char. Emended, Villalobos, 1950).

Diagnosis. First pleopod of first form male terminating in two to five distinct parts which truncate, in form of plate, or spiniform. Shoulder present or absent on cephalic surface. If pleopod terminating in only two parts, shoulder always present. Hooks present on ischiopodites of third or third and fourth pairs of pereopods; in latter case, those of third pair sometimes vestigial; or hooks present only on fourth pair of pereopods. Third pair of maxillipeds of normal size with row of teeth along internal margin of ischiopodite.

BARBATUS SECTION

Diagnosis. Cephalodistal surface of first pleopod of first form male terminating in sharp or truncate flange or in kneelike prominence which clearly not one of terminal processes; mesial process always directed distally unless spatulate; cephalic process, when present, always extending distally from mesial surface (except in *shermani*); central projection never decidedly most conspicuous terminal element. Hooks present on ischiopodites of third or third and fourth pairs of pereopods.

alleni Group

Procambarus simulans regiomontanus

digueti Group

Procambarus digueti

Procambarus bouvieri

KEY TO SPECIES

- 1 Rostrum with lateral spines. First pair of pleopods of male, form I, with shoulder on cephalic portion near apical region. Mesial process extending beyond other apical structures; cephalic process spiniform or dentiform 2

- 47 1' Rostrum without lateral spines. First pair of pleopods of male, form I, without shoulder. Mesial process not extending beyond other apical structures; cephalic process in form of horsehoof *Procambarus bowieri*
- 2 (1) Basal internal region of first pair of pleopods of male, form I, with spine or conical tubercle directed toward distal portion. Mesial process implanted in caudomesial region. Caudal process well developed, trapezoidal in outline. *Procambarus simulans regiomontanus*
- 2' Basal internal region of first pleopods of male, form I, without spine or tubercle. Mesial process implanted in caudolateral region of internal ramus of pleopod. Caudal process reduced or crestlike *Procambarus digueti*

Procambarus simulans regiomontanus Villalobos

1954 a *Procambarus simulans regiomontanus* Villalobos, An. Inst. Biol. de la Univ. Nal. A. de México, Vol. XXV, pp. 289 – 298, Plates I – II.

Diagnosis. Rostrum deeply grooved, broad at base, borders almost straight, converging anteriorly; ventral keel of rostrum with dentiform tubercle in posterior third. Areola narrow or almost obliterated. Carapace with small lateral spines. Anterior portion of telson without spines in posterolateral angle. Chelae of first pair of pereopods with emargination in proximal part of cutting edge of dactylopodite. Tubercle on ischiopodite of third pair of pereopods. First pair of pleopods of male, form I, with spiniform process on internal side of base; fold approximately in upper third of external ramus; caudal process trapezoidal in contour; shoulder present very near apical region on cephalic part; caudal and cephalic processes and central projection flattened in cephalocaudal plane. *Annulus ventralis* more or less semicircular in outline, surface rough, deep cavity in right median part; sinuous groove in median part.

- 48 **Male, form I.** The general size is rather large in relation to the species from the southern part of the Republic. The carapace (Plate 9, figs. 1 and 2) is compressed anteriorly and ovate in the branchial area. The surface is finely granulate in the branchial region, the granules more conspicuous in the anterior and lower parts of the carapace, principally below the hepatic region; the surface is otherwise smooth, except for a few very small punctations. The carapace exhibits a small lateral spine on each side which in spite of its size is clearly visible. The dorsal surface of the carapace exhibits clearly visible, very fine punctations in the gastric region. The rostrum is broad at the base and narrow in the apical part; the rostral margins are distinctly convergent and terminate anteriorly in very small tubercles although the rostrum

does not seem to possess lateral spines; the acumen is triangular, terminating in a rounded chitinous spine which reaches the distal third of the third segment of the antennular peduncle, the ventral keel exhibits a single dentiform tubercle in the proximal third. The surface of the rostrum is deeply excavate and completely smooth except for the posterior part which shares punctations with the gastric region.

The postorbital ridges are convergent anteriorly, following the same direction as the rostral margins; they terminate anteriorly in a short spiniform tubercle.

The areola is very narrow or almost obliterated, and the supra-branchial grooves are distinctly divergent anteriorly and posteriorly; the surface of the areola is elevated and exhibits a few punctations.

The branchiostegal spine is small, short, and acute.

The proportions of the different parts of the carapace are as follows: the length of the areola is slightly less than half the length of the cephalic part; the length of the rostrum is exactly one-fourth the total length of the carapace; the posterior width of the rostrum is six and one-third times less than the total length of the carapace; the length of the carapace is slightly greater than that of the abdomen.

The abdomen is clearly narrower than the posterior width of the carapace; the abdominal somites are profusely punctate in the pleural regions; the tergal regions are more sparsely punctate.

In the posterolateral angles of the first part of the telson, there are no spiniform processes.

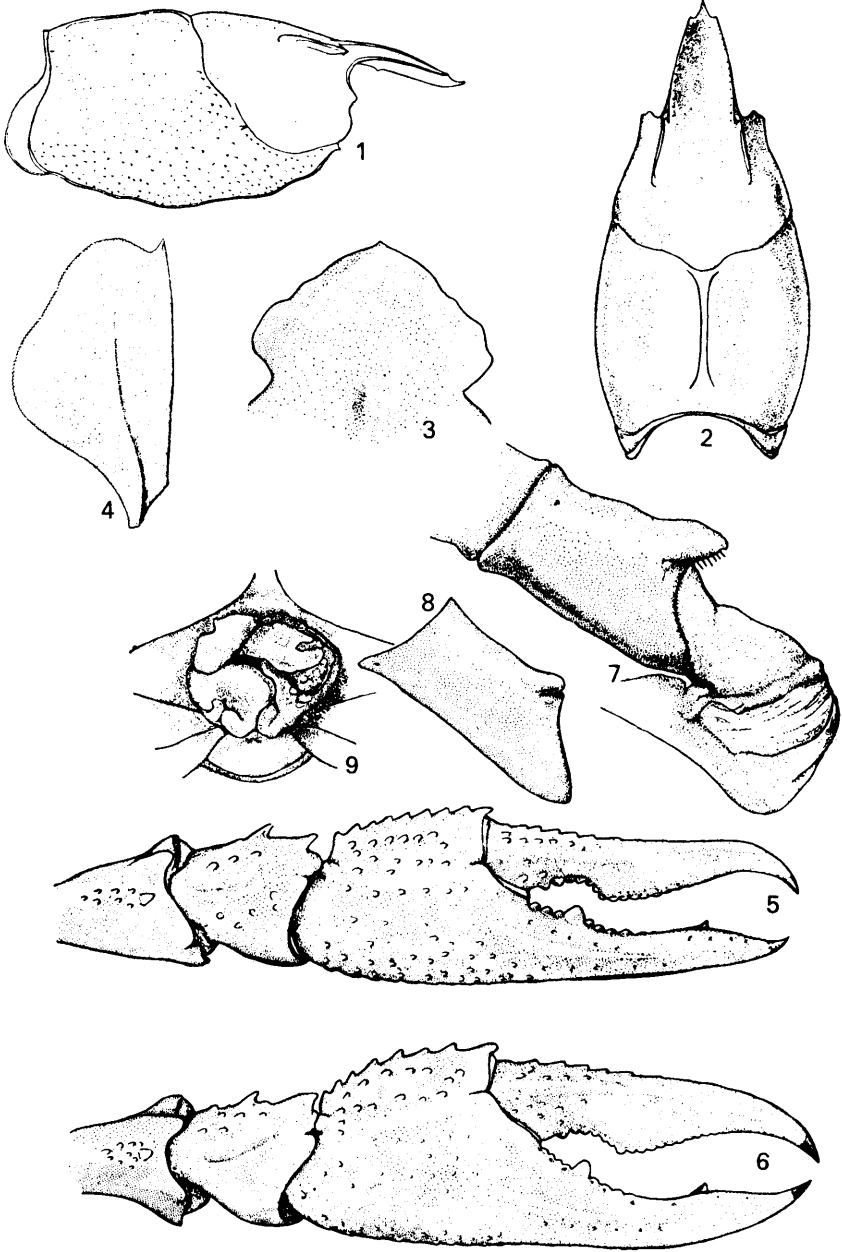
50 The epistome (Plate 9, fig. 3) is pentagonal in outline, the anterior angle is obtuse, at times very short and almost rounded; the anterolateral borders are longer than the others, gently concave, and elevated above the surface.

The antennal scale (Plate 9, fig. 4) is broad and short; the external margin is straight and terminates anteriorly in a broad-based small spine; the greatest width is situated proximal to its midlength and is a little greater than half the distance between the spine and the base of the scale.

The first pair of pereopods exhibit narrow chelae (Plate 9, fig. 5); the surface of the palmar region is sparsely tuberculate; the more prominent ones are on the internal part, principally on the margin of the palm, which appears serrate; the immovable finger is straight and slender, with four or five teeth, forming a group, on the proximal part

Plate 9. *Procambarus simulans regiomontanus* (Villalobos).

1, lateral view of the carapace of the male, Form I; 2, dorsal view of the same; 3, epistome; 4, antennal scale; 5, chela of the male, Form I; 6, chela of the female; 7, ischiopodite of the third pair of pereopods of the male, Form I; 8, ischiopodite of the pereopod of the male, Form II; 9, *annulus ventralis*.



of the cutting margin; the ultimate or distal tooth is noticeably larger than the others; there is a broad concavity on the cutting border distal to the last tooth that ends in the second third, precisely where a triangular dentiform process with a broad base is located. The movable finger, or dactylopodite, exhibits a deep emargination in the proximal part of the cutting margin which is provided with an orderly arrangement of hemispherical denticles of which the proximalmost is larger than the others; at the end of the emargination, the anterior part of the finger is noticeably broadened, and distally narrows to the terminal spine; the remainder of the cutting border also exhibits a row of hemispherical denticles. The surface of the fingers of the chela bears sparse large punctations; the proximal internal border of the dactylopodite is provided with a series of six or seven conspicuous tubercles.

The length of the palmar region is equal to exactly half the length of the dactylopodite; the greatest width of the chela is one-third of its length.

The carpopodite exhibits a deep groove on the surface; that part external to it is smooth or very slightly punctate, and that internal to it provided with tubercles, of which one of them protrudes because of its size and is situated near the edge of the distal articular emargination.

The meropodite is flattened laterally in the median proximal part and broadened in the anterior; both the external and internal surfaces are smooth; the upper border is armed with tubercles disposed along its entire length, the anterior one forming a major tubercle, more or less sharp and projecting forward; the inferior border bears two rows of dentiform tubercles; in the internal row they are more numerous and the tubercles in the distal part are larger and pointed.

The ischiopodite of the third pair of pereopods bears a tubercle which arises from the proximal part of the article and which clearly exceeds the ischiobasipodal articulation; the tubercle is circular in section at its base, round at its extremity although it projects in a small punctate structure, bent and gently arched backward (Plate 9, fig. 7).

The first pair of pleopods differ noticeably from those of *P. simulans simulans* in their more slender form (Plate 10, figs. 1, 2, and 3). These appendages exhibit a conical spine at the base of the internal part which is directed distomesially. At the level of the second third of the external ramus, the chitin is folded in a ply forming a small notch on the margin of the appendage. The apical region (Plate 10, figs. 4 and 5) is provided with four spiniform, completely chitinized structures, moreover with a shoulder on the cephalic part, near the apex; the caudal process (D) is trapezoidal in outline, flattened in the cephalocaudal plane and its most prominent angle is directed toward the internal part. The mesial process (A) is the largest of all of the apical structures. The central projection (CE) is triangular, gently recurved laterally and with a clear

chitinous reinforcement between the two parts forming it: the centrocephalic process (C) and the centrocaudal process (E). The cephalic process (B) is the shortest structure, is implanted in the cephalic part of the appendage, and is flattened; its external margin is continuous with the chitinous reinforcement that separates the two parts of the central projection.

Male, form II. The rostrum is more excavate on the surface than in the male, form I; moreover, the surface is completely smooth; the rostral margins are strongly convergent, parallel only in the posterior part; the anterior width of the rostrum is one-third that of the posterior; the small tubercles that remain in place of the lateral spines of the rostrum are scarcely visible, but clearly distinguishable by their chitinous quality; the spine of the acumen has the same relation to the third article of the antennular peduncle as that of the first form male.

52 The carapace is similar to that of the male, form I, except that the areola is almost obliterated (width 0.3 mm). The lateral spines are present and clearly visible in dorsal aspect.

The epistome does not exhibit an anterior angle, only a convex contour anteriorly. We have observed this character in two or three specimens of the lot.

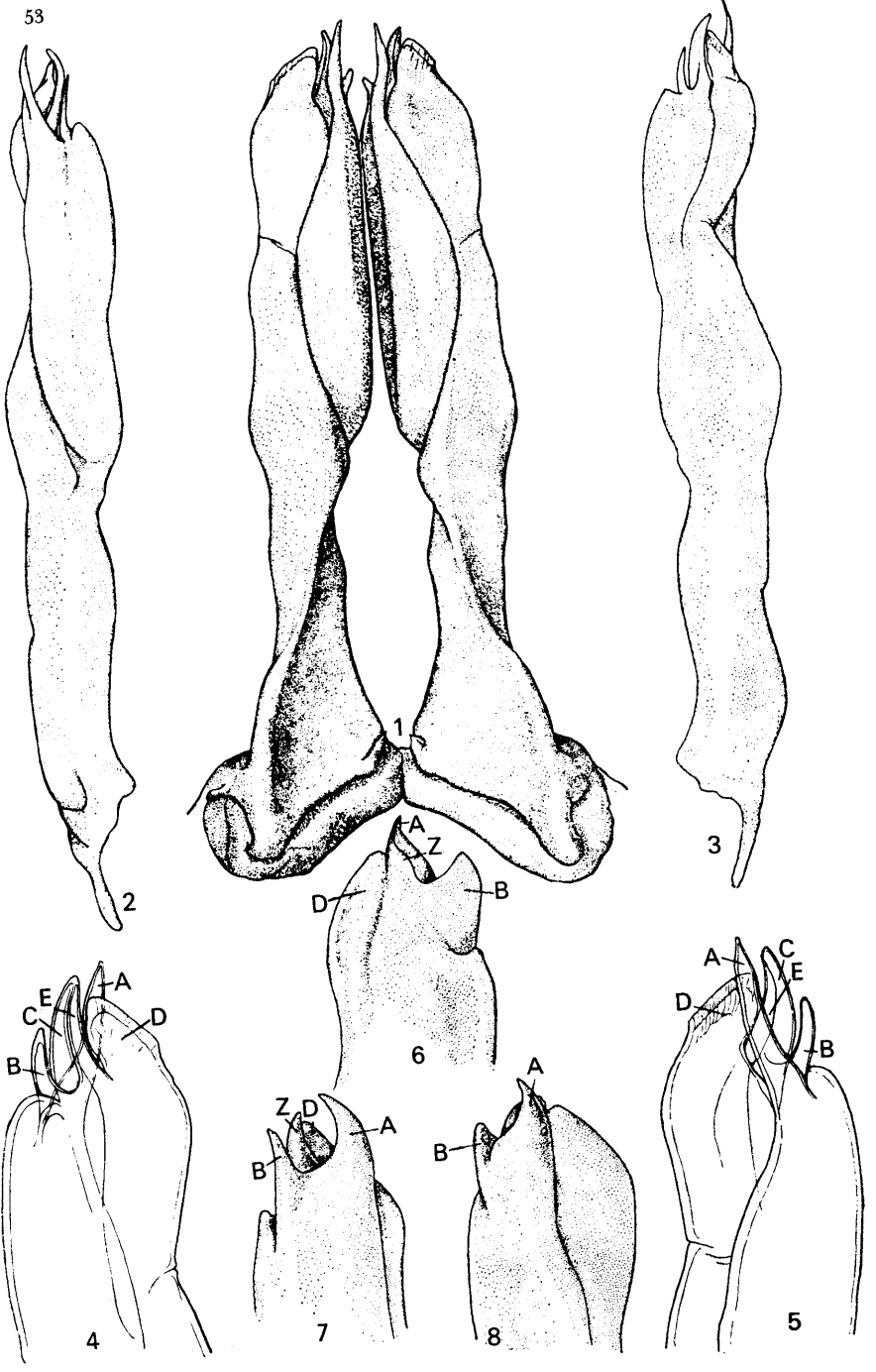
The chelae of the first pair of pereiopods are like those of the first form male.

The ischiopodite of the third pair of pereiopods has a small tubercle situated on the proximal extremity of the article (Plate 9, fig. 8). This tubercle is more or less conical and rounded at the extremity, and does not exceed the articulation between the ischiopodite and basipodite.

The first pleopods also exhibit a spiniform tubercle on the basal internal region; in the upper third of the internal ramus there is no fold in the cuticle. The apical parts are not chitinized (Plate 10, figs. 6, 7 and 8).

The mesial process (A) is conical, long, and sharp, is free and exceeding the other parts; the cephalic process (B) is triangular in outline, flattened in the cephalocaudal plane, and situated on the internal cephalic part of the apex of the appendage; it is one of the shorter structures; the caudal process (D) is triangular with its vertex rounded and abutting the central projection (Z); the latter is conical in form, slightly compressed in the cephalocaudal plane and with the vertex curved toward the caudal process; the two constituent parts are clearly evident, and it is the centrocephalic process that forms the vertex of the structure.

Female. The rostrum is less excavate and narrower than in the first and second form males, its entire surface smooth; the rostral borders are thick and terminate anteriorly in a small but clearly visible chitinous tubercle; the areola is narrower than that of the first form male. The



lateral spines of the carapace are present. The granulations of the anteroventral part are heavy.

The epistome is as in the first form male.

The chelae of the first pair of pereopods (Plate 9, fig. 6) are broad and robust; the emargination of the immovable finger is broader and deep, thus giving the article its greatest width at the end of the emargination.

54 The *annulus ventralis* (Plate 9, fig. 9) is more or less circular in outline, and tubercles arising from its surface give it an irregular aspect; in the left anterior region, there is a promontory formed by a conglomeration of hemispherical tubercles that constitute the most prominent part of the *annulus*; slightly displaced to the right, and in the median part, is an oblique fissure in which the groove originates; it runs backward forming an angle the vertex of which is directed to the left and ends on the median posterior portion in an angular emargination; in the right anterior part, there is a plate which is slantingly elevated from the surface that is separated from the promontory of the left side by a deep fold.

Between the fifth pereopods, there is a tubercle that occasionally ends in a short point.

Measurements in millimeters

	Male, Form I	Male, Form II	Female
Total length	79.0	80.7	87.6
Length of carapace	41.0	42.2	46.2
Anterior part of carapace	26.0	27.3	30.0
Length of areola	15.0	14.9	16.2
Width of areola	. . . .	0.3	0.3
Length of abdomen	38.0	38.5	41.4
Anterior width of rostrum	2.2	2.1	2.5
Length of rostrum	10.5	10.5	11.4
Posterior width of rostrum	5.8	6.0	7.0
Length of chela	31.0	29.1	34.0
Length of movable finger	20.3	18.7	20.0

Type-locality. 5 km. N. of Monterrey, Nuevo León (Jordi Julia Z.).

Relationships. *Procambarus simulans regiomontanus* belongs to the *barbatus* Section, established by Hobbs.

Plate 10. *Procambarus simulans regiomontanus* (Villalobos).

1, caudal view of the first pair of pleopods of the male, Form I; 2, mesial view of the pleopod of the male, Form I; 3, lateral view of the same; 4 and 5, lateral and caudomesial views, respectively, of the apical part of the first pair of pleopods of the male, Form I (A, mesial process; B, cephalic process; C, centrocephalic process; E, centrocaudal process; D, caudal process); 6, 7, and 8, cephalic, mesial, and caudomesial views of the apical part of the first pleopod of the male, Form II (Z, central projection).

Procambarus simulans simulans (Faxon) is widely distributed in Kansas and northern Texas, but from there to the northern part of Mexico there are no records of new localities. One subspecies very near *P. simulans regiomontanus*, not yet described, has been collected in Ciudad Bravo, Tamaulipas, near the border with the United States.

The characteristic differences between the subspecies described here and *Procambarus simulans simulans* from Texas and the same species from Kansas are tabulated according to the descriptions in the respective works.

55

<i>Procambarus simulans regiomontanus</i>	<i>Procambarus simulans simulans</i> (Faxon), from Texas	<i>Procambarus simulans simulans</i> , after Williams and Leonard, from Kansas
I. Lateral spines of carapace present.	I. Without lateral spines on carapace.	I. With lateral spines on carapace.
II. Rostrum with short lateral spines, presence of which, although very small, undeniable.	II. Rostrum without lateral spines.	II. Rostrum without lateral spines.
III. Areola very narrow or almost obliterated.	III. Areola narrow.	III. Areola very narrow (?).
IV. Telson without lateral spines.	IV. Telson bi- to multidenticulate.	IV. Telson with two to five lateral spines.
V. Spiniform tubercles on internal part of base of first pair of pleopods of male.	V. Data not given.	V. Data not given.
VI. First pair of pleopods of male, Form I, slender.	VI. Pleopods of male, Form I, robust.	VI. First pair of pleopods of male, Form I, moderately robust.
VII. Processes of apical region of first pair of pleopods of male, Form I, directed distally.	VII. Processes of apical region of same appendage inclined.	VII. Processes of apical region of same appendage directed distally.
VIII. Caudal process trapezoidal in outline.	VIII. Caudal process semi-circular in outline.	VIII. Caudal process trapezoidal or triangular in outline (?).
IX. Mesial process slightly larger than other apical structures.	IX. Mesial process equal in length to other apical structures.	IX. Mesial process noticeably longer than other apical structures.

Procambarus digueti (Bouvier)

1897 *Cambarus digueti* Bouvier, Bull. Mus. Hist. Nat., Vol. III, pp. 224 – 228.

58

- 1898 *Cambarus carinatus* Faxon, Proc. U. S. Nat. Mus., Vol. XX, p. 648.
- 1905a *Cambarus (Cambarus) digueti* (Bouvier). Ortmann, Proc. Amer. Phil. Soc., Vol. XLIV, p. 99.
- 56 1905b *Cambarus (Procambarus) digueti* (Bouvier). Ortmann, Ann. Carnegie Mus., Vol. III, pp. 435 – 437.
- 1906 *Cambarus (Procambarus) digueti* (Bouvier). Ortmann, Proc. Wash. Acad. Sci., Vol. III, p. 21.
- 1914 *Cambarus digueti* (Bouvier). Faxon, Mem. Mus. Comp. Zool., Harvard Coll., Vol. XI, p. 410.
- 1942b *Procambarus digueti* (Bouvier). Hobbs, Amer. Midl. Nat., Vol. XXVIII, p. 341.
- 1946 *Procambarus digueti* (Bouvier). Villalobos, An. Inst. Biol. de la Univ. Nal. A. de México, Vol. XVII, No. 1, pp. 215 – 218, 220 – 224.

Diagnosis. Robust crayfish; rostrum with median carina on anterior surface; lateral spines on carapace; chelae with palmar portion subcylindrical, dactyl slender; hooks on ischiopodites of third pair [of pereopods]. First pair of pleopods robust; angular shoulder on cephalic part very near apex; mesial process spiniform; caudal process very reduced; cephalic process and central projection dentiform. *Annulus ventralis* with fissure in form of S completely traversing it anteroposteriorly.

Male, form I. The adult males of this species are of large size. The carapace is wider than the abdomen and bears dense granules laterally where short hairs are also present; the dorsal region of the carapace is slightly punctate.

The rostral margins are straight, convergent, and terminate anteriorly in sharp and divergent marginal spines; the acumen is triangular, its length greater than the distance between the two marginal spines; the acuminal spine slightly exceeds the distal border of the second article of the antennular peduncle. The surface of the rostrum is excavate, the basal region more deeply so than the apical; anteriorly and along the median line, the rostrum bears a carina which begins at the marginal spines and terminates insensibly near the base of the rostrum; this structure is elevated little above the surface but is well defined, particularly in the middle portion.

The postorbital ridges differ clearly from the surface of the carapace, are slightly convergent forward, and terminate anteriorly in short but sharp spines which are directed laterally.

The cephalic groove is deep, slightly sinuous and discontinuous in the last undulation which is rather large and possesses a well developed lateral spine on the posterior border of the first superior third; the spine is conical and rather sharply pointed.

57 The branchiostegal spine is present and located at the end of the last undulation of the cephalic groove.

The areola is broad; the suprabranchial margins disappear insensibly posteriorly.

The abdomen is slightly narrower than the cephalothorax; the first part of the telson terminates in two or three spines at the distolateral angles; the ultimate section of the telson is semicircular.

The proportions between the different parts of the cephalothorax are as follows: the posterior part of the thorax is exactly equivalent to the distance between the cephalic groove and the marginal spines of the rostrum; the length of the rostrum is twice the distance between the marginal spines; the least width of the areola is one-fourth its length.

The epistome is heart-shaped with the margins slightly elevated and in some cases with irregularities that make it almost always asymmetrical (Plate 11, fig. 9).

The antennal scale is long and provided with a large spine; its external border is slightly concave; the laminar region is narrow; the length of the external part is little more than twice that of the major width of the scale (Plate 11, fig. 8).

The first pair of pereopods have very well developed chelae; the palmar region is subcylindrical, whereas that of the dactyl is slender, the surface of the chela is almost smooth to the naked eye, broken only by the tubercles present on the internal border of the palm; but with the aid of the microscope, one is able to appreciate the tuberculiform, flat structures that are dispersed homogeneously over the entire surface. The fingers are slender and long, and their cutting borders are flat and provided with numerous plaquettes which give them a peculiar appearance; the dentiform tubercles are small and almost hidden by the plaquettes and are more apparent in the proximal region of the fingers. The length of the dactylopodite equals that of the length of the palm and anterior third of the carpopodite.

The carpopodite is short and robust; its upper surface is provided with punctations, and moreover with a groove which is clearly defined and which extends almost the total length of the article. The internal face of the article bears a short, broadly-based spine on the distal portion.

58 The meropodite is flattened laterally in the proximal part, but in the distal portion becomes prismatic in form. The inferior border exhibits two rows of spines that extend longitudinally along the article; the external row ends distally in a spiniform tubercle larger than the others. The superior margin of the article is blunt and exhibits subsquamous tubercles along its entire length, those of the distal part being larger, and distinct from the others is a spiniform conical tubercle that is inclined forward.

The ischiopodites of the third pair of pereopods exhibit well developed hooks that have the appearance of tuberculiform structures and which are borne on the extreme proximal part of the ischiopodite; they are circular in section at the base, and their extremities are beveled. The internal surface of the tip is provided with setae. As for their disposition, these hooks clearly exceed the articulation between the ischium and the basipodite.

The first pair of pleopods (Plate 11, fig. 1) are robust, and, in position, their apical region reaches the coxopodites of the third pair of pereopods. On the internal part, caudal to the base, are straight conical prominences, one against the other. Both rami of each appendage maintain their independence in the apical region (Plate 11, fig. 5); the internal ramus exhibits the mesial process and the cephalic process, whereas that of the external bears the caudal process and the central projection.

The mesial process (Plate 11, figs. 4 and 5a) is a slender semiflexible structure which is in the form of a very sharp spine; it is inserted on the caudal external part of the internal ramus and its length hardly reaches that of the central projection. The cephalic process (Plate 11, figs. 4 and 5c) is a toothlike plate, flattened in the cephalocaudal plane, with a triangular contour having rounded angles, and of a chitinous texture. The central projection (Plate 11, figs. 4, 5, and 7b) resembles an irregular trapezoid with its distal angle directed toward the internal part; the centrocephalic process (Plate 11, fig. 7e) is situated near the mesial process and the centrocaudal on the outer cephalic part of the appendage (Plate 11, fig. 7f). The caudal process resembles a small crest, directed obliquely from outside toward the base of the appendage (Plate 11, fig. 5b).

In the cephalic part, near the apex, each pleopod of the first pair exhibits a small shoulder in the form of an angular prominence (Plate 11, figs. 2 and 3).

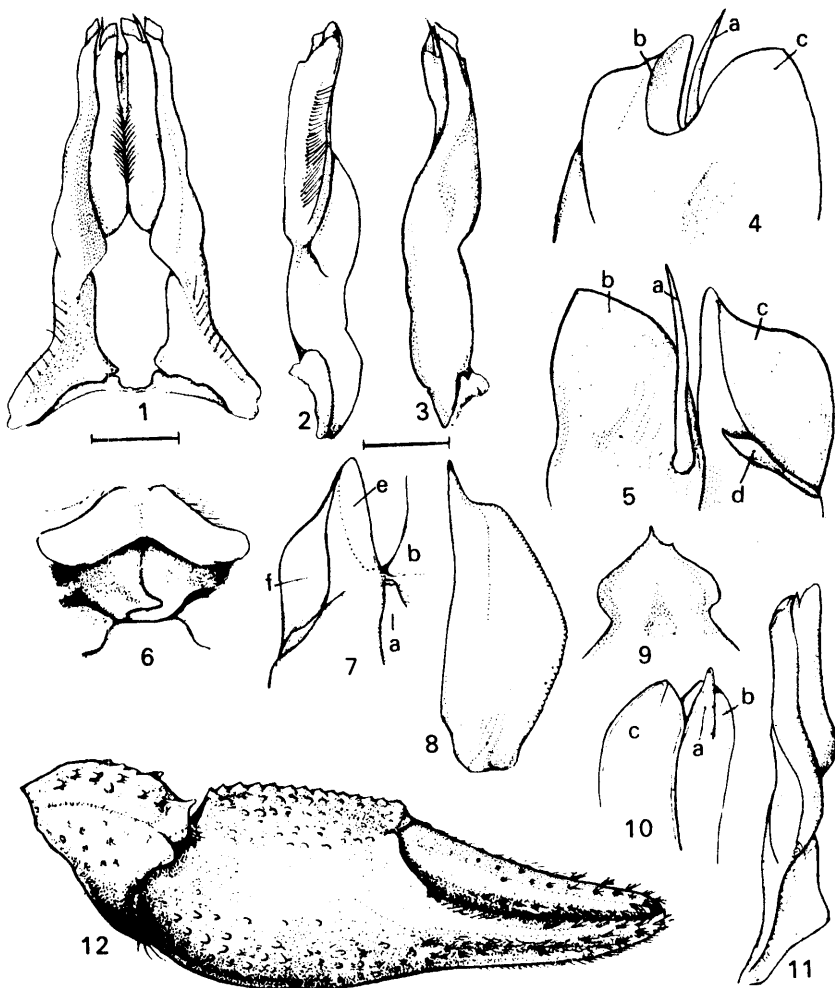
Male, form II. In the young form II males, the carapace is of the same width as the abdomen. The surface of the cephalothorax is very weakly punctate; the areola is wide and complete; the cephalic groove is slightly undulate; lateral spines are present.

The rostrum is sharp-pointed; the median carina is very well defined; the marginal spines are sharp and the acuminial spine long.

59 The epistome is triangular and its free margins are somewhat convex.

60 The chelae are slender; the surface is smooth and covered with slender, short hairs. The dactylar region of the chela is longer than the palmar region; longitudinal ridges are not present on the fingers; the cutting margin is devoid of denticles.

The carpopodite lacks a well defined dorsal sulcus.



1, caudal view of the first pair of pleopods of the male, Form I; 2 and 3, pleopods of the same pair in mesial and lateral views, respectively; 4 and 5, cephalic and caudal views of the apical part of the first pair of pleopods of the male, Form I (a, mesial process; b, cephalic process; c, central projection; d, caudal process); 6, *annulus ventralis*; 7, central projection of the first pair of pleopods of the male, Form I (e, centrocephalic process; f, centrocaudal process); 8, antennal scale of the male, Form I; 9, epistome of the same; 10, view of the apical part of the first pair of pleopods of the male, Form II; 11, general view of the same; 12, chela of the male, Form I.

The meropodite bears an internal row of tubercles on the mesial margin of the article; two spines stand out from the other tubercles because of their large size.

The first pair of pleopods in the male, form II, are little chitinized. The internal ramus exhibits a short mesial process (Plate 11, fig. 10a); the two parts which constitute the central projection may be clearly seen (Plate 11, fig. 10e); the caudal process is a small crest which is found below the central projection.

Female. Generally it is smaller than the male. The carapace is narrower than the abdomen and the surface more clearly scabrous. The rostrum is deeper and the median carina shorter. The epistome is triangular and its margins gently concave.

The first pair of pereopods have shorter chelae, the palmar region is more depressed, and the dactylar shorter than in the male. The surface of the chela is completely covered with subsquamous tubercles that extend onto the immovable finger and on the proximal part of the dactylopodite. On the internal margin of the palmar region, the tubercles are more massive than elsewhere on the surface. A longitudinal row of slightly prominent, hemispherical tubercles is present on the cutting borders of both fingers; on the dactylopodite, the largest of these tubercles is located in the median part of the article, whereas on the immovable finger there is a relatively large tubercle situated in the distal third and on the lower part of the cutting border. As in the chela of the male, the length of the dactylopodite has the same proportion with respect to the palmar part and distal third of the carpopodite.

The *annulus ventralis* in the adult female exhibits its structural characteristics with a clarity that is not apparent in the juvenile females. When the organ attains full development, it is semicircular in outline, convex caudally, and flat cephalically. In the anterior part, two crests are elevated that almost meet in the median posterior part, however, remaining separated by the groove. The latter has the form of an S, inclined from right to left, and beginning in the median part, ending displaced to the left.

Between the fifth pereopods, there is a massive prominence that bears a conical, but very short, tubercle.

61

Measurements in millimeters

	Male, Form I	Male, Form II	Female
Total length	87.0	58.0	82.4
Length of carapace	43.0	27.4	39.1
Anterior part of carapace	29.0	19.4	27.0
Length of areola	14.0	8.0	12.1
Width of areola	2.5	2.0	3.0
Length of abdomen	44.0	30.6	43.3

	Male, Form I	Male, Form II	Female
Posterior width of rostrum	5.5	4.0	5.3
Length of rostrum	11.0	7.3	10.0
Length of chela	35.0	14.4	26.0
Length of movable finger	18.5	8.0	15.0

Localities. 1. State of Jalisco: tributaries of Rio Santiago (Bouvier). 2. Ameca, Jalisco (A. Dugès). 3. Guadalajara, Jalisco (P.L. Jovy). 4. Tributary of Rio Santiago, near Laguna-de Chapala (Lima). 5. State of Michoacán: Hacienda de Villachuato, Dto. de Puruandiro (A. Dugès). 6. Jacona, Michoacán (Dieter Enkerlind).

Relationships. *Procambarus digueti* has been considered the most ancient species of Mexico. The characteristics of the first pair of pleopods of the male, form I, indicate that it has few affinities with the other species of *Procambarus*. On the other hand, the geographic distribution, located in the western zone of the Republic, leads to the supposition that *P. digueti* became established there in very ancient times. Corroborating our suspicion are the following facts: the absence of related species and its isolation with respect to the generically related groups of the eastern zone, as well as the geographic region, which is the oldest in the Mexican Republic, occupied by this species.

Procambarus bouvieri (Ortmann)

- 1909 *Cambarus* (*Cambarus*) *bouvieri* Ortmann, Ann. Sci. Nat. Zool., Vol. VII, Ser. 9, pp. 159 – 166.
- 1914 *Cambarus* (*Cambarus*) *bouvieri* Ortmann. Faxon, Mem. Mus. Comp. Zool., Harvard Coll., Vol. IX, No. 8, p. 411.
- 1931 *Cambarus* (*Cambarus*) *bouvieri* Ortmann. Creaser, Occ. Pap. Mus. Zool., Vol. X, No. 224, p. 10.
- 1946 *Procambarus bouvieri* (Ortmann). Villalobos, An. Inst. Biol. de la Univ. Nal. A. de México, Vol. XVII, No. 1, pp. 219 – 220, 224 – 229.
- 62 **Diagnosis.** Crayfish of medium size; rostrum of male, form I, and of female without lateral spines, rostral surface concave; areola narrow; without lateral spines on carapace; chelae flattened; hooks on ischiopodites of third pair of pereopods; pleopods of male, form I, slender, mesial process spiniform and short, cephalic process in form of “horsehoof,” central projection small, without shoulder in apical region near tip. *Annulus ventralis* circular.

Male, form I. In adult specimens, the carapace exhibits coarse granulations in the branchial and hepatic regions, whereas in the cardiac and gastric regions large punctations are abundant.

The rostrum is broad at its base, moderately narrow anteriorly; the rostral margins are straight, clearly convergent forward; lateral spines are not present, represented by rounded anterolateral angles; the acumen is triangular, its extremity reaching the distal articular part of the second article of the antennular peduncle. The surface of the rostrum is clearly fluted and the punctations of the cephalodorsal part extend to the posterior third of the surface of the rostrum; its remaining surface is smooth (Plate 12, fig. 3).

The postorbital ridges are short, gently convergent anteriorly and without a terminal spine. The cephalic groove is deep and slightly sinuous. Lateral spines are not present on the carapace; occupying its place on each side is a flattened hemispherical tubercle implanted on the posterior margin of the groove. The branchiostegal spine is small and acute. The areola is narrow, and its surface convex with punctations; the suprabranchial margins are interrupted posteriorly, in front of the margin of the carapace.

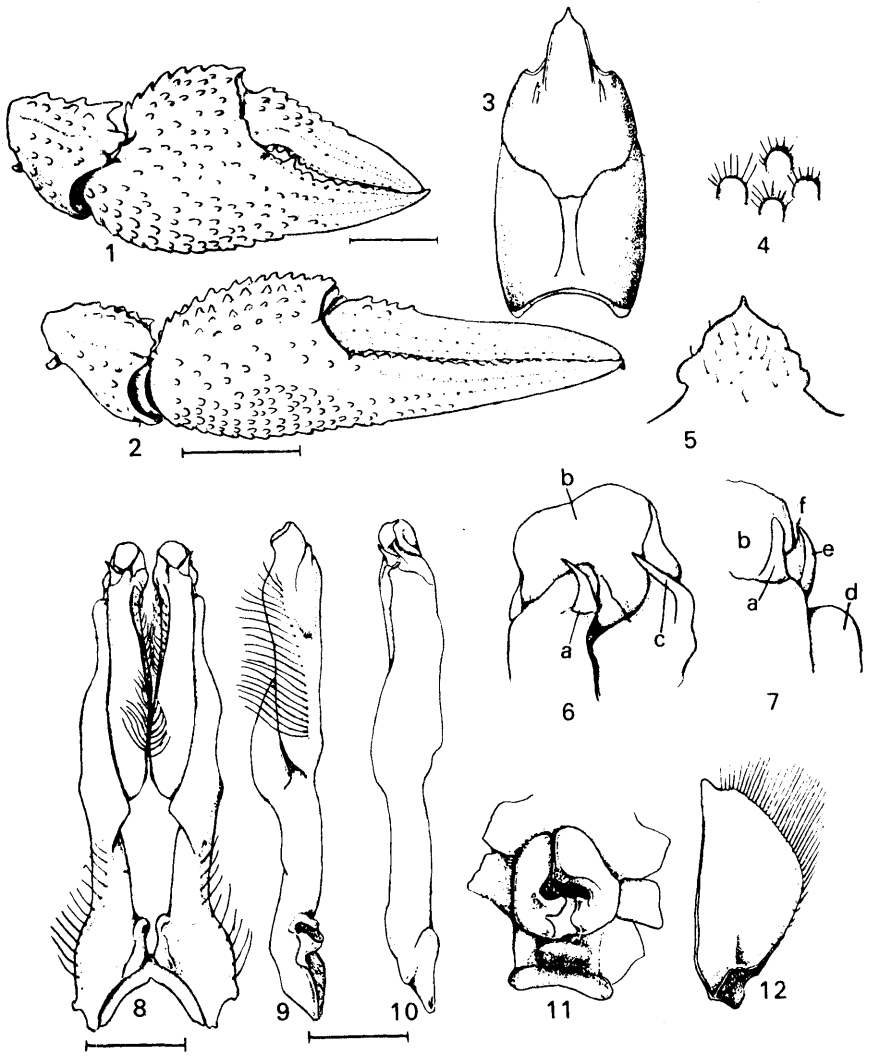
The proportions of the different parts of the cephalothorax are: the length of the cephalic part is almost double the length of the areola; the width of the areola is seven times less than the length; the posterior width of the rostrum is exactly half the length of the areola; the length of the rostrum is slightly less than the length of the areola; the total length of the carapace is equal to the length of the abdomen.

The surface of the segments of the abdomen is slightly punctate; the telson is wide, and the length of the anterior part is greater than that of the posterior, presenting, moreover, distolateral angles armed with two or three spines on each side. The posterior part is semicircular.

63 The epistome is heptagonal in outline, but its borders bear a series of emarginations that makes it asymmetrical; its surface is provided with small setae (Plate 12, fig. 5).

64 The antennal scale is somewhat elongate; the greatest width is greater than half of its length along the midline; the antennal spine is robust and slightly sharp (Plate 12, fig. 12).

The first pair of pereopods are armed with strong chelae, the dactylar region of which is longer than the palm. In general the chela is flattened, the internal border provided with triangular tubercles; in contrast, the external border possesses squamous tubercles in greater number than does the internal (Plate 12, fig. 4). The surface of the palmar region is covered with subsquamous tubercles which are more abundant on the external part. The dactylar part of the chela is slender; the immovable finger exhibits a hemispherical tubercle on the proximal third of the cutting margin which stands out from the others by its greater size; the same finger bears a conical tooth ventrally in its distal third. The cutting border of the immovable finger has teeth on its extreme proximal part which are progressively smaller toward the tip of



1, chela of the female; 2, chela of the male, Form I; 3, dorsal view of the carapace of the male, Form I; 4, subsquamiform tubercles of the carapace; 5, epistome of the male, Form I; 6 and 7, different views of the apical part of one of the first pleopods of the male, Form I (a, mesial process; b, cephalic process; c, central projection; f, centrocephalic process; e, centrocaudal process; d, caudal process); 8, caudal view of the first pair of pleopods of the male, Form I; 9 and 10, mesial and lateral views of the same; 11, *annulus ventralis*; 12, antennal scale of the male, Form I.

the finger. Both fingers bear longitudinal ridges on the dorsal and ventral surfaces (Plate 12, fig. 2).

The carpopodite is short, almost a third as long as the chela. The internal border of this article is provided with tubercles which at times become spiniform; the surface of the external border bears punctations and a few subsquamous tubercles; dorsally this article bears a groove which extends obliquely along almost its entire length. Ventrally, the carpopodite exhibits four conical spines of about two millimeters length; three of these spines are found on the subarticular border, and the other belongs to the group of tubercles on the internal part.

The meropodite has the approximate form of a triangular prism; the superior margin exhibits a series of tubercles on the distal extremity, among them, one, which has acquired the form of a spine, stands out; the inferior margin of this article bears two series of spines arranged in rows, those of the inner row are more numerous and larger.

The ischiopodite of the third pair of pereopods is armed with a robust hook, flattened in the same plane of the article, notched and beveled at the free extremity. The implantation of the hook occupies almost the proximal half of the article, and the free extremity extends considerably beyond the articulation of the basipodite and ischiopodite.

65 The first pair of pleopods are straight and slender; their apical parts reach the posterior region of the coxopodites of the second pair of pereopods, with both rami of the appendage close together (Plate 12, figs. 8, 9, and 10). The mesial process is a spiniform structure, straight, somewhat flattened, slightly inclined toward the external part of the appendage; its insertion differs from that common in other species in that it is implanted on the external part of the internal ramus of the appendage (Plate 12, figs. 6 and 7a). The cephalic process resembles a plate in the form of a "horsehoof" situated in the cephalic part (Plate 12, figs. 6 and 7b). A torsion of the apical part, from left to right, is clearly marked in this process; consequently the remaining structures have been displaced in the same direction, remaining grouped on the lateral part of the appendage. Thus, the central projection (Plate 12, figs. 6 and 7c) is situated on the lateral side at the base of the cephalic process; it is triangular with a bisector indicating the two constituent parts: the centrocaudal process (Plate 12, fig. 7e) which is narrow and gently recurved from behind forward, and the centrocephalic process (fig. 7f) which is applied along most of its surface to the concavity of the caudal external part of the cephalic process, separating from it in the apical part to form the angle of the central projection. The caudal process (Plate 12, fig. 7d) is found in the lower lateral part of the apical portion; it has the form of a flange, which appears in the junction of the pleopod as an angular structure with a rounded vertex, precisely on the external part of the appendage.

Male, form II. In the specimen 42.5 mm long, one is able to perceive that the surface of the carapace is covered with broadly dispersed large punctations and a few granulations in the posterior part of the hepatic region. The rostrum is broad at its base and narrow in its anterior part, with very small lateral spines; the acumen is triangular and reaches anteriorly to the distal part of the third article of the antennular peduncle. The surface of the rostrum is deeply excavate, with small punctations bearing setae scattered over its surface; the punctations are larger in the posterior part of the rostrum, becoming similar to those on the rest of the surface of the carapace.

The postorbital ridges are almost parallel and terminate anteriorly in small spines.

The epistome is heptagonal in outline.

The spine of the antennal scale is very sharp.

- 66 The chelae of the first pair of pereopods are small and the palmar region is broad and short; the dactyl is somewhat long, double the length of the palm. The surface of the chela is densely covered with tubercles. The internal border of the chela is sharp and bears a serrate row of tubercles.

The carpopodite is short, conical, and the groove clearly delimits two areas of the surface; the external part is provided with punctations and the internal with subsquamous tubercles.

The spine on the upper border of the meropodite is very sharp.

The ischiopodite of the third pair of pereopods bears a small hemispherical tubercle, separated from the proximal articulation by an emargination at midlength.

The first pair of pleopods are very slender with the same proportional length as that of the first form male. The mesial process is very short and conical in form, with the same emplacement as in the first form male. The cephalic process is heavy, not chitinized, but conserves the form described previously. The central projection is crestlike and wrapped around the external border of the cephalic process. The caudal process is lower and less pronounced than in the first form male.

Female. The carapace is densely granulate laterally; the dorsal surface exhibits punctations that are more abundant in the anterior region.

The rostrum is somewhat wide at the base, narrow anteriorly, without lateral spines; the acumen reaches midlength of the ultimate antennular article. The epistome is heptagonal in shape. The postorbital ridges lack spines anteriorly.

The chelae of the first pair of pereopods (Plate 12, fig. 1) are more flattened than those of the first form male; they are suboval in the palmar region; the surface is covered with sparsely dispersed subsquamous tubercles. The internal margin bears spines that give it a

serrate aspect. The tubercles of the surface extend over the borders of the fingers, those of the dactyl being more prominent. Both the upper and lower surfaces of the fingers exhibit ridges along their entire length. The dactylopodite is as long as the palmar portion, longer than the carpopodite; the greatest width of the chela is at midlength.

67 The *annulus ventralis* (Plate 12, fig. 11) is composed of two pieces in the form of a V that join at the extremity of its rami, and their vertices are directed laterally and backward; the posterior ramus of the left piece is shorter than the right; on the other hand, the anterior ramus of the same left piece is longer and more massive than the opposing corresponding piece. The two upper rami are separated by a deep and narrow groove which is disposed obliquely from left to right, whereas those of the posterior ramus are united in the middle by an articular membrane where the groove is located. The two parts of the V leave a central space lengthened in the transverse plane, which from time to time is provided with setae.

Between the fifth pereopods, there is a transversely elongate tubercle which is blunt apically.

Measurements in millimeters

	Male, Form I	Male, Form II	Female
Total length	69.0	43.0	60.0
Length of carapace	35.0	21.0	35.5
Anterior part of carapace	24.0	14.3	21.0
Length of areola	11.0	6.7	10.5
Width of areola	1.2	1.0	1.0
Length of abdomen	34.0	22.0	28.5
Posterior width of rostrum	6.5	3.4	5.0
Length of rostrum	7.0	5.5	7.5
Length of chela	41.5	10.2	22.0
Palm of chela	11.5	3.7	8.0
Greatest width of chela	12.2	4.5	10.0
Length of dactylopodite	19.5	6.4	13.5

Localities. Small torrential river of Uruapan, Michoacán (M. L. Diguët). Presa del Ahorcado, Uruapan, Michoacán (Villalobos).

Relationships. Without doubt, *Procambarus bowyeri* is related to *Procambarus digueti*, not only in the geographic distribution on the Pacific slope, but also in the disposition of the apical structures of the first pair of pleopods of the first form male, since the implantation of the mesial process on the external part of the internal ramus in both species is of great importance. In regard to the remaining structures, the flattened form of the cephalic process of *P. digueti* may well be related to the horsehoofed shape of the cephalic process. The torsion

which was clearly noted in *P. bouvieri* could be the cause of the displacement of the other structures toward the external side of the cephalic process, taking as a point of departure the normal position which they have in the pleopod of *P. digueti*.

- 68 Creaser pointed out a certain similarity between *P. bouvieri* and *P. contrerasi* in respect to the apical structure in the form of a "horse-hoof," but we believe that this is only a phenomenon of convergence between these species.

SYSTEMATIC DISCUSSION OF THE MEXICAN SPECIES OF THE BARBATUS SECTION

Hobbs (1942b) discussed adequately the relationship of *P. simulans simulans* with *P. alleni*, and we concur in his conclusions, which seem logical to us; consequently *P. simulans regionontanus* maintains its place within this group by being a subspecies very close to the type species.

In regard to the position of *P. digueti* and *P. bouvieri*, we have placed them together in the *barbatus* Section for the following reasons: *P. digueti* has always been considered a species with very primitive characters (Ortmann, Faxon, and Hobbs), and the disposition of the apical parts of the first pair of pleopods of the male, form I, shows marked similarities to the pleopods of *P. simulans regionontanus*. In respect to *P. bouvieri*, the relationship with *P. digueti* is undeniable, and therefore both species have been placed in the same Section, but in a special group which we designate the *digueti* Group, with the following diagnosis: Rostrum with or without lateral spines. Areola broad. Mesial process spiculiform, borne on caudolateral surface of internal ramus of pleopod; caudal process reduced or absent; cephalic process and central projection in form of plate.

Ortmann has emphasized the importance of *P. digueti* and *P. bouvieri* in respect to the primitive characters of these species which is strengthened by the relationships which they have with the *simulans* Group and the *alleni* Group. (*Procambarus simulans simulans* is considered to be a very ancient species.) The geographic distribution provides a firm base for this hypothesis, but in contrast to the belief of Ortmann, the invasion should have occurred from North to South, between the Middle and Upper Cretaceous, and, keeping in mind the antiquity of *P. digueti* and of *P. bouvieri*, it is supposed that they became established in the southern part of the continental mass and were left there encircled by the folding of the Sierra Madre Occidental. These species, however, do not represent a continuity of relationship with those that populate the Atlantic slope, a fact that provides other data supporting our opinion.

Diagnosis. Cephalodistal margin of first pleopod of male never possessing flange or kneelike prominence unless constituting part of some terminal process; distal part of appendage directed straight [= distally] or caudally; mesial process inclined (either caudodistally or caudolaterally); crescent-shaped protuberance never present; cephalic process when present springing from cephalic or cephalolateral margin, never from mesial surface; hooks present on ischiopodites of third and fourth pairs of pereopods.

blandingii Section

blandingii Group

blandingii Subgroup *Procambarus blandingii cuevachicae*
Procambarus caballeroi
Procambarus toltecaae

clarkii Subgroup

evermanni Subgroup

fallax Subgroup

spiculifer Group

pictus Group

pictus Subgroup

lucifugus Subgroup

seminolae Subgroup

KEY TO SPECIES

- 1 Plate of sternite immediately anterior to *annulus ventralis* not cleft by median posterior emargination *Procambarus blandingii cuevachicae*
- 1' Plate of sternite immediately anterior to *annulus ventralis* cleft by median posterior emargination 2
- 2 (1') First pair of pleopods of male, form I, with caudal and cephalic processes, and central projection inclined caudally at angle of 120° to principal axis of appendage. Cephalic process spiculiform. Caudal process very reduced, in form of spine *Procambarus toltecaae*
- 70 2' First pair of pleopods of male, form I, with caudal and cephalic processes and central projection inclined caudally at angle of 145° to principal axis of appendage. Cephalic process lamelliform. Caudal process very well developed, platelike *Procambarus caballeroi*

BLANDINGII SUBGROUP

Diagnosis. First pleopod of male, form I, terminating in four well developed parts; lacking curvature or hump on anterior margin of appendage (except in *P. caballeroi* and in *P. tolteca*); mesial process spiculiform or in form of narrow plate; cephalic process never spiculiform, but in form of claw or plate (except in *P. tolteca* in which spiculiform); central projection conspicuous, large and corneous; caudal process corneous and strongly developed, situated caudal to central projection and without obscuring centrocaudal process. Margins of rostrum interrupted and frequently bearing spines. Areola long and relatively narrow.

Procambarus blandingii cuevachicae (Hobbs)

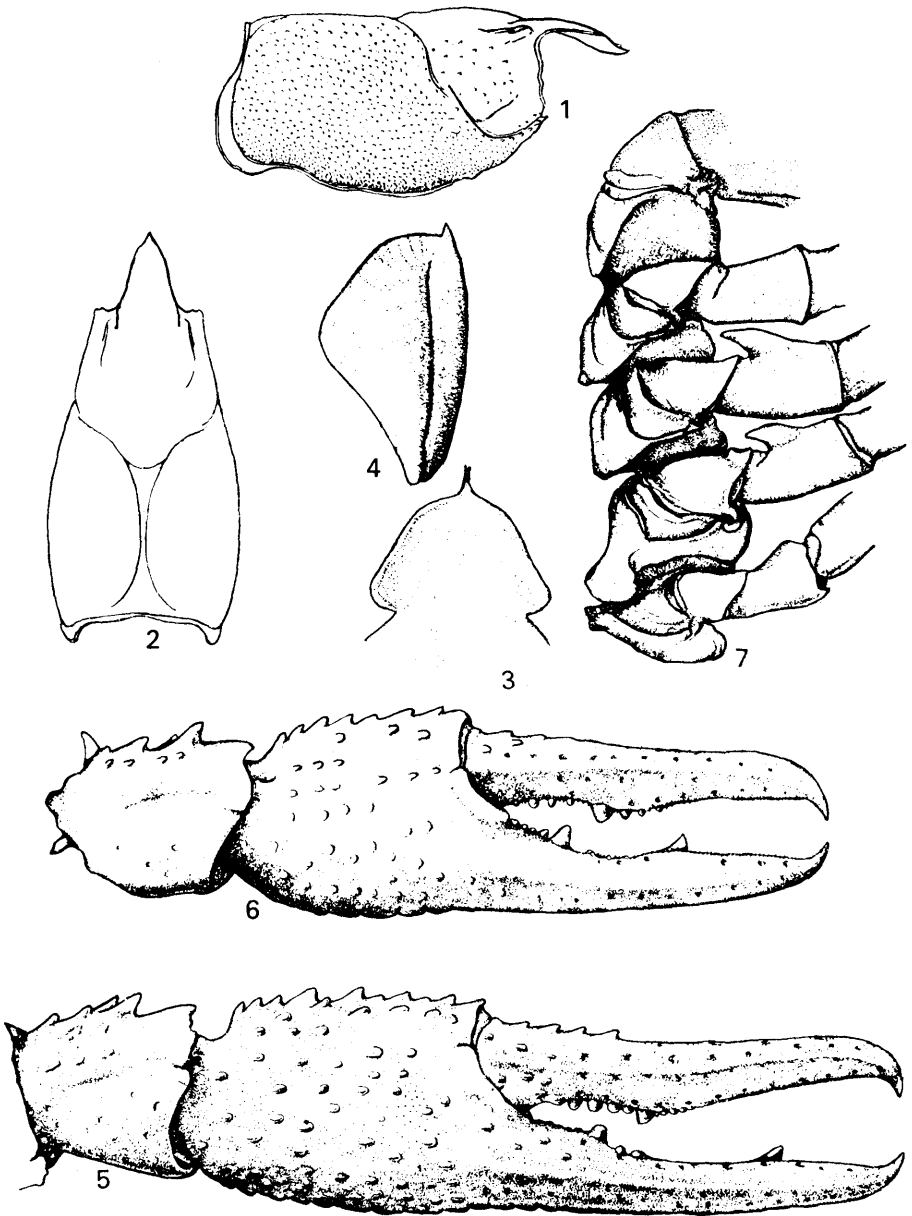
1941 *Cambarus blandingii cuevachicae* Hobbs, Zoologica, N. Y. Zool. Soc., Vol. XXVI, Pt. 1, Nos. 1 and 2, pp. 1–4, Pl. 1.

1942b *Procambarus blandingii cuevachicae* Hobbs, Amer. Midl. Nat., Vol. XXVIII, No. 2, p. 342, Pl. 3, fig. 7.

Diagnosis. Specimens of large size. Carapace provided with tubercles; rostrum broad with very small tubercles in place of lateral spines; areola very narrow to virtually obliterated. Hooks on ischiopodites of third and fourth pairs of pereopods. First pair of pleopods with tuft of setae on external side of apical portion; apical processes directed caudolaterally. *Annulus ventralis* with deep groove in right central portion. Sternite of fourth pair of pereopods in female with tuberculiform processes in median posterior part which in very old females prolonged over anterior region of *annulus ventralis*.

Male, form I. The cephalothorax is definitely ovate and noticeably wider than the abdomen. Its surface bears punctations and numerous small tuberculiform prominences, which at times attain the form of a spine. In the gastric region and in the posterior part of the rostrum there are homogeneously distributed circular punctations. The inferior part of the hepatic region is almost smooth but in the upper part there are a few well marked prominences; the largest are below the post-orbital ridges; moreover, bordering the cephalic groove and almost at the limits of the anterior part of the carapace, there is a row of six or seven tubercles. The branchial regions are completely covered with tuberculiform prominences, which are made more visible by being located near the inferior border of the cephalothoracic shield (Plate 13, figs. 1 and 2).

The rostrum is lanceolate, its borders almost entire since in the place where normally there are lateral spines, there is a small angle or prominence hardly visible with the microscope. The surface of the



71

Plate 13. *Procambarus blandingii cuevachicae* (Hobbs). Male, Form I.

1, lateral view of the carapace; 2, dorsal view of the same; 3, epistome; 4, antennal scale; 5, chela; 6, chela of the female; 7, ischiopodites I to V of the male, Form I.

rostrum is excavate and smooth. It is important to point out that the specimens from San Diego, Puebla, exhibit certain differences with regard to the outline of the rostrum as compared with specimens from the type locality, for in them, the rostrum is wide at the base and from there the margins are strongly convergent and very slightly convex.

The postorbital ridges are convergent anteriorly and bear on their anterior part a very small, conical, chitinous prominence, at a glance seeming to lack this structure.

The cephalic groove is deep. It is formed by the anterior part of the groove that limits the branchial region and which continues insensibly with the suprabranchial margins which form the areola. In the median part, the cephalic groove terminates in a flange that rises in the anterior region of the areola. In the lateral region, this groove is almost continuous with that which limits the lower hepatic region. In the anterior part of the carapace, the groove terminates in the branchiostegal spine. Lateral spines are present on the carapace, which without being very large, may be distinguished easily from the other prominences. The entire posterior border of the cephalic groove is provided with small spiniform prominences arranged in a single row, ending with the branchiostegal spine.

73 The areola is narrow, particularly in the median part. The surface of the areola is deep and almost smooth, only presenting punctations in the posterior and anterior regions. The limits of the areola are well marked, although disappearing in the posterior part (in the specimens from Crucecero de Aquismon, S. L. P., the areola is clearly marked throughout its length, because the suprabranchial grooves are quite distinct in the posterior region). The suprabranchial grooves are elevated slightly above the areola. In the crayfish from Cueva Chica, San Luis Potosi, the areola is practically obliterated, a character that is not shared with specimens from other localities in the vicinity of Valles, S. L. P.

The proportions that exist between the different regions of the carapace are the following: the length of the areola is little more than one and one-half times the length of the carapace. The greatest width of the rostrum is six and one-third less than the total length of the carapace. The length of the rostrum is one-fourth the total length of the carapace.

The proximal section of the telson exhibits a single spine in its distolateral angles. The distal section has a weak emargination on the posterior margin.

The epistome is almost semicircular, with its margins smooth and gently elevated. It is slightly asymmetrical (Plate 13, fig. 3).

The antennae bear a somewhat long and slender flagellum which extends over the dorsal part of the body, reaching the distal region of

the first section of the telson. The antennal scale is broad; it is provided with a short and robust spine. Its dorsal surface is furrowed by a kind of canal which fades insensibly in the anterior region. The broadest part of the scale is located slightly beyond midlength (Plate 13, fig.4). The figure which represents the antennal scale in the original description by Hobbs seems a little more slender. We have made comparisons with topotypes, and the width is very similar to that of specimens from El Ajenjibre, Pue., and other localities from Valles, S. L. P.

The first pair of pereopods are robust and exhibit chelae of regular size (Plate 13, fig. 5). The ischiopodite bears four or five small denticles on its inferior margin. The meropodite, or following article, has spines along the entire length of the superior border. These spines are subsquamous in appearance and are not arranged linearly, although some of them form a row; in the distal extremity of the article and on the same margin, there is a spiniform process which completes the just mentioned series. The external face of the article is smooth, although it exhibits a few circular concavities. In contrast, the internal face, although with the major part smooth, bears a group of spiniform processes
74 located principally on the anterior part; moreover, very near the lower border and on the same internal face, there are several processes, approximately seven in number, that form a longitudinal series located exactly in the distal half of the meropodite. The lower border of the article is armed with spiniform processes that are arranged in two series; an internal one which is longer and has more denticles; it begins slightly beyond the articulation of the merus with the ischiopodite; the 14 or 15 spiniform processes are conical with their vertices directed forward; some are very small and appear to be intercalated between the larger ones; their size decreases toward the proximal extremity. The external series is arranged in a divergent manner in relation to the internal; it is not straight but describes a laterally convex curve, and the denticles composing it are slightly larger; the first are subsquamous. This series is interrupted distally by a larger tubercle; then follow three small ones and farther along a rather larger one which is of the same type as those of the internal series. At the distal extremity, the two series fuse and terminate in a conical spiniform process, larger than the others, which is situated on the margin of the articulation of the meropodite with the carpopodite. The surface of the carpopodite is smooth dorsolaterally, interrupted by only small circular punctations, the fundus of which bears a few setae. The groove is shallow and gently oblique from forward to behind and inside to outside. The internal region, in contrast, exhibits subsquamous processes of unequal size. Exactly on the internal margin of the article, four processes are located in two series of two each; the proximal two, almost equal in size; the distal two distinctly unequal, the larger inserted on the border of the

articulation with the chela. On the inferior face of the article, there are five or six other processes which are arranged almost regularly in a small area. On this face and approximately in the median part, there is a large triangular process, the vertex of which is directed forward. Another process, also triangular in form, is found slightly more medially; its vertex is directed forward and rests on a prominence of the propodus. With the exception of these processes all of the inferior region of the carpopodite is smooth.

75 The chela is large and its fingers long and slender, the surface of the palmar region is totally covered with subsquamous processes; those found on the internal border are large, and elevated; those on the dorsal surface of the chela are broader and slightly elevated; those on the external portion of the chela are very abundant and are very close together. The finger part of the propodus is narrow in its basal region and becomes rapidly slenderer toward its extremity; it has a longitudinal ridge or border, curved in the same direction as the finger; the cutting margin has a few denticles which are disposed in the following manner: in the proximal region, there are four small hemispherical teeth which are hardly perceptible, a large conical tooth rounded apically and directed forward; following them, two small hemispherical teeth of the same shape as the four proximal ones; beyond, there is one more denticle, also small but isolated; the dentiform structures that follow are very small; on the inferior face of the immovable finger and more or less at the base of the distal third, there is a large dentiform prominence, conical in form, flattened dorsoventrally, and with its vertex pointed.

The dactylopodite is also slender; the internal border is gently concave and the dorsal surface of the proximal portion bears four subsquamous processes; near the articular portion, there are two other small processes. The upper face of the movable finger exhibits a rib or low ridge; the cutting border is concave along its proximal third and is armed with denticles the form and position of which are described as follows: proximally there are four small hemispherical denticles decreasing in size distally; beyond them, and displaced toward the ventral surface, is a large tooth which stands out from the others on the article because its form is very similar to the proximal tooth of the immovable finger; in the specimens from San Luis Potosi, this tooth is not prominent. Other small teeth occur forward and are found precisely on the convex portion; the rest of the cutting margin bears nothing more than the numerous small denticles similar to those of the immovable finger. Both fingers terminate in strong, chitinous, recurved spines.

The ischiopodites of the third and fourth pairs of pereopods (Plate 13, fig. 7) exhibit conical hooks, flattened anteroposteriorly and

gently recurved; the hook on the ischiopodite of the third pair is slightly larger; that of the fourth pair has its apical portion curved cephalically. The basipodite of the fourth pair of pereopods possesses a prominence on its distal articulation that has a cluster of setae at the tip. The coxopodite of the same appendage exhibits a protuberance situated on the internal posterior region of the article; it has the form of a knee and, by its size, stands out from the coxopodites of the other thoracic appendages. The coxopodite of the fifth pair of pereopods has a
76 platelike prominence on its caudal region; the internal angle of this plate exhibits a more or less hemispherical process which is situated immediately above the sexual apertures; this process corresponds very nearly to that on the coxopodite of the fourth pair of pereopods.

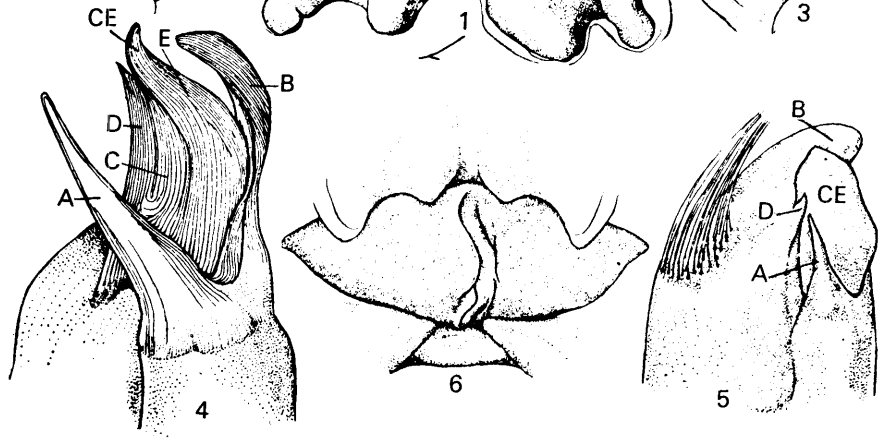
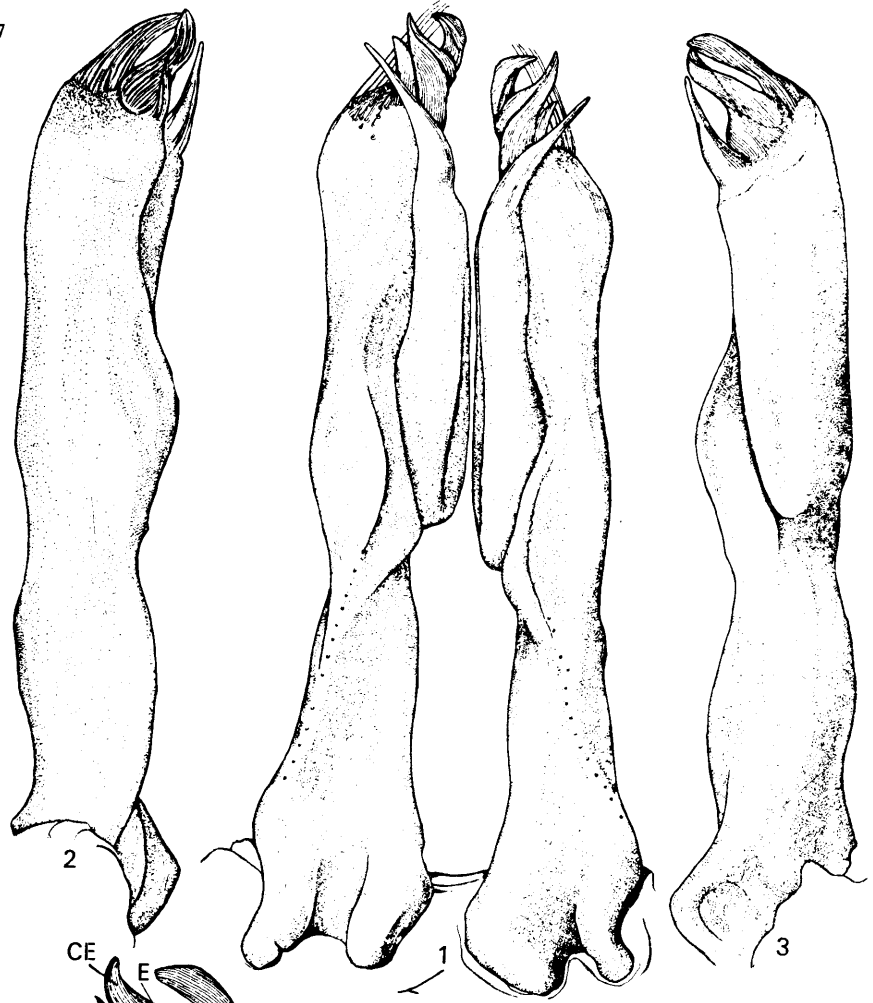
The first pair of pleopods are robust and short (Plate 14, figs. 1, 2, and 3). Their apical regions reach the coxopodites of the third pair of pereopods. The apical part (Plate 14, fig. 4) is slightly bent toward the caudal region, exhibiting five structures which may be identified: with the mesial process (A), with the cephalic process (B), with the caudal process (D), and with the central projection (CE), consisting of the centrocephalic process (E) and the centrocaudal process (C).

The mesial process is conical, slightly chitinized, bent toward the sides and gently turned toward the apical portion. The cephalic process has the form of a triangular pyramid, with one of its faces slightly concave; it is recurved from forward to rear, in such a manner that its vertex points toward the central projection; in lateral view, it may be noted that one of its edges is continuous with the centrocephalic process of the central projection. The latter has the form of a triangle with a curvature that gives it a very peculiar appearance. The caudal process is intimately associated with the central projection, is dentiform, elongate, and straight, and is completely chitinized.

Male, form II. The carapace is noticeably less scabrous, because the tubercles on the upper and middle part of the branchial regions are very small; in contrast, those of the inferior and anterior regions are well developed. The tubercles that occupy the position of the lateral spines of the carapace are not distinct from the others. The rostrum is acute because the margins are strongly convergent, and the discontinuity with the acumen is hardly noticeable; at most, one observes a small, almost insignificant angulation which establishes the end of the rostral margins and the beginning of the acumen. The acuminal spine reaches midlength of the ultimate article of the antennule.

The areola is narrow, but not obliterated; its surface is low in relation to the branchial margins; in the posterior part it bears a few punctations; the remainder is smooth.

The external border of the antennal scale is slightly convex; the



antennal spine is small and the greatest width of the scale is situated slightly proximal to midlength.

78 The chelae of the first pair of pereopods are not well developed, but their general form does not differ from that already described for the adult male. On the dactylopodite, the tooth that is located on the proximal third of the cutting border is clearly evident, a character that we did not find in the topotypes.

The hooks of the third and fourth pairs of pereopods are very poorly developed, having a tuberculiform appearance and being markedly similar to one another.

The first pair of pleopods reach the apical region of the coxopodites of the third pair of pereopods. In caudal view, the mesial and cephalic processes resemble the thumb and index finger of a hand, between which the central projection is held closer to the cephalic process. The mesial process and central projection are conical, non-chitinized tubercles of more or less the same size; the two parts that constitute the apical part of the central projection are visible. In contrast, the cephalic process has the approximate form of a triangular pyramid. The caudal process is very small and located in front of the mesial process and is narrowly united with the central projection. In caudolateral view (Plate 14, fig. 5) one is able to appreciate the spiniform mesial process (A), the tuberculiform central projection (CE), the cephalic process (B), and the caudal process as a small angular structure (D).

Female. Undoubtedly, judging by its characters, the largest specimen that we have been able to obtain from La Mesa de San Diego, Puebla, is an immature female; consequently the characters that are mentioned refer only to the differences found between it and specimens from the type locality.

The chela of the first pair of pereopods is shorter in all of its proportions than that of the first form male (Plate 13, fig. 6). The cutting border of the dactylopodite shows the tooth on the proximal third clearly.

The *annulus ventralis* (Plate 14, fig. 6), given the juvenile characteristics of the specimen, does not show the concavity so peculiar to the mature females from Cueva Chica and other localities in the vicinity of Valles, S. L. P.; in contrast, the terminal position of the groove is typical of the females of this subspecies, regardless of from where they come.

One feature that could be added to the characteristics of the

Plate 14. *Procambarus blandingii cuevachicae* (Hobbs). Male, Form I.

1, caudal view of first pair of pleopods; 2, lateral view; 3, mesial view; 4, caudal view of the apical part of the pleopod; 5, caudal view of the apical region of the first pleopod of the male, Form II (A, mesial process; B, cephalic process; C, centrocaudal process; E, centrocephalic process; CE, central projection; D, caudal process); 6, *annulus ventralis*.

79 subspecies is the sternite of the fourth pair [of pereopods] of the very mature females, the posterior border of which forms two slightly asymmetrical tuberculiform prolongations over the anterior part of the *annulus ventralis*, one on each side of the median line. This character has been observed by us in the adult female specimens from the localities at Valles, S. L. P., and less marked in our juvenile female from La Mesa de San Diego, Pue.

We present a table of comparative measurements of specimens of *Procambarus blandingii cuevachicae* from three different localities, among them the type locality, Cueva Chica, S. L. P. (See Table below.)

80

Measurements in millimeters

	Male, Form I			Male, Form II			Female		
	Loc.	Loc.	Loc.	Loc.	Loc.	Loc.	Loc.	Loc.	
	1	2	3	1	2	3	1	2	3
Total length	73.9		73.0	55.7	73.6	68.0	75.5	96.8	70.2
Length of carapace	37.9		39.0	27.8	37.8	34.6	38.3	50.1	36.0
Anterior part of carapace	19.0		24.0	18.0	25.0	21.7	24.7	32.4	22.7
Length of areola	18.9		15.0	8.8	12.8	12.9	13.6	17.7	13.3
Width of areola	0.2		0.8	—	1.0	0.7	0.7	1.0	0.6
Length of abdomen	36.0		34.0	27.9	35.8	33.4	37.2	45.7	34.2
Posterior width of rostrum	15.9?		6.9	4.4	6.3	6.1	6.4	7.8	6.5
Length of rostrum	18.9?		9.5	7.5	10.0	8.6	8.9	12.0	9.3
Length of chela	42.3		32.0	14.5	28.3	21.0	28.6	34.8	19.0
Length of movable finger	25.3		19.4	8.0	17.0	12.3	18.5	23.0	11.0

Locality 1: Cueva Chica, S. L. P.

Locality 2: Los Naranjos, Valles, S. L. P.

Locality 3: La Mesa de San Diego, Pue.

The measurements of the specimens from Cueva Chica are those that Hobbs reported in the original description; only the measurements of the male, form II, had to be made of a topotype collected by us. It is important to note that the data presented for the posterior width and the length of the rostrum of the male holotype seem to us erroneous since it is practically impossible that they reach a measurement of 1.59 and 1.89 cm, respectively. With regard to the width of the areola, those specimens from the type locality exhibit narrower ones than do those from other localities, being completely obliterated in the male, form II, topotype.

Unfortunately, in our collections from different localities in Valles, S. L. P., we were not able to obtain first form male specimens;

consequently the column of measurements corresponding to it is vacant.

On the other hand, the largest female that was collected attained a total length of almost 97 mm.

Localities. Type locality: Cueva Chica, 1600 m N.E. El Pujal; 3 km S.E. Valles, San Luis Potosí (Hobbs). Mi Ranchito, 4 km E. of Aquismon, km 419 de la carretera Mexico-Valles, San Luis Potosí (Villalobos). Los Naranjos, km 420 de la carretera México-Valles, San Luis Potosí. (Villalobos). Mesa de San Diego, km 262 de la carretera. Mexico-Tuxpan, Puebla (Villalobos).

Relationships. *Procambarus blandingii cuevachicae*, according to Hobbs, is closely related to *Procambarus blandingii acutus*. The specimens from Mesa de San Diego, Pue. (possibly the same locality recorded by Hobbs "Villa Juárez, Tamaulipas," corresponds to it; there is no such locality in Tamaulipas) served us for making the description and in it we noted certain differences that add to the characteristics of *P. blandingii cuevachicae*. We believe that they do not have sufficient taxonomic value to separate these specimens [one line repeated and another omitted
81 here]. . . the specimens obtained in the cited localities coincide in their fundamental characters, and the differences, such as the width of the areola, the disposition of the teeth on the cutting borders of the chelae, the form of the rostrum, etc., are so small that they do not warrant a subspecific separation.

Mesa de San Diego, Pue., exhibits characteristics similar to those of the region of Valles, S. L. P., and we do not doubt that *P. blandingii cuevachicae* has become dispersed in this region because of the similarity in environmental conditions.

Procambarus tolteca Hobbs

1943 *Procambarus tolteca* Hobbs, Lloydia, Vol. VI, pp. 198 – 203, Pl. 1.

Diagnosis. Crayfish of medium size. Rostrum broad at base, rostral margins slightly convex, without lateral spines. Carapace without lateral spines; areola broad. Male with hook on ischiopodites of third and fourth pairs [of pereopods]; basipodite of fourth pair of pereopods with prominence on distal part; coxopodite of same appendage with kneelike projection on posterior internal part. First pair of pleopods of male, form I, with tuberculiform process in posterior internal region of base; shoulder present at some distance from apex in cephalomesial portion; tuft of setae in subdistal lateral region. Mesial process subdistal, setiform, and directed caudally; central projection clawlike, also directed caudally. Sternite of fourth pair of pereopods of female cleft in median line and with tubercles in posterior region. *Annulus ventralis* with irregular surface on which

groove coincides with cleft of sternite of fourth pair [of pereopods].

Male, form I. The carapace is long and compressed laterally, densely punctate on the dorsal surface, including the posterior region of the rostrum; the lateral regions are provided with widely spaced granules, but in the superior part of the branchial regions and in the dorsolateral part of the cardiac region, they are more abundant; a series of these tubercles is arranged along the first portion of the posterior border of the cephalic groove. The hepatic region exhibits a few large punctations and tubercles. The branchiostegal spine is present.

82 The postorbital ridges are short and prominent, terminating anteriorly in a small conical tubercle; on the posterior part of these ridges, there is a hemispherical prominence that is slightly elongate in the anteroposterior axis.

The rostrum is broad, its margins convex and slightly convergent forward; there are no lateral spines; the acumen is triangular, distinctly delimited from the margins; the acuminal spine slightly exceeds the middle part of the third article of the antennular peduncle. The surface of the rostrum is deeply excavate, smooth in its anterior two-thirds; the basal part is punctate. The ventral keel of the rostrum has a small dentiform process on the proximal extremity.

The areola is broad and densely punctate.

The proportions of the different parts of the carapace are the following: the posterior width of the rostrum is five and one-half times less than the total length of the carapace; the length of the areola is exactly half the length of the cephalic portion of the carapace; the width of the areola is one-quarter of the posterior width of the rostrum; the anterior width of the rostrum is half of its posterior width; the length of the carapace is almost equal to the length of the abdomen.

The abdomen exhibits punctations on its surface, those of the pleural regions are larger. The distolateral angles of the first section of the telson bear one or two spines.

The epistome exhibits two prominences in the anterolateral region; the anterior angle is turned toward the dorsal portion and not clearly defined; moreover it has a rather rounded contour.

The basal segment of the antennules exhibits a spine on the ventral part.

The antennal flagellum extends to the fourth abdominal somite. The antennal scale is broad with its anterior internal angle rounded; the spine of the scale is strong, slightly turned outward; the external margin is broadly convex in the proximal half and gently concave in the anterior half. The greatest width of the scale is one and two-thirds its length.

The first pair of pereopods is comparatively well developed; the length, projected over the dorsum of the body, reaches the middle of

the sixth abdominal somite. The lower border of the meropodite exhibits in its anterior portion, a series of conical, sharp, spiniform processes, of which the largest is implanted on the distal articular border. The dorsal margin bears two or three large and sharp tubercles on the distal region; when there are three, one is blunt apically. The dorsal surface of the carpopodite is clearly divided into two parts by the
83 groove that extends longitudinally along this article; the external portion exhibits only large and widely spaced punctations, and the internal region, tubercles, two of which stand out on the internal part of the article, one of them noticeably larger than the other. The chelae are relatively slender and the fingers rather long and slender; the palm is ovate in section, rounded on the external border, slightly angular on the internal; its surface is provided abundantly with subsquamous tubercles; the dactylar portion of the propodus exhibits two large teeth, one on the subproximal region and the other on the subdistal; the latter is implanted on the lower part of the cutting border; the interval along the cutting border between its base and the last tooth is armed with regularly arranged hemispherical denticles. The movable finger exhibits a broad emargination on the proximal third of the cutting border in which four teeth are placed very close together; the anterior of the group is very large in relation to the others; following, there is a series of nine or ten small, hemispherical denticles that are arranged in a single series. The width of the dactylopodite increases precisely at the level [junction] of the first and second third and then decreases toward its end. The internal border exhibits two flanges delimited along their entire length by subsquamous tubercles or punctations.

The ischiopodites of the second and third pairs of pereopods exhibit hooks; that of the third pair is large, flattened in the antero-posterior plane and has the form of a spur; it is located on the proximal portion of the article and its apical part extends considerably beyond the articulation of the ischium with the basipodite. The hook on the ischiopodite of the fourth pair is smaller; it is inserted on the middle part of the article and is also flattened, but less broad at the base and less sharp apically. On the distal part, very near the articulation of the basipodite of this appendage, there is a more or less hemispherical prominence which projects in the direction of the apical part of the hook. The coxopodite of the fourth pair [of pereopods] exhibits a kneelike tubercle on the basal internal portion which almost rests on the coxopodite of the fifth pereopod; this, in turn, has a structure analogous to that of the former [= fourth] but in the form of a plate.

The apical part of the first pair of pleopods reaches the posterior part of the coxopodites of the third pair [of pereopods]; the apical portion is turned caudally. At the base of these appendages two conspicuous tubercles situated on the internal part are directed

84 posteriorly. The mesial process is setiform, cylindrical in form, very sharp, and borne subdistally, the distance between its implantation and the apical region being approximately one-sixth of the total length of the pleopod; this mesial process is directed caudally and forms an angle of 118° to 120° to the axis of the appendage. The cephalic process is borne on the cephalolateral region of the appendage, but its distal portion is definitively placed on the lateral part; it is setiform, cylindrical, and very sharp, slightly exceeding the central projection. The caudal process and the central projection are united in a single structure which is turned toward the caudal part almost at a right angle; it is triangular in form, flattened, and located in the mesial region. The central projection is similar in form to the caudal process, situated very near the cephalic process; the external margin of the caudal process is prolonged toward the angle of the central projection, the latter divided into its two constituent parts.

Male, form II. The structures of the surface of the carapace are less distinct than in the first form male. The rostrum is deeply excavate and the rostral margins continue insensibly toward the apex; the surface is completely smooth.

The epistome is similar to that of the male, form I.

The hooks on the ischiopodites of the third and fourth pairs of pereopods are poorly developed. The basipodite of the fourth pair does not exhibit a tubercle on the distal articular border.

The first pair of pleopods have a short mesial process that is conical, sharp, its apical portion faintly chitinized, but exhibiting the same location and disposition as in the first form male. The cephalic process is broad at its base and partly embraces the central projection, terminating in an angle.

The caudal process is hardly evident. The central projection is present as a short conical tubercle.

Female. The tubercles of the carapace are more prominent but less numerous. The rostrum is as in the first form male.

The epistome exhibits its crenulate contour and does not show the angular prolongations in the anterolateral region.

The *annulus ventralis*, determined by the examination of several females, has the following general form: its contour is semicircular, convex forward and flattened in the posterior portion. The surface is marked by a flange in the form of an arc, convex in the cephalic portion and interrupted by the groove; the latter begins in the anterior part; first it is arclike, concave on the left and then straight almost to the posterior border of the *annulus* where it disappears.

85 The sternite of the fourth pair of pereopods exhibits a fissure on its posterior margin which is prolonged approximately five millimeters forward; the posterior angles which are formed on the caudal margin

are provided with tubercles, some on the margin and others on the surface.

There is no spiniform tubercle between the fifth pereiopods.

Measurements in millimeters of the topotypes

	Male, Form I	Male, Form II	Female
Total length	55.0	47.3	58.0
Length of carapace	27.6	23.8	30.0
Anterior part of carapace	19.0	16.3	19.6
Length of areola	8.6	7.5	10.4
Width of areola	1.2	1.1	broken
Length of abdomen	27.4	23.5	28.0
Anterior width of rostrum	2.2	..	2.1
Posterior width of rostrum	4.8	4.3	5.5
Length of rostrum	7.0	6.0	7.0
Length of chela	22.7	12.3	20.4
Length of movable finger	12.3	9.5	1.9

Localities. Type locality: Puente de Palitla [= Xilitla], 8 km N. of Tamazunchale, San Luis Potosí (Hobbs) (Villalobos). La Conchita, 3 km N.E. of Xilitla, San Luis Potosí (Villalobos).

Relationships. *Procambarus tolteca* has unquestionable affinities with *Procambarus blandingii cuevachicae*. The characteristics that the two species share are the following:

I. The general form of the antennal scale and of the epistome.

II. The tubercle on the subarticular region of the basipodite of the fourth pair of pereiopods.

III. The boss that is exhibited posteriorly on the coxopodite of the fourth pair of pereiopods.

IV. The tubercles that occur on the caudomesial base of the first pleopods of the male.

V. The tuft of setae on the subdistal lateral region of the first pleopod of the first form male.

VI. The disposition of the groove on the posterior region of the *annulus ventralis*.

The form and disposition of the apical structures of the first pair of pleopods of *Procambarus tolteca* exhibit marked resemblances to the terminal part of the first pleopods in *Paracambarus ortmannii* Villalobos, a similarity that we totally reject as resulting from the phenomenon of convergence. The form and implantation of the mesial process as well as the manner in which the central projection is exhibited suggest to us a possible phylogenetic parentage which may be useful in the arrangement of *Paracambarus* in relation to *Procambarus*.

Procambarus caballeroi Villalobos

1944b *Procambarus caballeroi* Villalobos, An. Inst. Biol. de la Univ. Nal. A. de México, Vol. XV, No. 1, pp. 175–184, Plates 1 and 2.

Diagnosis. Rostrum broad, slightly concave, without lateral spines. Areola broad. Carapace without lateral spines. Ischiopodites of second and third pairs of pereopods with hooks. Tubercle on distal articular border of basipodite of fourth pair; coxopodite of same pereopods with more or less prominent kneelike tubercle. First pair of pleopods of male with tubercles on caudal, internal portion of base; cluster of setae in subapical external region. Mesial process conical, very sharp, and short, borne on mesial subapical region. Cephalic and caudal processes and central projection dentiform, flattened laterally. Sternite of fourth pair of pereopods in female cleft in median line posteriorly. *Annulus ventralis* small and partly protected by posterior prolongations of sternite of fourth pair of pereopods; without spiniform tubercles between fifth pereopods.

Male, form I. The cephalothorax is ovate, slightly wider than the abdomen, and its length projected over the abdomen reaching the posterior part of the second section of the telson. The dorsal surface of the carapace is punctate and only the lateral inferior parts exhibit small tubercles, which are most prominent in the hepatic region. The cervical groove is deep, slightly sinuous, and terminates anteriorly in the branchiostegal spine. There are no lateral spines; only in the hepatic region and on the posterior margin of the cephalic groove may one observe three or four tubercles that stand out from others by their larger size.

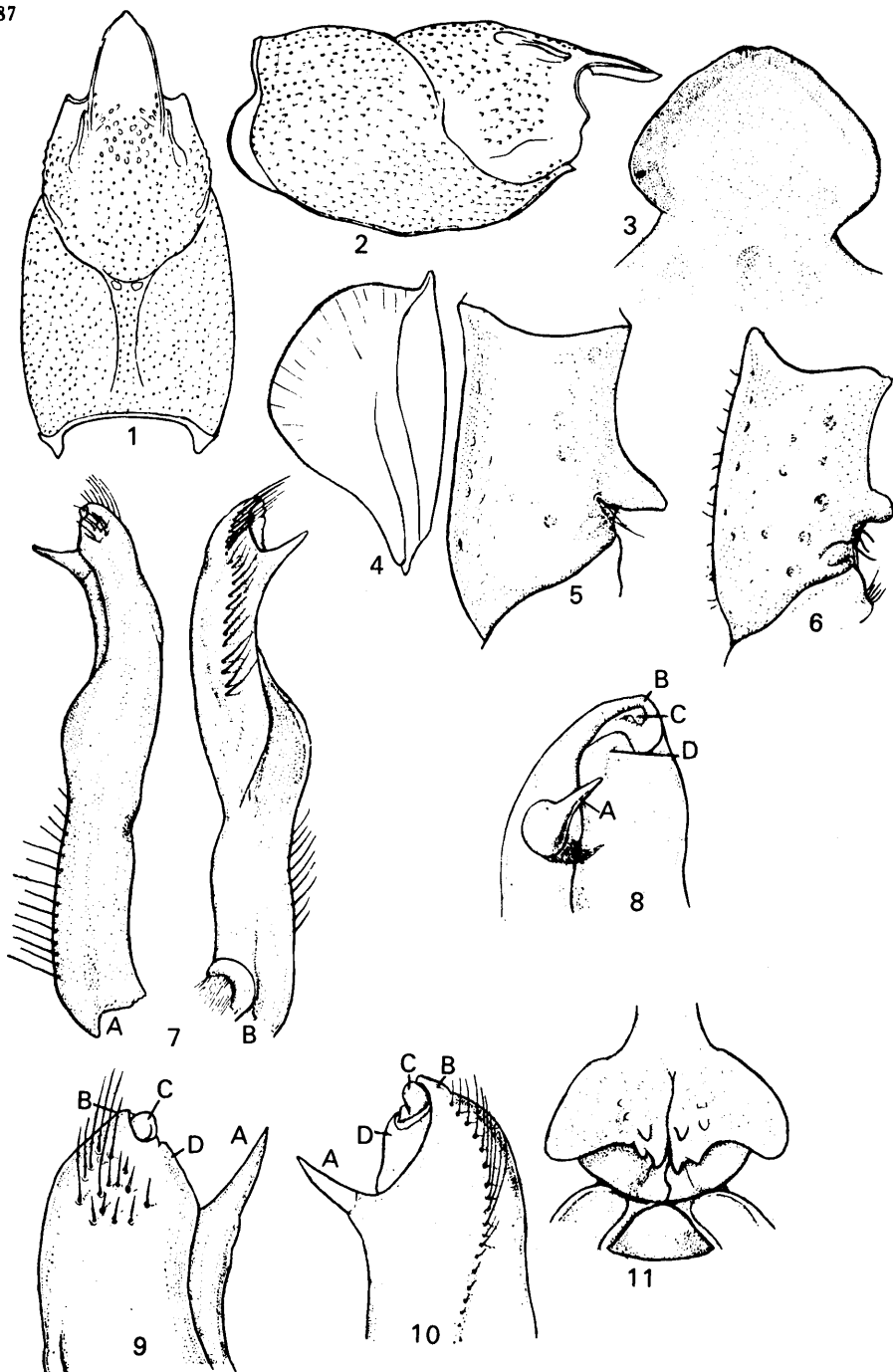
The postorbital ridges are almost parallel, situated very near the posterior part of the rostral margin, and lack terminal spines on the anterior part.

The areola is rather broad and its surface is slightly punctate (Plate 15, fig. 1).

The rostrum is lanceolate and lacks lateral spines. Its surface is 88 slightly concave, smooth in the anterior part, whereas that of the posterior is provided with well defined punctations. At its base, the rostrum bears a concavity in which the punctations are more clearly

Plate 15. *Procambarus caballeroi* (Villalobos). Male, Form I.

1, dorsal view of the carapace; 2, lateral view of the same; 3, epistome; 4, antennal scale, Male, Form II; 5 and 6, ischiopodites of the third and fourth pairs of pereopods, respectively; 7a and b, lateral and mesial views of the first pair of pleopods; 8, caudal view of the apical part of a pleopod of the first pair; 9 and 10, lateral and mesial views of the apical part of the first pair of pleopods (A, mesial process; B, cephalic process; C, central projection; D, caudal process); 11, *annulus ventralis*.



defined. The acuminal spine is short and reaches the mesial part [= midlength?] of the third article of the antennular peduncle.

The proportions between the different parts of the carapace are the following: the length of the areola is slightly greater than half that of the cephalic part; the width of the areola is one-sixth that of its length; the length of the rostrum is one-fourth that of the carapace; the posterior width of the rostrum is three and one-half times less than the length of the cephalic portion; the total length of the carapace is a little less than the length of the abdomen.

The epistome is very regular in form, its anterolateral margins are convex and entire; the anterior angle is rounded; the posterolateral margins are very short. On the entire periphery, the margins are slightly elevated above the surface (Plate 15, fig. 3).

The abdomen bears only light punctations in the dorsal and pleural regions of the somites; in the latter, they are more abundant. The distolateral angles of the first part of the telson bear a single spine.

The flagellum of the antennae is as long as the distance between the apex of the rostrum and the first abdominal segment. The antennal scale (Plate 15, fig. 4) is broad; its greatest width is anterior to its midlength; the external margin is slightly convex and the spine is short and slender.

The first pair of pereiopods are well developed; their length, projected over the dorsal region of the body, reaches over the sixth abdominal somite. The palmar part of the chelae (Plate 16, fig. 17) is subcylindrical and the dactylar portion slender. The surface of the palm is sparingly tuberculate, the larger tubercles are implanted on the dorsal internal region. The immovable finger has a ridge on the upper surface which extends longitudinally and is flanked on both sides by setiferous punctations; the cutting border bears three small teeth proximally followed by a large one; hemispherical denticles are disposed along the remainder of the border, these become progressively smaller and disappear insensibly proximal to the distal extremity; at the approximate midlength of the finger, there is a large dentiform tubercle which is implanted on the ventral part of the cutting border; between this tooth and the terminal spine there are innumerable crowded plaquettes that are disposed longitudinally.

- 89 The immovable [= movable] finger, or dactylopodite, is half the length of the chela; it is slender and slightly incurved in the proximal third; the cutting border exhibits a moderately deep excavation in the first third in which there are two or three teeth; beyond them is another slightly larger one followed by a series of hemispherical denticles forming a row along the entire margin; the size of the denticles decreases toward the distal portion; like the immovable finger, the

small and numerous plaquettes occupy the cutting border from the terminal spine to the proximal part of the second third.

On the upper surface of the carpopodite, there is a more or less ovate depression that divides it; on the internal side there are subsquamous tubercles, whereas on the external the surface exhibits only punctations provided with short setae.

The meropodite exhibits a few tubercles on the distal part of the dorsal border among which one is conspicuous by its greater size.

The ischiopodites of the third and fourth pairs of pereopods exhibit hooks. That of the third pair is implanted on the middle part of the article; it is large and more or less sharp, flattened anteroposteriorly, and its apex extends over the articulation of the basipodite with the ischiopodite. The hook of the fourth pair is small, tuberculiform, curved toward the basipodite, and does not extend over the articulation; the basipodite of the same pair of pereopods exhibits a tuberculiform prominence on the distal part very near the articulation and the apical portion of the tubercle of the ischiopodite is directed toward it; the coxopodite exhibits a kneelike prominence on the posterior internal part that is less well developed than in the other species of the group. The coxopodite of the fifth pair of pereopods exhibits a similar, but platelike, structure (Plate 16, fig. 16).

The apical parts of the first pair of pleopods, when the abdomen is flexed below the thorax, reach the middle portion of the coxopodite of the third pair of pereopods. These are slightly turned toward the caudal portion. At the base of the pleopods and in the posterior internal part, each exhibits a tubercle unlike the other; the right one is higher and seems to rest over the left. These appendages exhibit a cluster of setae on the external part of the apical portion; another cluster, formed by the setae of the mesial portion, is located on the internal side and extends distinctly beyond the apical part of the appendage.

90 The mesial process (Plate 16, figs. 14 and 15A) is spiniform, circular in transverse section, and is inserted some distance from the apical part of the appendage; it is inclined from above downward and directed slightly outward; in its inclination, it forms an angle of approximately 105° with the principal axis of the appendage. The cephalic process (B) has the form of a laterally flattened hook and is incurved in the direction of the mesial process. The caudal process (D) is crestlike with its distal margin slightly inclined and irregular; this crest is disposed in a cephalocaudal direction and terminates in a triangular spine. The centrocephalic and centrocaudal processes of the central projection (C) are fused, forming a dentiform prominence in which may be seen a median line that indicates the division between these processes. This line of separation continues forming a smooth emargination with the

posterior border of the cephalic process. The pleopod lacks a well developed shoulder, but on the cephalic surface one may observe at some distance from the apex an elevation in the form of a hump, not comparable to the shoulder of *Procambarus tolteca*.

Male, form II. The rostrum of these specimens is less acuminate; it does not exhibit lateral spines, and the dorsal surface is clearly concave and smooth. The postorbital ridges are little elevated above the surface and exhibit very small spiniform tubercles at the anterior extremity. The areola is slightly narrower than in the adult male. The surface of the carapace appears less punctate.

The chelae of the first pair of pereopods have weakly developed tubercles; the dactyls are more nearly straight and the distal extremity of the fingers is provided with clusters of setae which are inserted in the cavities of the surface.

The third and fourth pairs of pereopods exhibit their respective tubercles on the lower part of the ischiopodites; that of the ischiopodite of the third pair with the aspect of a hook and that of the fourth of a weakly developed hemispherical tubercle; the coxopodite of the fourth pair of pereopods exhibits a rudiment of the prominence so characteristic of this group of species.

The first pair of pleopods are robust in appearance. The apical part exhibits the four terminal structures found in the male, form I, but in this case some of them are very weakly developed, scarcely chitinized and, on occasions, hardly delimited by grooves. One is able to recognize readily the mesial process in juvenile males, which by its
91 form and size is distinguished from the other apical structures; this process changes little with growth of these animals for, among the exceedingly young specimens we have observed, it is almost identical to that of the older individuals (Plate 15, figs. 7, 8, 9 and 10).

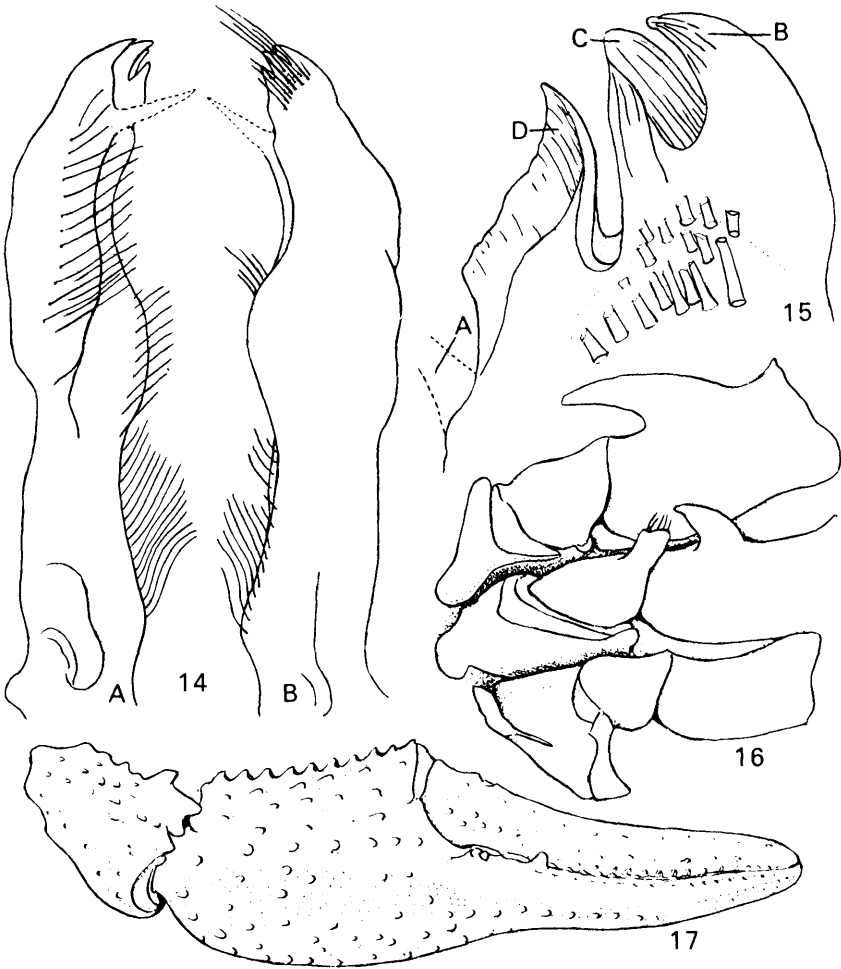
The cephalic process (B) is little developed, but it may be observed clearly when the pleopod is viewed laterally; it has the form of a vertex
92 formed by a dihedral angle, which in its distal region acquires the form of a hood; the tuft of hairs which was described in the male, form I, is found in the caudolateral region, near this process.

The centrocephalic and centrocaudal processes (C) are represented by the tubercle which is found partly covered by the cephalic process and which later forms the so-called central projection.

The caudal process (D) is represented by a small promontory which culminates in a barely visible crest near the central projection.

In the young males, the shoulder is less well developed than in the adults, but one may observe the elevation on the cephalic surface, almost at the same distance from the apical part of the appendage as that in the male, form I.

Female. The female specimens, in general, are intermediate in size



14 A and B, mesial and lateral views of the first pleopod; 15, mesial [lateral] view of the apical region of the first pleopod (A, mesial process; B, cephalic process; C, central projection; D, caudal process); 16, ischiopodites of pereopods III to V; 17, chela.

between the first and second form males, but in our collection some females reach a considerable size.

The carapace is more or less smooth; however, the presence of tubercles on the surface that are disposed as in the male, form I, must be taken into account. The abdomen is broader than the cephalothorax.

The chelae appear more cylindrical than in the male, this form being accented in the posterior palmar region. The dactylar portion is short; each finger bears a well defined ridge that extends along its entire

length; the disposition of the teeth on the cutting border is very similar to that of the chela of the males.

The sternite of the fourth pair of pereopods is cleft caudally, making the posterior margin project amply over the *annulus ventralis* in the form of two lobes provided with tubercles of which a few have a terminal position and the others inserted on the posterior surface (Plate 15, fig. 11).

The *annulus ventralis* exhibits a groove in the median part which extends longitudinally (Plate 15, fig. 11).

Measurements in millimeters

	Male, Form I	Male, Form II	Female
Total length	65.7	55.0	71.3
Length of carapace	32.0	26.4	35.3
Anterior part of carapace	21.5	18.0	23.5
Length of areola	10.5	8.4	11.8
Width of areola	1.5	2.0	1.5
Length of abdomen	33.7	28.6	36.0
93 Posterior width of rostrum	5.7	5.0	6.4
Length of rostrum	8.0	6.6	8.0
Length of chela	29.0	14.8	23.6
Length of palmar region	10.5	5.0	7.3
Length of movable finger	16.6	9.3	13.0

Locality. Bodies of water south of Villa Juárez, Puebla.

Relationships. *Procambarus caballeroi* forms part of the *blandingii* group and has close affinities with *Procambarus tolteca* Hobbs.

The principal differences between *P. caballeroi* and *P. tolteca* are as follows:

<i>P. caballeroi</i>	<i>P. tolteca</i>
I. Areola narrow (7 times smaller than the posterior part of the thorax).	I. Areola moderately wide (3.8 times smaller than the posterior part of the thorax).
II. Epistome with smooth margins.	II. Epistome with irregular margins, with crenulations.
III. Sternite of the fourth pereopods of the female with a symmetrical posterior emargination.	III. Sternite of the fourth pereopods of the female with a symmetrical posterior emargination.
IV. Pleopods of the male, form I, without clearly formed shoulder.	IV. Pleopods of the male, form I, with clearly formed shoulder.
V. Mesial process of the male, form I, conical and directed at an angle of 105°.	V. Mesial process of the male, form I, setiform and directed almost at a right angle.
VI. Cephalic process of the male, form I, platelike.	VI. Cephalic process of the male, form I, spiculiform.
VII. Caudal process in form of crest.	VII. Caudal process triangular in outline.

TAXONOMIC DISCUSSION OF THE MEXICAN SPECIES OF THE BLANDINGII SECTION

Procambarus blandingii cuevachicae is the species determining the taxonomic position of *P. caballeroi* and *P. toltecaae*.

There is no doubt that some of the characteristics of *P. blandingii cuevachicae* conform with the diagnosis of the respective Section; and, when Hobbs described *P. toltecaae* (1943), the species was related in general terms with the *digueti*, *barbatus*, and *blandingii* sections; having taken into account the apical structures of the first pair of pleopods of the male, form I, and the presence of hooks on the ischiopodites of the third and fourth pairs of pereopods, he leaned more toward relationship with the *blandingii* Section. The other features, such as the interrupted margins of the rostrum and the broad areola resemble those of *barbatus* and *mexicanus*.

The finding of a new species, *P. caballeroi*, clearly defined the systematic position of *P. toltecaae*.

In effect, on the basis of the similarities that exist in the apical structures of the first pleopods of the first form male of both species, *P. caballeroi* has close affinities with *P. blandingii cuevachicae*. At the same time, by exhibiting a cleft in the posterior part of the sternite immediately anterior to the *annulus ventralis*, as occurs in *P. toltecaae*, this allows us to consider the latter species among the *blandingii* Section.

We have united the three species mentioned in the *blandingii* group because it seems to us unnecessary to create a new subgroup to contain *P. toltecaae*, notwithstanding the existence of two distinct diagnostic characteristics: the hump in the cephalic region, and the subspiculi-form cephalic process. With a broad criterion, we do not venture to modify the diagnosis of the *blandingii* subgroup but only to point out the exceptions in each one of the characters as required. *Procambarus caballeroi* does not clearly exhibit a hump on the cephalic portion of the pleopod, but it is possible to observe a more or less broad and rounded elevation in the cephalic contour that is more conspicuous in a caudal view of the apical portion; in contrast, *P. toltecaae* shows this hump at the top of the superior part of the middle third, exactly where the mesial process is borne. With regard to the form of the cephalic process of *P. toltecaae*, it is difficult to decide whether it is spiculiform or has the form of a claw with a very sharp point; this structure does not deviate from the general disposition which we find in the other two species, that is to say, a triangular plate folded in a dihedral angle, partly surrounding in its basal part the proximal region of the central projection, and its extreme apex free, but in *P. toltecaae*, obeying the general form of the appendage, the cephalic process is very slender; because of this we say that it is subspiculiform.

In resumé, the differences that are exhibited by *P. tolteca* are not sufficiently important to consider this species in a group separate from that to which the other two belong.

RIOJAE SECTION

Diagnosis. First pair of pleopods of male, form I, straight, without
 95 shoulder, unequal in length, terminating in five distinct parts (central projection being counted as a double structure). Mesial process directed distally, at times very well developed. Cephalic process spiniform. Central projection platelike, never exceeding length of other processes. Rostrum without lateral spines. Tubercles present on coxopodites of fourth pair of pereopods. Hooks vestigial or absent on ischiopodites of third pair of pereopods; hooks well developed on ischiopodites of fourth pair of pereopods.

riojae Group

- Procambarus riojae*
- Procambarus hoffmanni*
- Procambarus hortonhobbsi*
- Procambarus teziutlanensis*
- Procambarus tlacacoyanensis*

erichsoni Group

- Procambarus erichsoni*
- Procambarus contrerasi*
- Procambarus zihuateutlensis*

KEY TO SPECIES

- 1 First pair of pleopods of male, form I, with mesial process very well developed, projecting beyond other processes by more than two-thirds its length 2
- 1' First pair of pleopods of male, form I, with mesial process of medium or small size, not projecting beyond other processes by more than two-thirds its length 3
- 2 (1) Mesial process flattened and sinuous ... *Procambarus tlacacoyanensis*
- 2' Mesial process conical and straight ... *Procambarus teziutlanensis*
- 3 (1') Cephalic process spiniform 4
- 3' Cephalic process platelike 7
- 4 (3) Caudal process displaced toward cephalic region 5
- 4' Caudal process not displaced toward cephalic region 6
- 5 (4) Caudal process in form of horsehoof ... *Procambarus contrerasi*
- 96 5' Caudal process in form of gently curved plate
 *Procambarus erichsoni*
- 6 (4') Cephalic process joined to flange disposed along entire cephalic

- surface *Procambarus zihuateutlensis*
 6' Cephalic process without cephalic flange ... *Procambarus riojae*
 7 (3') Cephalic process spatulate *Procambarus hortonhobbsi*
 7' Cephalic process angular *Procambarus hoffmanni*

RIOJAE GROUP

Diagnosis. Mesial process conical or flattened, equal in length to cephalic process, or distinctly longer than other apical structures; if of equal length, cephalic process subsquamiform; if mesial process very long, other structures very much reduced. Adventitious process sometimes implanted on lateral border of apical part (*P. riojae*).

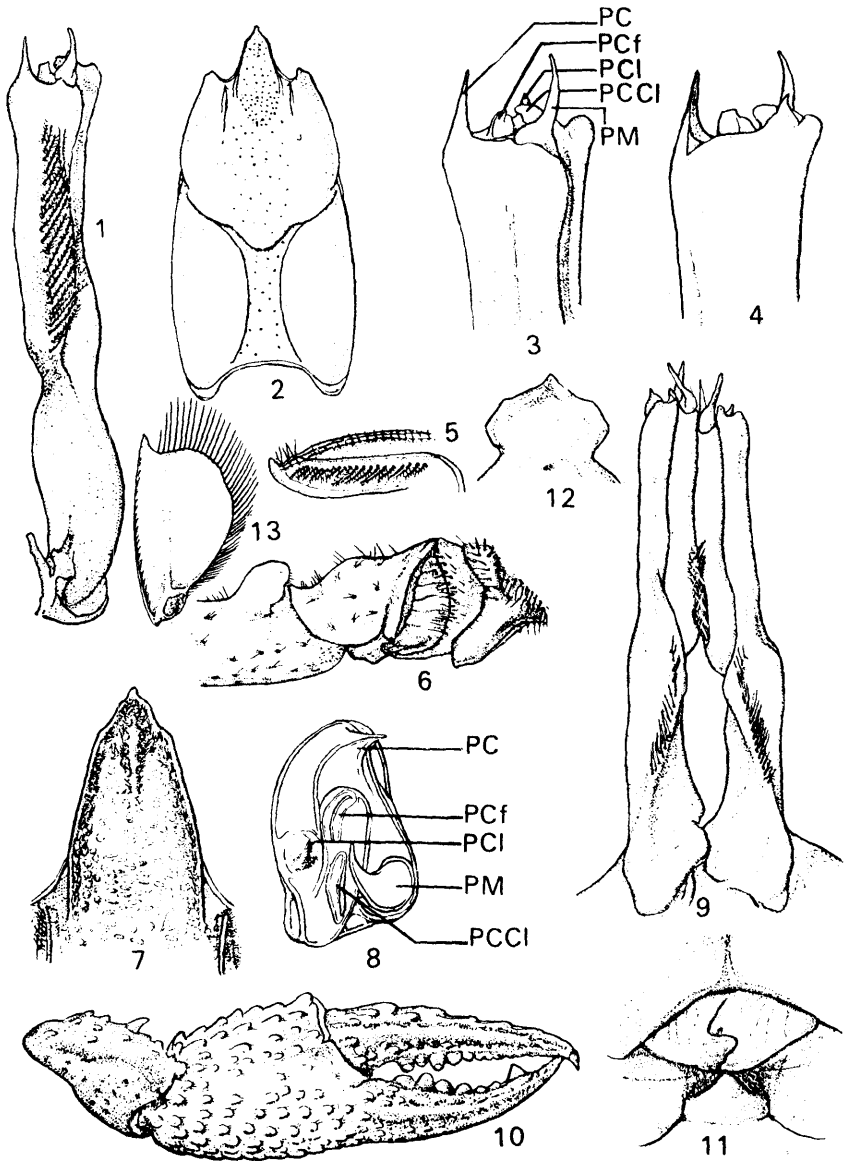
Procambarus riojae (Villalobos)

- 1944a *Paracambarus riojae* Villalobos, An. Inst. Biol. de la Univ. Nal. A. de México, Vol. XV, No. 1, pp. 161 – 169, Plate 1.
 1951 [sic; 1950] *Procambarus riojae* (Villalobos), An. Inst. Biol. de la Univ. Nal. A. de México, Vol. XXI, No. 2, pp. 401 – 402, Plate 1, fig. 1.

Diagnosis. Rostrum without lateral spines, with keel disappearing in anterior part of dorsal surface. Areola broad. Hooks only on ischiopodites of fourth pair of pereopods; coxopodites of same pair with strong tubercle. First pair of pleopods of male, form I, straight, unequal in size; apical region with five processes of which one adventitious; mesial and cephalic processes spiniform; central projection lamelliform; caudal process triangular; adventitious process implanted in distolateral region. *Annulus ventralis* with apical crest on right side; groove disposed in form similar to that of *P. blandingii cuevachicae*.

Male, form I. The carapace is moderately prolonged and compressed, showing punctations in the dorsal region that are more abundant in the subrostral area, in the posterior part of the gastric region, and on the surface of the areola; the hepatic region is provided with small tubercles that extend to the lateral parts of the gastric region;
 97 the branchial regions are finely granulate, at the same time exhibiting very small punctations. The carapace lacks lateral spines (Plate 17, fig.2).

98 The rostrum is subtriangular, its margins straight, more or less convergent and lacking lateral spines anteriorly; in the place where they are usually situated, the margin forms a gentle angle. The acumen is triangular, short, and the acuminal spine is tuberculiform, elevated above the surface; the latter is subplane with distinct punctations bearing two or three very short setae, the punctations of the median



1, mesial view of the first pleopod; 2, dorsal view of the carapace; 3 and 4, mesial and lateral views of the apical part of the first pleopod (PM; mesial process; PC, cephalic process; PCCI, caudal process; PCI, adventitious process; PCf, central projection); 5, lateral view of the rostrum; 6, basal part of the fourth pereiopod; 7, dorsal view of the rostrum; 8, distal view of the first pleopod; 9, caudal view of the first pair of pleopods; 10, chela of the male; 11, *annulus ventralis*; [12, epistome; 13, antennal scale].

posterior region are ovate and restricted to a limited area; other punctations are situated in a row parallel to the rostral margins; in them the setae are more conspicuous and numerous. In the median anterior part of the rostral surface there is a longitudinal ridge, weakly developed and limited laterally by the punctations of the surface (Plate 17, figs. 5 and 7).

The postorbital ridges are short and weakly developed, slightly convergent anteriorly, lacking a spiniform process anteriorly, and, in the posterior part, ending in a smooth hemispherical prominence.

The areola is broad, its least width is approximately one-third of the length; the suprbranchial margins are distinctly delineated; the punctations of the areolar surface sometimes modify its contour, principally in the anterior part.

In respect to the proportions that exist between the different regions of the carapace, we are able to state the following: the length of the areola is slightly greater than half the length of the cephalic portion; the posterior width of the rostrum is nearly one-seventh of the total length of the carapace; the length of the rostrum is approximately four and one-half times shorter than the total length of the carapace.

The epistome is regularly heptagonal in form; occasionally it is cordiform (Plate 17, fig. 12).

The anterior portion of the abdomen has the same width as the carapace. The posterodorsal surface of each of the somites exhibits a few punctations; in contrast, the pleural regions show more dense punctations; the sixth abdominal somite and the telson have many punctations over the entire surface; these are characteristic in that they exhibit the form of small cavities provided with a cluster of four or five short setae which occur over the surface of the segment. The first portion of the telson exhibits two or three conical, depressed, and sharp spines in its distolateral angle.

The antennal scale (Plate 17, fig. 13) is short and broad. Its external margin is strengthened and terminates anteriorly in a short, broad spine, the apex of which reaches midlength of the ultimate antennular article. The greatest width of the scale is situated at midlength and is approximately half as long as the external margin. The antennal flagellum reaches the first abdominal somite.

The first pair of periopods (Plate 17, fig. 10) are quite robust. The meropodite is flattened laterally; its superior border bears very small tubercles, those of the distal portion being larger; the dorsal part of the distal articular margin has the form of a sinuous line and is limited by the two hinges by which this article is articulated with the carpopodite. The lower border bears two rows of conical spines: the external row formed by seven of these structures, whereas the internal row exhibits ten or twelve spines larger than the others and which are dispersed from

the proximal articulation to the edge of the emargination where they reach their maximum size.

The carpopodite is short, conical in form; the dorsal surface exhibits a broad shallow groove that extends along almost its entire length; delimited by this groove, the internal portion of the surface exhibits two series of subsquamous tubercles; moreover, two spiniform tubercles are borne on the internal border, one larger than the other, both implanted near the distal margin. The external surface is devoid of tubercles, but in contrast exhibits large, widely-spaced punctations.

The chela is broad, depressed; its length is two and one-half times its width; there is a ridge on the internal part that when seen in profile consists of six or seven subsquamous tubercles; the external border is rounded. The surface of the palmar region is covered with subsquamous tubercles which are more numerous on the external margin. The upper and lower faces of the immovable finger bear a ridge which extends the entire length; the cutting border is armed with hemispherical, dentiform tubercles, those of greater size implanted along the proximal half; in the distal third, there is a large dentiform tubercle which is borne on the inferior region of the cutting border.

The movable finger, or dactylopodite, is more or less straight; sometimes its internal border is gently concave; in consequence, the cutting border is convex and matches the concavity of the cutting border of the immovable finger. Also its upper and lower surfaces are provided with ridges already mentioned as occurring on the immovable finger, but the dorsal one is much more distinct. On the upper
100 surface and in the proximal region, the dactylopodite exhibits subsquamous tubercles similar to those of the palmar region but which are larger near the articulation; the remainder of the surface bears more or less deep cavities provided with tufts of very short and rigid setae. The cutting border is armed with teeth; among them those on the proximal half are conspicuous by their size.

The ischiopodite of the third pair of pereopods does not have a hook, and there is hardly an angular structure.

The ischiopodite of the fourth pair of pereopods is provided with a very well developed tubercle borne on the internal part of the article; it is circular in section at its base, broader at the apex where it has the form of a gauntlet (Plate 17, fig. 6). The coxopodite of the same pair is provided with a tuberculiform structure which is situated on the internal border of the article; the distal extremity of this structure is free and sharp (Plate 17, fig. 6).

The first pair of pleopods (Plate 17, figs. 1, 3, 4, and 9) are straight and unequal in length; the right is longer than the left, and their apical parts reach the posterior region of the coxopodites of the second pair of pereopods. The basal region of these appendages is asymmetrical. The mesial process is spiniform, gently recurved, and inclined to the side, its

base spheroidal (Plate 17, figs. 3 and 8 PM). The cephalic process is also spiniform, straight, triangular in section at its base, and implanted in the cephalomesial angle of the appendage (Plate 17, figs. 3 and 8 PC). The central projection (Plate 17, figs. 3 and 8 PCf) is a short platelike structure borne in the center of the apical region; the centrocephalic process is quadrangular, whereas the centrocaudal process is triangular; both structures are narrowly united, but may be perfectly demarcated. The caudal process (Plate 17, figs. 3 and 8 PCCl) has the form of a small angular crest with its apex inclined toward the central projection; this structure is borne on the caudal region of the apical part of the external ramus of the pleopod. In addition to the processes mentioned, there exists another, the adventitious process, which does not correspond to any of the above and is located on the lateral region of the apical part of the appendage (Plate 17, figs. 3 and 8 PCl).

Male, form II. The surface of the carapace is smoother than that of the male, form I. The epistome is clearly heptagonal. The chelae bear dentiform tubercles along the cutting border that are hardly perceptible.
 101 The ischiopodite of the fourth pair of pereopods bears a small hemispherical tubercle near the proximal articular border; the characteristic tubercle of the coxopodite of the same pair [of pereopods] is very small. The apical structures of the pleopods are slightly chitinized; the mesial and cephalic processes are spiniform; in the first, the articular zone is not evident; the central projection is scarcely evident; the caudal process occurs as a slight hemispherical promontory; the adventitious process is very small and also hemispherical.

Female. The carapace is more finely punctate than in the male; the abdomen is distinctly wider than the cephalothorax. The chelae of the first pair of pereopods are shorter and smaller than in the first form male; the surface of the propodus is provided with a more regular arrangement of subsquamous tubercles; the cutting borders of the fingers exhibit few, poorly developed tubercles.

The *annulus ventralis* is more or less semicircular in outline; the anterior margin is convex, the posterior straight. The groove is sinuous and deep. In the central part of the surface, and a little displaced toward the right side, there is what could be called a tubercle that represents the highest part of the organ.

Between the fifth pereopods, there is a subpyramidal tubercle which is slightly flattened laterally.

Measurements in millimeters

	Male, Form I	Male, Form II	Female
Total length	65.0	51.5	61.5
Length of carapace	31.2	24.4	30.0
Anterior part of carapace	20.1	16.1	19.7

	Male, Form I	Male, Form II	Female
Length of areola	11.1	8.3	10.3
Width of areola	2.0	1.6	1.7
Length of abdomen	33.8	27.1	31.5
Posterior width of rostrum	4.5	3.4	4.5
Length of rostrum	6.7	5.0	7.3
Length of hand	27.2	16.7	20.2
Length of movable finger	16.4	9.9	12.0

Localities. Huachinango, State of Puebla, stream tributaries of the Río Necaxa (type locality). Rancho El Suspiro, Honey, Puebla. Barranca de Hueyapan, Zacatlán, Puebla. Curva El Milagro, km 172 de la Carretera México-Tuxpan, Municipality of Acaxochitlán, Puebla.
 102 Arroya de La Laja, state line between Puebla and Hidalgo on the México-Tuxpan highway, Municipality of Acaxochitlán, Puebla.

Relationships. *Procambarus riojae* has close affinities with *Procambarus hoffmanni*, not only in regard to the morphological characteristics but also in its geographical distribution. The disposition of the apical structures of the first pair of pleopods of the first form male in the two has great similarity. In addition, the fact that both lack hooks on the ischiopodites of the third pair of pereopods, and moreover have a tubercle between the fifth pereopods of the females permits uniting these species with the others of the *erichsoni* group.

The relationship of *P. riojae* with the species of the *blandingii* group is established by the characteristic tuberculiform structure on the ischiopodites of the fourth pair of pereopods in the males.

Procambarus hoffmanni (Villalobos)

- 1944a *Paracambarus hoffmanni* Villalobos, An. Inst. Biol. de la Univ. Nal. A. de México, Vol. XV, No. 1, pp. 169 – 174, Plate I.
 1951 [sic; 1950] *Procambarus hoffmanni* (Villalobos), An. Inst. Biol. de la Univ. Nal. A. de México, Vol. XXI, No. 2, pp. 411 – 412, Plate I, fig. 2.

Diagnosis. Rostrum broad at base, without lateral spines. Male, form I, with ischiopodites of third pair of pereopods lacking tubercle but possessing small emargination near proximal articulation of article. Ischiopodites of fourth pair of pereopods with slender tuberculiform process. First pair of pleopods of first male form straight, slightly unequal in length; mesial process spiniform, clearly distinct from other processes which are small; cephalic process triangular and keelshaped; caudal process little differentiated; components of central projection clearly indicated. *Annulus ventralis* with two adjacent mammiform

prominences at apex, groove originating posteriorly between them. Process between fifth pereopods of female small.

Male, form I. The cephalothorax is slightly shorter than the abdomen and its surface is finely granulate, caused by a large number of small subsquamous tubercles that may be disclosed with a lens. The gastric region is covered with well defined punctations of which the largest are found on the cephalic part of the carapace; the areolar region also exhibits punctations, but they are hardly perceptible (Plate 18, 103 fig. 4).

The rostrum is subtriangular and its margins lack lateral spines; the acuminal spine is sharp and gently upturned; the rostral surface is concave and almost smooth in appearance, yet one may observe very small grooves perpendicular to the main axis of the rostrum which are provided with a short seta inserted on the posterior margin and adhere 104 anteriorly over the surface. Parallel to the rostral margins, there is a series of short setae that form a row toward the acuminal region.

The postorbital ridges are clearly visible, almost parallel and terminate anteriorly in a spine, in the axillary part of which is found a tuft of small setae.

The cephalic groove is deep, slightly sinuous and separated laterally from the ultimate undulation which ends on the anterior inferior part of the carapace at the level of the branchiostegal spine.

The areola is broad; its least width is one-sixth that of its length.

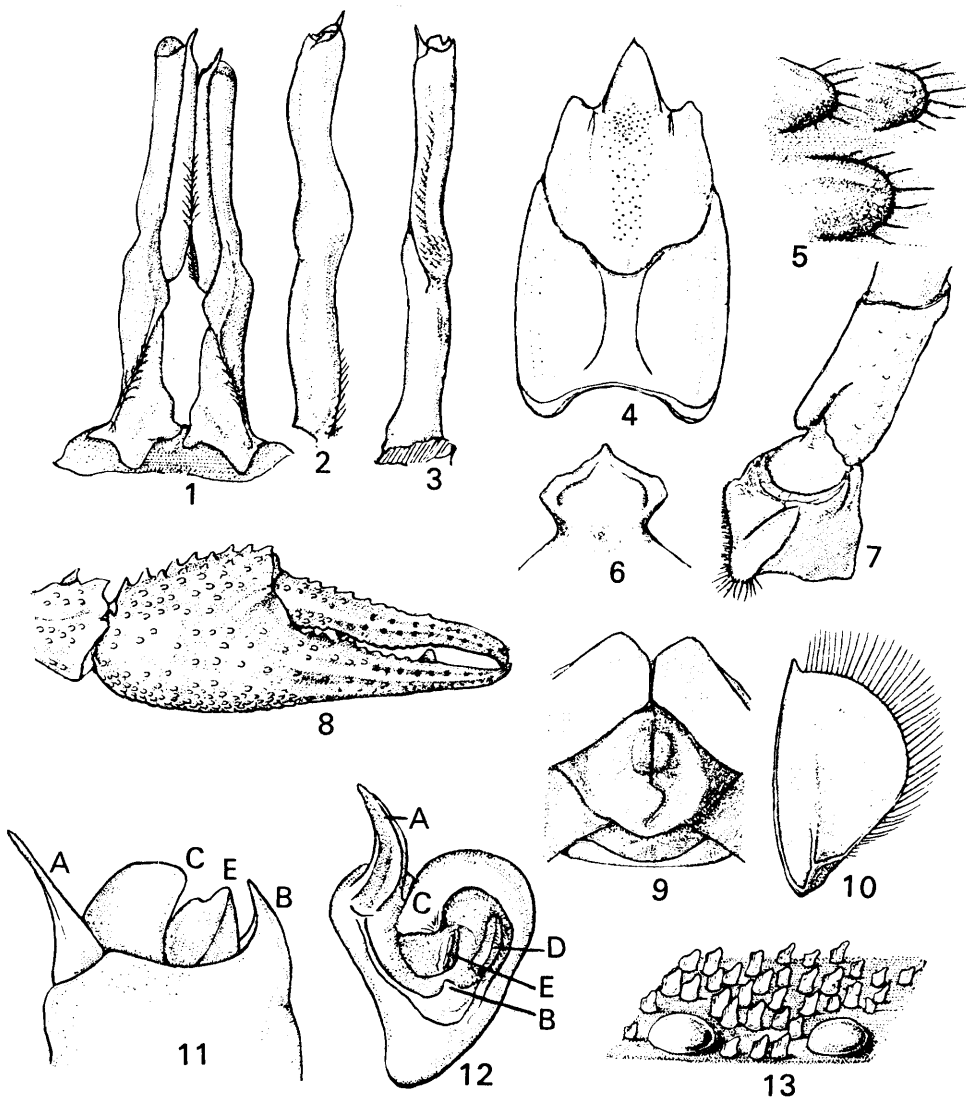
The epistome is heart-shaped but at times is polygonal, and its margins are elevated (Plate 18, fig. 6).

The proportions of the different parts of the carapace are the following: the length of the areola is a little less than half the length of the cephalic portion; the posterior width of the rostrum goes into the total length of the carapace six and one-half times; the length of the rostrum is three and one-half times less than the total length of the carapace.

The abdomen is slightly narrower than the posterior part of the cephalothorax and the surface of the somites is almost smooth; however, many small punctations are present in the pleural regions of the segments. The posterior margin of the ultimate abdominal segment is undulate and bears a tuft of rigid setae in each excavation. The distolateral angles of the first portion of the telson exhibit two or three spines; the second part of the telson is trapezoidal with its terminal angles rounded.

The antennal scale is broad; its greatest width lies posterior to midlength of the scale, being a little longer than half the length of the external border; it is slightly convex.

The chela of the first pair of pereopods is robust, its surface covered with subsquamous tubercles that are more numerous dorsally. On the



1, caudal view of the first pair of pleopods; 2 and 3, lateral and mesial views of one of the pleopods of the same pair; 4, dorsal view of the carapace; 5, appearance of the subsquamous tubercles on the surface of the carapace; 6, epistome; 7, ischiopodite of one of the fourth pair of pereiopods; 8, chela; 9, *annulus ventralis*; 10, antennal scale; 11 and 12, lateral and distal views of the apical part of one of the first pair of pleopods of the male, Form I (A, mesial process; B, cephalic process; C, caudal process; E, central projection); 13, appearance of the small plaquettes of the cutting border of the fingers of the chela.

internal margin the tubercles are characteristically spiniform, and there may be as many as eight or nine of them (Plate 18, fig. 8). The fingers of the chela are longer than the palmar region. The immovable finger is straight on the external border and concave on the cutting border, whereas the dactylopodite is concave on the internal border and convex on the cutting border. Both fingers exhibit longitudinal ridges on the dorsal and ventral faces that extend the total length; these ridges are limited proximolaterally by a series of scales of the same nature as those on the surface of the palm, and distally by a row of small cavities in which are borne tufts of setae. The cutting borders are provided with a limited number of teeth, which, with the exception of one situated on the ventral part of the border of the immovable finger that is conical in form, are clearly hemispherical, the larger being those situated on the proximal region of the fingers; the distal part exhibits a zone apparently lacking teeth, but when observed with the aid of a microscope, one is able to discern a large number of chitinous, dentiform plaquettes, approximately a millimeter in length, that are disposed longitudinally (Plate 18, fig. 13).

The dorsal surface of the carpopodite is also covered with subsquamous tubercles and moreover bears a sinuous groove which extends almost the total length of the article. The anterior articular margin has a spine on the dorsal internal part and an emargination on the external.

The dorsal margin of the meropodite is provided with tubercles that are more numerous in the subarticular region; among them is a large conical spine directed forward. The ventral margin of this article exhibits two rows of spines that converge toward the proximal articular region; the external row ends anteriorly in a very large spine; the spines of the internal row are more numerous and of greater size, increasing in length distally; this row terminates in a spiniform tubercle inserted on the distal articular margin.

The ischiopodite of the third pair of pereiopods lacks hooks, and there is no structure that indicates to us its presence; it is smooth and has only an emargination on its proximal portion.

The coxopodite of the fourth pair of pereiopods exhibits a robust spiniform tubercle, cylindrical in the greater part of its length and conical at the free extremity; it is directed to the side and forward; the ischiopodites of the same pair exhibit a hook which is tuberculiform with the apical part narrower than in the other species, but which retains the spatulate form and a few setae inserted on the flat surface (Plate 18, fig. 7).

The first pair of pleopods follow the same plan of construction as that of *P. riojae*. They are of unequal length, the left one being smaller. This asymmetry is principally accented in the basal articular region

(Plate 18, figs. 1, 2, and 3). These appendages are somewhat straight, slightly flattened, and their apical parts reach the coxopodites of the second pair of pereopods. The mesial process is spiniform, short and sharp, but distinctly exceeds the other apical structures; it has an articular base and is slightly recurved and inclined; the cephalic surface is flat (Plate 18, fig. 12A). The cephalic process is located on the cephalomesial angle of the apical part of the appendage; it has the form of a triangular plate (Plate 18, fig. 12B). The caudal process has the form of a chitinous ring which is situated on the caudal part of the apical region of the external ramus of the pleopod; near the mesial region, there is an angular structure close to the central projection (Plate 18, figs. 11 and 12C).

The central projection consists of a platelike structure which is located in the center of the apical region; it is triangular and the two parts composing it are clearly defined (Plate 18, figs. 11 and 12E).

Male, form II. The carapace is smooth. The ischiopodites of the fourth pair of pereopods exhibit a small tubercle on the proximal articular part of the article; the coxopodite of the same appendage bears a very poorly developed spiniform tubercle. The first pair of pleopods are very weakly chitinized and their basal regions are somewhat separated, leaving a regular space between the two pleopods. The mesial process is short and slightly chitinized; the other apical structures are hardly evident.

Female. The carapace of the female is finely granulate. The abdomen is a little broader than the posterior part of the cephalothorax. The chelae of the first pair of pereopods are small and their surfaces sparsely studded with subsquamous tubercles, more numerous on the external margin of the palm.

The *annulus ventralis* is rhomboidal basally and exhibits two elongate mammiform tubercles on the anterior part of the apical portion; they are parallel and almost touching, leaving between them a fissure bearing the groove that extends backward, making a curve, and disappearing submarginally (Plate 18, fig. 9).

The sternite between the fifth pereopods exhibits a conical tubercle, the vertex of which rests on the posterior part of the *annulus* 107 (Plate 18, fig. 9).

Measurements in millimeters

	Male, Form I	Male, Form II	Female
Total length	61.0	61.0	57.0
Length of carapace	29.0	30.0	27.0
Anterior part of carapace	19.0	21.0	19.0
Length of areola	10.0	9.0	8.0
Width of areola	1.2	1.2	1.7

Length of abdomen	32.0	31.0	30.0
Length of rostrum	8.0	9.0	8.0
Length of chela	25.0	22.0	17.0
Length of palm	10.0	9.0	7.0
Length of movable finger	14.0	14.0	11.0

Localities. Overflow from la Presa de Necaxa, Necaxa, Puebla (type locality). 1 km S. of Villa Juárez, in a stream that flows by Camposanto, Puebla. Small tributary of the Río Grande, Tlapacoyan, Veracruz. Cumbres de Cuanepixca, Municipality of Zihuateutla, Puebla. Los Estajos, Arroyo de Tlatentiloyan, Municipality of Zihuateutla, Puebla 2 km N. of Coyutla, Veracruz. 18 km S.E. of Martínez de la Torre, Veracruz. 5 km N.E. of Hueytamalco, Veracruz. El Escolin, Papantla, Veracruz.

Relationships. *Procambarus hoffmanni* has a wide distribution in the northern part of the State of Puebla and in the central part of the State of Veracruz; it is a species very near *P. riojae*.

Procambarus hortonhobbsi Villalobos

1951 [sic; 1950] *Procambarus hortonhobbsi* Villalobos, An. Inst. Biol. de la Univ. Nal. A. de México, Vol. XXI, No. 2, pp. 402 – 410, Plates 10 and 11.

Diagnosis. Rostrum without lateral spines, with small carina in anterodorsal region. Hooks restricted to ischiopodites of fourth pair of pereopods in male. First pair of pleopods of male, form I, with five terminal structures; cephalic process in form of chitinous plate; central projection very well developed; mesial process spiniform. *Annulus ventralis* with crest in right apical region, disposed perpendicular to major axis of body.

108 **Male, form I.** Its carapace is narrow and long, slightly broader in the posterior region. The surface is punctate; the punctations are large and circular in the dorsal region of the cephalic portion; immediately behind the rostrum and in the area embraced between the postorbital ridges, the punctations are much larger and closely assembled. In the hepatic region, the surface is provided with small subsquamous structures that exhibit three to five, and occasionally more, setae which are disposed in a divergent manner over the surface and are directed toward the posterior part. The cephalic groove is deep, somewhat sinuous, and is interrupted laterally on the median part of the carapace. A little lower, it continues across the groove that limits the hepatic regions; in the origin of this groove, a subsquamous prominence is located which is conspicuous by its greater size; this structure reminds us of the lateral spines of the carapace. The ultimate part of the cephalic

groove terminates on the anteroinferior margin of the carapace where the branchiostegal spine is located.

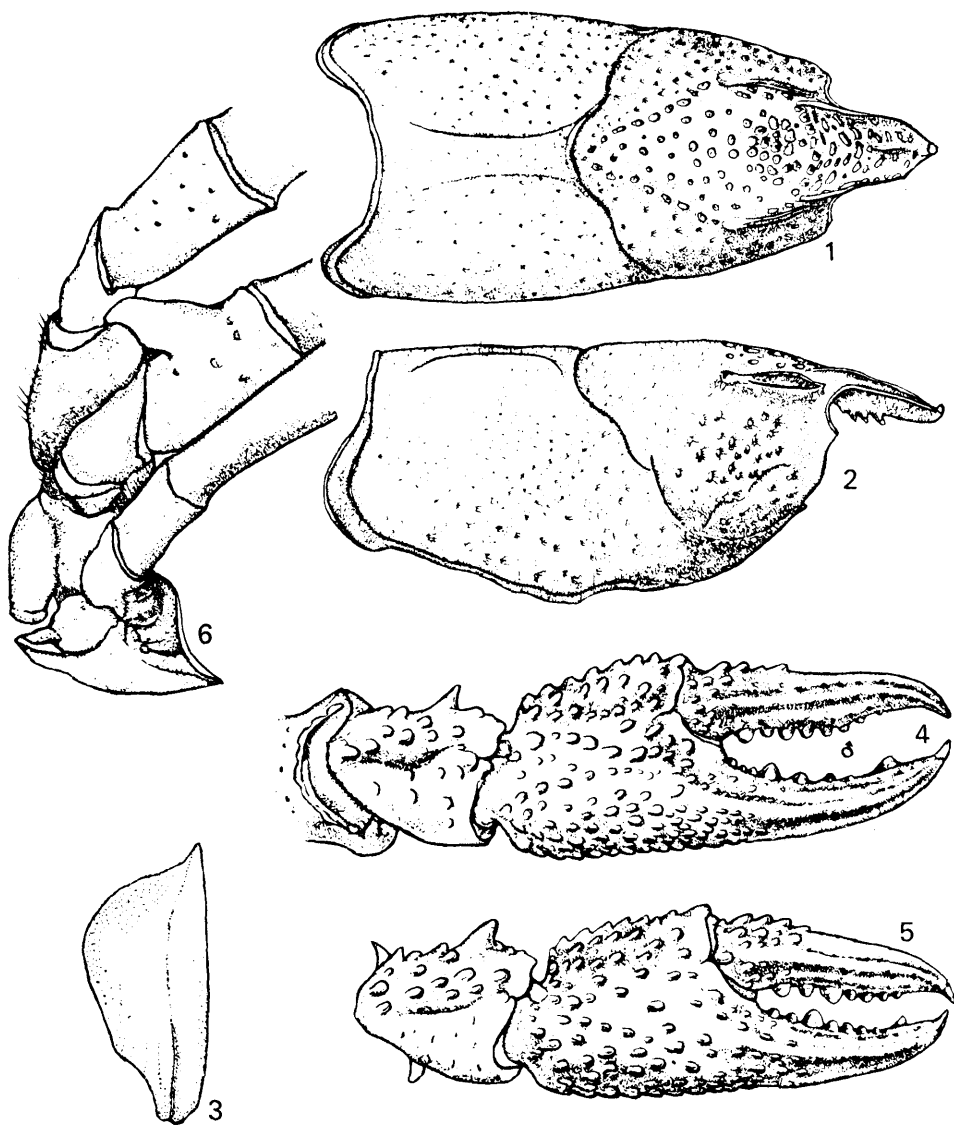
The rostrum lacks lateral spines; the apical spine is represented by a blunt apical tubercle that is directed forward and upward; the lateral margins are strong in the anterior portion, becoming attenuated toward the distal extremity of the rostrum; the margins are convergent but exhibit two smooth angulations, one posterior to the level of the orbital arc and the other in the site in which normally the lateral spines are located. The surface of the rostrum is somewhat plane in the posterior region, but in the anterior is concave; it is studded with punctations, the circular form of which tends to be lost; a series of these punctations delimit the margins; both are provided with setae of the same type that occurs in the hepatic regions. In the anterior part of the rostral surface, on the median line, there is a carina, or slender ridge, at its extremity which is disposed along the anteroposterior axis of the body. On the basal portion of the ventral keel of the rostrum three spiniform prominences of more or less the same size stand out; their apical regions are chitinized and are directed forward; moreover, near the proximal spine of this series is a small angulation which may be the first of these structures.

The postorbital ridges stand out clearly from the surface of the carapace; anteriorly they terminate in a very short tubercle and posteriorly in smooth hemispherical elevations.

109 The areola is moderately wide; the suprabranchial margins are poorly defined, and the surface of the areola is provided with punctations which, although small, are abundant and their margins fused in the proximity of the suprabranchial grooves.

110 The different parts of the carapace exhibit the following proportions: the length of the areola is a little greater than half the length of the anterior part of the carapace; the posterior width of the rostrum goes into the total length of the carapace almost seven and one-half times; the length of the rostrum is almost four times smaller than the total length of the cephalothoracic shield (Plate 19, figs. 1 and 2).

The abdomen is narrower than the carapace; the somites are punctate in the pleural regions; moreover, there is a row of punctations on each side in the dorsal part of the first four. The punctations are provided with setae that are disposed as are those described in the hepatic region. The sixth somite has abundant punctations and the setae are longer. The telson has a pubescent aspect and its surface is ornamented with subsquamous elevations which generally exhibit two setae inclined over the surface, set at an angle, and directed toward the distal portion. The first portion of the telson bears four spines on the distal margin of the lateral parts of which the second, counting from the outside, is distinctive both in form and in being inserted differently



109

Plate 19. *Procambarus hortonhobbsi* (Villalobos). Male, Form I.

1, dorsal view of the carapace; 2, lateral view of the same; 3, antennal scale; 4, chela; 5, chela of the female; 6, ischiopodites of pereopods III to V of the male, Form I.

from the others; the smallest spine is that found on the internal part. The posterior or terminal margin of the ultimate part of the telson is semicircular. The surface of the uropods is very similar to that of the

telson, and on it the three [two] setae, which have already been described, may be more readily observed.

The epistome is rather regular, its borders are elevated, and the anterior part is not angular, rather it is rounded (Plate 19 [20], fig. 7).

The antennal scale slightly exceeds the apical part of the rostrum. The spine is short, triangular, and slightly turned to the side. In the proximal part, the lamella bears a broad emargination. The greatest width of the scale is located in the distal half and is almost half the length of the antennal scale (Plate 19, fig. 3).

The first pair of pereopods are robust. The meropodite is smooth laterally and armed with tubercles on the superior and inferior borders. In proportion to the carpopodite, it is 1.5 times longer. The upper margin is ridged proximally and in profile has a sawlike aspect because of the presence of a row of subsquamous tubercles; distally the margin is blunt and the tubercles are grouped and stand out from the surface. The lower margin bears spiniform tubercles, some of which form a linear series on the internal part of the article; the number of them in our specimen is ten, but in other specimens varies from ten to twelve. The other spines are less numerous, with a broader base, and also arranged
111 in a linear series which is bent in an obtuse angle, in such a manner that the two extremities tend to join with the internal row; the distal part of this series borders a part of the articular emargination and ends in two conical, spiniform structures on the inferior surface of this article that are larger than all of the others. The upper part of the distal articular margin is notched with small undulations.

The carpopodite is scabrous on the upper surface and is marked by a somewhat deep longitudinal depression. The internal part of the upper surface of this article bears subsquamous tubercles. The margin of the articular emargination of the carpopodite with the propodite is armed with three large spiniform tubercles.

The propodite and dactylopropodite which form the chela possess the same characteristics as in other species. The chela is strong and the dactylar region is gently inwardly curved; the palm is suboval in section; the internal margin bears a row of teeth which forms a kind of crest; the surface is covered with tubercles that are most abundant and have a darker color on the upper surface. The teeth of the immovable finger are disposed in the following manner: beginning at the proximal extremity, there are three teeth of which the middle one is smallest, following is a large tooth; continuing is a series of four teeth decreasing in size; and finally a tooth which is implanted on the lower part of the cutting margin; the finger terminates in a spine.

The dactylopropodite, or movable finger, bears three subsquamous tubercles on the internal border, that is, opposite the cutting border; of these, two are large and the distal one small. The upper surface of the

article exhibits a rib which extends the entire length of the finger. At the base of the finger and over the ridge, there is a subsquamous tubercle; on the external surface of the finger and also near its articulation with the propodus, there are five tubercles, three large ones and two small; on the internal side there are also tubercles that are arranged in two series of three each, and these rows are disposed parallel to the articular margin of the propodus. The cutting border exhibits the following dentiform processes: initially a tooth of usual size, followed by another smaller one, continuing, another very similar to the first, and finally five teeth of decreasing size. The finger terminates in the typical corneous spine (Plate 19, fig. 4).

112 The ischiopodites of the third pair of pereopods lack a hook, and there is no structure that recalls it to us, since the inferior border of the article is completely smooth (Plate 19, fig. 6).

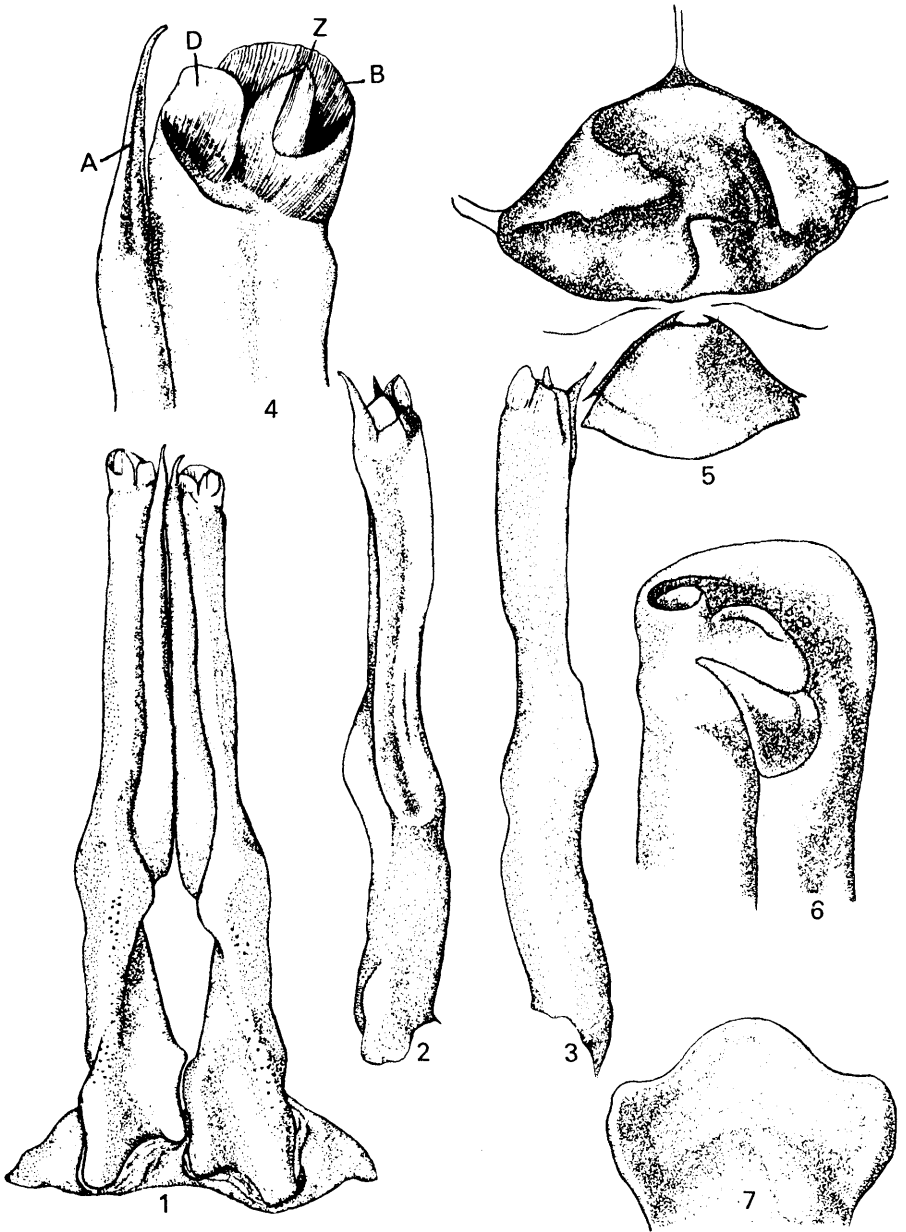
The coxopodites of the fourth pair of pereopods exhibit a more or less fusiform tubercle on the posteroinferior angle. The ischiopodites are provided with a hook which is inserted on the proximal part of the article and terminates in a strong spine, the apical part of which is gently curved backward (Plate 19, fig. 6).

The coxopodites of the fifth pair of pereopods exhibit an almost circular plate on the internal posterior part of the distal articular border that stands out conspicuously from the article (Plate 19, fig. 6).

The tips of the first pair of pleopods (Plate 20, figs. 1, 2, and 3) touch the coxopodites of the second pair of pereopods. They are straight, unequal in length, the right larger than the left. The mesial process (Plate 20, fig. 4A) is spiniform, circular in section, and with the extremity slightly bent (in other specimens it seems completely straight), but extending beyond the other structures of the apical region. The cephalic process is formed by a chitinized plate and is clearly associated with the central projection (Plate 20, fig. 4B). The central projection (Plate 20, fig. 4Z) is a dentiform structure, chitinized and terminating in an angle; the centrocaudal process of this structure is distinctly associated with the cephalic process. The caudal process is very close to the mesial; it has the form of a gently concave plate and is also chitinized (Plate 20, fig. 4D). Even though these pleopods differ in length, the apical structures are similar and maintain in both an equal disposition.

Male, form II. The body is more slender than that of the first form male. The carapace is narrow, and the punctations are provided with setae of which one in each punctation is elevated, thus giving the body a pubescent aspect. The angles of the rostral margins are less accented and they are somewhat convergent toward the apex of the rostrum.

The lateral margins of the telson are somewhat inclined toward the distal extremity.



113

Plate 20. *Procambarus hortonhobbsi* (Villalobos). Male, Form I.

1, caudal view of the first pair of pleopods; 2, mesial view; 3, lateral view; 4, caudal view of the apical part of the pleopod (A, mesial process; B, cephalic process; D, caudal process; Z, central projection); 5, *annulus ventralis*; 6, caudal view of the apical part of the pleopod of the first pair of the male, Form II; 7, epistome of the male, Form I.

110

The anterior part of the epistome ends in an angle.

The chelae are small.

The ischiopodites of the third pair of pereopods do not exhibit a trace of tubercles. The coxopodites of the fourth pair of pereopods exhibit a tuberculiform prominence which we pointed out in the first form male, only here the inferior part of the tubercle is not independent of the article but is fused with it. The ischiopodite of the same pair exhibits a small tubercle on its proximal part.

114 The plate which we described in the posterointerior region of the distal articular margin of the coxopodite of the fifth pereopods of the male, form I, does not stand out clearly.

The extremities of the first pair of pleopods scarcely exceed the coxopodites of the third pair of pereopods; they are straight and unequal in length. The apical part is not chitinized and the structures, although poorly developed, are clearly evident. The mesial process retains the form that we described in the male, form I; its tip is straight but directed to the side and backward. The cephalic process is a heavy flange which is located on the cephalic part of the apical portion; this flange gives rise to and is situated in contact with a small structure that is equivalent to the central projection. The caudal process is half-moon shaped (Plate 20, fig. 6).

Conspicuous on the first pair of pleopods of this specimen is a groove which is found at the end of the proximal third of the caudal surface of the appendage; it is inclined from forward to behind and from below to above, and because of it the separation between the protopodite and the two rami, exopodite and endopodite, is clear.

Female. The surface of the carapace is punctate and as pubescent as in the male, form II. The rostrum is broader at its base, almost channel-like; the rostral margins are heavy and lack lateral spines. The cephalic groove is deep, and the areola stands out from the carapace by its distinct color.

The pleural parts of the abdomen exceed in width the posterior part of the carapace.

The epistome is pentagonal; the anterior part terminates in an angle.

The chelae are strong, their surface tuberculate, and the dactylar portion slightly recurved. The teeth on the cutting border of the immovable finger are disposed in the following manner: proximally there is a tooth followed by two very close together, all three of the same size; following is a large tooth that stands out from all of the others, and finally four teeth of decreasing size; moreover, in the distal third there is a dentiform tubercle. On the immovable finger the teeth are disposed in the following manner: proximally there are two slightly separated teeth; the first is larger, following there are four teeth of decreasing size.

The carpopodite bears three spines which are implanted on the margin of the articular excavation that are darker in color than the surface (Plate 19, fig. 5).

The *annulus ventralis* is movable, asymmetrical, with two crests on its apical part; the one on the right side is perpendicular to the major axis; 115 the other is directed at a sharp angle with respect to the same axis. The groove originates on the posteromedian part of the *annulus*, is doubly curved, forming an inverted S and arranged perpendicularly to the left crest (Plate 20, fig. 5).

Between the fifth pereopods there is a more or less conical or pyramidal tubercle with its apical portion blunt (Plate 20, fig. 5).

Measurements in millimeters

	Male, Form I	Male, Form II	Female
Total length	55.0	45.0	56.0
Length of carapace	26.5	21.1	26.3
Anterior part of carapace	17.2	14.0	17.4
Length of areola	8.8	7.0	8.8
Width of areola	2.0	2.0	2.2
Length of abdomen	27.2	23.6	29.6
Posterior width of rostrum	3.5	3.8	4.2
Length of rostrum	6.8	5.0	6.0
Length of chela	20.6	14.8	19.6

Localities. El Coyular, 7 km N.E. of La Unión, Municipality of Zihuateutla, Puebla (type locality).

Relationships. *Procambarus hortonhobbsi* has strong morphological affinities with *Procambarus zihuateutlensis* as indicated by the disposition of the apical structures of the first pair of pleopods in the first form male. Moreover, a certain relationship between these species is indicated by their geographic distribution.

The lack of a hook on the ischiopodite of the third pair of pereopods in the male permits the inclusion of this species in the *erichsoni* group.

The presence of the tuberculiform structure on the coxopodites of the fourth pair of pereopods of the male is a character that places it near the species belonging to the *blandingii* group.

Procambarus teziutlanensis (Villalobos)

1947 a *Paracambarus teziutlanensis* Villalobos, An. Inst. Biol. de la Univ. Nal. A. de México, Vol. XVIII, No. 1, pp. 233 - 247, Plates 1 and 2.

1951 [sic; 1950] *Procambarus teziutlanensis* (Villalobos), An. Inst. Biol.

116 **Diagnosis.** Rostrum without spines. Ischiopodites of third pair of pereopods of male, form I, without hooks, those of fourth pair provided with strong tubercle. Coxopodites of fourth pair of pereopods of male with posterior tubercle. First pair of pleopods in male, form I, unequal in length; mesial process very well developed, conical, slightly turned toward side; cephalic process weakly developed, forming group with remaining processes; central projection present; caudal process weakly developed. *Annulus ventralis* hexagonal in outline with two small parallel crests in anterocentral part of *annulus*. Conical tubercle present between fifth pereopods of female.

Male, form I. The body is rather slender, small, and flattened laterally; the cephalothorax is of the same width as the first abdominal segments. The surface of the cephalothoracic shield is pitted by numerous small circular cavities of more or less the same size, with the exception of those that are located in the dorsal part of the cephalic region which are very large; some of the punctations on the surface of the rostrum are oval in contour. In the areolar region, the punctations are scarce and in the hepatic regions the surface exhibits numerous tubercles which extend further than the last undulation of the cephalic groove (Plate 21, figs. 1 and 2).

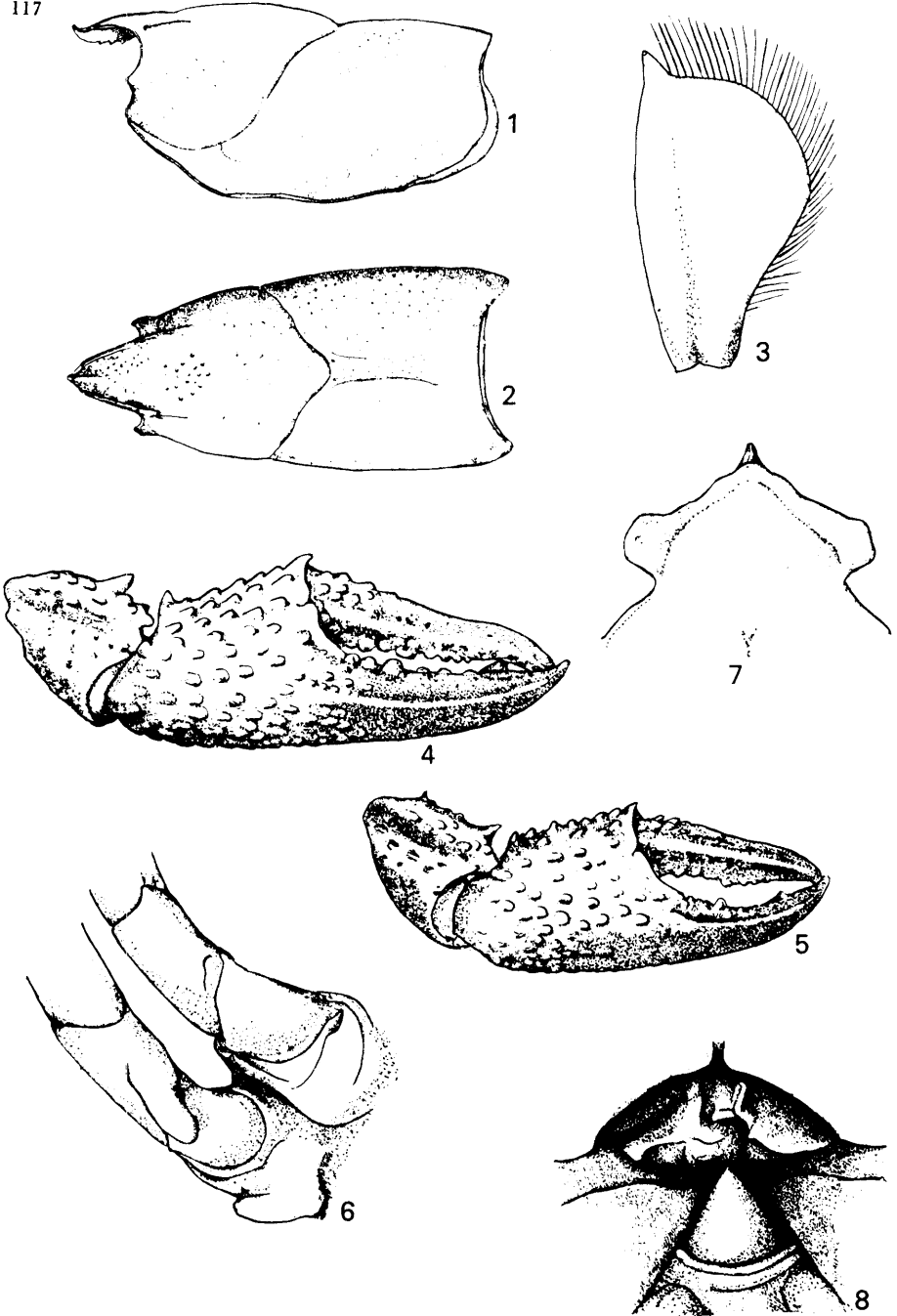
The rostrum is subtriangular, has a flat surface, and is slightly inclined downward; the margins are strong, slightly elevated above the surface, almost straight, and converging, terminating near the acumen; the lateral spines are absent. The apical spine is represented by a tubercle which is elevated vertically above the surface. The ventral keel of the rostrum bears three teeth in the proximal region (Plate 21, figs. 1 and 2).

The postorbital ridges are short, almost parallel, and are situated very near the rostral margins; anteriorly they terminate in a very small tubercle and posteriorly in a rounded prominence with a smooth surface.

The cephalic groove is well defined; the margin bordering the thoracic region is high and abruptly elevated above the groove, not like that bounding the cephalic region. The groove is divided into three typical parts, a dorsal one formed by three undulations of which the dorsal is the most pronounced, and the other two are lateral and almost
118 semicircular, limiting the posteroinferior part of the hepatic regions.

The areola is narrow; its surface bears punctations which are more numerous in the posterior part.

The proportions that exist between the different parts of the carapace are the following: the length of the areola is a little more than two and onehalf times less than the length of the carapace; the



posterior width of the rostrum goes into the entire length of the carapace exactly five and one-half times; the length of the rostrum is a little more than four and one-half times less than the length of the carapace.

The dorsal part of the abdomen is smooth and the pleural regions are slightly punctate. The telson and uropods have their dorsal surfaces covered with small setae; the distolateral angles of the first portion of the telson exhibit two or three spines.

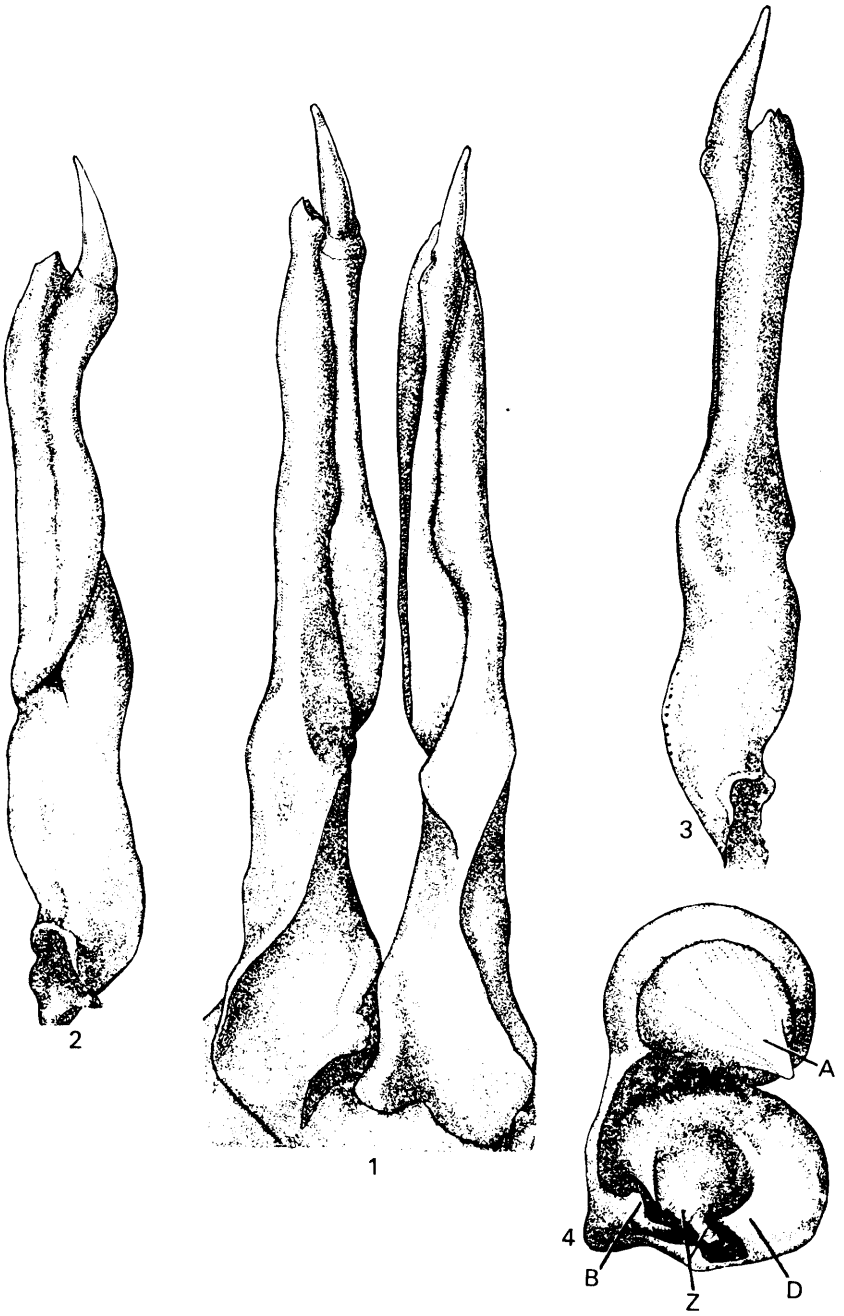
The epistome is slightly asymmetrical and shieldlike; its margins are elevated above the surface; the anterolateral borders are slightly concave (Plate 21, fig. 7).

The anterior part of the antennal scale is broad; the spine of the scale is short and robust. The greatest width of this article is located at midlength (Plate 21, fig. 3).

The first pair of pereopods are slightly robust. The dorsal margin of the meropodite is smooth except for two or three tubercles on the distal part that are hardly evident; the lateral faces are also smooth; in contrast, the ventral margin exhibits a double row of conical tubercles; the external row is composed of a limited number of these prominences, approximately four to six, one of which stands out by its larger size; all of them are conical, slightly sharp, and their apical parts are not chitinized. The internal row consists of nine or ten conical spines, gently inclined forward, and their apical regions are clearly chitinized. The carpopodite is smooth externally, bearing only a few setiferous punctations; the groove which is usually located on the dorsal part of this article is a depression which gives the appearance of a broad fossa that is gently stretched along the length of the podomere. The internal side is scabrous in appearance and the tubercles that are elevated above the surface are subsquamous and present in limited numbers. The distal articular margin bears emarginations; the deepest and widest is that found on the internal side of the article, and is limited by two spiniform tubercles; the inferior is larger than the superior one; moreover, the border of the emargination exhibits two or three conical tubercles that are clearly defined and others that are small and subsquamous. The ventral face of the article bears another slightly deep excavation which is situated between two tubercles, one corresponding
120 to the internal emargination, whereas the other is a projection of the margin of the article which rests on the hinge tubercle on the lower face of the chela.

Plate 21. *Procambarus teziutlanensis* (Villalobos). Male, Form I.

1, lateral view of the carapace; 2, dorsal view of the same; 3, antennal scale; 4, chela; 5, chela of the female; 6, ischiopodite of pereopods III and IV of the male, Form I; 7, epistome of the same; 8, *annulus ventralis*.



The propodus is slightly robust; its surface is totally covered with subsquamous tubercles which are most visible on the dorsal region of the palm where each of them is distinguished from the surface by a darker color. On the internal border of the chela, the tubercles are elevated and acquire the character of subspiniform prominences which give the margin a dentate aspect with six to eight such prominences. On the internal [= external?] border, the tubercles are broader, almost semicircular, and flattened; on the internal face these are less abundant and smaller. The immovable finger bears a strong flange or rib on each of its faces; on its external part it bears another flange which stands out between two rows of punctations that run parallel to it; the punctations are derived from the subsquamous tubercles that invade all of the basal region of the finger; the cutting border is slightly concave, with six hemispherical teeth, of which the third, counting from the proximal extremity, stands out clearly. On the distal extremity, rather more on the inferior face of the cutting border, there is a chitinized, conical tubercle.

The dactylopodite is slender, with its internal margin almost straight and the cutting border convex; the proximal region of the internal border exhibits three squamous tubercles elevated above the surface, the most posterior one smaller than the others. Both faces exhibit two ridges or flanges that extend from the articulation to the extremity of the article. The teeth of the cutting border are hemispherical and are situated in the following manner: first, there are two small ones, followed by a large one, and beyond a series of small denticles, the size of which diminishes distally (Plate 21, fig. 4).

The ischiopodites of the third pair of pereopods do not exhibit a trace of a tubercle, not even in the fully adult specimens.

The ischiopodites of the fourth pair of pereopods bear a strong tubercle on which the convex region is smooth and the concave bears short setae. The coxopodite of this same appendage bears a fusiform prominence, the distal extremity of which is directed toward the terminal region of the tubercle on the ischiopodite.

The coxopodites of the fifth pair of pereopods alone exhibit a small crest on the internal part of its distal articular margin (Plate 21, fig. 6).

121 The first pair of pleopods are long, slender, and straight; their apical regions reach the median part of the coxopodites of the second pair of pereopods. The right pleopod is longer than the left; in their basal part, these appendages are also asymmetrical (Plate 22, fig. 1). The mesial process is very well developed, its base is spheroidal, its apex

Plate 22. *Procambarus teziutlanensis* (Villalobos). Male, Form I.

1, caudal view of the first pair of pleopods; 2, mesial view; 3, lateral view; 4, distal view (A, mesial process; B, cephalic process; D, caudal process; Z, central projection).

sometimes flattened; in general, it is conical in form and inclined slightly over the external side (Plate 22, fig. 4A). The caudal process is an angular prominence, its apical part flat and chitinized (Plate 22, fig. 4D). The central projection, with the two structures composing it, evidently, exceeds the height of the caudal process (Plate 22, fig. 4Z). Another much smaller, sparsely chitinized crestlike prominence also may be noted; by its relationship with the central projection it is identified as the cephalic process (Plate 22, fig. 4B).

The pleopods are dissimilar basally; the articular border of the right pleopod is higher than the corresponding border of the left.

Male, form II. The most conspicuous characteristics that differ from those of the male, form I, are the following. The hooks on the ischiopodites of the fourth pair of pereopods are shorter, scarcely reaching the articulation with the basipodite; the first pair of pleopods are shorter and the structures of the apical region are not chitinized; the mesial process is short, conical in form, whitish in color, and situated completely in a caudal position; the remaining apical processes are not distinguishable.

Female. The female specimens at times are more robust than the male, and their chelae are sometimes shorter (Plate 21, fig. 5). The *annulus ventralis* (Plate 21, fig. 8) has a hexagonal contour, lengthened in the transverse axis; the groove is well defined in the posterior region and its margins exhibit two outstanding prominences in the apical and anterior part of the *annulus*; they form a kind of notch in the middle of which the groove is borne (Plate 21, fig. 8).

A short, conical tubercle may be observed between the fifth pereopods that is much less well developed than that of *Paracambarus paradoxus*; its apical region hardly touches the posterior part of the *annulus* (Plate 21, fig. 8).

Measurements in millimeters

	Male, Form I	Male, Form II	Female
Total length	50.0	44.5	55.0
Length of carapace	25.5	22.0	27.0
Anterior part of carapace	17.0	14.5	17.5
122 Length of areola	9.0	7.5	10.0
Width of areola	1.5	1.5	1.5
Length of abdomen	25.5	23.5	27.5
Posterior width of rostrum	5.0	4.0	5.0
Length of rostrum	6.0	5.0	6.0
Total length of chelae	20.0	16.0	20.0
Length of hand	8.5	6.5	7.5
Length of immovable finger	11.0	9.0	10.0

Localities. Chignautla, Teziutlán, Puebla (type locality). Las Margaritas, 5 km N.W. of Hueytamalco, Veracruz. Cristóbal Colon, 10 to 12 km N.W. of Hueytamalco, Veracruz.

Relationships. *Procambarus teziutlanensis* is related on one side to *Paracambarus paradoxus*, and on the other to *Procambarus tlapacoyanensis*. In the latter case, the differences are pointed out at the end of the description of *P. tlapacoyanensis*.

The fact that *Procambarus teziutlanensis* exhibits hooks on the ischiopodites of the fourth pair of pereopods only was taken as the base by which initially the species was placed in the genus *Paracambarus*, but undoubtedly it has more characteristics of the genus *Procambarus*, and, because of this, it was later placed in this genus. On the other hand, we should not abandon the idea of a possible relationship between *Paracambarus* and *Procambarus*, as indicated by these species.

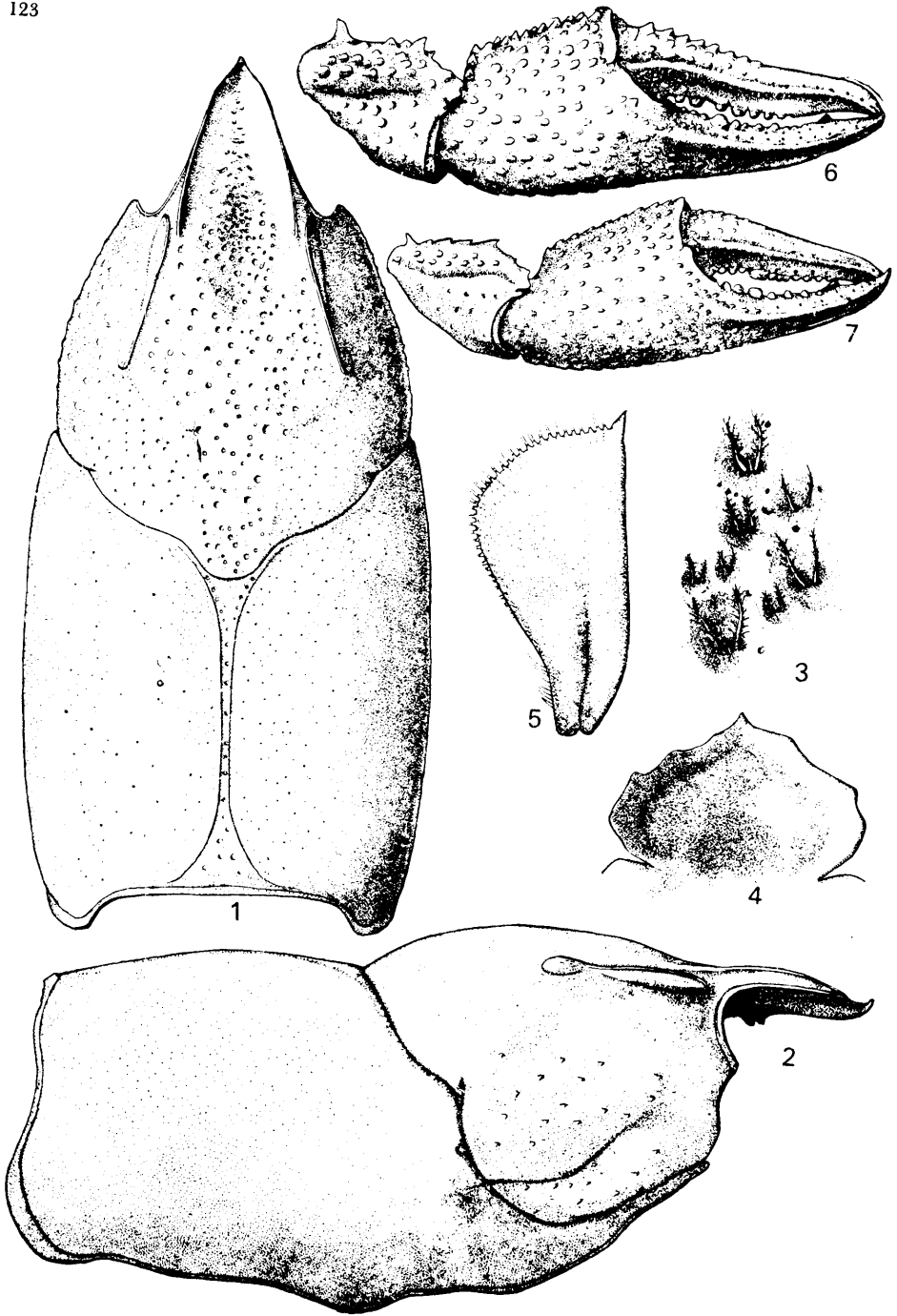
Procambarus tlapacoyanensis (Villalobos)

1947 b *Paracambarus tlapacoyanensis* Villalobos, An. Inst. Biol. de la Univ. Nal. A. de Mexico, Vol. XVIII, No. 2, pp. 537 – 546, Plates 1 and 2.

1951 [sic; 1950] *Procambarus tlapacoyanensis* (Villalobos), An. Inst. Biol. de la Univ. Nal. A. de México, Vol. XXI, No. 2, p. 372, Plate 1, fig. 6.

Diagnosis. Rostrum without spines. Ischiopodites of third pair of pereopods of first form male with small triangular process, those of fourth pair with strong tubercle. First pair of pleopods of male, form I, slightly unequal in length; mesial process very well developed, flattened and undulating; cephalic process very small; central projection standing out perfectly and with clear relationship to cephalic process; caudal process slightly developed. *Annulus ventralis* very similar to that of *Procambarus teziutlanensis*, but one of the crests, that of the right side, is developed much more than the other. The female exhibits a tuberculi-
124 form process with a blunt apex between the fifth pereopods.

Male, form I. It is medium in size. The cephalothorax is clearly punctate in the dorsal region; in the hepatic and branchial regions, the surface bears small subsquamous tubercles that are more prominent in the former. At the base of the rostrum, the punctations are circular and rather deep, particularly in the depressed area. Some small fissures may be noted on the surface of the rostrum; in the gastric region, the punctations are smaller and in the thoracic they become well marked. Most of the punctations bear two whitish setae that are borne on the posterior margin of the punctation; they extend over the anterior margin and their extremities are separated in a sharp angle (Plate 23, fig. 3). This disposition of the setae occurs with much regularity, except



in some punctations on the anterior part of the areola, which bear three or more short setae.

The hepatic region exhibits tubercles that are almost conical and inclined forward; on the anterior face of them are borne three or four setae very similar to those that we have just described. In the branchial region, the tubercles are hardly more than slight elevations, with one, two, or three setae disposed in the same manner as those of the punctations (Plate 23, fig. 2).

The rostrum is short, the margins converging, elevated, and without lateral spines. The apical region ends in a blunt tubercle directed upward and forward. The surface is slightly concave, and at the base of the rostrum there is a rather oblong depression where the punctations are clearly marked. The ventral rib of the rostrum exhibits two denticles, although in some specimens there may be three; these teeth bear clearly chitinized apices (Plate 23, figs. 1 and 2).

The postorbital ridges are distinctly convergent, almost parallel to the rostral margins; anteriorly, they terminate in a very small spine, and in the posterior region they end in a more or less rounded prominence (Plate 23, figs. 1 and 2).

The cephalic groove is deep, and the undulations are little pronounced; the part of the groove that limits the hepatic region ends anteriorly on the margin of the carapace immediately behind the branchiostegal spine. The hepatic region is furrowed below by a line disposed almost transversely to the groove (Plate 23, fig. 2).

The areola is very narrow; the margins that limit it are clearly marked on the anterior region of the thorax, but are almost lost in the
125 posterior region. Its surface scarcely permits the existence of a single line of punctations, although their number is augmented in its anterior and posterior regions (Plate 23, fig. 1).

In regard to the proportions that exist between the different parts of the carapace, we are able to say that: the length of the cephalic part is little more than one and one-half times greater than the length of the areola; the posterior width of the rostrum goes into the total length of the carapace approximately seven times; the length of the rostrum is a little less than one-fourth the total length of the carapace.

The length of the abdomen is exactly half the total length of the body. The abdominal segments are punctate dorsally, whereas in the pleural regions some punctations may be noted toward the posterior part of the segment. The surface of the telson is studded with short setae which are disposed in the same manner as those on the surface of the

Plate 23. *Procambarus tlapacoyanensis* (Villalobos). Male, Form I.

1, dorsal view of the carapace; 2, lateral view of the same; 3, view of the setiferous punctations of the carapace; 4, epistome; 5, antennal scale; 6, chela; 7, chela of the female.

cephalothorax. The distolateral angles of the anterior part of the telson exhibit three spines on each side, two of which are of small size.

The epistome is a scutiform plate with asymmetrical, more or less undulate margins slightly elevated above the surface; an acute antero-medial angle is present (Plate 23, fig. 4).

The length of the antennal flagellum, projected over the body, reaches the second abdominal segment. The antennal scale is rather long; its length is slightly more than twice its greatest width which is situated anterior to its midlength; the antennal spine is short, gently inclined outward, and its apex chitinized (Plate 23, fig. 5).

The first pair of pereopods are robust. The meropodite exhibits a few punctations on the lateral surface; the distal part of the dorsal border bears a group of more or less blunt tubercles that are pale blue, thus making them stand out from the surface. On the posterior part of this margin, the tubercles become smaller, fewer in number, and almost lose their coloration. The internal side is almost smooth with some subsquamous tubercles on the distal part. The ventral margin is armed with tubercles that are arranged in two rows: an internal one in which large and small tubercles alternate, and the outer in which the tubercles are less numerous, smaller, and less sharp. The space between the two rows contains some small spines, those situated near the distal articular margin of the article attaining a greater size.

126 The carpopodite exhibits a very large depression which courses the entire length of the article. On the internal side, the surface is armed with abundant well developed tubercles, whereas that of the external side supports only punctations in the fundus of which are borne short setae disposed radially forward, lying on the surface (Plate 23, fig. 6).

The chela is large with abundant subsquamous tubercles. The palm, or propodus, is somewhat flattened, the internal border slightly blunt; but viewing the chela from its dorsal surface, a row of tubercles may be noted which gives it a cristiform aspect. On the dorsal surface, the tubercles are abundant and their blue tone makes them stand out from the rest of the surface; the tubercles on the external margin are broader, more abundant, and have the same color as the surface of the chela. The ventral face of the chela is also provided with abundant subsquamous prominences without color; among them, those that are near the internal border are elevated more than the others and assume the blue coloration. The tubercles invading the proximal regions of the fingers are more abundant on the proximal part of the immovable finger. The cutting border of this finger is provided with teeth that are hemispherical and disposed in the following manner: on the proximal region there are three small teeth followed by a large one, then four adjacent small teeth; separated from the latter are two more teeth that are also small. On the distal extremity, but in the ventral region of the

cutting border, there is a conical tubercle. The dorsal and ventral surfaces of the finger show the characteristic ribs, or ridges, which extend along their total length; these structures are bordered first by tubercles followed by punctations provided with their respective clusters of setae in the form of a brush.

The movable finger, or dactylopodite, is slender, slightly incurved in its distal half; the teeth of the cutting border are disposed in the following manner: first, three small teeth some distance apart, followed by a little larger tooth slightly more anterior than the large tooth of the immovable finger, then six slightly separated teeth diminishing in size distally.

128 The ischiopodites of the third pair of pereopods bear a small clearly visible angular prominence on the distal extremity of the ventral margin that is similar to that noted in *Paracambarus paradoxus* (Plate 24, fig. 6). The ischiopodites of the fourth pair of pereopods exhibit a prominent, well developed tubercle, with an emargination on its terminal portion that gives it a characteristic aspect; the external surface of the tubercle is convex and smooth, whereas that of the internal is concave and bears a few short setae (Plate 24, fig. 6).

Only on the coxopodites of the fifth pair of pereopods do we find the outline of the plate which exists in *Paracambarus teziutlanensis*.

The first pair of pleopods are unequal in length, the apical region of the larger, which is the right, reaches midlength of the coxopodites of the second pair of pereopods; the basal region of these appendages is markedly asymmetrical (Plate 24, fig. 1). The mesial process is well developed, its articular part broadened and the site of its insertion easily discerned. Starting from the base, the process takes the form of a lance and is flattened anteroposteriorly; also it is recurved toward the caudal region, taking the form of an italic S (Plate 24, figs. 2, 3, 4, and 5A). The central projection (Plate 24, fig. 5Z) is the point of departure for the location of the other parts of the apical portion; it has the characteristic form, that is to say, it consists of two short processes, flattened in the anteroposterior axis; the centrocaudal process (Plate 24, fig. 4F) is quadrangular in form and remains independent of the other processes; the centrocephalic process (Plate 24, fig. 4E) is triangular in contour and is related to a smaller, little chitinized, and slightly inclined prominence, situated in the cephalomesial region of the pleopod, which corresponds to the cephalic process (Plate 24, fig. 4B). On the lateral part of the apical region, another small angular projection is noted that corresponds to the caudal process (Plate 24, fig. 5D). It is important to note that the setae of the mesial region invade the apical region and form a cluster grouped approximately on the cephalomesial side.

Male, form II. The carapace is completely punctate; the rostrum is

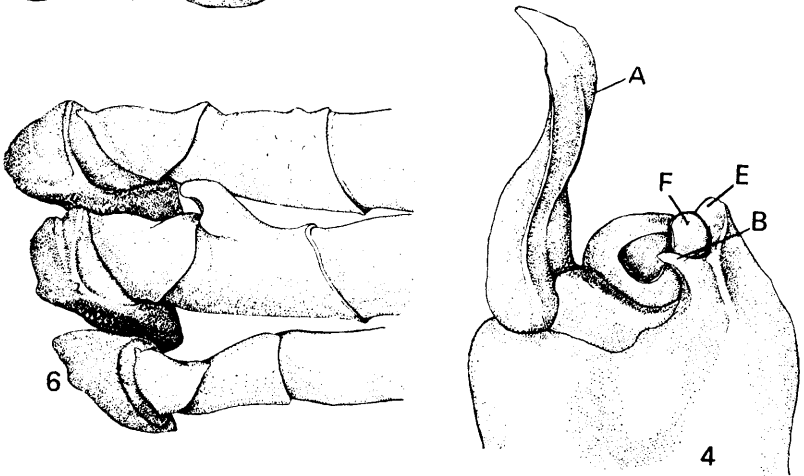
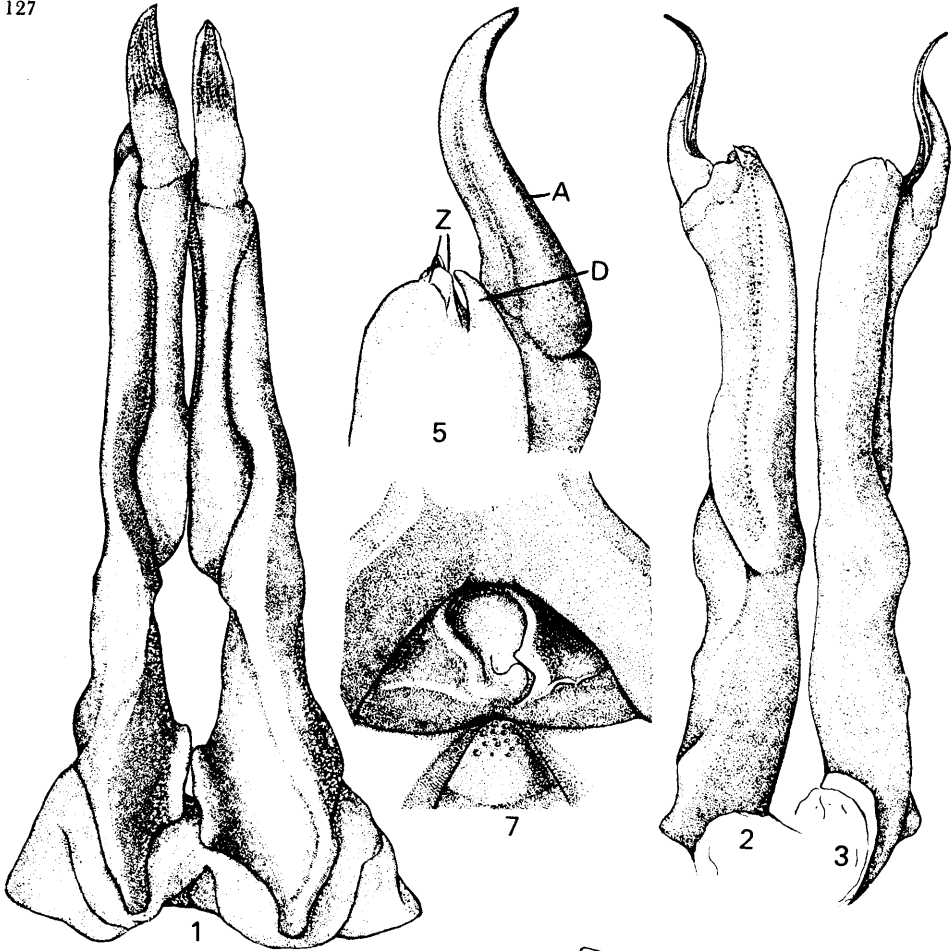


Plate 24. *Procambarus tlapacoyanensis* (Villalobos). Male, Form I.

1, caudal view of the first pair of pleopods; 2, mesial view; 3, lateral view; 4, mesial view of the apical region of the pleopod; 5, cephalolateral view of the same apical part (A, mesial process; B, cephalic process; D, caudal process; E, centrocaudal process; F, centrocephalic process; Z, central projection); 6, ischiopodites of pereiopods III to V; 7, *annulus ventralis*.

fluted and without lateral spines; the areola is a little broader than in the form I.

The chelae are small, their surface completely covered with subsquamous tubercles; the cutting borders of the fingers have small teeth; the movable finger is straight.

The ischiopodites of the third pair of pereiopods lack the small tubercle that appeared in the male, form I.

The ischiopodites of the fourth pair of pereiopods bear a small tuberculiform prominence on the proximal part of the article.

129 The first pair of pleopods are slender and straight, and the mesial process is conical, pale, pliable, and turned gently toward the caudal region. The other processes are not evident; only a spiral groove is discernible and the margins that limit it are elevated.

Female. In the female, the cephalothorax is punctate; the rostrum is slightly concave, the apical part triangular, and the apical spine tuberculiform. The areola is a little broader than in the male, form I.

The fingers of the chelae are short and the surface is less densely covered with tubercles than in the males. The dactylopodite is slightly curved; its cutting border exhibits numerous small denticles (Plate 23, fig. 7).

The *annulus ventralis* is fusiform in outline, its major axis is transverse to the body, its central part is prominent, and the surface exhibits two parallel ridges in the major axis of the body arranged more or less on each side of the median line. These ridges are borne on the anterior part, near the sternite of the thirteenth segment, extend toward the central part, diverging gently and then tending to reunite, but finally remaining separated. They terminate on the posterior part near the apical region of the *annulus*, where a groove in the form of an S is disposed in the same direction as that of the major axis of the *annulus ventralis* (Plate 24, fig. 7).

Between the fifth pereiopods, there is a small conical tubercle with a rounded apex and which does not attain the proportions of a real spiniform tubercle (Plate 24, fig. 7).

Measurements in millimeters

	Male, Form I	Male, Form II	Female
Total length	57.0	42.5	61.0
Length of carapace	29.0	20.0	31.0

	Male, Form I	Male, Form II	Female
Anterior part of carapace	18.0	13.3	20.0
Length of areola	11.0	6.7	11.0
Width of areola	0.3	0.5	1.0
Posterior width of rostrum	4.0	3.3	4.8
Length of rostrum	6.3	5.0	7.0
Length of chelae	24.5	12.0	20.3
Length of hand	9.3	4.5	8.0
Immovable finger	14.5	7.0	13.0

Localities. Cañada de Tomata, Tlapacoyan, Veracruz (type locality). Filipinas, Tlapacoyan, Veracruz.

Relationships. This species is closely allied to *Procambarus teziutlanensis* which is explained in part by both living in the same river basin. The differences that exist between them, however, seem to us sufficient for separating them.

The following list contains the characteristics that have served us in distinguishing between the species *P. tlapacoyanensis* and *P. teziutlanensis*:

<i>Procambarus tlapacoyanensis</i>	<i>Procambarus teziutlanensis</i>
I. Rostrum fluted.	I. Rostrum plane.
II. Areola narrow, less than 1 mm.	II. Areola broad, more than 1 mm
III. Third pair of pereiopods with a small prominence on the ischiopodite.	III. Third pair of pereiopods without prominence on the ischiopodite.
IV. First pair of pleopods with the mesial process flattened and curved.	IV. First pair of pleopods with the mesial process conical and almost straight.
V. Setae of the mesial region invading the apical region.	V. Setae of the mesial region not invading the apical region.
VI. <i>Annulus ventralis</i> with two well formed ridges. Groove in the form of an S perpendicular to the major axis of the body.	VI. <i>Annulus ventralis</i> with two prominences on each side of the median line, one of them larger than the other; both continuing in the anterior part with two ridges that soon disappear. Groove in the form of a slightly inclined S.
VII. Tubercles between the fifth pereiopods small.	VII. Tubercles between the fifth pereiopods large.

ERICHSONI GROUP

Diagnosis. Mesial process reduced, generally shorter than other apical structures. Caudal process platelike in central or cephalic position. Central projection platelike and well developed. Cephalic process spiniform and reduced.

Procambarus erichsoni Villalobos

1951 [sic; 1950] *Procambarus erichsoni* Villalobos. An. Inst. Biol. de la Univ. Nal. A. de México, Vol. XXI, No. 2, pp. 383 [sic; 384] – 393, Plates 1, 2, and 3 [sic; 5, 6, and 7].

Diagnosis. Carapace elongate. Rostrum with lateral spines. Ischiopodites of third and fourth pairs of pereopods with hooks; those of third pair very reduced. First pair of pleopods straight, unequal in length; mesial process present; caudal process platelike; central projection and cephalic processes present. *Annulus ventralis* with two ridges in anterior region.

Male, form I. The carapace is equal in length to the abdomen and its lateral margins are parallel. The surface is provided with scales and small punctations; the more conspicuous are those that are found on the posterior part of the rostrum. In the hepatic regions and in the lower part of the branchial regions there are granulations that are slightly elevated; those of the hepatic region seem more dispersed. The cephalic groove is deep; the section of it that limits the hepatic region anteriorly is very deep in its median part, but at the same time, it terminates more superficially. The carapace lacks lateral spines.

The rostrum is short and its apical part reaches the distal articular region of the second article of the antennule; the margins are distinctly convergent, lacking lateral spines. The surface is subplane and rugose, although slightly depressed in the median part. The ventral keel of the rostrum bears a series of three teeth of which the distalmost is larger than the others (Plate 23 [sic; 25], figs. 1 and 2).

The postorbital ridges are little elevated, convergent, and terminate anteriorly in a very small, almost imperceptible tubercle.

The areola is moderately large, the suprabranchial grooves may be readily distinguished. The areolar surface is almost smooth, some punctations appearing in it and along its margins.

The proportions between the different parts of the carapace are as follows: the length of the areola is greater than half the length of the cephalic part. The posterior width of the rostrum is a little more than six times smaller than the total length of the carapace. The length of the rostrum goes into the total length of the carapace almost five times (Plate 25, figs. 1 and 2).

The somites of the abdomen are smooth dorsally and with a few punctations in the pleural regions. The telson is narrow and its margins convergent posteriorly; its surface is provided with setae; the distolateral regions of the first section of the telson bear two spines on each side; the terminal part is semicircular.

The epistome is irregular; the posterolateral margins are parallel, whereas those of the anterior part exhibit three emarginations which

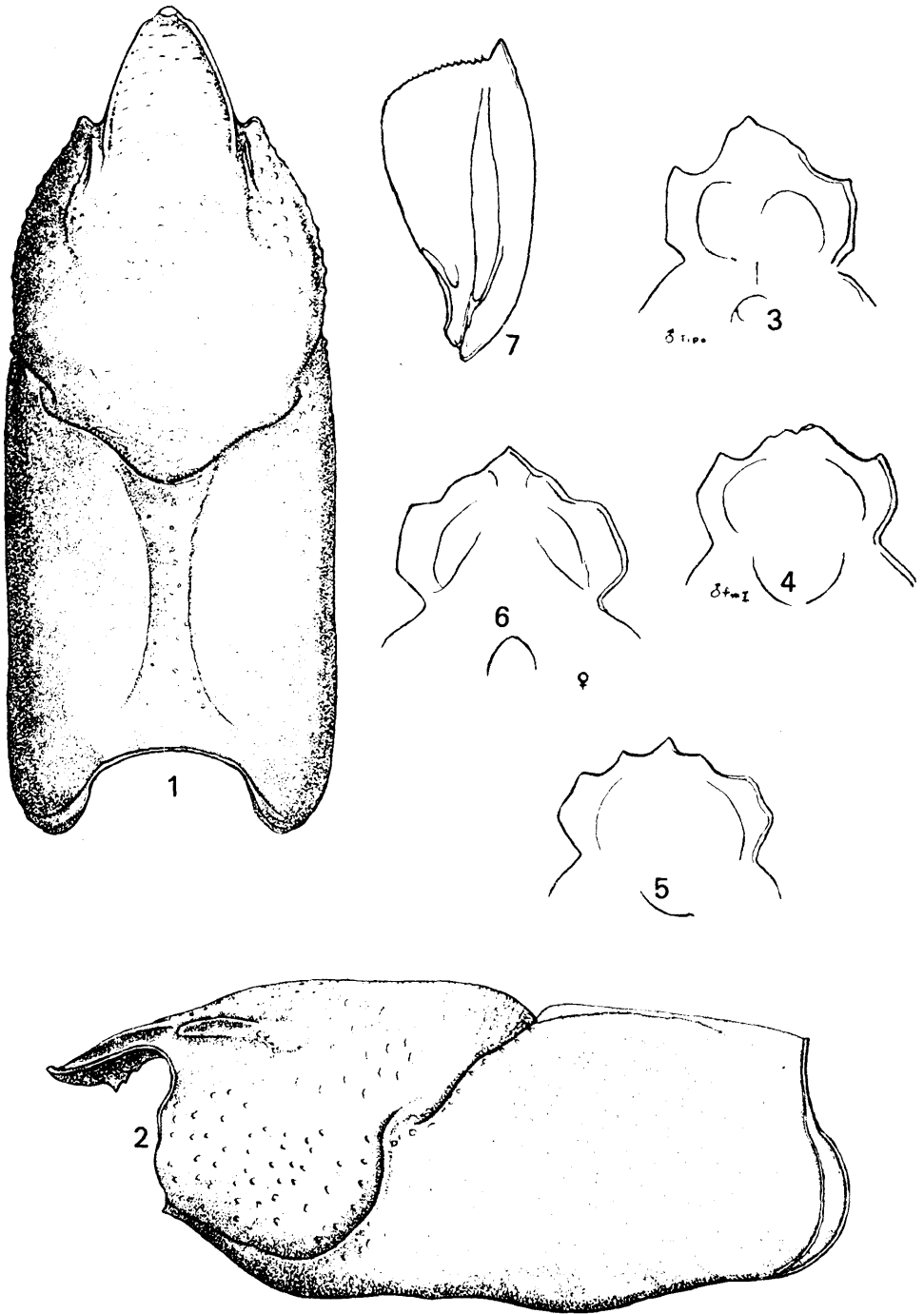


Plate 25. *Procamburus erichsoni* (Villalobos).

1, dorsal view of the carapace of the male, Form I; 2, lateral view of the same; 3 and 4, two forms of epistome of the male, Form I; 5, epistome of the male, Form II; 6, epistome of the female; 7, antennal scale of the male, Form I.

bring about its asymmetry (Plate 25, fig. 3). In the epistome of other specimens that we have examined, we notice the same tendency of irregularity (Plate 25, fig. 4). In the second form male, the asymmetry is less manifest and we can establish a certain relationship in the form.

134 The spine of the antennal scale reaches the distal half of the third article of the antennule. The spine of the scale is short, triangular, and the apex chitinized. The external margin of the scale is convex; the greatest width is found very near the distal part (Plate 25, fig. 7).

The first pair of pereopods exhibit a very well developed chela. The two faces of the meropodite are smooth; the superior margin presents small, very flattened tubercles that barely stand out from the remainder of the surface by their color which is greenish blue; of these structures, only the more distal are elevated as subsquamous tubercles. The inferior margin has only a single internal row of spiniform tubercles; the external row is represented by only a very few small tuberculiform structures. The proportion of this article to the carpopodite is the following: the length of the carpopodite is 1.3 times less than that of the meropodite.

The carpopodite is comparatively smoother than in the other species; its upper surface exhibits a more or less elongate depression that does not attain the characteristics of a groove; the articular emargination exhibits two or three tubercles.

The chela is long, an aspect that is accentuated in the fingers which moreover are slender and gently curved inward. The internal margin of the palmar region exhibits three rows of subsquamous tubercles; of these, those of the middle row are largest. The upper and lower surfaces have more or less visible tubercles as they are only slightly elevated above the surface; those of the upper face differ from the rest by their darker color. The dactylar region of the propodus is slender in its anteromedian part; in contrast, at the base it is quite wide; its cutting border is gently concave and is armed with teeth that are small and hemispherical and disposed in the following manner: in the proximal part, there are first two small separated teeth; following is a slightly larger tooth, and beyond a series of seven small hemispherical teeth that are more or less equal; finally, a tooth is implanted on the lower cutting border in the distal third of the finger.

The dactylopodite is also slender and long; the cutting border of this article bears teeth that are very similar to those of the other finger and which are described as follows: proximally a series of three teeth, followed by a tooth of greater size, then seven teeth of decreasing size (Plate 26, fig. 1).

The ischiopodites of the third pair of pereopods exhibit a small ridge which represents the rudiment of the corresponding hook. The coxopodite of the fourth pair of pereopods has a very well developed

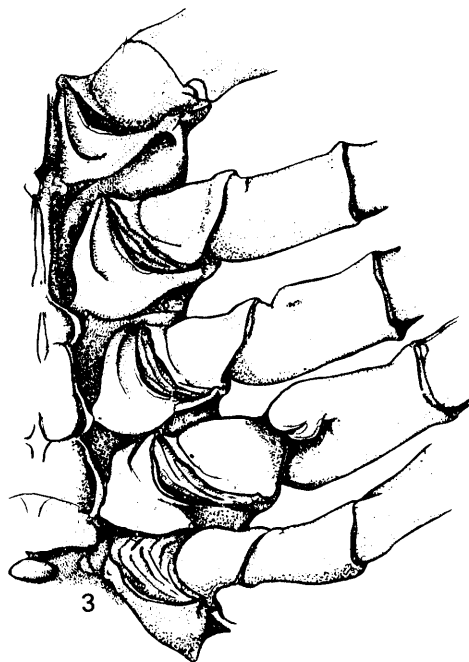
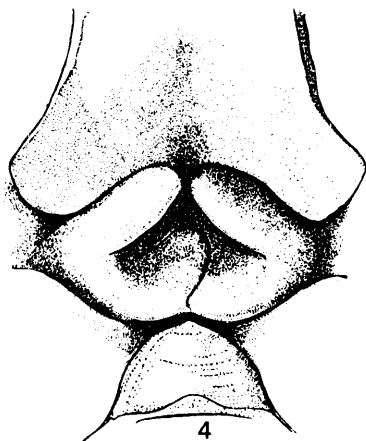
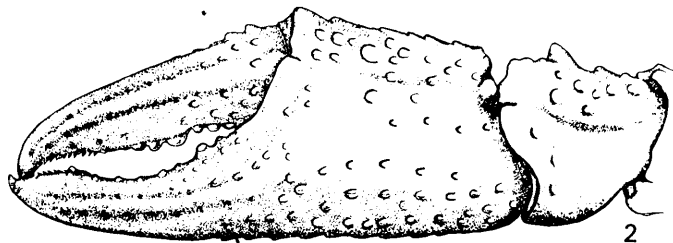
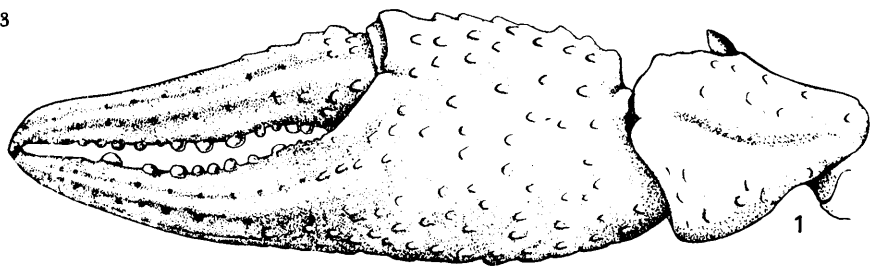


Plate 26. *Procambarus erichsoni* (Villalobos).

1, chela of the male, Form I; 2, chela of the female; 3, ischiopodites of pereopods I to V of the male, Form I; 4, *annulus ventralis*.

135 tubercle which stands out conspicuously from the article. The ischiopodite of the same pair exhibits a very well developed tuberculiform structure; its extremity is broadened and moreover has the form of a mitten, or gauntlet (Plate 26, fig. 3).

The first pair of pleopods are straight, unequal in length; the right pleopod is larger than that of the left side (Plate 27, figs. 1, 2, and 3). The mesial process is conical, rather short, and its apex hardly exceeds the end of the pleopod (Plate 27, figs. 4 and 5A). The caudal process is platelike in form and chitinous; it is convex cephalically and concave toward the caudal region; this plate exhibits a slight fold on the external part (Plate 27, figs. 4 and 5D). The central projection stands out clearly and its two parts are independent of the caudal process (Plate 27, figs. 4 and 5 Z). The cephalic process is a small triangular spine that is inserted at the base of the central projection and is connected directly to one of the components (Plate 27, figs. 4 and 5B).

On the external part of the sternite where the first pair of pleopods are articulated, there is a small tubercle on each side very near the base of the appendages.

Male, form II. Its carapace is seemingly more smooth than that of the male, form I, which signifies that the punctations and tubercles are less numerous and less conspicuous.

The surface of the rostrum is flat, but the margins are elevated.

The postorbital ridges are short, broad, and without spines or tubercles.

The epistome is symmetrical with emarginations on its anterior part that give a crenulate appearance to this region (Plate 25, fig. 5).

The chelae are large; the palmar portion globose; the dactylar portion slender and longer than the palm.

The ischiopodites of the third pair of pereopods have a small crest that stands out from the rest of the article because of the presence of an emargination on its proximal part, and it is much broader than in the male, form I.

The coxopodite of the fourth pair of pereopods exhibits the same tubercle that we described for the male, form I, but in the male, form II, this structure is shorter and is triangular. The ischiopodite of the same pair of appendages exhibits a very small tuberculiform hook that manifests itself boldly on the distal region of the article.

136 The first pair of pleopods are straighter than in the male, form I, and the unequal size persists, the appendage of the right side being larger. The mesial process is small, conical and directed cephalodorsally. The caudal process is a small incurved crest which is located on the lateral portion of the apical part. The cephalic process is hardly more than a triangular projection on the cephalomesial part of the appendage. The

central projection is represented by two very small, mammiform elevations situated in front of the cephalic process (Plate 27, fig. 6).

Female. The carapace is slightly smaller than the abdomen and has the same mien as in the male, form I. The surface exhibits many very small punctations; those on the dorsal part of the cephalic region are larger and less abundant. The granulations of the hepatic region persist.

The rostral margins are distinctly convergent; the apical spine is represented by a tubercle that is inclined cephalodorsally. The surface of the rostrum is almost plane and exhibits a small ridge on the anterior part that is placed on the median line.

The areola is broad and well delineated. The punctations on the surface of the areola are more or less scattered.

The postorbital ridges occur very near the rostral margins; they are slightly convergent and terminate in a small conical tubercle.

The epistome is quite symmetrical; the anterior part has the form of an arrow, and the basal part is polygonal and short (Plate 25, fig. 6).

The chelae of the first pair of pereopods are shorter than those of the male, form I. The teeth of the cutting border of the immovable finger are disposed as follows: proximally two teeth of medium size; following, a large one and then four regularly spaced; finally, the tooth of the distal third which is situated on the lower part of the cutting border. The teeth of the cutting border of the dactylopodite are arranged thus: proximally two small teeth followed by a large one, and finally, four teeth of decreasing size (Plate 26, fig. 2).

The *annulus ventralis* is a very regular structure with two crests in the anterior part. The groove has the form of a U, the two rami of which are directed: one toward the median posterior region and the other toward the right and rear (Plate 26, fig. 4).

Between the fifth pereopods there is a somewhat pyramidal tuberculiform process with a rounded apex.

Measurements in millimeters

	Male, Form I	Male, Form II	Female
Total length	56.5	51.5	51.2
Length of carapace	28.5	25.2	25.3
Anterior part of carapace	18.3	16.8	16.5
Length of areola	10.2	8.4	9.0
Width of areola	1.9	1.9	2.0
Length of abdomen	28.0	26.3	25.9
Posterior width of rostrum	4.5	4.5	4.2
Length of rostrum	5.3	5.8	5.8
Length of chela	24.3	18.6	18.6
Length of movable finger	13.5	10.0	10.4

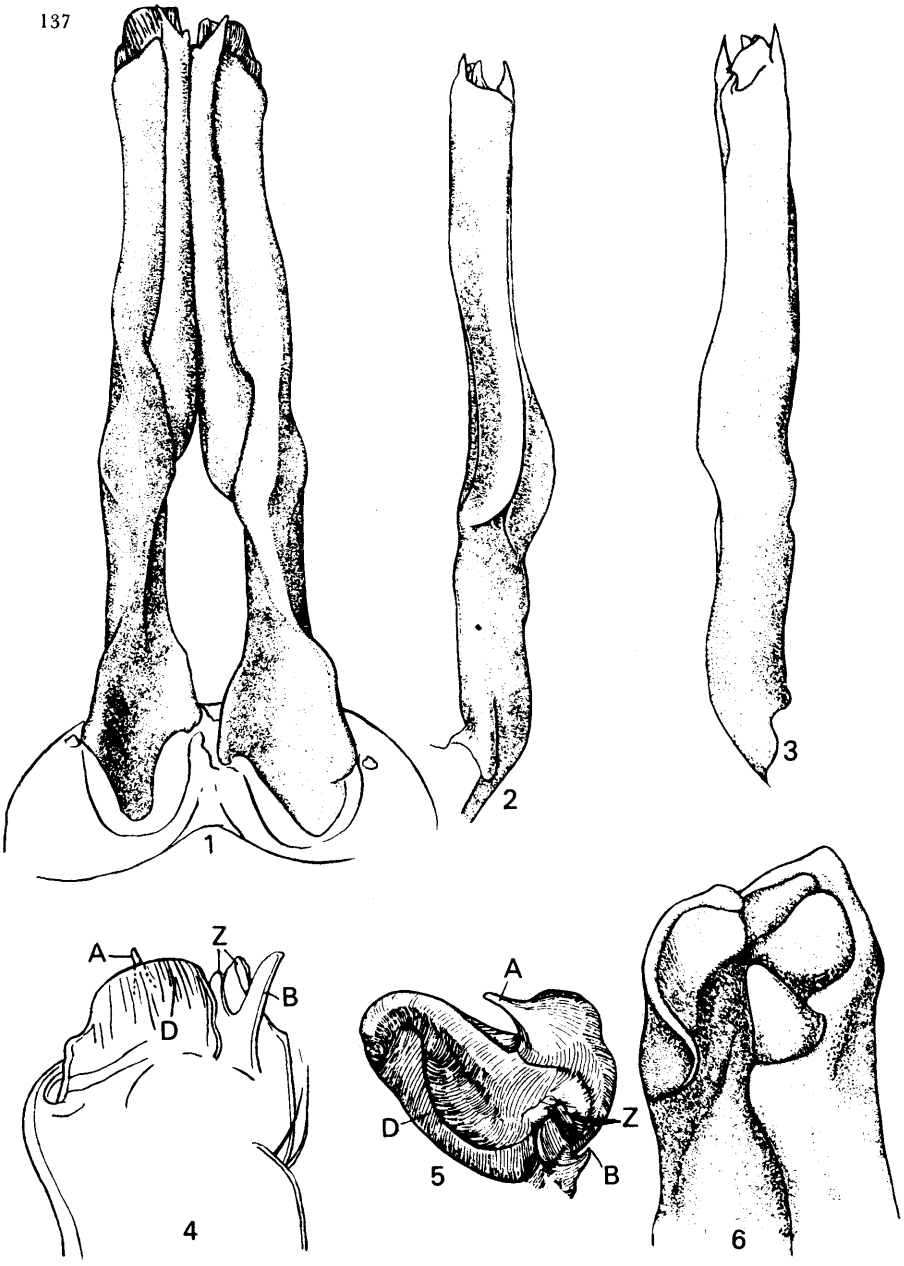


Plate 27. *Procambarus erichsoni* (Villalobos). Male, Form I.

1, caudal view of the first pair of pleopods; 2, mesial view; 3, lateral view, 4, cephalic view of the apical part of the pleopod; 5, distal view of the same; 6, apical view of the first pleopod of the male, Form II.

Localities. Arroyos Puendo, Mamay y Bojoy, Tenango de Doria, Hidalgo (type locality). Arroyo de San Bartolo, 9 km N. of Tenango de Doria, Hidalgo.

Relationships. The uncertainty that has existed for some time concerning *Procambarus weigmanni* [sic; = *wiegmanni*] (Erichson) was definitely resolved with the finding of some specimens belonging to the genus *Procambarus* which we initially provisionally identified as *P. weigmanni* [sic] (Erichson), based on the description that A. E. Ortmann made on a male specimen in the collections of the Academy of Natural Sciences of Philadelphia.

Bearing in mind the doubtful issues concerning the identity of this species, we decided to clarify the problem once sufficient material had become available for studying carefully the systematic question arising from a series of rare and anomalous circumstances.

Procambarus weigmanni [sic] was described in 1846 by W. F. Erichson under the name *Astacus (Cambarus) weigmanni* [sic]; the locality given by the author was "Mexico," and the specimens were collected by Von Deppe. The type, it seems, was deposited in the Berlin Museum.

Analyzing the original description, we found that it contained hardly any specific structural characters; consequently, the identification is essentially impossible. The total lack of illustrations and the vaguely annotated locality in the work with the general indication of "Mexico" make the specific recognition of the specimens described by Erichson very difficult.

In 1870, Dr. Hermann H. Hagen wrote a monograph on the North American astacids in which he said that he was unable to find the type of
140 *P. weigmanni* [sic] in the Berlin Museum, and based on the original description, he assigned to the species a female crayfish, with the same vague locality, "Mexico," that had been collected by Mr. Pearse [Peace].

Fourteen years later, W. Faxon described new species of crayfishes and in a synonymical list referred to *P. weigmanni* [sic] as follows :

"14. *Cambarus Weigmanni* [sic].

Astacus (Cambarus) Weigmanni [sic] Erichson, op. cit., p. 99. 1846.

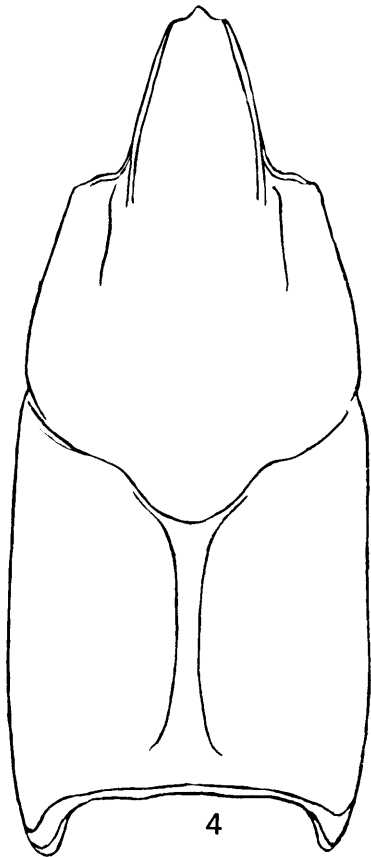
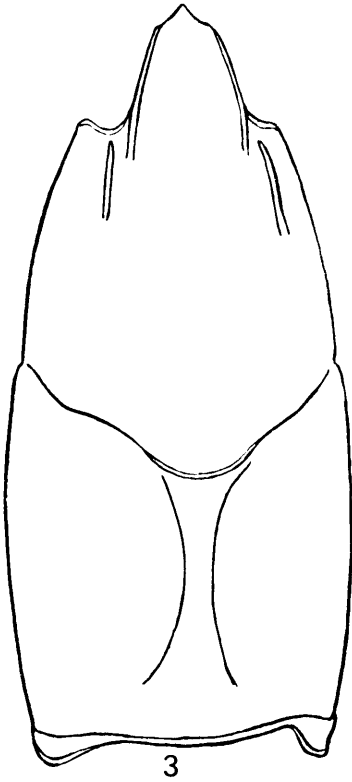
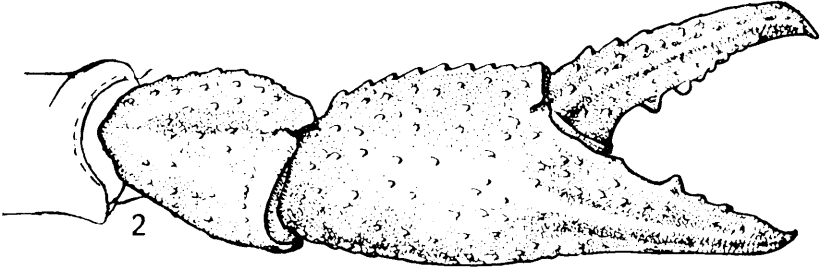
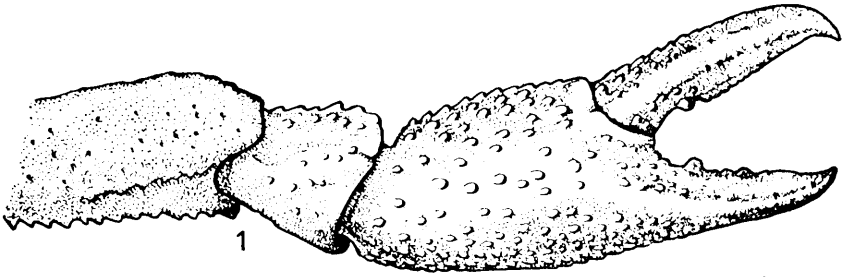
? *Cambarus Weigmanni* [sic] Hagen, op. cit., p. 54, Pl. III. fig. 151
1870. Hab. Mexico."

Moreover he presented the following information :

"The types of Erichson's two Mexican species of *Cambarus*,

Plate 28.

1, chela of the female specimen No. 4176 in the collection of the Academy of Natural Sciences of Philadelphia; 2, chela of a female specimen of *Procambarus mexicanus* collected in the Barranca de Jamapa, Veracruz, No. 110848, Col. Inst. Biol.; 3, dorsal view of the carapace of the female No. 4176 in the Col. of the Acad. Nat. Sci. of Philadelphia; 4, dorsal view of the same female from the Barranca de Jamapa, Veracruz.



C. Weigmanni [sic] and *C. Mexicanus*, could not be found in the Berlin Museum, either by Hagen, who examined the collection in September 1870, or by Von Martens (Arch. Naturgesch., 1872, p. 131). *C. Weigmanni* [sic] alone of the known Mexican species belongs to the *C. Blandingii* group, with hooks on the third and fourth pairs of legs in the male. The female specimen in the Acad. Nat. Sci. Phila. (No. 170, Mr. Pearse [sic; Peace]), fully described by Hagen, is probably correctly referred to this species by him, although in the absence of male specimens there is some uncertainty, I have seen but one specimen of *C. mexicanus* [sic], a male. In this the chelae are more cylindrical, and are covered with smaller, more closely set, granular tubercles. In the collection of the Acad. Nat. Sci. Phila., I find another alcoholic female from Jalapa, Mexico, which agrees well with [sic] Mr. Pearse's [sic] specimen. A mutilated female in the U. S. Nat. Mus. (No. 3288), collected by Sumichrast at the Isthmus of Tehuantepec, seems also to belong here."

In 1885, a new revision of the Astacids, by Faxon, and published in the Memoirs of the Museum of Comparative Zoology, appeared in which he included the original description of Erichson.

In 1905 and 1906, Ortmann described a new subgenus, *Procambarus*, and at the end of his work referred to *P. weigmanni* [sic] as "a doubtful species," because the copulatory organs were not mentioned in the original description; but places this species in the *Alleni* group.

In 1906, the same author found a male crayfish in the Academy of Natural Sciences of Philadelphia collected by Cope in Lago de Xochimilco. This specimen is the one described in his work in which he
141 presents, in addition to its characteristics, a sketch of the first pair of pleopods of the male, form I.

The first thing that we did was to send specimens to Dr. Horton H. Hobbs for comparison, which this carcinologist did, and the result was his finding a great similarity between the specimens collected by us and the male specimen No. 1366, collected by Cope, in the Academy of Natural Sciences of Philadelphia. Dr. Hobbs, moreover, made photographs of the male and of the female No. 4176, collected by Mr. Pearse, [sic; Peace], which seemed to be representatives of *P. weigmanni* [sic]. Thanks to them and to the annotated data by Faxon, we were able to find among the specimens of our collection a female of *P. mexicanus* collected in the Barranca de Jamapa, Veracruz, that resembled greatly the photographs obtained by Dr. Hobbs of the carapace and the chela.

In order to make these similarities more objective, sketches were made of the female specimen No. 4176 in the collection of the Academy of Natural Sciences of Philadelphia and are represented in Plate 28 (figs. 1 and 3). Figures 2 and 4 on the same plate were drawn from the female specimen No. 11 0848 in our collection. As a result, we reached

the conclusion that the female specimen No. 4176 belongs to the *mexicanus* group.

If the type of *P. weigmanni* [sic] is lost from the Berlin Museum and the original description does not permit identification, we believe that neither Hagen nor Ortmann had evidence for selecting neotypes with completely different specimens. Inasmuch as the locality "México," noted in the original description, is highly confusing we would have to look for topotypes in a territorial area which encompasses the American Continent between the fifteenth and thirty-first parallel.

But it could be considered that A. E. Ortmann, in describing the male specimen No. 1366 in the collection of the Academy of Natural Sciences of Philadelphia, would have the right of priority. Notwithstanding the fact that his intention was to redescribe *P. weigmanni* [sic], the specimen would remain the type of a new species, with the same name, which would be feasible after the loss of Erichson's type and the confusion in the original description.

Even taking all of this into consideration, we have reached the conclusion that although the description is good, the locality cited is completely erroneous inasmuch as undoubtedly this species does not exist in Lago de Xochimilco; moreover, only the genus *Cambarellus* has been found in this Lake, one that is very distinct from the genus ¹⁴² *Procambarus*. Thus a type with an "unrecognizable" locality cannot be admitted.

In view of what has been mentioned, we proposed (Villalobos, 1951) [sic; 1950] that *Procambarus weigmanni* [sic] (Erichson) should remain a *Nomen nudum*, that the species described by Ortmann should be invalidated because of the fact that it lacked a locality, and that the specimens described in my work should be considered a new species under the name of *Procambarus erichsoni*, dedicated to W. F. Erichson.

Procambarus contrerasi (Creaser)

1931 *Cambarus* (*Cambarus*) *contrerasi* Creaser. Occ. Pap. Mus. Zool., Vol. X, No. 224, pp. 1 – 10, Plates 1 – 5.

1942b *Procambarus contrerasi* (Creaser). Hobbs. Amer. Midl. Nat., Vol. XXVIII, No. 2, p. 342.

1951 [sic; 1950] *Procambarus contrerasi* (Creaser). Villalobos. An. Inst. Biol. de la Univ. Nal. A. de Mexico, Vol. XXI, No. 2, pp. 373 – 378, Plates 2 and 3.

Diagnosis. Rostrum without spines. Ischiopodites of third and fourth pairs of pereopods with hooks, those of third very reduced. First pair of pleopods straight, unequal; mesial process present, cephalic process reduced to small spine, caudal process in form of plate similar

to horsehoof. *Annulus ventralis* almost covered by two plates implanted in anterolateral regions.

Male, form I. The lateral contours of the carapace are gently ovate and its length, projected over the abdomen, reaches the anterior part of the telson. The surface is provided with punctations that stand out clearly in the dorsal part of the cephalic portion; in the branchial regions, these punctations are abundant but small; the hepatic regions are scabrous. The cephalic groove is moderately deep and in the form of an arc, discontinuous in its lateral parts; the portion of the cephalic groove that limits the hepatic regions posteriorly is almost semicircular and very slightly sinuous. The carapace lacks lateral spines.

The apical spine of the rostrum reaches the distal part of the second antennular article. The rostral margins are straight, almost parallel; in the anterior part they are insensibly continuous with the acumen, which terminates in a tubercle that is elevated over the surface. There are no lateral spines. The rostral surface is punctate and an oblique series accompanies the margins for almost their entire length; in the
144 median part there is a crest which is elevated very slightly above the surface. The ventral keel of the rostrum exhibits a tooth on its proximal portion (Plate 29, figs. 1 and 2).

The postorbital ridges are gently convergent and are formed by two almost parallel ribs, separated by a row of setae; the lower rib terminates anteriorly in a small but clearly projecting tubercle.

The areola is delineated by the two suprabranchial grooves that are parallel along their median part; the surface of the areola is a slightly convex and has some very small, but clearly visible, punctations.

The proportions of the different parts of the carapace are the following: the length of the areola is a little less than half the length of the cephalic portion; the posterior width of the rostrum is about one-sixth of the total length of the carapace; the length of the rostrum is a little more than one-fourth that of the total length of the carapace (Plate 29, figs. 1 and 2).

The dorsal region of the abdominal somites is very smooth, but the pleural regions are abundantly punctate. The surface of the telson exhibits very small tubercles provided with short setae.

The epistome (Plate 29, fig. 3) is regular along its base and slightly irregular anteriorly; it is scutiform and its margins are elevated.

The antennal scale possesses a strong spine; its broadest part is at midlength (Plate 28, fig. 4).

The chelae of the first pair of pereiopods are very well developed. The palmar region is more or less globose and the surface bears large tubercles that are conspicuous by their darker color. The immovable finger is shorter than the movable one and the internal border of the latter is gently curved inward. The cutting margin of the immovable

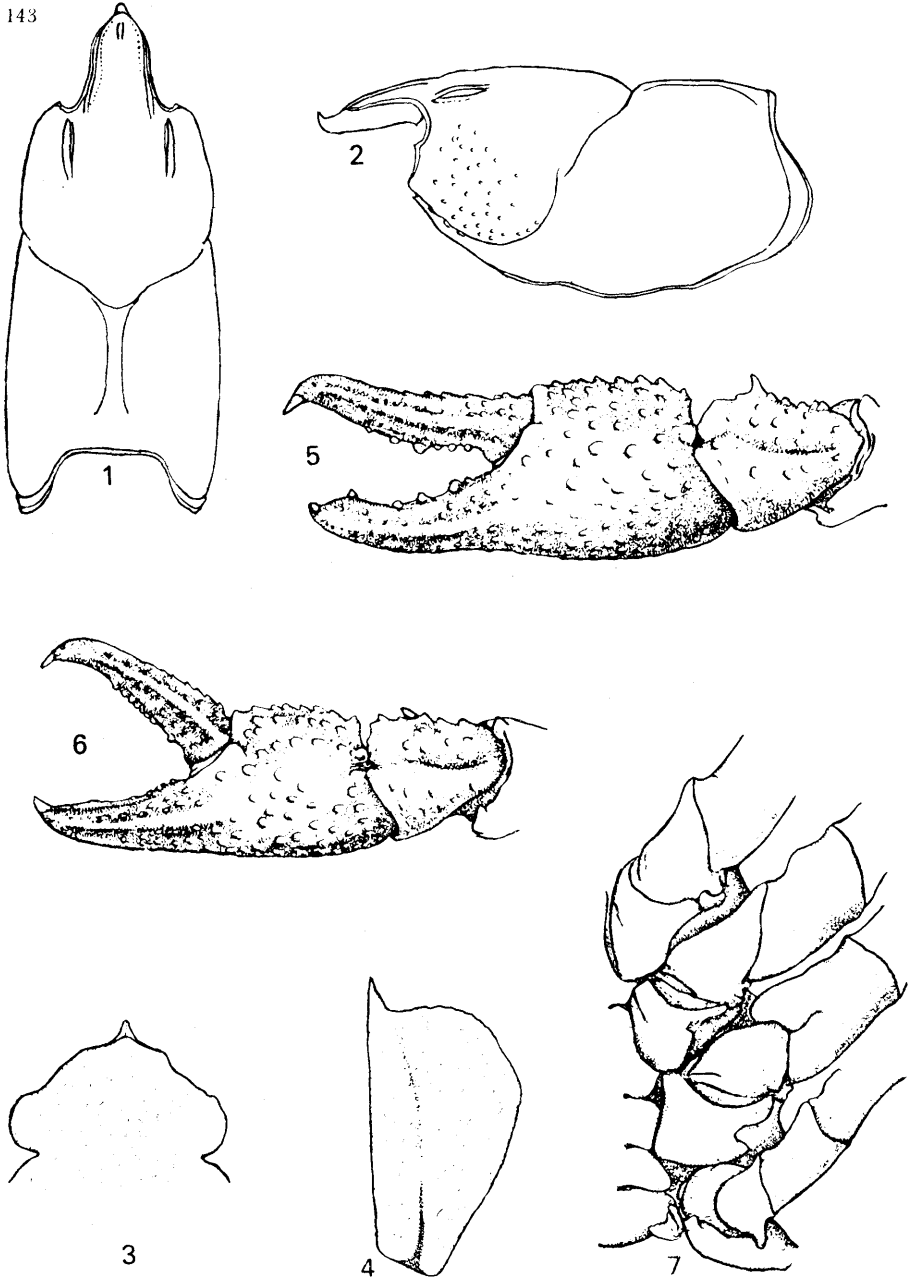


Plate 29. *Procambarus contrerasi* (Creaser). Male, Form I.

1, dorsal view of the carapace; 2, lateral view of the same; 3, epistome; 4, antennal scale; 5, chela; 6, chela of the female; 7, ischiopodites of pereopods III to V of the male, Form I.

finger has two very small teeth proximally, followed by another, the largest of the series, and the latter by four small ones somewhat separated from one another. The cutting margin of the movable finger, or dactylopodite, has first a series of three teeth followed by a large one, and beyond these, two small teeth (Plate 29, fig. 5).

The upper surface of the carpopodite is provided with abundant, well developed, subsquamous tubercles. The groove on the upper surface of the article is broad, curved, and extends from one extremity
145 to the other. The distal articular emargination bears a series of four spiniform tubercles, the largest of them terminating below the emargination.

On the upper anterior part of the meropodite, there is a spine that stands out clearly from the other tuberculiform structures in this region.

The ischiopodite of the third pair of pleopods exhibits a very poorly developed tubercle implanted on the median part of the lower margin of the article; between this structure and the proximal articulation, there is a more or less deep emargination. The coxopodite of the same pair of pereopods exhibits a crestlike protuberance.

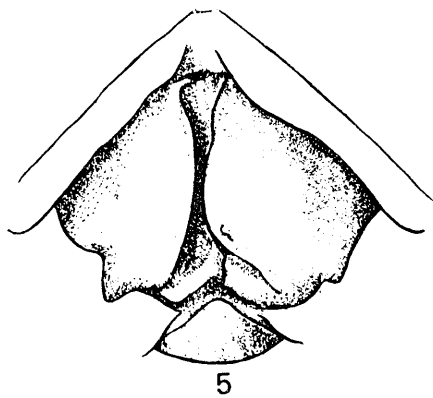
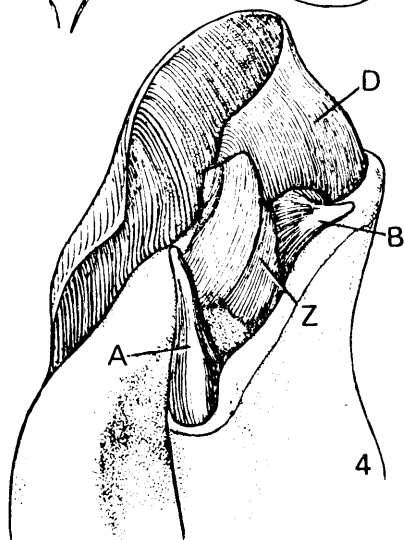
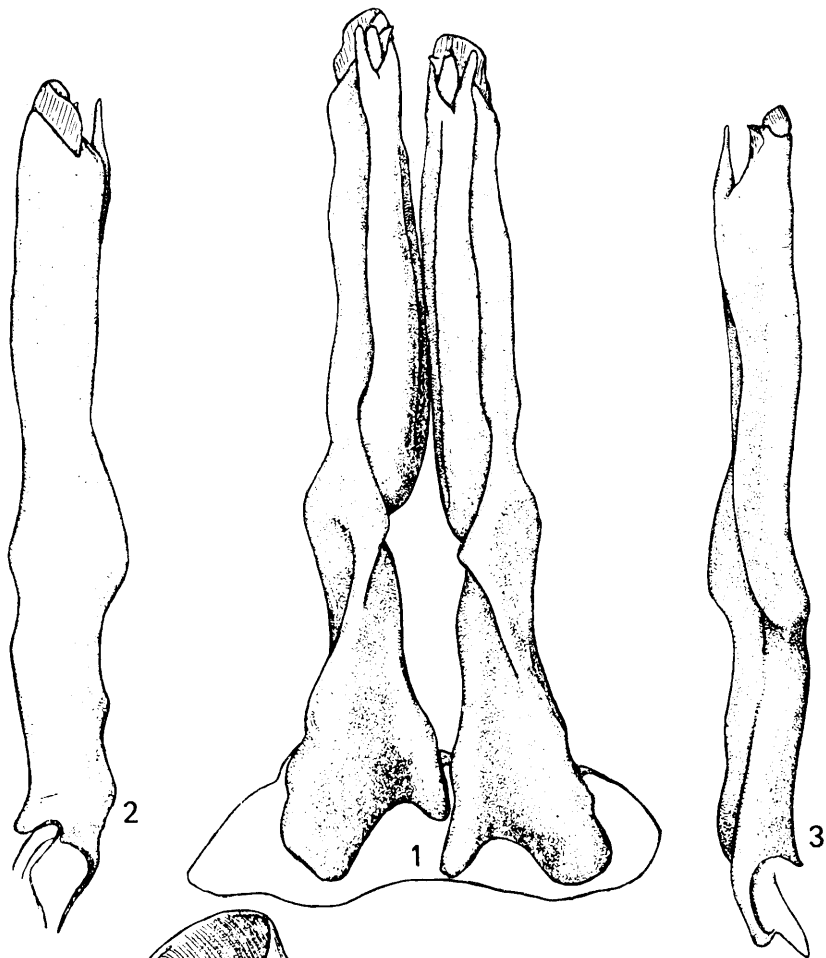
The ischiopodite of the fourth pair of pereopods is armed with a well developed tubercle that is implanted in the proximal region of the article and its free extremity is broadened and occasionally exhibits an emargination which gives it the appearance of a mitten. The coxopodite bears a spiniform tubercle the free extremity of which projects clearly from the article (Plate 29, fig. 7).

The first pair of pleopods are straight, unequal in length; the left is the smaller. They are gently compressed laterally and their apical regions are truncate. The mesial process is straight, spiniform, and does not exceed the other apical structures (Plate 30, figs. 1, 2, 3, and 4A). The cephalic process is very small and rather conical; it is situated in the mesial region very near the caudal process (Plate 30, fig. 4B). The caudal process has the form of a horsehoof; it is a chitinized plate with a smooth fold on the external part (Plate 30, fig. 4D). The central projection is well developed; its relationship to the cephalic process is slightly obscure, but the two structures that normally constitute it are clearly visible (Plate 30, fig. 4Z).

Male, form II. Its carapace is a little narrower than that of the male, form I. The margins of the rostrum are straight, convergent, and its surface is fluted.

Plate 30. *Procambarus contrerasi* (Creaser). Male, Form I.

1, caudal view of the first pair of pleopods; 2, lateral view; 3, mesial view; 4, caudomesial view of one of the pleopods of the first pair (A, mesial process; B, cephalic process; D, caudal process; Z, central projection); 5, *annulus ventralis*.



The chelae of the first pair of pereopods are a little less well developed than in the male, form I, but they are as tuberculate. The dactylopodite is straighter and slenderer; the teeth on the cutting margin of the fingers are more closely grouped.

The crestlike structure of the coxopodites of the third pair of pereopods that was mentioned in the male, form I, is less prominent. The ischiopodite exhibits a very small conical tubercle implanted on the median part of the article.

The spiniform process on the coxopodites of the fourth pair of
146 pereopods is small, but its apex stands out perfectly. The tubercle on the ischiopodite is small and is adnate to the surface of the article, its extremity coinciding with the proximal articular border.

The first pair of pleopods are weakly chitinized in their apical region. The mesial process is less slender and of conical form. The caudal process retains the mien of a gently coiled crest. The cephalic process and the central projection are mammiform structures; the central projection is a little better developed than the other.

Female. The carapace is densely punctate and is slightly shorter than that of the male. The rostrum is broad at its base, almost flat, and the distal part gently flexed. In the anterior part of the surface and on the median line, there is a small crestlike elevation. The rostral margins are very similar to those of the male, form I, but they fold gently toward the inside in their anterior portion.

The epistome is more symmetrical than in the male, form I, but the anterior part seems more incised in the female.

The meropodite is as long as the dactylopodite; both the internal and external surfaces are smooth, although isolated punctations may be observed. The inferior margin is armed with a double row of spiniform tubercles; the internal row consists of ten and ends anteriorly in one that is the largest of all; the external row has only nine; the six proximal ones are disposed in an irregular linear series; the rest are represented by large tubercles slightly larger than those of the internal row.

The carpopodite is as long as the width of the palmar region of the chela; its surface is densely laden with subsquamous tubercles and pits; these are separated by an oblique median groove that extends the entire length of the article. On the internal part of the carpopodite there are tubercles that range from subsquamous to spiniform; among them one stands out from the adjacent ones, and two smaller ones are implanted on the border of the articular emargination.

The propodus also seems to be very densely covered with subsquamous tubercles; those on the internal margin are arranged in a series that contains as many as seven. Those located on the median part

of the upper surface are flattened, broad, almost semicircular, and provided anteriorly with setae that are inclined on the surface.

The palmar region of the chela is less bulky than in the male. The immovable finger is short, but of the same size as the movable finger; it is very robust basally, and on the proximal third of the cutting border one tooth is barely visible.

The dactylopodite is straight, robust, and its base is provided with tubercles; a series of four or five very small teeth are evident on the cutting border (Plate 29, fig. 6).

The *annulus ventralis* is asymmetrical. It has two plates that almost totally cover it; these are implanted on the anterolateral regions; that on the left side is better developed and surpasses the median line; the plate on the right side is less broad. In the posterior region, it is possible to see part of the *annulus ventralis* and at least a part of the groove. In young females the plates are poorly developed and consist of only two small crestlike processes that are disposed as in the adult female (Plate 30, fig. 5).

There is a conical process that stands out clearly between the fifth pereopods.

Measurements in millimeters

	Male, Form I	Male, Form II	Female
Total length	51.2	52.4	55.7
Length of carapace	24.9	26.0	25.8
Anterior part of carapace	17.5	17.0	17.5
Length of areola	7.4	9.0	8.3
Width of areola	1.0	1.2	1.3
Length of abdomen	26.3	26.4	29.9
Posterior width of rostrum	4.2	4.2	4.0
Length of rostrum	6.2	6.5	6.8
Length of chela	19.1	19.0	17.0
Length of immovable finger	11.6	10.7	9.8

Localities. Mesa de San Diego, 5 km S.W. of Agua Fria, Puebla. Arroyo de San Diego, 3 km S.W. of Agua Fria, Puebla. La Magdalena, 3 km from La Unión, Municipality of Zihuateutla, Puebla. La Unión, Municipality of Zihuateutla, Puebla. Cumbres de Cuanepixca, Municipality of Zihuateutla, Puebla. Arroyo del Coyular, 7 km N.E. of La Unión, Municipality of Zihuateutla, Puebla.

Relationships. *Procambarus contrerasi* is very closely allied to *Procambarus zihuateutlensis* in the apparent similarity of the apical portion of the pleopods; however, the phylogenetic relationship may be more

clearly established with *Procambarus erichsoni* by the analogy which exists between the different apical structures of its pleopods.

149 In the original description of *Procambarus contrerasi*, Creaser noted a relationship with *Procambarus bouvieri*, which we have considered elsewhere in this work to be a phenomenon of possible convergence.

Procambarus zihuateutlensis Villalobos

1951 [sic; 1950] *Procambarus zihuateutlensis* Villalobos, An. Inst. Biol. de la Univ. Nal. A. de México, Vol. XXI, No. 2, pp. 394 – 401, Plates 1 and 2 [sic; Plates 1, figs. 4, 8, and 9].

Diagnosis. Crayfish of medium size. Rostrum without spines. Ischiopodites of third pair of pereopods with small tuberculiform prominence; those of fourth pair exhibiting well developed hook. First pair of pleopods of male, form I, straight; mesial process short, spiniform; cephalic process small, ending in crest ringing cephalic part of appendage; caudal process spatulate, and excavate; central projection present. *Annulus ventralis* with two crests situated in anterior part.

Male, form I. The specimen that has been chosen for preparing the description is the largest of those obtained in the single collection made at Los Estajos. The carapace is subequal in length to the abdomen, and its lateral regions are oval. The dorsal surface is provided with punctations which, although numerous, are not very conspicuous. The lateral regions exhibit tubercles that give it a scabrous appearance. The cephalic groove is deep and discontinuous with that which limits the hepatic regions posteriorly. The carapace is devoid of lateral spines.

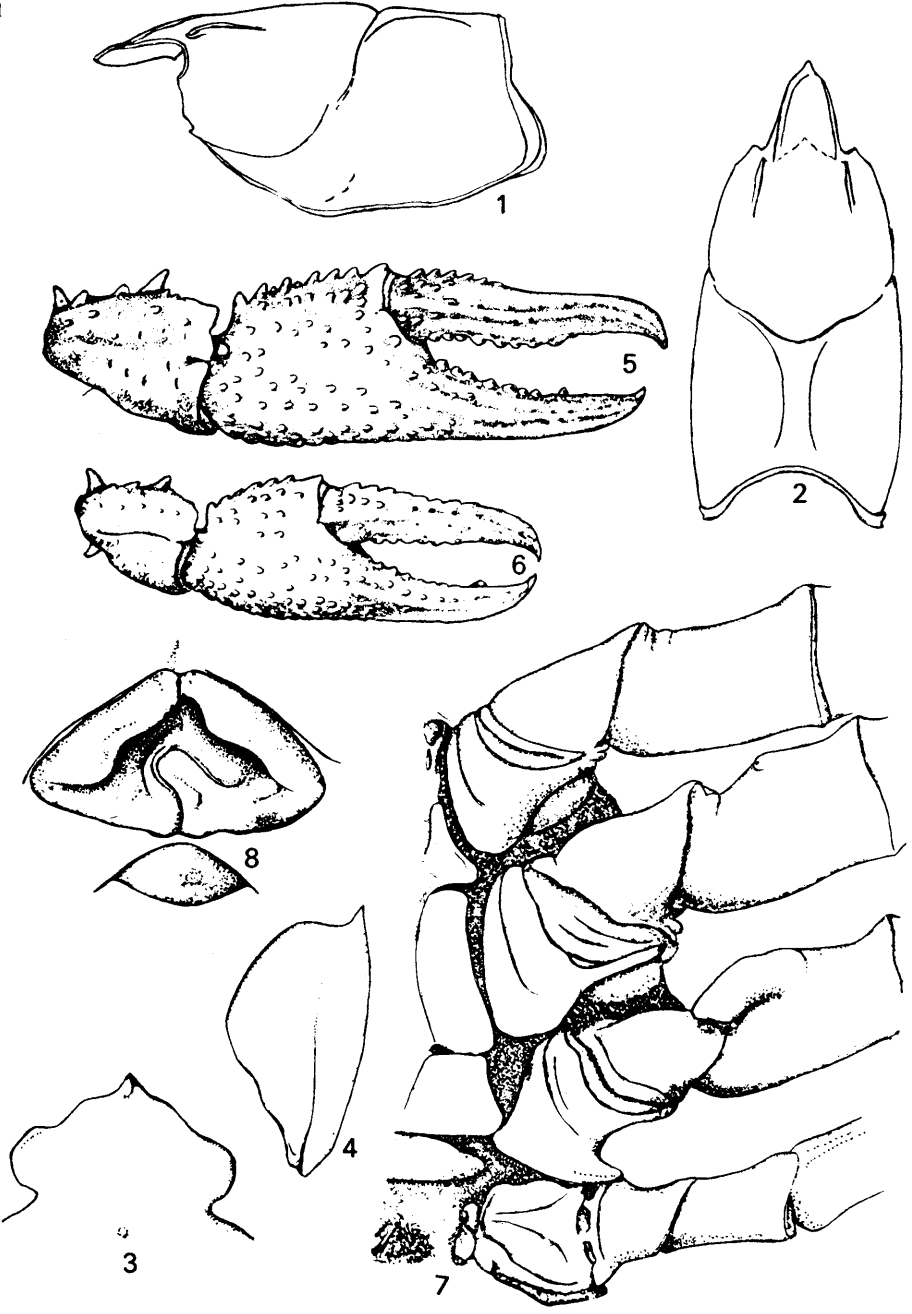
The apex of the rostrum reaches midlength of the distal article of the antennule. The lateral margins are only slightly convergent, lacking spines, and in the place where they normally occur, the margins are interrupted and then converge to the anteromedian extremity; the margins are pigmented in a characteristic manner which consists of dark spots alternating with clear regions. The rostral surface is fluted and provided with punctations. The ventral keel of the rostrum ends posteriorly in a spine.

The postorbital ridges are convergent and stand out distinctly from the surface; the tubercle in which they end is very small but clearly visible.

The areola is broad and the suprabranchial grooves that limit it are

Plate 31. *Procambarus zihuateutlensis* (Villalobos). Male, Form I.

1, lateral view of the carapace; 2, dorsal view of the same; 3, epistome; 4, antennal scale; 5, chela; 6, chela of the female; 7, ischiopodites of pereopods II to V of the male, Form I; 8, *annulus ventralis*.



rather shallow; the areolar surface exhibits small isolated punctations very similar to those found on the dorsal and posterior surfaces of the carapace.

150 The proportions between the different parts of the carapace are as follows: the length of the areola is half that of the cephalic part of the carapace. The posterior width of the rostrum goes into the total length of the carapace six and one-half times. The length of the rostrum goes into that of the carapace almost four times (Plate 31, figs. 1 and 2).

The epistome is very symmetrical, scutiform. In other specimens the form varies little from that exhibited by the male, form I (Plate 31, fig. 3).

The somites of the abdomen are almost smooth dorsally, but on the posterior margins of the pleural regions numerous punctations are conspicuous. The somite anterior to the telson is punctate over the entire surface. Outstanding is a pigmented zone on the posterior margins of the tergum of somites I to VI.

The spine on the distal extremity of the antennal scale exceeds the second antennular article; it is short and the external border is distinctly reinforced. The greatest width is exactly at midlength and is equal to one-half of the greatest length (Plate 31, fig. 4).

The chelae of the first pair of pereopods are robust and covered with subsquamous tubercles. The meropodite is flattened laterally especially in the proximal portion of the article; the external and internal faces are rather smooth except for a few punctations; the internal face exhibits a groove that runs parallel to the inferior margin; this border is provided with a double series of spiniform processes, disposed in two divergent rows which reunite near the distal extremity of the article. The superior margin is scabrous distally, owing to the presence of tubercles which while being very near the articular border are very large and distinctly elevated. The articular emargination of this article situated on its lower anterior part is armed with only four spines disposed along the internal margin.

The superior face of the carpopodite has a sulcus that is very deep and broad, particularly in the central part. The upper surface has pits on both sides of the groove. The borders of the articular emargination are armed with three large tubercles.

The propodus is oval in section; the internal margin is cristiform and is bordered with tubercles; of those that stand out on the internal margin we are able to count six. The subsquamous tubercles on the upper surface are darker in color and thereby distinct from the remainder of the surface; in contrast, the tubercles on the lower face are
152 less numerous, less elevated, and with a color very similar to that of the surface. The immovable finger is slender and its cutting border exhibits a series of nine hemispherical teeth of more or less the same size; the

last of the series is inserted at the level of the conical tooth that is implanted on the internal face of the cutting border, approximately at the ultimate third.

The dactylopodite, or movable finger, is also slender; proximally, the internal border exhibits a series of six squamous tubercles decreasing in size distally; on the superior face, lateral to the series just mentioned, there are an additional 10 or 11 subsquamous tubercles. The cutting border is armed with nine teeth which are disposed as follows: proximally three teeth of similar size, followed by a large one which stands out clearly from the others, then five that are more or less evenly spaced and of decreasing size. On both fingers there are longitudinal ridges that extend along their total length (Plate 31, fig. 5).

The coxopodite of the third pair of pereopods exhibits no peculiar structure; it is very similar to that of the second pair.

The ischiopodite of the third pair of pereopods does not exhibit a hook *per se*, instead it has a poorly defined tubercle situated more or less on the median part of the lower border of the article. The space which remains between this tuberculiform structure and the proximal articular margin has the form of a shallow angular emargination.

The coxopodite of the fourth pair of pereopods is armed with a strong tubercle.

The ischiopodite of the fourth pair of pereopods is provided with a strongly developed tubercle that is borne on the median part of the inferior margin of the article; moreover it is excavated by a slight emargination bearing short setae.

The coxopodites of the fifth pair of pereopods have a conical prominence implanted on the internal part of the distal articular margin (Plate 31, fig. 7).

The first pair of pleopods are straight, unequal in size, that of the right side larger; their apical regions have a truncate appearance and touch the posterior part of the coxopodites of the second pair of pereopods (Plate 32, figs. 1, 2 and 3). The mesial process (Plate 32, fig. 5A) is pyramidal in form, curved outward, and its tip does not exceed the extremity of the appendage. The cephalic process (Plate 32, fig. 5B) is a small angular structure arising from a curved crest which surrounds all
154 of the cephalic region of the appendage; this process embraces the base of the central projection (Plate 32, fig. 5Z) in which may be observed the two structures that normally constitute it; of course one of them, that which corresponds to the centrocephalic process, shows clear relationship to the cephalic process. The caudal process (Plate 32, fig. 5D) is spatulate or fanshaped, concave caudally, and clearly independent of the cephalic process.

Male, form II. The carapace is very short; its length projected over the abdomen reaches the posterior articulation of the telson; it is

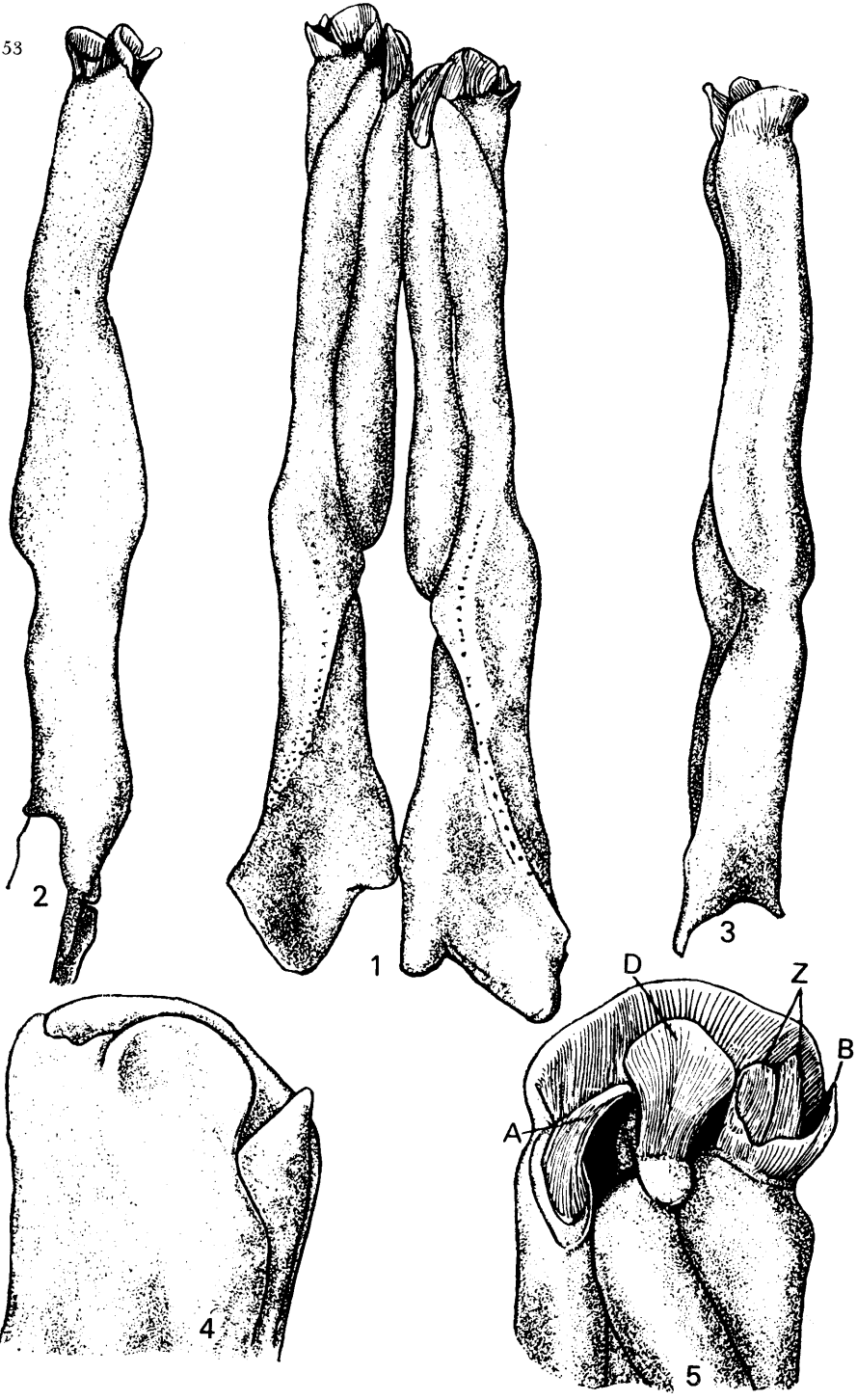


Plate 32. *Procambarus zihuateutlensis* (Villalobos). Male, Form I.

1, caudal view of the first pair of pleopods; 2, lateral view; 3, mesial view; 4, caudolateral view of the apical part of one of the first pleopods of the male, Form II; 5, caudal view of the apical part of one of the first pleopods of the male, Form I (A, mesial process; B, cephalic process; D, caudal process; Z, central projection).

smoother than that of the male, form I. The margins of the rostrum are more convergent and the lateral angulations exhibited by the male, form I, appear here as gentle curves of the borders before they join in the apical part.

The ischiopodites of the third pair of pereopods have no trace of a tubercle; in its place there is only a slight, almost insignificant, angle.

The coxopodites of the fourth pair of pereopods exhibit the characteristic tubercle of the male, form I, but in this case, it is very small and its apex is little elevated above the article.

The ischiopodites of the fourth pair of pereopods have a small tuberculiform structure implanted on the proximal third of the article.

The first pair of pleopods have the same appearance as those of the male, form I, although their apical regions are slightly wider. The mesial process is short and conical. The cephalic process is scarcely evident but its relationship to the two mammiform structures that correspond to the central projection is very clear; the crest which borders the cephalic region here appears as a heavy semicircular ridge. The caudal process has the appearance of a short, heavy grooved plate (Plate 32, fig. 4).

Female. Most of the punctations on the carapace are provided with small hairs. The cephalic groove is deep and a little sinuous. The rostral margins are slightly convex laterally, convergent, and insensibly joined in the apical region; the spots or pigmentations which we described for the male, form I, persist.

The chelae are small, provided with tubercles, and the fingers are armed with small teeth (Plate 31, fig. 6).

The anterior part of the *annulus ventralis* exhibits two angular crests, 155 whereas the posterior has a ridge, and the central part is depressed. The groove is well defined; it has the form of an S arranged transverse to the major axis of the animal (Plate 31, fig. 8).

Between the fifth pereopods there is a tuberculiform structure with a blunt apex.

Measurements in millimeters

	Male, Form I	Male, Form II	Female
Total length	55.7	48.5	57.0
Length of carapace	27.7	24.0	27.8
Anterior part of carapace	18.6	16.4	18.8

	Male, Form I	Male, Form II	Female
Length of areola	9.1	7.6	9.0
Width of areola	1.9	1.7	1.8
Length of abdomen	28.0	24.5	29.2
Posterior width of rostrum	4.2	3.6	4.4
Length of rostrum	7.0	6.8	7.0
Length of hand	25.5	14.9	19.2
Length of movable finger	14.8	9.0	11.9

Localities. Arroyo de Tlatentiloyan, Los Estajos, Municipality of Zihuateutla, Puebla (type locality). La Magdalena, 3 km N. of La Unión, Municipality of Zihuateutla, Puebla. La Cumbre de Cuanepixca, Municipality of Zihuateutla, Puebla.

Relationships. *Procambarus zihuateutlensis* was collected in the type locality with *Procambarus hoffmanni* and *Paracambarus ortmanni*. This datum seems of great interest to us because never before have we obtained three distinct species living together in the same place.

In reality, the affinity of the species redescribed here can be established only with *P. contrerasi* and *P. erichsoni*, this by the similarity of the *annulus ventralis* in these species. In the first pair of pleopods, however, the apical structures are disposed very similarly, the difference being that in *P. contrerasi* the caudal process is not spatulate, but rather occurs in the form of a horsehoof; in *P. erichsoni* the caudal process is much reduced.

TAXONOMIC DISCUSSION OF THE SPECIES OF THE RIOJAE SECTION

The species of the *riojae* Section form a natural group in which the fundamental characteristics that unite them are: the absence of hooks on the ischiopodites of the third pair of pereopods; the first pair of pleopods of the male are straight, unequal in length, and their apical processes directed distally.

Relying upon the character of the hooks, four of these species were described originally in the genus *Paracambarus*; these are: *Procambarus riojae*, *P. hoffmanni*, *P. teziutlanensis*, and *P. tlapacoyanensis*, and although their [taxonomic] position was very insecure, it was necessary to await the collection of specimens from other localities in order to determine their true position. Later, in a revision (Villalobos, 1951 [sic; 1950]), we were able to evaluate the character of the hooks; although of great taxonomic importance, in this case they could not serve as a basis for considering these species as members of the genus *Paracambarus*, because of the morphological features of the first pair of pleopods of

the male which are noticeably different from those exhibited by *Paracambarus paradoxus* and *Paracambarus ortmanni*. Consequently, in order to include the species of the *riojae* Section in the genus *Procambarus*, it was necessary to modify the diagnosis of the genus.

In effect, a quick analysis of the form and disposition of the mesial process in the species of both *Paracambarus* and of the *riojae* Section of the genus *Procambarus* permits us to separate them in that, whereas in *Paracambarus* this process is borne subdistally and is directed toward the caudal region, in the *riojae* Section, the mesial process, although sometimes well developed, is always directed distally. Another character is the central projection which in *Paracambarus* is the terminal element of the principal body of the appendage; in contrast, in the *riojae* Section it is a structure that never juts out from the principal body of the appendage.

The affinities of the *riojae* Section with the *blandingii* Section are exhibited by the presence of a tubercle, more or less similar in form and disposition, located on the coxopodites of the fourth pair of pereopods of the male. In contrast, it differs from the *advena* Section in that in the first pair of pleopods of the male, the central projection never is the most conspicuous terminal element.

The groups that we have established in the *riojae* Section are based on the constitution of the first pair of pleopods of the male as well as on the *annulus ventralis* of the female. The *riojae* group comprises all of those species in which the mesial process is conical or flattened, of equal length to the cephalic process, or distinctly longer than the other apical structures. In *Procambarus riojae*, the disposition of the apical structures of the first pair of pleopods of the male has a schematic disposition that concurs in almost all of its characteristics with that which Hobbs (1942a) proposed to establish the nomenclature of these structures, but in this species we found that in addition these appendages exhibit a very singular adventitious process (Plate 33, fig. 1 F).

Procambarus hoffmanni displays a cephalic process reduced in length but, in contrast, noticeably dilated; at the same time, the central projection is larger than that in *P. riojae*; in regard to the mesial process, without losing its conical form, it exceeds the other apical structures by almost half of its length (Plate 33, fig. 2).

Procambarus teziutlanensis exhibits a very well developed, conical mesial process; correlatively, the other apical structures are reduced (Plate 33, fig. 3). The same occurs in *Procambarus tlapacoyanensis*, a species very closely allied to the former, but in it the mesial process is flattened, gently undulant, and does not lose its distal disposition (Plate 33, fig. 6).

Procambarus hortonhobbsi has a strong similarity to *P. hoffmanni* in respect to the disposition of the apical processes, but here the cephalic process is broader and less sharp (Plate 33, fig. 5). Similar to *P. hoffmanni*,



Plate 33. Representation of the apical parts of the first pleopods of the male, Form I, of the species of the *riojae* Section.

- 1, *Procambarus riojae*; 2, *Procambarus hoffmanni*; 3, *Procambarus teziutlanensis*; 4, *Procambarus zihuatlensis*; 5, *Procambarus hortonhobbsi*; 6, *Procambarus tlapacoyanensis*; 7, *Procambarus erichsoni*; 8, *Procambarus contrerasi* (A, mesial process; B, cephalic process; D, caudal process; F, adventitious process; Z, central projection).

the mesial process exceeds the other apical structures, but in this case hardly jutting out a fifth or fourth of its length. One may be sure that *P. hortonhobbsi* is the species that links the two groups of the *riojae* Section.

The *erichsoni* Group is characterized as follows: the mesial process is very reduced, smaller than the other apical structures; the caudal process and the central projection have a platelike form; furthermore the cephalic process is also very reduced and spiniform. In *Procambarus erichsoni*, the apical structures terminate at more or less the same height, but with the caudal process very broad (Plate 33, fig. 7). There seems to be a profound difference between this species and *Procambarus zihuateutlensis*, but the conformation of the *annulus ventralis* is very similar in both, since it exhibits two heavy, very characteristic, flanges in its anterior portion, which in *P. contrerasi* are transformed into true plates that almost totally cover the *annulus ventralis*. *P. zihuateutlensis* exhibits an apical flange in the first pair of pleopods of the male that is disposed in the cephalic part and which extends from the mesial process to the cephalic process (Plate 33, fig. 4).

In *Procambarus contrerasi*, the caudal process is conspicuously well developed in the form of a horsehoof, the basis on which Creaser, in the original description, compared this species with *Procambarus bouvieri*. The other apical structures are much shorter than the caudal process and essentially there is no marked similarity to the pleopods of *P. zihuateutlensis* and *P. erichsoni*, but as we have pointed out above, it is the *annulus ventralis* that by its disposition allows us to consider it as the most differentiated species of the *erichsoni* Group.

The *riojae* Section is of considerable importance from the point of view of its geographic distribution. Almost all of the species of the Section are found in tributaries of the Cazonas, Tecolutla, and Nautla rivers. Except for *P. hoffmanni*, which has almost reached the coastal plain, the other species are located in the lower part of the Atlantic slope of the Sierra Madre Oriental, in an area lying between the parallels 19°30' and 20°30', north of which are found the species of the *blandingii* Section and to the south toward Misantla, the species of the *mexicanus* Section (Plate 62).

All of the species of the *riojae* Section are endemic in this restricted area, which increases its value as a natural group, and represents a barrier between the species of the *mexicanus* Section and those of the *blandingii* Section.

MEXICANUS SECTION

Diagnosis. First pair of pleopods of male straight; cephalic surface with shoulder some distance from apical part, which sometimes reduced but never absent. Mesial process always present, reduced in

size; central projection compressed, rather small, never overreaching apical portion distally, directed cephalically, cephalodistally, or laterally, never caudally; cephalic process almost always absent, if present reduced. Rostrum with or without lateral spines; ventral keel without dentiform processes. Hooks on ischiopodites of third pair of pereopods. *Annulus ventralis* cloven by longitudinal depression in cephalic portion. Spiniform tubercle generally present between fifth pereopods of female.

Owing to the characteristics that we have just pointed out, the species related to *P. mexicanus* cannot be included in the *advena* Section, the diagnosis of which does not occur in many aspects with our species.

Hagen (1870) placed *P. mexicanus*, under *Incertae sedis*, in the first Section of group III of his taxonomic arrangement because of the presence in this species of hooks on the ischiopodites of the third pair of pereopods, the absence of lateral spines on the rostrum, and also because of other characters.

160 Faxon (1885a) included *P. mexicanus* in his group II (type *C. advena*), also taking as the basis, the character of the position of the hooks on the ischiopodites of the third pair of pereopods. Later (1914), he moved this species to group I.

Ortmann (1905a) considered *P. mexicanus* to be in the *digueti* Section, which later came to constitute his subgenus *Procambarus*.

It is important to notice that these arrangements were made taking into consideration the then described species related to *P. mexicanus*: *P. mexicanus*, *P. cubensis*, *P. aztecus*, *P. consobrinus*, and *P. ruthveni* [? lapsus, *P. ruthveni* for *P. pilosimanus*].

The new *mexicanus* Section, here proposed, comprises endemic species of Mexico, northern Guatemala, and Cuba. Those from Mexico are limited on the north by the area occupied by the species of the *riojae* Section of the genus *Procambarus*, which constitute a barrier of biological importance.

The *mexicanus* Section comprises two groups:

mexicanus Group

Diagnosis. Chelae not pubescent. Single branchiostegal spine present. Only one spine on each side of carapace present or absent. Rostrum with or without lateral spines. Mesial process distinctly overreaching apical region and directed distally or laterally.

pilosimanus Group

Diagnosis. Chelae totally or partly pubescent. More than one branchiostegal spine. More than one spine on each side of carapace.

Rostrum with lateral spines. Mesial process rather reduced, hardly overreaching apical region, almost always directed laterally.

mexicanus Group

- Procambarus mexicanus*
- Procambarus aztecus*
- Procambarus rodriguezi*
- Procambarus veracruzanus*
- Procambarus vazquezae*
- Procambarus ruthveni*
- Procambarus ruthveni zapoapensis*
- Procambarus mirandai*

161

pilosimanus Group

- Procambarus pilosimanus*
- Procambarus llamasi*
- Procambarus acanthophorus*

KEY TO THE SPECIES OF THE MEXICANUS SECTION

- 1 Chelae not pubescent. Single branchiostegal spine. Single spine present or absent on each side of carapace. Rostrum with or without lateral spines. Mesial process distinctly overreaching apical region, directed distally or laterally 2
- 1 Chelae totally or partly pubescent. More than one branchiostegal spine. More than one spine on each side of carapace. Rostrum with lateral spines. Mesial process rather reduced, hardly exceeding apical region, almost always directed distolaterally 9
- 2 (1) Rostrum without lateral spines 3
- 2' Rostrum with lateral spines 4
- 3 (2) Angle of declivity of shoulder with cephalic margin sharp *Procambarus mexicanus*
- 3' Angle of declivity of shoulder with cephalic margin rounded *Procambarus aztecus*
- 4 (2') Eyes very reduced, cornea with pigment reduced to only small black spot; chelae subcylindrical and very long *Procambarus rodriguezi*
- 4' Eyes of normal size, cornea normally pigmented; chelae depressed and short 5
- 5 (4') Epistome with anterior emargination, with or without limiting angular processes laterally 6
- 5' Epistome terminating in angle anteriorly 8
- 6 (5) Epistome without angular processes limiting anterior emargination laterally *Procambarus veracruzanus*
- 6' Epistome with angular processes limiting anterior emargination laterally 7

- 7 (6') Hook on ischiopodites of third pair of pereiopods of male hardly reaching articulation of ischiopodite and basipodite *Procambarus ruthveni*
- 7' Hook on ischiopodites of third pair of pereiopods of male easily reaching articulation of ischiopodite and basipodite *Procambarus ruthveni zapoapensis*
- 162 8 (5') Size very small. Chelae very short. Carpopodite with sharp spine on internal border near distal articulation *Procambarus vazquezae*
- 8' Size moderate. Chelae long. Carpopodite without spine on internal border near distal articulation *Procambarus mirandai*
- 9 (1') Chelae entirely pubescent 10
- 9' Chelae partly pubescent, only dactylar region with setae *Procambarus llamasii*
- 10(9) Four spines on lower anterior margin of carapace in addition to branchiostegal spine. Hook on ischiopodites of third pair [of pereiopods] not overreaching articulation of ischium with basipodite *Procambarus acanthophorus*
- 10' Only one spine on lower anterior margin of carapace in addition to branchiostegal spine. Hook on ischiopodites of third pair [of pereiopods] easily reaching articulation of ischium with basipodite *Procambarus pilosimanus*

Procambarus mexicanus (Erichson)

- 1846 *Astacus* (*Cambarus*) *Mexicanus* Erichson, Arch. Für. Naturgeschichte, Zwölfter Jahrgang Erster Band mit Zwölf Knpfertaflen, 12 (pt. 1), pp. 99 – 100.
- 1858 *Cambarus Mexicanus* (Erichson). Saussure, Mem. pour servir a l'Histoire Naturelle du Mexique, des Antilles et des Etats Unis, Genève, pp. 44 – 45.
- 1870 *Cambarus Mexicanus* (Erichson). Hagen, Illus. Cat. Mus. Comp. Zool., Harvard Coll., No. III, pp. 84 – 85.
- 1884 *Cambarus Mexicanus* (Erichson). Faxon, Proc. Amer. Acad. Arts and Sci., Vol. XX, p. 141.
- 1885a *Cambarus Mexicanus* (Erichson). Faxon, Mem. Mus. Comp. Zool., Harvard Coll., Vol. X, No. 4, pp. 50 – 51.
- 1898 *Cambarus Mexicanus* (Erichson). Faxon, Proc. U. S. Nat. Mus., Vol. XX, p. 649.
- 1902 *Cambarus Mexicanus* (Erichson). Ortmann, Proc. Amer. Phil. Soc., Vol. XLI, p. 284.
- 1905a *Cambarus* (*Cambarus*) *mexicanus* (Erichson). Ortmann, Proc. Amer. Phil. Soc., Vol. XLIV, pp. 99 – 100.
- 1905b *Cambarus* (*Procambarus*) *mexicanus* (Erichson). Ortmann, An. Carnegie Mus., Vol. III, pp. 435, 436, 437.

- 1906 *Cambarus (Procambarus) mexicanus* (Erichson). Ortmann, Proc. Wash. Acad. Sci., Vol. VIII, pp. 11, 21, 22.
- 1914 *Cambarus Mexicanus* (Erichson). Faxon, Mem. Mus. Comp. Zool., Harvard Coll., Vol. XI, No. 8, p. 363.
- 1942a *Cambarus (Procambarus) mexicanus* (Erichson). Hobbs, Proc. Fla. Acad. Sci., Vol. V, p. 57.
- 1942b *Procambarus mexicanus* (Erichson). Hobbs, Amer. Midl. Nat., Vol. XXVIII, No. 2, p. 341.
- 163 1943 *Procambarus mexicanus* (Erichson). Hobbs, Lloydia, Vol. VI, p. 206.
- 1948 *Procambarus mexicanus* (Erichson). Villalobos, An. Inst. Biol. de la Univ. Nal. A. de México, Vol. XIX, No. 1, p. 182.
- 1954b *Procambarus mexicanus* (Erichson). Villalobos, An. Inst. Biol. de la Univ. Nal. A. de México, Vol. XXV, pp. 307 - 314.

Diagnosis. Rostrum without lateral spines, with clearly convergent margins. Carapace with small lateral tubercle in hepatic portion of cephalic groove. Chela of first pair of pereiopods not pubescent, but surface covered with subsquamous tubercles. Palmar index of male 79. Internal margin of meropodite provided with spiniform tubercles. Hook on ischiopodites of third pair of pereiopods clearly overreaching articulation of ischiopodite with basipodite. First pair of pleopods of male with shoulder of sloping arc, angle with cephalic margin sharp; mesial process foliaceous, directed almost distally. *Annulus ventralis* tuberculiform, cleft in median part by more or less deep groove. Tubercle between fifth pereiopods of female not terminating in point.

Male, form I. The carapace is long and compressed laterally, its surface densely punctate, the punctations deepest in the gastric region. In the hepatic portion of the cephalic groove there is a short, blunt tubercle; the branchiostegal spine is also very short.

The rostrum is wide at the base and anteriorly; its surface is slightly concave and bears punctations; the rostral margins are a little convergent, almost straight, and do not terminate in a spine anteriorly; the acumen is very short and the anterior angle reaches the distal region of the second antennular article. The ventral keel of the rostrum lacks dentiform tubercles.

The postorbital ridges are slightly convergent and terminate anteriorly in a small almost blunt process.

The areola is moderately wide and its surface is covered with small punctations (Plate 34, figs. 1 and 2).

The proportions of the different regions of the carapace are the following: the length of the areola is a little less than half of the length of the cephalic portion; the posterior width of the rostrum goes into the total length of the carapace almost five and one-half times.

1, dorsal view of the carapace; 2, lateral view of the same; 3, epistome; 4, antennal scale; 5, chela; 6, third and fourth pereopods; 7, ischiopodite of the third pereopod of the male, Form II; 8, chela of the female; 9, *annulus ventralis*.

The epistome is regular and triangular in contour; the margins are not elevated and the surface is smooth (Plate 34, fig. 3).

A prominent tubercle is present on the sternum between the second and third pair of pereopods.

The abdomen is as wide as the carapace and comprises almost half the length of the body. The somites are slightly punctate in the tergal region, but the punctations are more abundant in the pleural regions. The surface of the telson is covered with small setae; the distolateral angles of the first part of the telson are provided with two spiniform processes, one of which, the external, is larger and its vertex gently inclined laterally. The ultimate portion of the telson is semicircular in shape.

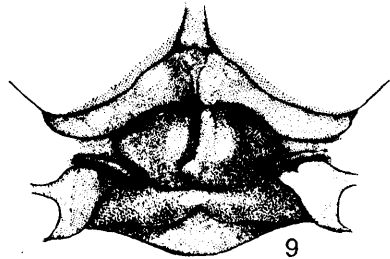
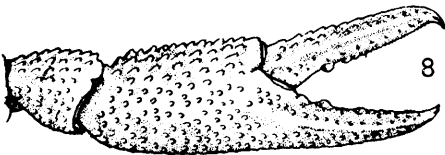
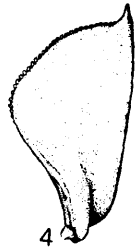
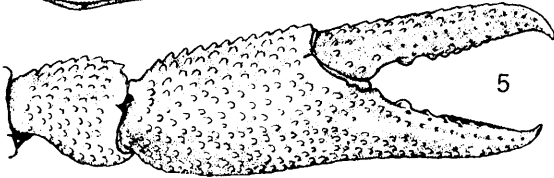
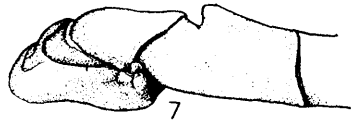
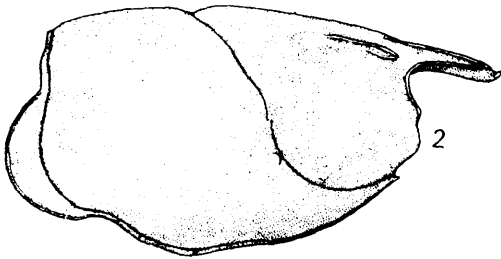
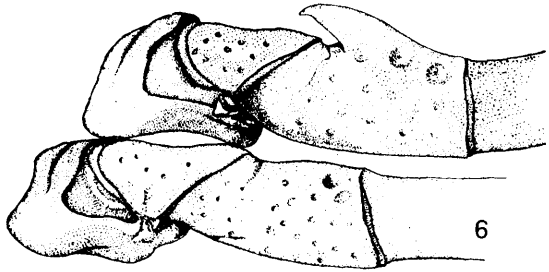
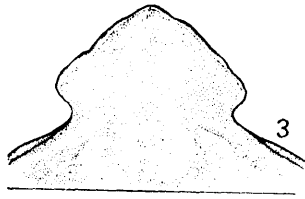
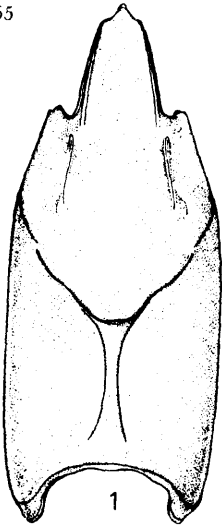
The antennal scale is very broad in its median portion; the external margin is gently convex and the spine of the scale is very reduced (Plate 34, fig. 4).

The first pair of pereopods are as long as the total length of the body; the chelae are not very robust and are covered with subsquamiform tubercles. The palm is oval in section (palmar index 79.0)*. The length of the dactylopodite is greater than that of the palmar region; its cutting border is armed with more or less hemispherical teeth of which one stands out by being situated proximally and completely separated from the rest; the others, approximately thirteen in number, diminish in size distally and are situated very close to one another; three of them are separated from the principal series by being inserted on the lower part of the border. The cutting border of the movable finger exhibits a proximal tooth very similar to that of the immovable finger; beyond it, there are two or three smaller teeth followed by a large dentiform tubercle implanted on the internal part of the margin; and distally, smaller teeth are disposed in two series that are very close together.

The carpopodite is short and conical, its dorsal and lateral surfaces covered with subsquamous tubercles; a weakly marked groove extends almost the entire length of the article. The superior internal part is

*With the objective of quantifying the more or less cylindrical character of the chela, we propose an index which is obtained by using the following formula:
$$\frac{\text{Thickness} \times 100}{\text{Greatest width}}$$

The measurements are taken at midlength of the palmar region. The object of the palmar index is to consider the character of the chelae in regard to their more or less cylindrical form, a feature that was considered very frequently [in the past by] Erichson, Saussure, Hagen, Faxon, and Ortmann.



armed with conical tubercles; only the lower surface exhibits a few subsquamous structures (Plate 34, fig. 5).

166 The upper distal surface of the meropodite exhibits spiniform prominences, one of which stands out by its size; the lateral internal [sic] surface of the distal portion is covered with flattened tubercles; the ventral border is armed along its entire length by spiniform tubercles disposed in two series that diverge distally; the external row consists of more or less regular tubercles and ends distally in a large spine; the internal row is shorter and bears fewer spines.

The ischiopodites of the third pair of pereiopods are armed with a hook in the form of a cock's spur, the tip of which extends over the articulation of the ischiopodite and basipodite (Plate 34, fig. 6).

The first pair of pleopods are straight, flattened laterally; the shoulder is situated at about one-sixth of the total length of the appendage [from its apex]; its declivity is arched and the angle with the cephalic margin sharp (Plate 35, figs. 1, 2, 3, 4, and 5). The mesial process is a foliaceous structure, gently folded at the base, thus taking a more or less fluted form, and has a slight lateral inclination of approximately 165° to the rest of the appendage (Plate 35, figs. 4 and 5A); the presence of the cephalic process is difficult to determine; it is located at the base of the mesial process and on the mesial face of the appendage (Plate 35, fig. 4 B). The central projection has a triangular contour and is directed cephalodistally (Plate 35, figs. 4 and 5CE).

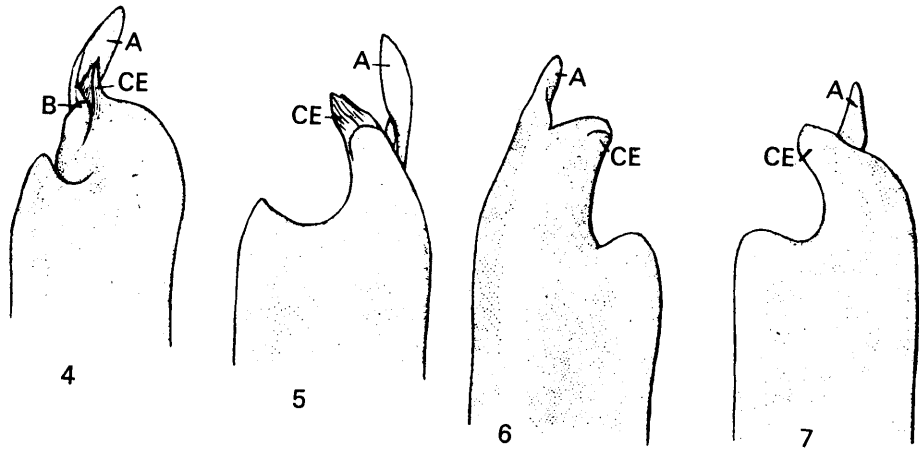
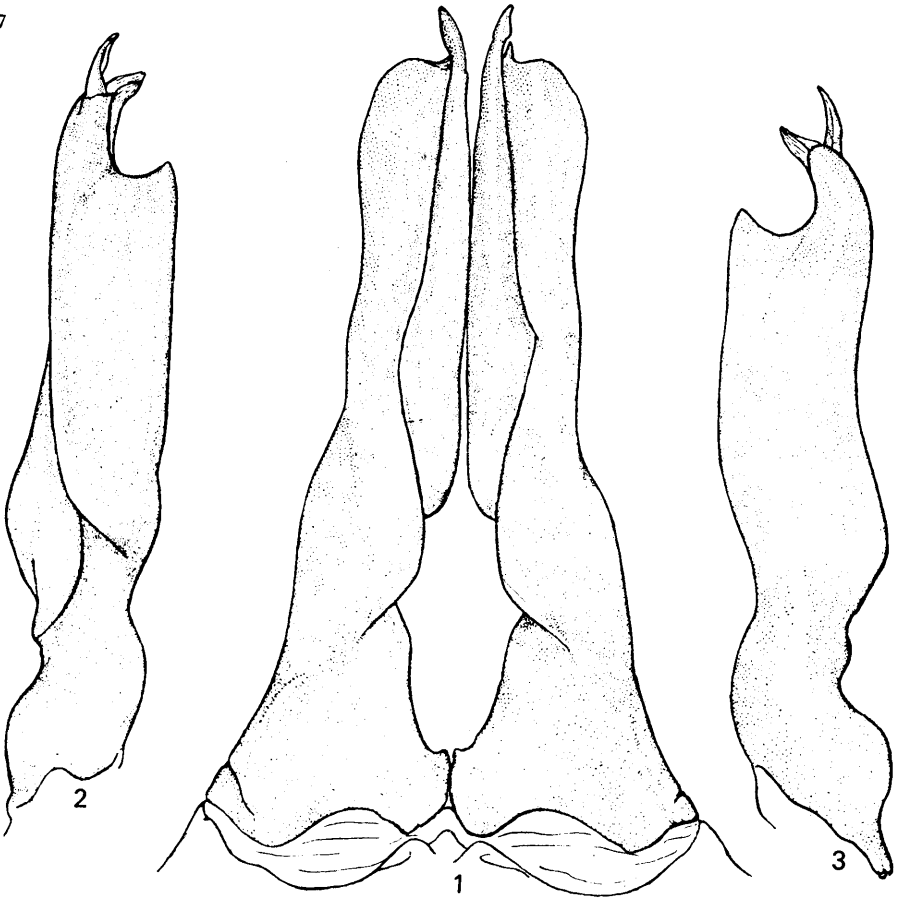
Male, form II. The carapace is less broad than the abdomen and is densely covered with punctations. The rostrum is subplane, the margins convergent, and the anterior angles rounded.

The chelae of the first pair of pereiopods are densely covered with small subsquamous tubercles. The cutting borders of the fingers exhibit few dentiform tubercles and those are not very prominent. The carpus is likewise covered with small subsquamous tubercles; the groove of the dorsal surface is little apparent, but spiniform tubercles are present on the internal surface of the article. The meropodite exhibits tubercles on the dorsodistal portion that are less acute than those in the male, form I.

The ischiopodites of the third pair of pereiopods exhibit an angular prominence that does not reach the articulation of the ischium with the basipodite (Plate 34, fig. 7).

Plate 35. *Procamburus mexicanus* (Erichson). Male, Form I.

[The first two lines of the explanation accompanying Plate 35 are identical to those for Plate 34 and obviously were erroneously introduced here. The first three figures are as follows: 1, caudal view of first pleopods of male, Form I; 2, mesial view of first pleopod of male, Form I; 3, lateral view of same;] 4, cephalomesial view of the apical region of the pleopod; 5, lateral view of the same; 6, mesial view of the apical part of the first pleopod of the male, Form II; 7, lateral view of the same (A, mesial process; B, cephalic process; CE, central projection).



The apical processes of the first pair of pleopods are scarcely defined. The shoulder is less angular; the central projection has the form of a blunt projection resembling a bird-beak, and in it may be seen the line which separates the two constituent structures; the mesial process is less flattened and its apex rounded (Plate 35, figs. 6 and 7).

Female. The carapace is narrower than the abdomen and its surface covered with punctations. The rostrum is sharper than in the male, with the surface weakly concave. The postorbital ridges terminate in short spines, and the lateral tubercles of the carapace are exceedingly small.

The dactylar part of the chela of the first pair of pereopods (Plate 34, fig. 8) appears shorter than in the male, the palmar index being 72.0; therefore, the palmar region is more flattened than in the male. The surface of the chela is also totally covered with subsquamous tubercles. The dorsal groove of the carpopodite is well marked, and the surface of the podomere is like that in the male. The dorsal border of the meropodite is provided with tubercles, but none of them in the distal part is conspicuously larger than others; the ventral border has smaller spiniform tubercles.

The *annulus ventralis* is tuberculiform, virtually symmetrical, cloven in the median portion by a longitudinal groove; the groove originates in the cephalomesial region of the *annulus* and is localized definitively in the caudal region, taking the form of a sickle. The tubercle between the fifth pereopods is blunt apically and the basal posterior portion cleft (Plate 34, fig. 9).

Measurements in millimeters

	Male, Form I	Male, Form II	Female
Total length	57.2	41.7	58.7
Length of carapace	27.3	20.0	28.7
Anterior part of carapace	18.2	13.3	19.7
Length of areola	9.1	6.7	9.0
Width of areola	0.9	0.6	0.9
Length of abdomen	29.9	21.7	30.0
Posterior width of rostrum	4.7	3.0	4.3
Length of rostrum	8.7	4.5	7.5
Length of chela	24.1	12.3	18.8
Length of movable finger	13.8	7.3	11.0

Locality. El Mirador de Zacuapan, 8 km N.E. of Huatusco, Veracruz.

This is the same locality as that of the neotype. The Hacienda El Mirador has continued to be the home of the Sartorius family, one of

whose members sent a specimen to the Academy of Natural Sciences of Philadelphia which was described by Faxon in 1885.

169 **Relationships.** *Procambarus mexicanus* has close affinities with *P. aztecus* from a geographic point of view, but differs from Saussure's species in the following characters:

I. The rostrum is narrower at the base and the anterolateral angles reduced.

II. The areola is broader and the spine of the postorbital ridges less sharp and prominent.

III. The epistome does not have its anterior angle cut away.

IV. The chelae are slenderer and the hook on the ischiopodites of the third pair of pereopods clearly overreach the articulation of the ischium with the basipodite.

V. The apex of the declivity of the shoulder with the cephalic margin is sharp, and the mesial process is less inclined over the distolateral part of the appendage.

VI. The tubercle between the fifth pereopods of the female is blunt.

Procambarus aztecus (Saussure)

1857b *Cambarus aztecus* Saussure, Rev. et Mag. de Zool., 2nd Ser., Vol. IX, p. 503.

1858 *Cambarus aztecus* Saussure, Mem. Soc. Phys. Hist. Nat. Geneve, Vol. XIV, p. 460, Pl. III, fig. 23.

1858 *Cambarus aztecus* Saussure, Mem. pour servir a l'Histoire Nat. du Mexique, des Antilles et des Etats-Unis. Premier Mem., pp. 44 – 45, Pl. III, figs. 23, 23a, 23b.

1884 *Cambarus Mexicanus* (Erichson). Faxon, Proc. Amer. Acad. Arts and Sci., Vol. XX, pp. 141 – 142.

1885a *Cambarus Mexicanus* (Erichson). Faxon, Mem. Mus. Comp. Zool. at Harvard Coll., Vol. X, No. 2, pp. 50 – 51.

1906 *Cambarus (Procambarus) mexicanus* (Erichson). Ortmann, Proc. Wash. Acad. Sci., Vol. VIII, p. 21.

1914 *Cambarus mexicanus* (Erichson). Faxon, Mem. Mus. Comp. Zool. at Harvard Coll., Vol. XL, p. 410.

1954b *Procambarus aztecus* (Saussure). Villalobos, An. Inst. Biol. de la Univ. Nal. A. de Mexico, Vol. XXV, pp. 314 – 321.

Diagnosis. Rostrum without lateral spines, anterolateral angles rounded. Carapace with small lateral spine. Chelae of first pair of pereopods not pubescent, but with numerous subsquamous tubercles (more densely dispersed than in *P. mexicanus*). Palmar index in male 80.3. Hooks on ischiopodites of third pair of pereopods with apices barely surpassing articulation of ischium with basipodite. First pair of
170 pleopods of male with declivity of shoulder slightly arched; angle of

declivity with cephalic margin rounded. Cephalic process inclined over lateral region of appendage. *Annulus ventralis* tuberculiform, with broad shallow depression on cephalic surface; groove situated caudally. Tubercle between fifth pereopods of female terminating in small spiniform process.

Male, form I. The carapace is compressed laterally, the surface of the thoracic portion is densely punctate; in the gastric region the punctations are more sparse; the hepatic regions are smooth. In the dorsal portion of the groove that limits the hepatic region, a small spine stands out, accompanied by other tuberculiform structures of smaller size. The branchiostegal spine is very reduced.

The rostrum is wide at the base and relatively narrow anteriorly; the rostral margins are low, parallel posteriorly beyond which convergent, ending without spines; instead, the anterolateral angles are rounded and are insensibly continuous with the acumen which is broad and short; the acuminal spine is rather short and reaches the distal articulation of the second antennular article. The surface of the rostrum is subplane, with large and sparse punctations which disappear in the anterior portion. The ventral keel of the rostrum lacks dentiform processes.

The postorbital ridges are subparallel, terminating anteriorly in a short, conical tubercle; posteriorly they are prolonged in a smooth curved ridge which terminates in two small prominences that correspond to the point of insertion of the mandibular muscles.

The areola is so narrow that it is almost obliterated; the small anterior and posterior triangular areas of the surface of the areola exhibit punctations (Plate 36, figs. 1 and 2).

The proportions of the different parts of the carapace are the following: the length of the areola is greater than half the length of the cephalic part; the posterior width of the rostrum is one-sixth of the total length of the carapace; the length of the rostrum constitutes one-fifth of the total length of the carapace.

The epistome is symmetrical with an anterior emargination which is prolonged on the surface as a depressed area; the lateral limits of the emargination are projected anteriorly in prominences; the anterolateral margins are almost straight and the posterolateral angles are very rounded (Plate 36, fig. 3).

A small tubercle is present on the sternite between the second and third pairs of pereopods.

172 The abdomen is slightly longer than the carapace and of almost the same width; the dorsal surface of the segments bears a moderate number of punctations, but they are more abundant on the pleural regions. The caudolateral angles of the first section of the telson are armed with two spines: the external is very broad and sharp; the

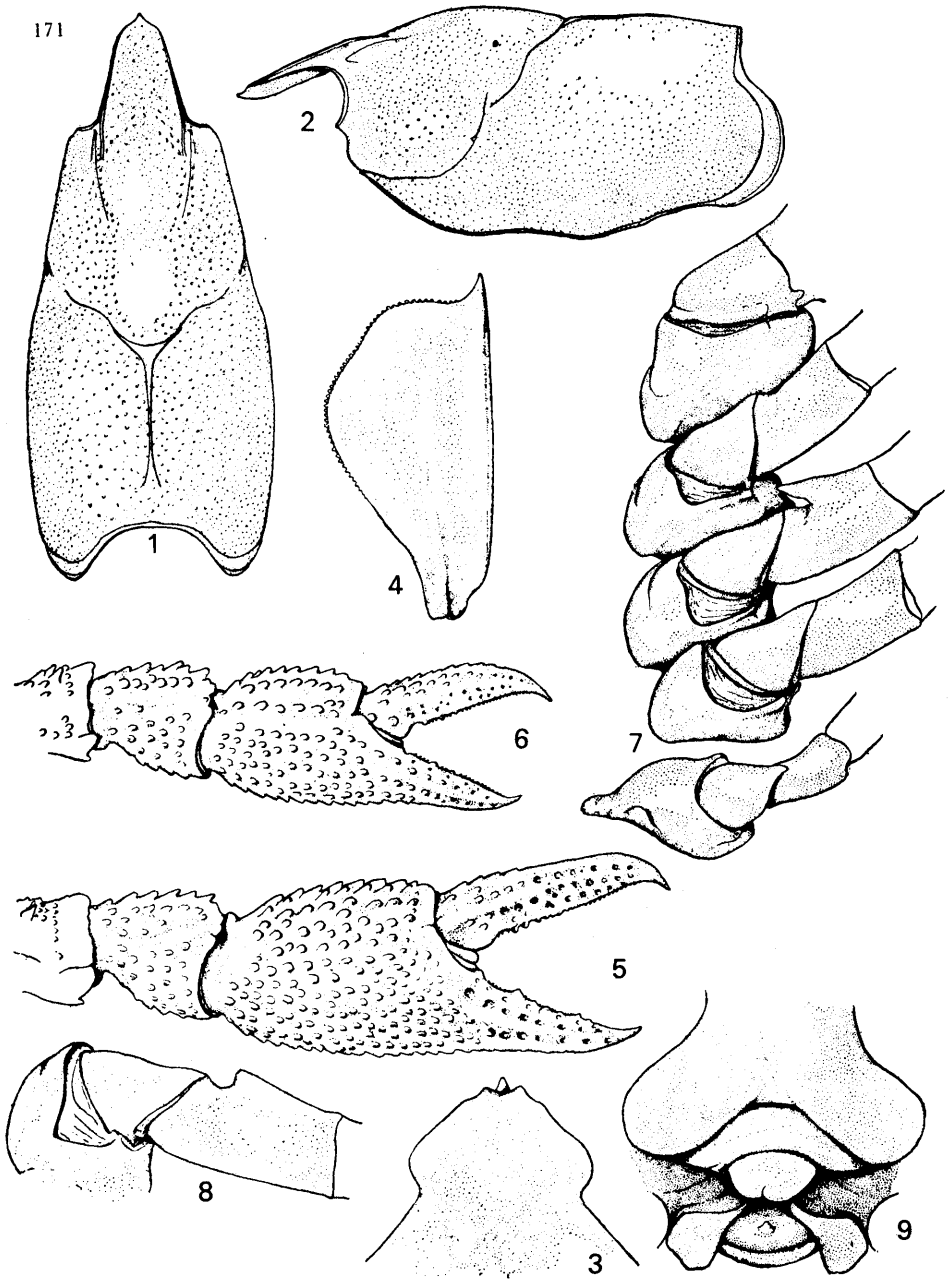


Plate 36. *Procambarus aztecus* (Saussure). Male, Form I.

1, dorsal view of the carapace; 2, lateral view of the same; 3, epistome; 4, antennal scale; 5, chela; 6, chela of the female; 7, pereopods I to V of the male, Form I; 8, ischiopodite of the third pereopod of the male, Form II; 9, *annulus ventralis*.

internal is quite small. The distal margin of the following section is almost straight.

The antennal scale (Plate 36, fig. 4) is broad and the greatest width situated distal to midlength; the anteromesial margin is slightly undulate; the antennal spine is very broad at the base, its apex sharp, and reaches midlength of the third article of the antennular peduncle. The external margin of the scale is straight.

The first pair of pereopods are shorter than the length of the body. The dorsal margin of the meropodite is armed with tubercles along its entire length, and in the anterior region invades the lateral faces; the distal subarticular region of this margin exhibits a broad, short, conical, spiniform process the apex of which is directed forward; on the lower margin of the same article there occurs the same double row of spines present in *P. mexicanus*, but here they are shorter and broader at the base. The surface of the carpopodite is completely covered with subsquamous tubercles; those of the dorsomesial surface are more prominent and those of the internal margin almost spiniform; the groove is very shallow but wide, and the presence of tubercles is not interrupted in it; the tubercles of the dorsolateral surface are subsquamiform and almost flat. The length of the article is equal to the greatest width of the palm of the chela. The chela is less flattened than in *P. mexicanus*; its palmar index is 80.3 ($I.P. = \frac{\text{Thickness} \times 100}{\text{Greatest width}}$); the surface is densely covered with subsquamous tubercles that invade the proximolateral part of the immovable finger. The mesial margin of the palm is gently convex and rounded; eight tubercles are conspicuous in profile. On the surface of the immovable finger, there is a rib or ridge that extends the entire length which is limited by setiferous punctations; the cutting border of this finger is armed with teeth, one of which is conspicuous in the proximal third and another smaller one in the median portion but implanted on the lower part of the border; other very small dentiform prominences may be observed on the rest of the margin; in addition to the teeth, there are numerous small plaquettes arranged along the entire length of the cutting border. The dactylo-
173 podite, or the movable finger, is straight, and the rib or ridge of the surface is not so well defined as on the immovable finger; the profile of the internal margin exhibits 11 subsquamous tubercles; additional ones are found on the proximal part of the surface; the cutting border is provided with nine to 11 small dentiform tubercles which begin a short distance from the articulation (Plate 36, fig. 5).

The ischiopodites of the third pair of pereopods exhibit a hook or slightly compressed, straight, conical tubercle with a sharp apex that hardly extends over the articulation of the ischium with the basipodite (Plate 36, fig. 7).

The first pair of pleopods are straight; the shoulder is in the form of an arched declivity, but the undulation is less profound than in *P. mexicanus*; the angle of declivity with the cephalic margin is rounded (Plate 37, figs. 1, 2, and 3). The mesial process is foliaceous; one of its faces is gently concave and turned toward the mesial surface; this process is inclined laterally at an angle of approximately 45° (Plate 37, fig. 4A); the central projection (Plate 37, figs. 4 and 5CE) is triangular, with the distal margin slightly concave and the proximal convex; its apex is directed cephalodistally; the cephalic process is lacking.

Male, form II. The punctations on the surface of the carapace are more sparse and scattered than in the male, form I. The rostrum is flat and the rostral margins, while converging, are slightly convex; the acumen is narrower and the spine of the acumen reaches the median part of the third article of the antennular peduncle. The surface of the rostrum exhibits punctations in the basal part; otherwise it is smooth.

The postorbital ridges terminate anteriorly in a very small tubercle.

The lateral spines of the carapace are short, sharp, and broad basally.

The areola is obliterated.

The epistome, as in the male, form I, is a little asymmetrical anteriorly.

174 The chelae of the first pair of pereopods are small, but the general aspect is similar to that of the male, form I, although the subsquamous tubercles of the surface are apparently more numerous and closer together. From the palmar index (69.7), it is apparent that the chela is more flattened than in the male, form I. The surface of the immovable finger is provided with squamous tubercles in the proximal half among which the rib, or ridge, stands out clearly; a small proximal, subterminal tooth is present on the cutting border and another in the distal third. The dactylopodite is slightly curved laterally, its surface is scabrous, and the rib, or ridge, stands out clearly; in the proximal third, the cutting border exhibits only two teeth that are somewhat separated.

The ischiopodite of the third pair of pereopods bears only a hint of the hooks, marked by the presence of an emargination near the proximal articulation of the article (Plate 36, fig. 8).

The declivity of the shoulder on the first pair of pleopods is gently arched. The mesial process is directed distally and is only very slightly flattened; the central projection maintains its cephalodistal direction, its extremity is rounded, and the structures that normally constitute it are clearly delimited by a groove (Plate 37, figs. 6 and 7).

Female. The rostrum is narrower basally and its surface more flattened than in the male, form I; the rostral margins are subparallel posteriorly and converge immediately; in one specimen the margins are distinctly convex, but in the majority the convexity is very slight; the

acumen is apparently broader and the acuminal spine reaches the middle of the third article of the antennular peduncle. The lateral spines of the carapace are very little developed.

The postorbital ridges are slightly convergent and bear a very small spiniform tubercle anteriorly.

The areola is almost obliterated.

The anterior emargination of the epistome may be absent, but in general has the same aspect as that in the male.

The first pair of pereopods are little developed and the dactylar portion of the chelae is slightly longer than in the males. The palmar region is subovate; the palmar index is 66.0, and consequently the chela is less cylindrical than in the male. The subsquamous tubercles on the surface are less numerous (Plate 36, fig. 6).

The *annulus ventralis* is tuberculiform, with an angular emargination in the caudal region where the sinus is barely perceptible. In the distal part of the cephalic face, there is a slight, more or less circular depression (Plate 36, fig. 9).

Between the fifth pereopods, there is a tubercle terminating in a small spiniform structure (Plate 36, fig. 9).

Measurements in millimeters

	Male, Form I	Male, Form II	Female
Total length	47.5	40.5	50.0
Length of carapace	23.1	20.4	24.8
Anterior part of carapace	15.0	13.5	15.5
Length of areola	8.1	6.9	9.3
Width of areola	0.2	.	0.2
Length of abdomen	24.4	20.1	25.2
Posterior width of rostrum	4.2	3.7	3.2
Length of rostrum	5.1	5.0	5.1
Length of chela	17.0	6.5	12.6
Length of movable finger	9.0	6.6	7.1

Localities. Tomadán, 14 km S.S.W. of Huatusco, Veracruz. Small stream of clear water (type locality). 3 km S. of Coscomatepec, Veracruz.

Relationships. Judging by the illustrations in Saussure's study, there is no doubt that the description of *Procambarus aztecus* was made on a male, form II; consequently the validity of the species had always been in doubt, and various specialists had considered it a synonym of *P. mexicanus*.

Now that we have had the opportunity to redescribe *P. mexicanus*, we are able to affirm that *P. aztecus* is a valid species. With regard to the



Plate 37. *Procamburus aztecus* (Saussure). Male, Form I.

1, caudal view of the first pair of pleopods; 2, lateral view of a pleopod; 3, mesial view of the same; 4, lateral view of the apical part of the same; 5, cephalic view of the same; 6 and 7, mesial and lateral views of the apical part of a pleopod of the male, Form II (A, cephalic [mesial] process; CE, central projection).

differential characteristics between the species, they have already been pointed out in the description of *P. mexicanus*.

Procambarus rodriguezii Hobbs

1943 *Procambarus rodriguezii* Hobbs, Lloydia, Vol. VI, pp. 203 – 206, Pl. II.

1954b *Procambarus rodriguezii* Hobbs. Villalobos, An. Inst. Biol. de la Univ. Nal. A. de México, Vol. XXV, pp. 321 – 323.

Diagnosis. Albinistic. Eyes very reduced with small black point in cornea. Rostrum short, margins converging, terminating anteriorly in short spines; acumen relatively broad at base, very sharp, its apex slightly overreaching distal articulation of second article of antennular peduncle; rostral surface excavate. Postorbital ridges subparallel, terminating anteriorly in sharp spiniform processes. Sharp spine on each side of carapace. Cervical groove very deep without undulations. Areola very broad. Length of cephalic part one and two-thirds greater
177 than length of areola. Posterior width of rostrum six and one-half times less than length of carapace; width of areola three and one-half times less than length.

Epistome semicircular in outline.

Posterolateral angles of first section of telson with single spine, its base very broad, and directed caudolaterally.

Antennal scale broad, external margin straight, spine of scale sharp; antennal flagellum very slender and long, greater than length of body.

First pair of pereopods of male slightly longer than body; mero-podite very long and slender, slightly greater in length than dactylo-podite; carpopodite relatively short; chela very long and slender, palmar region densely covered with very small, subsquamous tubercles, almost cylindrical (palmar index 81.0); fingers straight and long, dactylopodite greater than half length of chela; cutting border of immovable finger with three teeth in proximal region, two more teeth, very close together, in middle part of length and implanted on lower part of border; cutting border of dactylopodite with three small proximal teeth very close together, followed by larger one, and remaining part of border with small hemispherical tubercles.

Ischiopodite of third pair of pereopods of first form male with strong hook, conical in form, flattened in its axial portion and its apex distinctly overreaching articulation of ischiopodite and basipodite.

First pair of pleopods of first form male reaching posterior part of coxopodites of third pair of pereopods; distolateral region very pronounced, declivity of shoulder horizontal and excavated in undulation; vertex of cephalic border of shoulder rounded; mesial process very narrow, gently inclined laterally (approximately 170°); central

projection triangular, flattened laterally, and with its apex directed cephalodistally; cephalic process rudimentary.

178 Second form male with rostrum deeply grooved, rostral margins subparallel, slightly convex, terminating anteriorly in spine, directed distolaterally; acumen broad at base, less sharp than in first form male, its apex slightly overreaching distal articulation of third antennular article. Postorbital spines very sharp. Lateral spines of carapace small but sharp. Areola broad. Epistome as in first form male. Chelae relatively small, dactylopodite half as long as palm. First pair of pleopods with apical structures little developed and not chitinized; shoulder slightly sloping; mesial process conical, small, and inclined laterally; central projection hemispherical but slightly sharp apically.

Female with rostrum excavate; rostral margins little convergent; lateral spines of rostrum short, acumen very short and broad, slightly sharp. *Annulus ventralis* tuberculiform with longitudinal depression in center, flanked by curved ridges; groove sinuous, beginning in sub-apical region of mesial face and continuing onto caudal portion. Tuberculiform process between fifth pereopods very small and sharp.

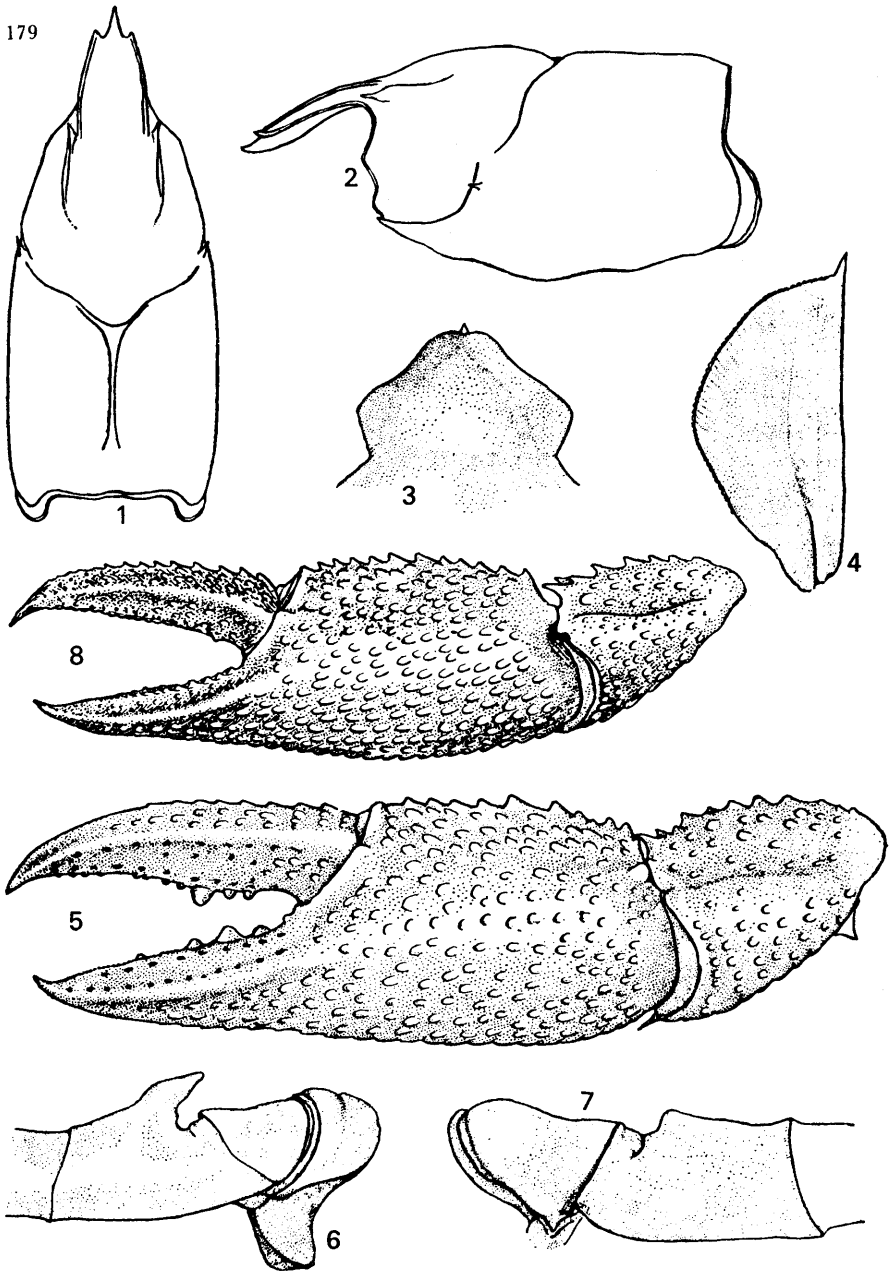
Locality. Cueva de Ojo de Agua, 4 km W.N.W. of the Hacienda Potrero Viejo, Paraje Nuevo, Córdoba, Veracruz.

Relationships. In view of its adaptive characteristics, *Procambarus rodriguezii* is a typical troglobitic species: for example, the reduction of the ocular peduncle, the depigmentation of the cornea and of the body, the length of the antennal flagellum, and the slender form of the first pair of pereopods. No other species of the *mexicanus* Section exhibits such characteristics, not even *Procambarus mirandai* which also has unquestionably cavernicolous habits. The relationship of this interesting species is directly with *Procambarus* sp. which soon will be described and which lives in streams of Córdoba and Orizaba. It also exhibits affinities with *Procambarus veracruzanus* to an extent much greater than with *Procambarus mexicanus* and *Procambarus aztecus*, inasmuch as the latter species do not have lateral spines on the rostrum and those of the carapace are reduced to small tubercles. By the general form of the shoulder on the first pair of pleopods of the male, form I, however, *P. rodriguezii* may be related to *P. aztecus*.

Procambarus veracruzanus Villalobos

1954b *Procambarus veracruzanus* Villalobos. An. Inst. Biol. de la Univ. Nal. A. de México, Vol. XXV, pp. 323 – 328.

Diagnosis. Rostrum with lateral spines, margins gently convex, convergent; acumen long and sharp. Carapace with well developed lateral spine; areola moderately narrow. Chelae of first pair of pereopods not pubescent but completely covered with subsquamous



180 tubercles; palmar index of chela of male 63.9. Hook on ischiopodites of third pair of pereopods with apex distinctly overreaching articulation of ischiopodite with basipodite. First pair of pleopods of first form male reaching anterior part of coxopodites of fourth pair of pereopods; shoulder with declivity almost horizontal; angle with cephalic margin rounded; mesial process flattened in form of arrow point, inclined laterally at angle greater than 135° . *Annulus ventralis* tuberculiform, slightly cleft in median part. Tubercle between fifth pereopods of female without spiniform process, but sharp apically.

Male, form I. The carapace is slightly enlarged in the branchial region, and is covered with punctations in the dorsal portion and with abundant small granules in the lateral parts. There exists a well developed and sharp lateral spine; the branchiostegal spine is present.

The rostrum exhibits a subplane and smooth surface; the rostral margins are little convergent, slightly elevated, and terminate anteriorly in well developed, sharp, angular processes; the acumen is narrow, long, and sharp; the acuminal spine is gently elevated and reaches the distal extremity of the third article of the antennular peduncle.

The postorbital ridges are parallel and terminate anteriorly in a large, sharp spine.

The areola is moderately narrow, its surface without punctations (Plate 38, figs. 1 and 2).

The proportions of the different parts of the carapace are the following: the length of the areola is almost half the length of the cephalic portion of the carapace; the length of the rostrum is divisible into the total length of the carapace nearly three and four-fifths times.

The epistome is regular in form, pentagonal with its margins gently elevated; the anterior part exhibits a very shallow emargination (Plate 38, fig. 3).

On the sternite between the second and third pairs of pereopods, there is a very slightly developed tubercle.

The abdomen is narrower and a little longer than the carapace; the somites are smooth in the dorsal region and with sparse very small punctations in the pleural regions; the distolateral angles of the first section of the telson exhibit two spines on each side, both the same size, the external very sharp; the distal margin of the ultimate part of the telson is almost straight.

The external border of the antennal scale is straight and terminates in a spine slender at its base and very sharp at the apex; this spine

Plate 38. *Procambarus veracruzanus* (Villalobos). Male, Form I.

1, dorsal view of the carapace; 2, lateral view of the same; 3, epistome; 4, antennal scale; 5, chela; 6, ischiopodite of the fourth [third?] pereopod; 7, ischiopodite of the third pereopod of the male, Form II; 8, chela of the female.

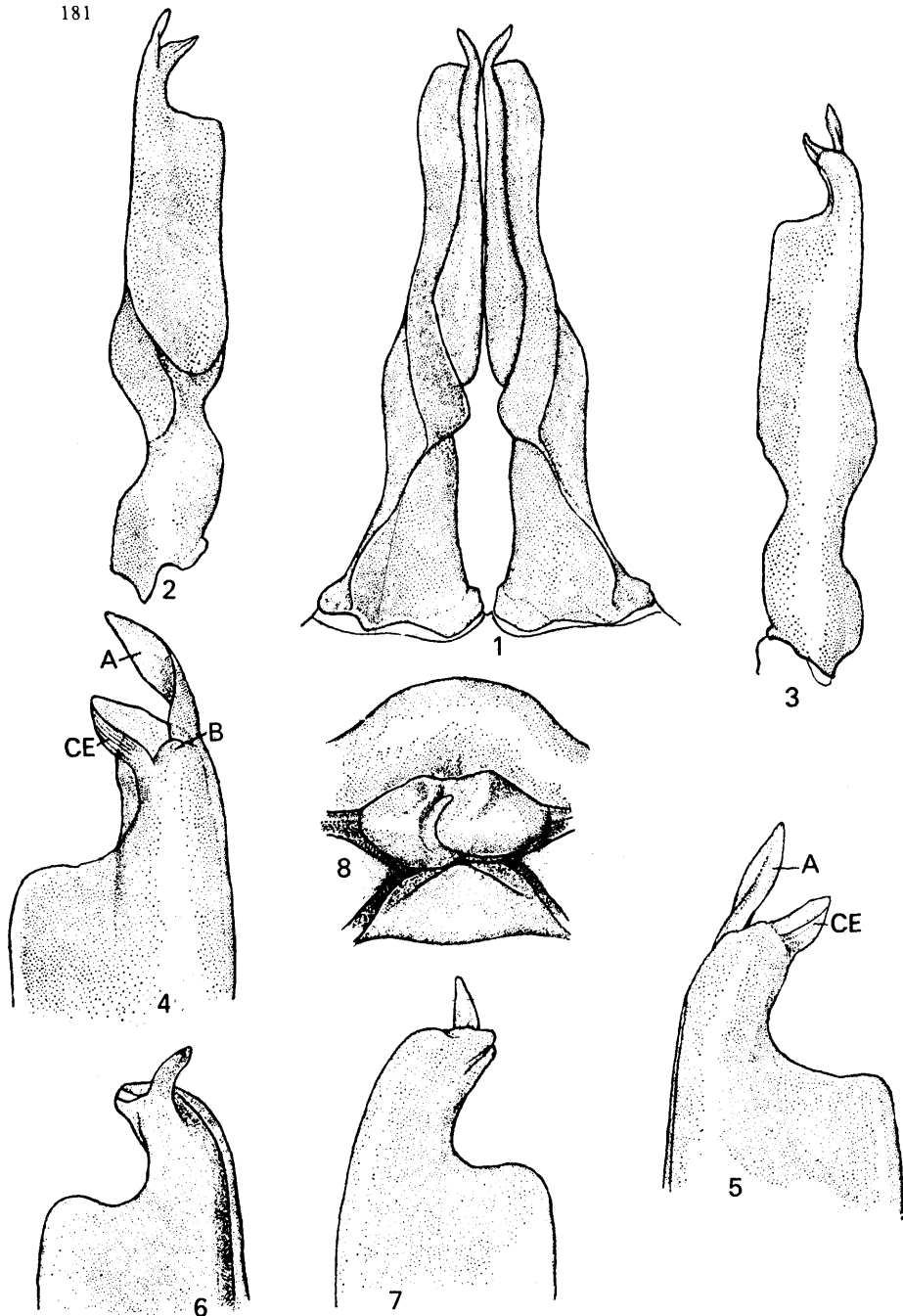


Plate 39. *Procambarus veracruzanus* (Villalobos). Male, Form I.

1, caudal view of the first pair of pleopods; 2, mesial view; 3, lateral view; 4, mesial view of the apical part of the pleopod; 5, lateral view of the same; 6 and 7, mesial and lateral views of the apical part of the first pleopod of the male, Form II (A, mesial process; CE, central projection; B, cephalic process); 8, *annulus ventralis*.

182 slightly overreaches the distal articular margin of the third article of the antennular peduncle. The greatest width of the scale is at midlength (Plate 38, fig. 4).

The first pair of pereopods are of regular size. The meropodite exhibits on its anterosuperior portion a spine which stands out clearly from a group of tubercles that are present in this area; the lateral parts are smooth; the lower border is armed with spines that are disposed in two series; those of the internal are somewhat regular in form and size, whereas the series on the external border is incomplete and two large spiniform tubercles stand out in it, these implanted almost at mid-length of the article. The carpopodite is short and broad, the tubercles on the internal border are spiniform; on the upper surface there is a moderately deep and slightly sinuous groove; there exist moreover subsquamous tubercles which are interrupted by the groove. The chela is of medium size and the surface is densely covered with tubercles; the contour of the palm is more or less oval and the palmar index is 63.9. The palmar length is equal to that of the dactylopodite or movable finger. The cutting borders of the fingers are almost devoid of large toothlike tubercles; almost all of them are very small and hardly noticeable. Both fingers exhibit a rib or ridge on its [dorsal] surface (Plate 38, fig. 5).

The ischiopodites of the third pair of pereopods exhibit a hook, the apical part of which distinctly overreaches the articulation of the ischiopodite with the basipodite; this hook is not perfectly conical, but slightly flattened in the same manner as the article, and on the anteroinferior border exhibits a small convexity (Plate 38, fig. 6).

The first pair of pleopods are straight, laterally flattened; the declivity of the shoulder is almost horizontal and the angle with the cephalic margin is rounded. The mesial process (Plate 39, figs. 1, 2, 3, 4, and 5A) is foliaceous and lanceolate in shape, gently inclined laterally at an angle of approximately 65°; the cephalic process (Plate 39, fig. 4B) is barely perceptible and has the form of a hemispherical prominence; the central projection (Plate 39, figs. 4 and 5CE) is a laterally flattened plate, more or less triangular in shape, and with the vertex projecting cephalodistally.

183 **Male, form II.** The rostrum is sharper than in the male, form I; consequently, the distance between the two lateral spines is shorter. The surface of the carapace is similar to that of the adult male. The first pair of pleopods exhibit poorly developed structures; of these the mesial process stands out; its cephalic margin is prolonged toward the central projection which is blunt apically, not chitinized, and observable in it is the clear delimitation of the two constituent parts by the line that extends from the mesial process.

Female. The specimen that we have selected for our description

exhibits a size much greater than that of the males, form I and II. The rostral margins are strongly convergent and somewhat elevated above the surface which presents a slight depression in the basal part. The punctations of the surface of the carapace are strongly impressed. The lateral spines of the carapace and the anterior ones of the postorbital ridges are very sharp; the branchiostegal spine is short and its base wide. The areola is as narrow as in the male, form I.

The chelae of the first pair of pereiopods are relatively robust; the shape of the palmar region is more or less obovate, and the index of the palmar region 68.6. The teeth on the cutting border of the fingers are well developed, and of them, three stand out in the proximal region of each margin (Plate 38, fig. 8).

The *annulus ventralis* is tuberculiform, with a longitudinal depression in the median part slightly inclined from left to right. The groove originates in the subapical region of the cephalic face and describes a broad curve, convex toward the right.

Between the fifth pereiopods of the female, there is a tubercle, the apical part of which is sharp (Plate 39, fig. 8).

Measurements in millimeters

	Male, Form I	Male, Form II	Female
Total length	43.6	41.7	59.0
Length of carapace	22.3	23.0	35.0
Anterior part of carapace	14.5	15.7	19.4
Length of areola	7.8	7.5	15.6
Width of areola	0.2	0.5	0.2
Length of abdomen	21.3	18.7	24.0
Posterior width of rostrum	3.3	4.0	5.0
Length of chela	15.2	15.7	18.2
Length of movable finger	9.0	8.4	10.0

Locality. Presidio, 30 km S.E. of Córdoba, Veracruz. Basin of Río Papaloapan.

Relationships. *Procambarus veracruzanus* differs from *P. mexicanus* and *P. aztecus* in the presence of lateral spines on the rostrum, by the distinct lateral spines on the carapace, by the declivity of the shoulder which is straight and almost horizontal, and by the presence of a cephalic process.

Procambarus vazquezae Villalobos

1954b *Procambarus vazquezae* Villalobos, An. Inst. Biol. de la Univ. Nal. A. de México, Vol. XXV, pp. 328 – 336.

Diagnosis. Very small crayfish in relation to other species of genus, perhaps similar in size to members of genus *Cambarellus*. Strengthened rostral margins terminating anteriorly in tubercles, blunt in adults, sharp in young; acumen long, slender, terminating in tubercle; postorbital ridges terminating in conical spines. Carapace with lateral spines. Areola narrow and almost obliterated. Telson with two or three spines in distolateral angles of anterior portion. Chelae of first pair of pereopods with short fingers. Ischiopodites of first [should be third] pair of pereopods with hooks. First pair of pleopods of male with shoulder; mesial process flattened, arrow-shaped, and inclined laterally. *Annulus ventralis* small, with circular depression. Tubercle between fifth pereopods terminating in small spiniform process.

Male, form I. Its size is smaller than that of the females. The carapace is slightly shorter than the abdomen and is slightly compressed; its dorsal surface exhibits fine punctations, whereas that in the lateral regions shows small granulations; the hepatic region lacks granulations. Present on each side of the carapace is a single spine that is moderately large, sharp, and implanted on the upper side of the groove which limits the hepatic region posteriorly. The branchiostegal spine resembles those of the carapace.

The areola is very narrow or almost obliterated, with four punctations in the zone posterior to the cephalic groove.

The rostrum is proportionately short and the acuminal spine reaches the distal third of the second antennular article; the rostral margins are thickened, more or less straight, very little convergent, and terminate anteriorly in a tuberculiform process, the apex of which is blunt as a result of abrasion; the acumen is broad basally but soon becomes slender, becoming narrow and long, its length is equal to the anterior width of the rostrum; the rostral surface is distinctly grooved and provided with small punctations distributed homogeneously over the entire surface; each punctation bears a seta which adheres anteriorly to the surface; the setae of the anterior portion of the rostrum are longer, particularly those that are inserted on the sides of the acumen and overreach the margin giving this portion a pubescent appearance; the ventral keel of the rostrum lacks the dentiform processes (Plate 40, figs. 1 and 2).

The postorbital ridges are long, parallel, and terminate in a well developed, conical, and sharp spine (Plate 40, figs. 1 and 2).

The proportions of the different parts of the carapace are the following: the length of the rostrum is one-fourth of the total length of the carapace; the posterior width of the rostrum is one-eighth of the total length of the carapace; the length of the areola is one-third of the total length of the carapace.

The anterior width of the abdomen is slightly greater than the

posterior width of the cephalothorax; the tergal portion of the abdominal somites is smooth and the pleural regions slightly punctate; the margins of the anterior section of the telson are parallel and its posterolateral angles terminate in two or three spines.

The epistome is lanceolate, very wide at the base, and the anterolateral margins are smooth, long, and slightly elevated; the posterolateral angles are rounded; the surface of the epistome is subplane (Plate 40, fig. 3). The antennal scale (Plate 40, fig. 5) is relatively narrow; the external margin is straight and terminates anteriorly in a large, conical, and very sharp spine that reaches the distal articulation of the third antennular article; the greatest width of the scale is exactly at midlength and goes into the length, from the apex to the base of the scale, less than two and one-half times.

The first pair of pereopods, in relation to the size of the body, are robust; the length projected over the body reaches the fifth abdominal somite; the meropodite is short and the distal part is triangular in section; the lateral face is smooth in its major part, only slightly tuberculate anteriorly; the mesial face has a similar appearance, but the tubercles are provided anteriorly with setae that adhere to the surface of the article, the superior border is scabrous and exhibits a large conical and sharp spine on the subarticular distal region; the inferior border exhibits two rows of spines that are sharp, inclined forward, and disposed in a linear series; of them, two stand out by their form and size, and are situated in the anterior third, one very near the articular emargination; according to our observations, these spines are less developed in the males; the carpopodite has the form of an inverted truncate cone, the surface covered with subsquamous tubercles which on their anterior margin exhibit setae that adhere to the surface of the article; the dorsal groove is shallow, inclined from forward to the rear, and from inside to outside; the cavity of the groove lacks tuberculiform structures; on the distal articular margin and in the internal region of the article there are two large and sharp spiniform processes; additional ones of similar form are implanted on the same margin, but on the exterior and inferior parts. The chela exhibits two very short fingers, and the section of the palm is oval; the dorsal surface is densely covered with subsquamous tubercles, more abundant on the internal and external regions, as well as in the posterior part of the immovable finger; the ventral face also exhibits tubercles, but sparingly and very dispersed; the immovable finger is straight, shorter than the dactylopodite, and very broad basally; the surface is almost smooth except some punctations are dispersed near the margins; the rib or ridge is not well defined; the subsquamous tubercles of the palmar surface are prolonged along the proximal half of the external border of the finger, distally only with deep pits of circular contour; the cutting border

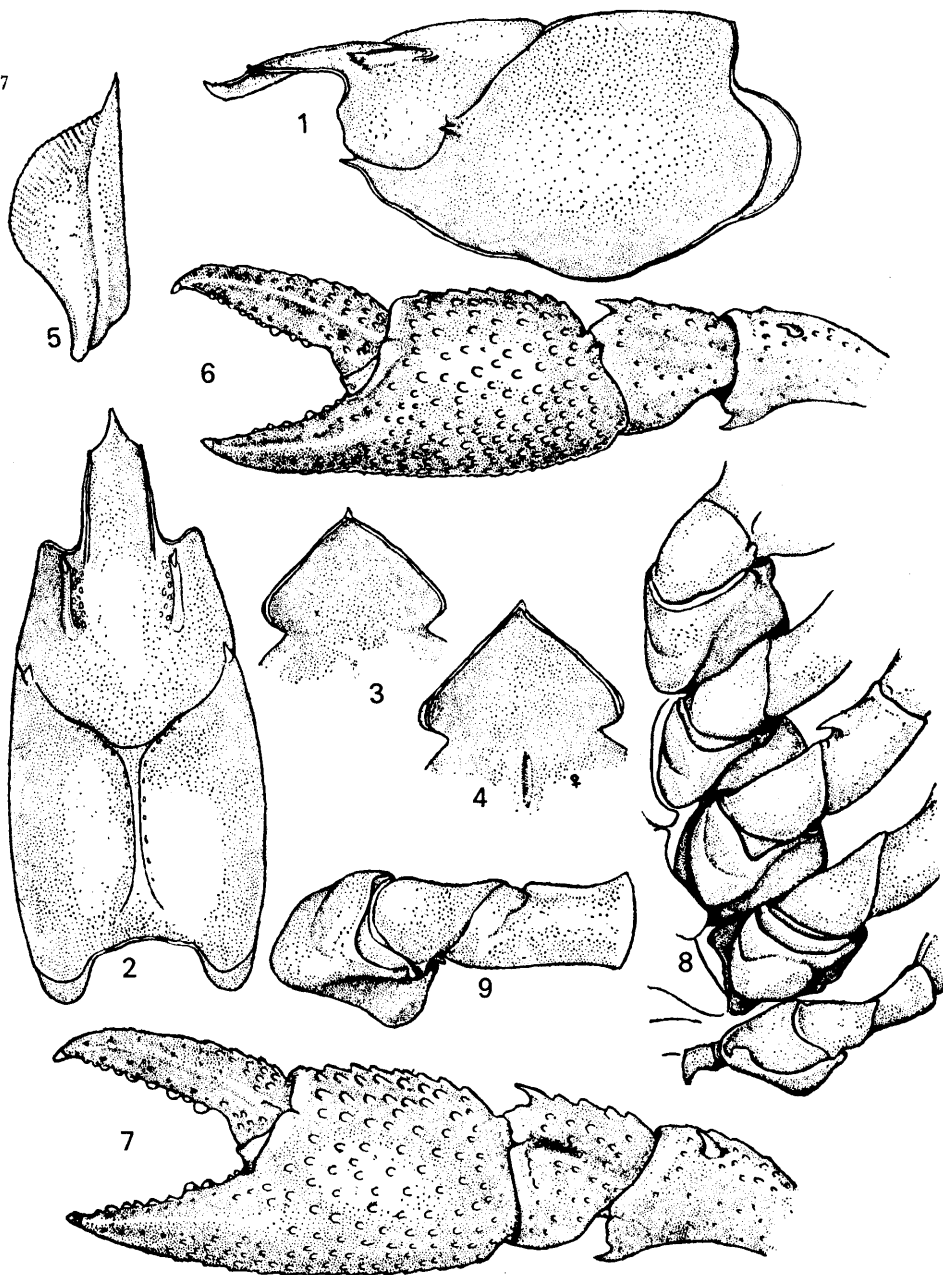


Plate 40. *Procambarus vazquezae* (Villalobos). Male, Form I.

1, lateral view of carapace; 2, dorsal view of same; 3, epistome; 4, epistome of the female; 5, antenna scale of the male, Form I; 6, chela; 7, chela of the female; 8, pereopods I to V of the male, Form I.

exhibits a few dentiform processes which are arranged along almost all of its length, widely separated one from the other, and which diminish in size distally. The dactylopodite, or movable finger, apparently is longer than the immovable one, but when the distal extremities of the two are brought together, their ends coincide; its external border is provided through its length with small tubercles; the cutting border bears two dentiform processes that are similar in form and disposition to those on the immovable finger; the length of the dactylopodite is exactly one-half the length of the chela (Plate 40, fig. 6).

The ischiopodites of the third pair of pereopods exhibit a hook that has the form of a spur; it is inserted at midlength of the article and is flattened in the same plane as the article; the apical part of the hook is very sharp and is slightly recurved toward the basipodite, hardly reaching the proximal articulation of the ischiopodite (Plate 40, fig. 8).

The apical region of the first pair of pleopods reaches the posterior part of the coxopodites of the third pair of pereopods; [the pleopods] are subequal in length, the left being longer than the right. The shoulder is well developed and the declivity has a slope of approximately 45°; the angle formed with the cephalic margin is rounded and slightly elevated; in the apical part of the shoulder there is a kind of gently concave plateau (Plate 41, figs. 1, 2, and 3). The mesial process (Plate 41, figs. 4 and 5A) is foliaceous and lanceolate, its apex slightly rounded, and inclined toward the side. The central projection (Plate 41, figs. 4 and 5CE) is small and subtriangular in shape; its apex is turned toward the lateral surface of the appendage; the apical margin is continuous with a platelike prominence which is disposed latero-mesially and clearly exceeds the height of the central projection. Actually, there is no cephalic process, but there is a ridge which extends from the mesial process to the median chitinous brace of the central projection.

Male, form II. The carapace is smooth; the areola is almost obliterated; the lateral spines of the carapace are present; the rostrum is broad and the rostral margins are almost parallel, the lateral spines of the rostrum are divergent, elevated, and very sharp; the acumen is very sharp and the acuminal spine slightly overreaches the antennular peduncle; the spines of the postorbital ridges are also sharp and divergent.

The epistome is triangular. The spine of the antennal scale is very sharp and clearly overreaches the antennular peduncle.

The chelae of the first pair of pereopods are shorter than in the male form I; they are densely covered with subsquamous tubercles; the fingers of the chela are short and broad at the base, straight, and with very small dentiform processes on the cutting border.

The hooks on the ischiopodite of the third pereopods of the male,

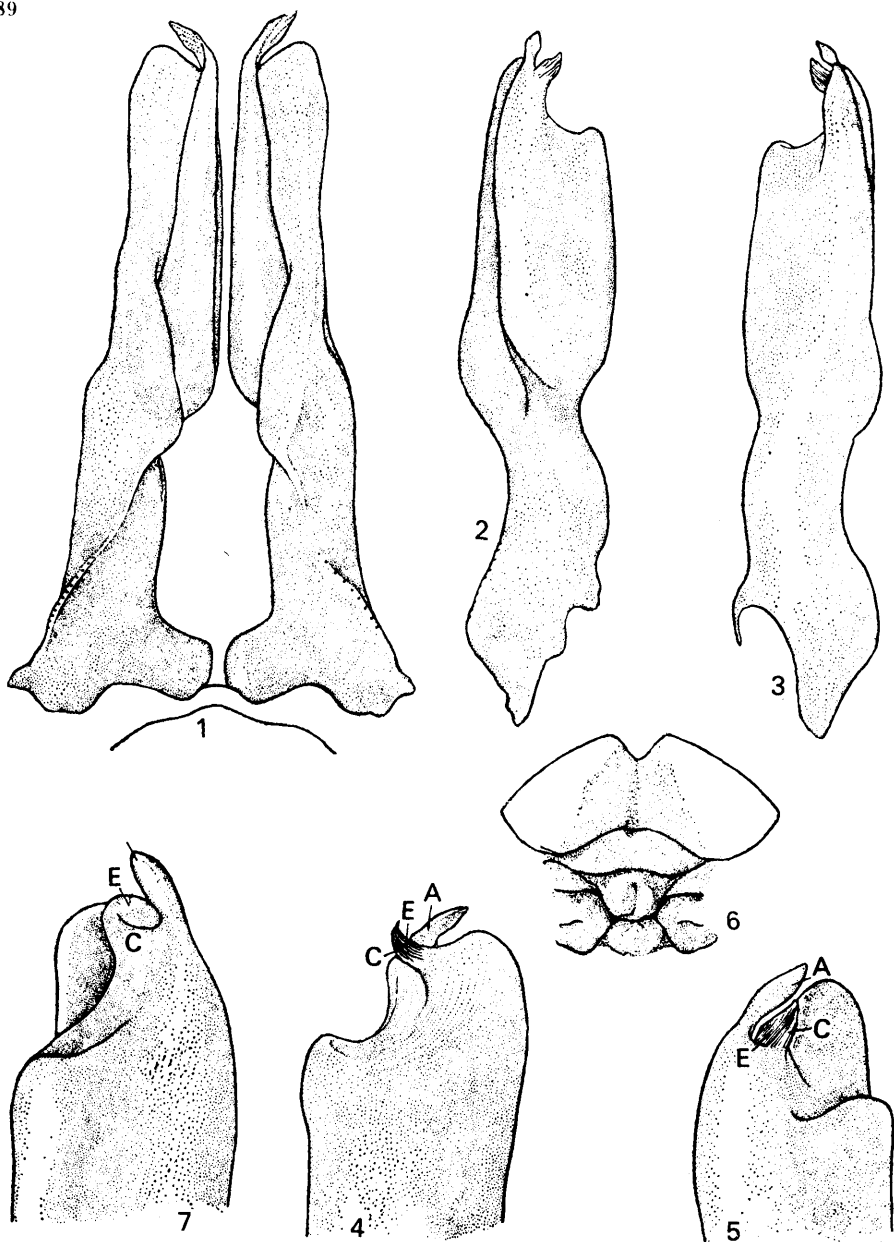


Plate 41. *Procamburus vazquezae* (Villalobos). Male, Form I.

1, caudal view of first pair of pleopods; 2, mesial view; 3, lateral view; 4, caudolateral view of the apical part of the pleopod; 5, mesial view of the same; 6, *annulus ventralis*; 7, mesial view of the apical part of the first pleopod of the male, Form II.

form II, develop very slowly; consequently, they are also very small in the young (Plate 40, fig. 9), hardly visible as a small tubercle adjacent to the proximal excavation. The first pair of pleopods are slender and slightly shorter than in the male, form I; the shoulder is well developed; the mesial process is flattened and slightly inclined over the apical surface; the central projection is barely evident in the form of a mammiform tubercle, split by a groove which begins on the basal portion of the mesial process (Plate 41, fig. 7).

Female. In general, the size of the females slightly exceeds that of the males. Many female specimens collected during the month of May carried eggs; these are large and few in number, averaging ten to twelve for each individual; the diameter of the eggs is 1.5 mm. The carapace exhibits punctations over all of its surface, those of the dorsal region
190 broadly dispersed; the punctations of the dorsolateral regions of the cephalic portion are larger and less well marked. The areola is narrow, but wider than in the males. The postorbital ridges are slightly convergent and terminate in a conical, sharp spine. The rostrum is broad and sharp; the acuminal spine slightly overreaches the distal articulation of the second antennular article; the rostral margins are almost parallel and terminate anteriorly in a tubercle with a blunt point; the rostral surface is distinctly grooved and slightly pubescent.

The epistome is triangular, similar to that of the male, form I (Plate 40, fig. 4).

The distal half of the external border of the antennal scale is slightly concave; the spine is sharp and straight, and reaches the distal articular border of the third antennular article.

The chela of the first pair of pereopods is broader and its fingers are shorter than in the male, form I; the surface of the palm is very densely covered with subsquamous tubercles, each with setae on the anterior border, which recline on the surface of the chela. The tubercles that are found on the proximal internal border of the dactylopodite are more numerous than in the male. The cutting border of the fingers exhibits dentiform tubercles along their entire length, but they are more numerous and consequently closer together than in the adult male.

The *annular ventralis* is tuberculiform, movable, circular in section near the apex, and with a circular depression in the apical region at the center of which there is a very shallow groove; but the true groove is located in the caudal region of the *annulus*, having the form of a C, at times reversed, and the borders that limit it are very elevated. Between the fifth pereopods, there is a tubercle which terminates apically in a very small spiniform process (Plate 41, fig. 6).

Measurements in millimeters

	Male, Form I	Male, Form II	Female
Total length	32.5	32.7	33.0
Length of carapace	15.5	15.0	16.0
Anterior part of carapace	10.2	10.0	11.0
Length of areola	5.2	5.0	5.0
Width of areola	0.2	..	0.4
Length of abdomen	17.0	17.7	17.0
Posterior width of rostrum	1.9	2.0	1.9
Length of rostrum	4.5	4.4	4.5
Length of chela	12.7	11.0	10.5
Length of movable finger	6.9	6.0	5.5

191 Locality. North beach of Laguna de Catemaco, Veracruz. Possibly it will be found along all of the shoreline of the lake.

Relationships. This species has affinities with the *mexicanus* group of the southern part of the Republic, relationships recognizable in the form of the apical part of the first pair of pleopods of the male and in the disposition of the mesial process. It is very near *Procambarus acanthophorus* and *P. mirandai*, but it differs from them in the notable reduction of its size and by the form and disposition of the spiniform processes. Undoubtedly, the closest relationships are with *Procambarus ruthveni*; not only is this indicated morphologically but also by their geographic distribution.

Procambarus ruthveni (Pearse)

- 1911 *Cambarus (Procambarus) ruthveni* Pearse, Thirteenth Rept. Mich. Acad. Sci., pp. 110 – 111, 4 figs.
- 1914 *Cambarus mexicanus* (Erichson). Faxon, Mem. Mus. Comp. Zool., Harvard Coll., Vol. XL, No. 8, p. 363.
- 1953 *Procambarus ruthveni* (Pearse). Villalobos, Mem. del Congreso Científico Mexicano. U. N. A. M., Vol. VII, pp. 363 – 364.
- 1954 *Procambarus ruthveni* (Pearse). Hobbs, Occ. Pap. Univ. Michigan (in press).
- 1954b *Procambarus ruthveni* (Pearse). Villalobos, An. Inst. Biol. de la Univ. Nal. A. de México, Vol. XXV, pp. 336-347.

Diagnosis. Rostrum moderately grooved, margins slightly convergent, terminating anteriorly in short, blunt tubercles, or in more or less rounded angular processes; acumen broad at base and sharp apically. Postorbital ridges terminating anteriorly in moderately well developed tubercles, barely evident or absent. Carapace with lateral spines, in some cases as small tuberculiform structures, or without them. Areola very narrow or obliterated. Epistome with anterior

emargination, lateral angles of which sometimes rounded or projecting in form of two small angular processes. Chelae of first pair of pereopods of equal size. Hooks on ischiopodites of third pair [of pereopods]. First pair of pleopods with declivity very sharp; mesial process slender, sharp, and recurved laterally; central projection sometimes presenting small angular process on distal margin. *Annulus ventralis* with more or less deep depression on apical surface. Tubercle between fifth pereopods of female with small apical spiniform process.

192 **Male, form I.** The carapace is slightly shorter or of the same length as the abdomen (30.6-31.7; 33.5-33.6; 28.3-29.7). At the level of the caudodorsal margin of the cephalic groove, the height of the carapace is less than the width, greatest width of the carapace approximately at the midlength of the areola (14.2). The surface of the carapace is very densely punctate in the dorsolateral region, sparsely so in the dorsal part of the thoracic region, and even less so in the gastric region; the hepatic region is provided with numerous tubercles; the median and anterior thirds of the branchial region exhibit very numerous small tubercles which are even more numerous in the anteroinferior region; a very short and sharp spine occurs on each side of the carapace, located at the superior and subterminal portion of the groove that limits the hepatic region; in other specimens there is only an indication of an additional small tubercle, but it may not be present; this latter we found in two individuals. The branchiostegal spine is conical and sharp.

The areola is very narrow (0.4 mm) but in other cases it is obliterated; in the anterior and posterior regions of its surface, there are a few punctations; the length of the areola is half the length of the cephalic portion and 34.2 per cent of the total length of the carapace.

The rostrum is broad at its base and in the anterior part the acuminal spine reaches the proximal third of the third antennular article; the rostral margins are almost parallel, very slightly convex laterally, and terminate anteriorly in a more or less sharp angular process; at times two small, almost imperceptible tubercles may be seen, but in other specimens, on the contrary, the anterolateral angles of the rostrum are rounded. The acumen is broad at the base and sharp apically. The rostral surface is smooth, although some very small punctations may be seen in the median line, each with a seta that rests on the surface; the submarginal setae of the acumen do not extend over the margin. The ventral keel of the rostrum lacks the dentiform processes.

The postorbital ridges are slightly convergent, equal in length to the rostral margins; anteriorly they terminate in a short spiniform process that is inclined to the side. In other specimens, this process may be less well defined or absent (Plate 42, figs. 1 and 2).

The epistome exhibits certain variations, but one type may be

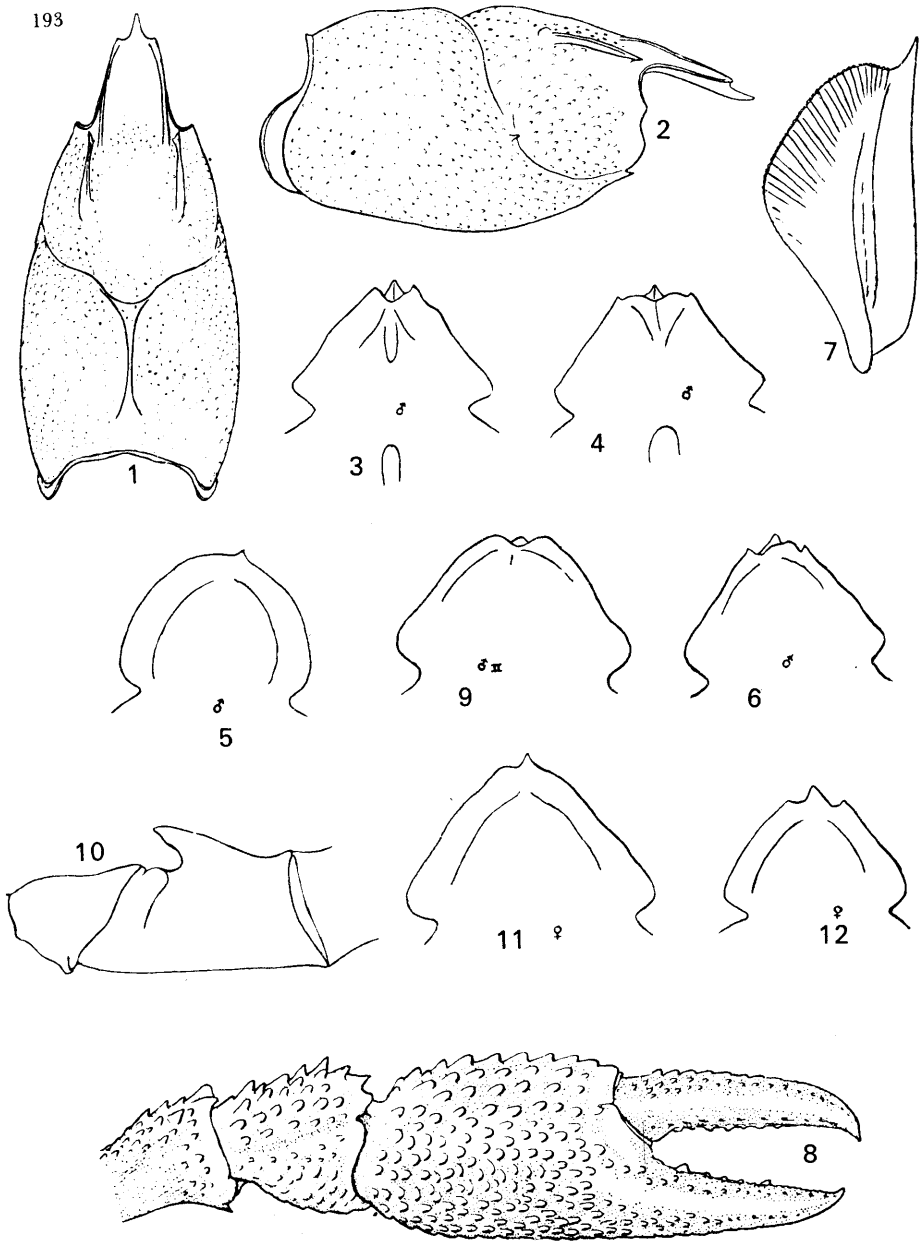


Plate 42. *Procambarus ruthveni* (Pearse). Male, Form I.

1, dorsal view of the carapace; 2, lateral view of the same; 3, 4, 5, and 6, different forms of the epistome; 7, antennal scale; 8, chela; 9, epistome of the male, Form II; 10, ischiopodite of the third pereopod of the male, Form I; 11 and 12, forms of the epistome of the female.

194 recognized (Plate 42, fig. 3) in which the contour is triangular with a more or less irregular emargination possessing two adjoining projecting angles; the epistome of other specimens (figs. 4 and 6) follows the same disposition; only one specimen (fig. 5) exhibits a semicircular epistome, but with the spiniform process on the left side of the anterior margin.

The abdomen is almost smooth, although there are a few small punctations on the surface of the somite, more abundant in the pleural regions. The distolateral angles of the first section of the telson exhibit two spines; one of them, the external, is very long, extending beyond the smaller by one-third or one-half of its length (the posterolateral spiniform angle of the telson is not included in these data).

The antennal flagellum, projected over the body, reaches the fifth abdominal somite. The antennal scale is moderately broad and its external border is slightly convex in the proximomedian part and slightly concave in the distal; the spine of the antennal scale is broad at its base and sharp in the anterior region; it is gently inclined to the side and reaches the distal articular border of the third antennular article; the greatest width is located a little beyond midlength and is less than half the total length of the scale (Plate 42, fig. 7).

The first pair of pereopods exhibit chelae of similar size; they are as long as the length of the body to the fifth abdominal somite, and in some specimens to the midlength of the cephalic part of the telson. The ischiopodite bears a series of three or four spiniform tubercles on its inferior border. The length of the meropodite is equal to that of the dactylopodite; its upper margin is scabrous; the tubercles are more numerous and larger in the distal part, and among them one of large size is conspicuous; a double row of spines is present on the lower margin, a characteristic of the other species of the genus; the spines of the internal row are very large and sharp and alternate with other smaller ones. The carpopodite is as long as the internal margin of the palm of the chela; on the dorsal surface there is a conspicuous deep groove and from it the internal surface of the article bears numerous heavy tubercles that become spiniform on the anterointerior margin of the article; the external surface is comparatively smoother than the internal, exhibiting only subsquamous, flattened and very isolated tubercles. The propodus is densely tuberculate; the tubercles of the internal part of the palmar region are very large, spiniform, and less numerous than those on the rest of the surface; those on the internal border are still more elevated, and there are nine or ten of them; the external dorsal region exhibits crowded subsquamous tubercles. The lower surface of the chela also has tubercles, but these are smaller and more widely dispersed. The movable finger is straight; the tubercles of

the palmar region invade the external base of the finger which exhibits a ridge extending its total length; in the proximal region of the cutting border, there stand out one or two large teeth, and on the remainder of the border there are small dentiform tubercles. The dactylopodite is longer than the immovable finger, slightly curved downward; in the proximal part of the dorsal surface there are very small tubercles that are present to the midlength of the finger; the ridge that runs along it is very low and completely smooth; on the cutting border, the teeth are more or less uniform in size; in the males, one large tooth situated at the end of the proximal third is well developed and conspicuous (Plate 42, fig. 8).

The ischiopodites of the third pair of pereopods exhibit a hook that is inserted on the median third of the article; its form is triangular, flattened in the same plane as is the ischiopodite; the base is more or less wide, the apex conical, a little incurved toward the appendix, and overreaching the articulation of the ischium with the basipodite (Plate 42, fig. 10).

The apices of the first pair of pleopods reach the coxopodites of the third pair of pereopods, are straight, and slightly unequal in length; the shoulder is as in the holotype and the inclination of declivity is approximately 35°; on the latter, there is a low prominence situated on the lateral part (Plate 43, figs. 1, 2, 3, 4, and 5); the mesial process is slender, sharp, curved inward, and is flexed over the lateral region of the apical part (Plate 43, figs. 4 and 5A). The central projection is short, broad, and directed cephalomesially; its apical margin bears a small angular prolongation (Plate 43, figs. 4 and 5CE). In one large specimen, the mesial process is wide, almost straight, and slightly inclined laterally, as occurs in the holotype.

Male, form II. The specimen that we describe has a length of 41.7 mm; the carapace is finely punctate in the gastric region; the punctations of the dorsal region of the thoracic portion of the carapace are more conspicuous; the branchial region is finely granulate, the hepatic region with sparser large tubercles; the lateral tubercles, in place of spines, of the carapace are very small. The areola is obliterated a little behind the median portion of its length.

The postorbital ridges are almost parallel and terminate anteriorly
196 in a very small spine.

The rostrum is short and subplane; the rostral margins are convergent and terminate anteriorly in rounded angles; the acumen is short, broad at the base, and sharp at the distal extremity (a strong similarity exists between the rostrum here described and that of the holotype).

The epistome (Plate 42, fig. 9) does not differ in general form from

that described for the male, form I, but in this case the anterior emargination is symmetrical with lateral angles rounded; nevertheless, in this character there is a similarity to the holotype.

The chelae of the first pair of pereopods are short and the palmar region wide; the tubercles of the surface are more sparing and much less well developed than in the male, form I. The dactylar part of the propodus or immovable finger is very wide at the base and straight; on the proximal cutting border there are three hardly discernible teeth; two smaller ones are evident on the remaining part of the border. The dactylopodite, or movable finger, is short, recurved toward the immovable finger, provided with tubercles in the proximal half of the upper surface; on the cutting border the dentiform processes are arranged along the entire length, progressively diminishing in size toward the extremity of the finger.

The ischiopodite of the third pair of pereopods exhibits only a hint of the hook, in the form of a rounded angular process preceded by an emargination (Plate 43, fig. 6).

The first pair of pleopods are slender in the proximal half and more robust in the distal, their apical parts reaching the caudal region of the coxopodite of the third pair of pereopods. The declivity of the shoulder is almost a right angle. The mesial process is subcylindrical, little sharp at the apical extreme, short, and slightly inclined laterally; the central projection is short, more or less flattened laterally, and projects cephalodistally (Plate 43, fig. 9).

Female. This is the largest specimen we have collected (total length 78.5 mm). The carapace is strongly punctate in the dorsal portion, but the punctations disappear in the gastric region; the branchial regions are finely granulate; in the hepatic region, the granules are a little larger and less numerous; the cephalic groove is very deep; the lateral spine of the carapace is well developed.

The areola is obliterated in the median portion of its length.

198 The postorbital ridges are slightly convergent, and terminate anteriorly in a very sharp, spiniform, slightly incurved tubercle.

The rostral margins are convergent, terminating anteriorly in an angular process which may be considered to be almost a small tubercle; the acumen is narrow at the base and the acuminal spine terminates at the level of the first third of the third article of the antennular peduncle. The rostral surface is slightly grooved with a group of punctations situated in a triangular area at the base of the rostrum; the remaining surface is smooth.

The cephalic section of the telson exhibits two spines in its distolateral angles, similar to those of the male, form I.

The epistome of this specimen (Plate 42, fig. 11) is quite distinct from the usual form that we have described for the male, form I; its

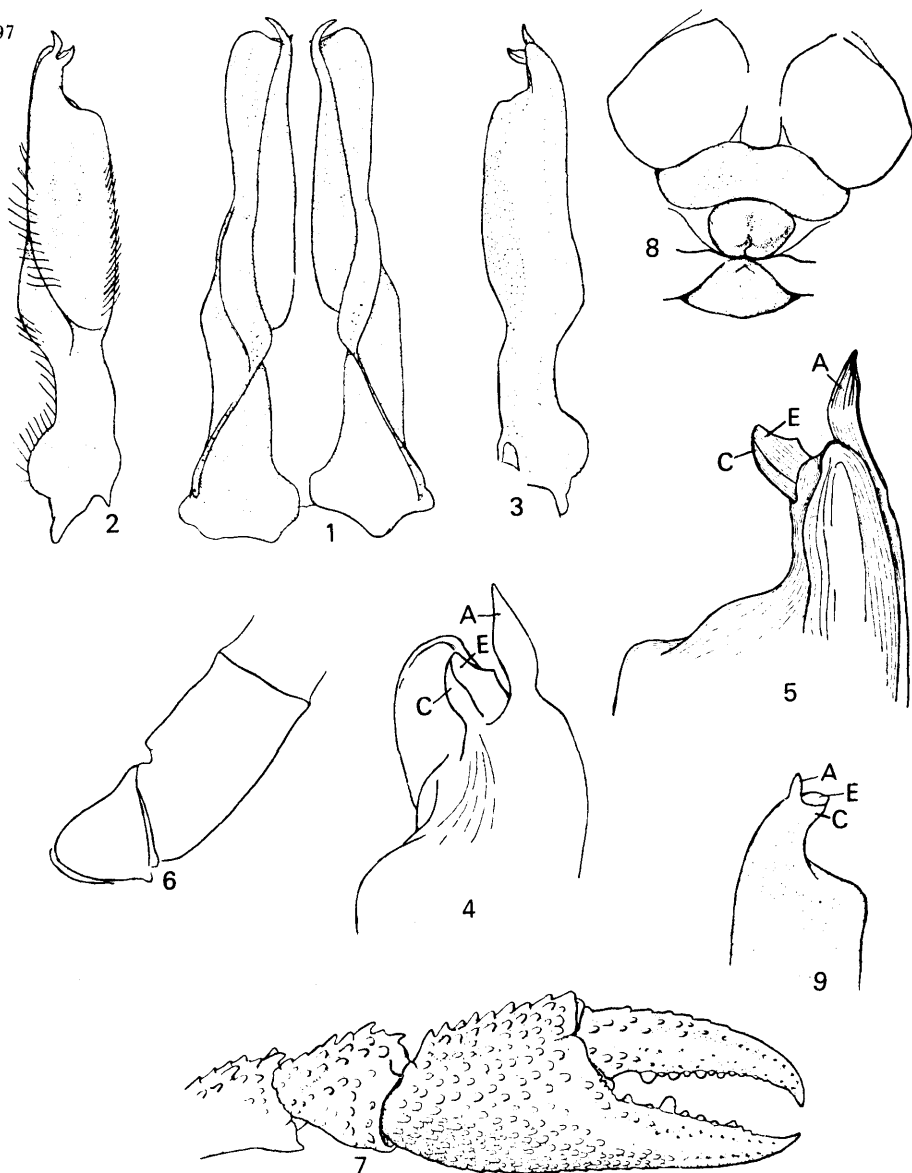


Plate 43. *Procambanus ruthveni* (Pearse). Male, Form I.

1, caudal view of the first pair of pleopods; 2, mesial view; 3, lateral view; 4, cephalomesial view of the apical region of the pleopod; 5, lateral view of the same; 6, ischiopodite of the third pereopod of the male, Form II; 7, chela of the female; 8, *annulus ventralis*; 9, view of the apical region of the first pleopod of the male, Form II (A, mesial process; CE, central projection).

contour is triangular, slightly asymmetrical anteriorly. Other specimens exhibit an epistome similar to that of the male, form I (Plate 42, fig. 12).

The first pair of pereopods (Plate 43, fig. 7) are very robust; the length projected over the body reaches the middle of the sixth abdominal segment. The carpopodite exhibits a very deep groove on the dorsal surface; the internal region is provided with large tubercles, less numerous and prominent than in the male; the external region bears a few small subsquamous tubercles near the border of the groove; the remainder of the surface has only large pits in the form of a half moon. The chela is broad, depressed, and the surface is heavily tuberculate; the tubercles of the internal margin are elevated and almost spiniform, giving the profile a serrate aspect; the tubercles of the dorsal internal surface are less prominent than in the male, form I. The external border is more or less angular, and bears crowded subsquamous tubercles. The finger region of the propodus is straight, broad at the base, sharp apically; a clearly delimited ridge is present on the upper surface; the basal external surface is provided with subsquamous tubercles that extend to the second third of the finger; the proximal region of the cutting border exhibits two teeth of moderate size, followed by a large one, and the latter by three teeth of decreasing size; beyond these, there is a dentiform process inserted on the lower part of the border, finally, in the distal third, there is a series of four or five very small teeth. The dactylopodite, or movable finger, does not have as well defined a ridge as does the immovable finger; the internal surface bears subsquamous tubercles that extend a little more than half its length; beyond, only setiferous punctations are arranged in a longitudinal series; the internal border is provided with nine subsquamous tubercles that diminish in size progressively to become almost imperceptible; the cutting border has numerous dentiform tubercles that begin in the proximal subarticular region with one large one; following there are three of lesser size of which the middle one is largest; immediately thereafter another as large as the first, and finally nine or ten regularly spaced teeth.

The *annulus ventralis* (Plate 43, fig. 8) exhibits very definite characters, perhaps associated with the size and age of the specimen; it is tuberculiform, its articulation permitting great movement cephalo-caudally, and able to turn in caudodorsal position between the sternite of the fourth and fifth pairs of pereopods; it presents a well defined median depression situated in the cephaloapical region where the margins are elevated in two mammiform processes. The groove begins in the apical cavity of this depression, and, for that reason, has a clear caudal position; it describes a curve in the form of an arc, convex to the right, on one or the other side of the groove there is another hemi-

spherical process less conspicuous than the anterior ones. Between the fifth pereopods, there is a conical tubercle gently inclined toward the *annulus* and which terminates in a small spine, also conical and not very sharp, which coincides with the extreme dorsal end of the groove of the *annulus ventralis*.

Measurements in millimeters

With the object of making the variations in this species more clear, in this case we follow the form in which Hobbs arranged the measurements in his redescription of the types of *P. ruthveni*; at the same time, we present together with the measurements of the types, which are within parentheses, measurements of our specimens which serve for this description.

To the data which Hobbs presented, we wish to add two measurements that seem to us of certain importance: the total length and the anterior width of the rostrum.

200

	Male, Form I		Male, Form II				Females			
Total length	65.2	60.5 (58.5)	51.5	48.0	41.6	79.0	61.5	56.0 (51.7)	47.0	
Carapace height	14.9	13.9 (13.8)	13.0	11.0	10.0	19.0	15.0	12.6 (12.4)	11.1	
width	15.9	14.3 (14.0)	13.3	11.4	10.0	19.4	14.8	13.2 (12.8)	11.2	
length	33.6	30.9 (29.9)	28.0	24.6	21.0	41.2	31.0	28.4 (26.4)	24.4	
Areola length	12.0	10.6 (10.5)	10.0	8.4	7.3	14.3	11.0	10.1 (9.3)	8.3	
width	..	0.4 ..	0.2	0.3	0.1	..	0.2	0.2 (0.2)	..	
Rostrum length	7.8	7.5 (6.7)	6.4	5.9	5.2	9.5	6.8	6.4 (5.8)	5.8	
anterior width	2.7	2.0 ..	2.1	1.6	1.6	2.1	2.0	1.8 ..	1.3	
posterior width	4.5	4.2 (4.3)	4.4	3.5	2.9	5.4	4.5	4.0 (4.0)	3.5	
Chela										
length of internal										
margin of palm	11.3	9.2 (10.1)	8.7	7.4	5.6	10.8	7.9	6.8 (6.4)	5.8	
width of palm	10.0	7.6 (9.1)	8.0	7.0	6.1	11.0	8.0	7.9 (6.5)	6.3	
length of external										
margin of hand	26.6	21.6 (23.7)	21.0	17.0	13.6	29.0	20.7	16.8 (15.5)	14.4	
length of										
dactylopodite	15.4	12.8 (12.8)	12.0	10.0	8.0	16.7	11.4	11.0 (8.6)	9.6	

Localities. Cuatotolapan, Veracruz. Alt. S.N.M. 15 m (type locality) Pearse. 1 male, form I, 1 female with young, San Juan Díaz Covarrubias, 10km S.W. of Cuatotolapan, Veracruz, Alt. S.N.M. 15 m, 4 males, form I, 1 male, form II, 4 females.

201

The specimens collected in San Juan Díaz Covarrubias have distinct burrowing habits. They were collected in pools of water along the roadside of the Carretera Transistmica. At the time in which we made our collection (December), the specimens were found within their burrows. These were recognized by the chimneys of pellets of mud which were observed on the bank of small pools; usually each burrow

has two entrances which, separated by some 20 cm, have independent tunnels; these, forming the rami of a Y, unite to form the principal tunnel which may reach a depth of 75 cm and may be vertical or inclined toward the pool.

Relationships. *Procambarus ruthveni* exhibits affinities with *P. vazquezae* and with the species of the southern part of the Republic, demonstrated by the form of the apical region of the pleopods of the male, form I; by this same character, it differs markedly from *Procambarus mexicanus*.

Discussion. For a long time, *P. ruthveni* was considered to be synonymous with *P. mexicanus*, furnishing a special desire on our part to collect material which would permit us to clarify this situation. On four or five occasions, we visited the area of San Andrés Tuxtla, attempting to obtain Pearse's species; later we sent a few specimens from these collections to Dr. Hobbs for his comparison with the types deposited in the Museum of Michigan [Museum of Zoology, University of Michigan], which gave occasion to Dr. Hobbs to prepare a redescription of these types, a copy of which, as of now unpublished, is in my possession by courtesy of said specialist.

There are two specimens upon which Pearse and Hobbs made the description and redescription, respectively, of the species; the latter is accompanied by excellent drawings and a table of measurements.

In December 1953, we had the opportunity to collect in San Juan Díaz Covarrubias, Veracruz, a good lot of material, a study of which showed great similarities to *P. ruthveni*; however, with some differences that, for a short time, made us think that we had specimens of a new subspecies. Thanks to the table of measurements of the types which Hobbs included in his redescription, we discovered that in reality our specimens coincide with the characteristics of *P. ruthveni* and furnished the occasion for broadening, with our description, our knowledge of the variability of the species.

Thus, comparing the localities of the types on one side and that of our specimens on the other, we find: (A) that San Juan Díaz is some 10 km distant from Cuatotolapan; (B) that the climatic and topographic conditions are the same, since both localities are at 15 m above sea level; (C) that the localities belong to the same hydrographic basin; and (D) that the types and the specimens from San Juan Díaz de Covarrubias also have the same habitat and the same habits.

Conclusion. The characteristics annotated in this study should be included among those of *Procambarus ruthveni*.

Procambarus ruthveni zapoapensis Villalobos

1954b *Procambarus ruthveni zapoapensis* Villalobos, An. Inst. Biol. de la Univ. Nal. A. de México, Vol. XXV, pp. 347 - 355.

Diagnosis. Crayfishes of medium size. Rostrum subplane; rostral margins convergent, terminating abruptly anteriorly in angular process, without lateral spines, acumen narrow basally and sharp apically. Postorbital ridges terminating in very short spines. Carapace with very small lateral spines; areola very narrow. Epistome with emargination in anterior part, ending on each side in spiniform process. Chelae of first pair of pleopods of male unequal in size. Hook on ischiopodites of third pair of pereopods. First pair of pleopods of male with shoulder strongly inclined, mesial process flattened cephalocaudally, slightly inclined laterally. *Annulus ventralis* small, tuberculiform, with depression in cephalic portion. Tubercle between fifth pereopods of female terminating in small spiniform structure.

Male, form I. The carapace is shorter than the abdomen and flattened laterally; the surface is densely punctate, except for the gastric region which is smooth; the anterolateral portion exhibits numerous small tubercles that are more abundant and conspicuous in the hepatic region. The carapace exhibits two lateral spines, one on each side, situated on the posterior margin of the groove limiting the hepatic region; the branchiostegal spine is present. The cephalic groove is deep with three very regular undulations in the dorsolateral portion. The areola is narrow (0.4 mm). The postorbital ridges are parallel and terminate anteriorly in a short, spiniform tubercle. The rostrum is narrow basally, the acuminal spine reaching midlength of the third antennular article; the rostral margins are slightly convex, convergent, and terminate abruptly anteriorly in angular processes; there are no lateral rostral spines. The acumen is narrow basally, distinctly sharp; the surface of the rostrum may be considered to be subplane or slightly grooved; it is smooth, but exhibits isolated punctations at the base that are limited to a circular depression on the surface; anteriorly there are a few setae reclining on the surface, those inserted on the margin of the acumen overreaching the edge; the ventral keel of the rostrum is smooth (Plate 44, figs. 1 and 2).

The proportions of the different parts of the carapace are the following: the length of the areola is a little more than half the length of the cephalic portion; the posterior width of the rostrum is one-seventh the length of the total length of the carapace; the length of the rostrum goes into the length of the carapace four and one-half times; the posterior width of the rostrum is two or three times greater than the anterior width.

The epistome (Plate 44, fig. 3) is scutiform, at times with a median emargination the lateral angles of which are produced in two projecting angles. In general, it may be said that variations exist in the contour of the epistome, but always in them there is the tendency to show the type just described.

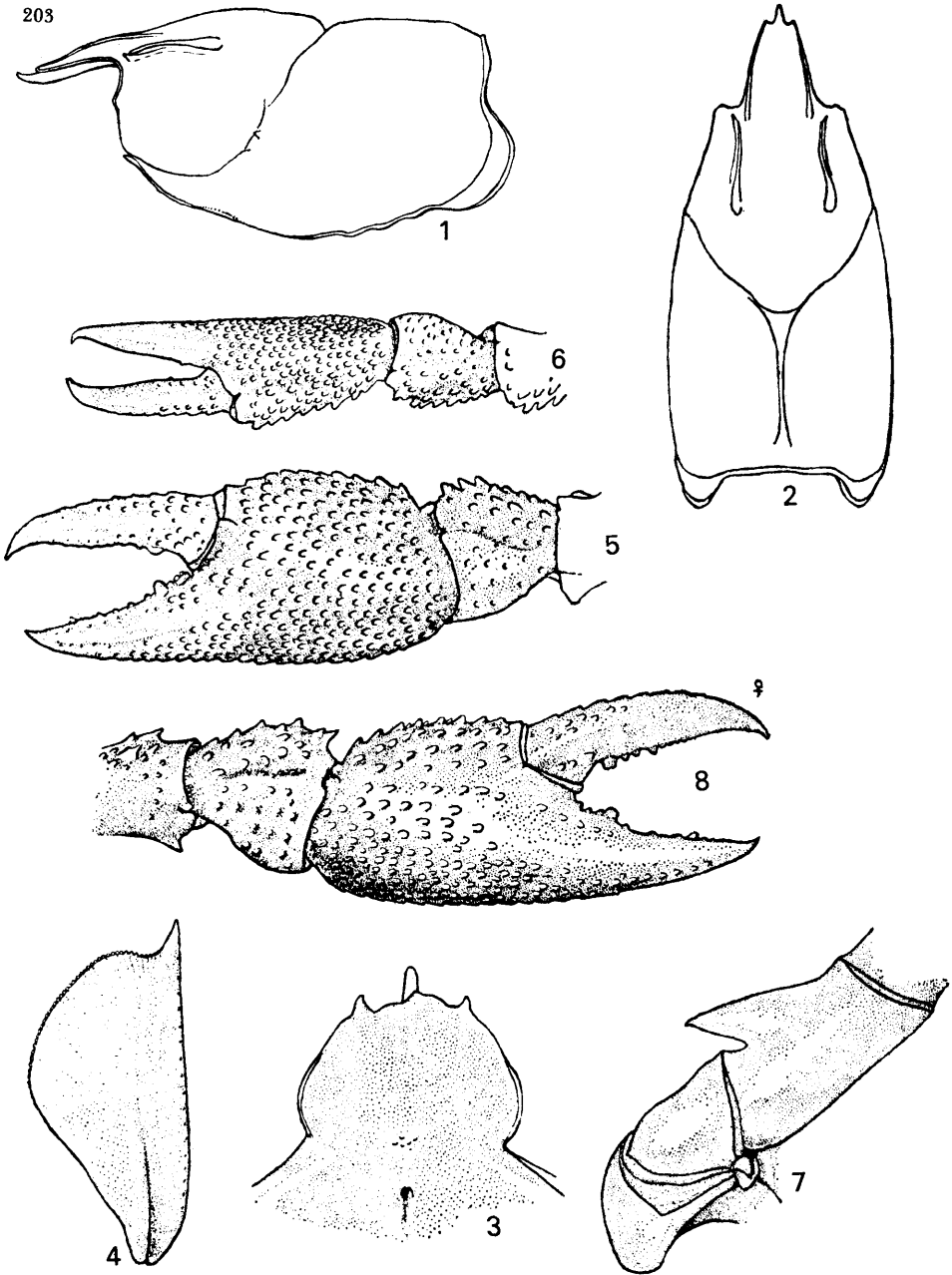


Plate 44. *Procambarus ruthveni zapaopensis* [sic] Villalobos. Male, Form I.

1, lateral view of the carapace; 2, dorsal view of the same; 3, epistome; 4, antennal scale;
5 and 6, chelae; 7, ischiopodite of the third pereiopod; 8, chela of the female.

The abdomen is almost smooth in the tergal region; only a few very small punctations are present in the posterior region of each somite; in contrast, in the pleural regions the punctations are more numerous but are still small. The anterior portion of the telson exhibits parallel margins, and the distolateral angles are provided with two spines, the internal forming part of the main piece of the telson and the external articulated.

The antennal scale (Plate 44, fig. 4) is of medium width, and its spine reaches the second third of the third antennular article; the external margin of the scale is slightly convex in its posteromedian portion and slightly concave in the distal half; the greatest width of the scale is slightly anterior to midlength, and less than half the width of the scale.

205 The first pair of pereopods are very characteristic in this species in exhibiting asymmetrical chelae, that is to say, one larger than the other; the smaller may be either left or right. This character is found principally in the adult males (Plate 44, figs. 5 and 6). The length of the major appendage, projected over the body, reaches over the sixth abdominal somite, and, when the appendage is very well developed, to the first section of the telson. The minor appendage may have the same length as the major one, but usually it is shorter. The meropodite is robust and short; the internal face is provided with subsquamous tubercles in the anterior half; the external face is apparently smoother and the only tubercles are dispersed in the upper part of the anterior third; the upper margin is densely tuberculate along the entire length and in the anterior part there is a conical, sharp, spiniform tubercle inclined forward that stands out conspicuously from the others; the lower margin is armed with a double series of short spines, conical and sharp, and very little inclined forward; in the internal row, two that are located more or less at the midlength of the article stand out slightly by their size. The carpopodite is short, with a more or less deep groove that extends the entire length of the article parallel to the internal margin; the dorsal internal surface is strongly tuberculate; the tubercles also invade the cavity of the groove; the dorsal external surface is smoother, but tubercles are present on the external border, uniquely very flattened in this case; the lower surface is armed with spiniform tubercles of which one large one stands out near the articular margin. The propodus of the major chela is broad and depressed; the external border is rounded, the internal cristiform; the surface of the palmar region is densely covered with tubercles which are more sparse in the center of the dorsal region and in all of the ventral region; the tubercles of the internal margin are sharp and elevated, giving this margin a serrate appearance; the dactylar portion of the propodus is almost straight, broad at its base, and the external dorsal surface covered with subsquamous tubercles; it presents, moreover, a ridge or rib, the base

of which is very broad, that extends the entire length of the finger; on the cutting border there is a large tooth in the proximal third; following is a double linear series of small hemispherical teeth, those on the lower part less numerous; sometimes other large teeth occur in the ultimate third of the finger, but implanted on the lower part of the cutting border. The dactylopodite, although longer than the immovable finger, does not overreach it when the terminal teeth are brought together; it is robust, almost straight, slightly concave on the inferior surface; it is provided with subsquamous tubercles on the proximal external half; it lacks a rib, or well defined thickened border; nevertheless its dorsomedian part is completely smooth and stands out clearly from the rest of the surface; in the dorsal internal region, there are a few subsquamous tubercles limited to the proximal half; the cutting border has two or three large tubercles in its posterior region; following are small denticles that diminish in size progressively and disappear in the subterminal region (Plate 44, fig. 5).

206 The smaller chela of the same pair of pereopods is slender, more densely covered with tubercles; the teeth of the cutting border of the immovable finger are very small, only one conspicuous in the proximal third; the dactylopodite, or movable finger, is straight, curved downward, slender, and the internal margin armed with subsquamous tubercles along its entire length, more numerous in the proximal third; the cutting border exhibits a single large tubercle in the proximal third; the others are exceedingly small, very close to one another, and visible only in the proximal two-thirds of the finger (Plate 44, fig. 6).

The ischiopodite of the third pair of pereopods is armed with a hook that is implanted on the proximal third of the article; the anterior margin of the hook is continuous insensibly with the margin of the article which presents the form of a ridge or keel; the basal section of the hook is flattened in the same plane as the article, but from there, the hook is more conical, nevertheless flattened on its axial face, which is provided with numerous short setae; the distal third of the hook overreaches the articulation of the ischium with the basipodite; on the internal part of the hook, the ischiopodite exhibits an emargination (Plate 44, fig. 7).

The first pair of pleopods reach, with their apical parts, the coxopodites of the third pair of pereopods; they are straight, slender distally, flattened laterally in their distal two-thirds, very slightly unequal in length; the shoulder is well formed and its declivity is approximately 35° , presenting a slightly concave plane inclined toward the lateral region of the appendage (Plate 45, figs. 1, 2, and 3). The mesial process (Plate 45, figs. 4 and 5A) is foliaceous distally, narrow proximally, slightly inclined toward the side of the apical part of the appendage. The central projection (Plate 45, figs. 4 and 5CE) is

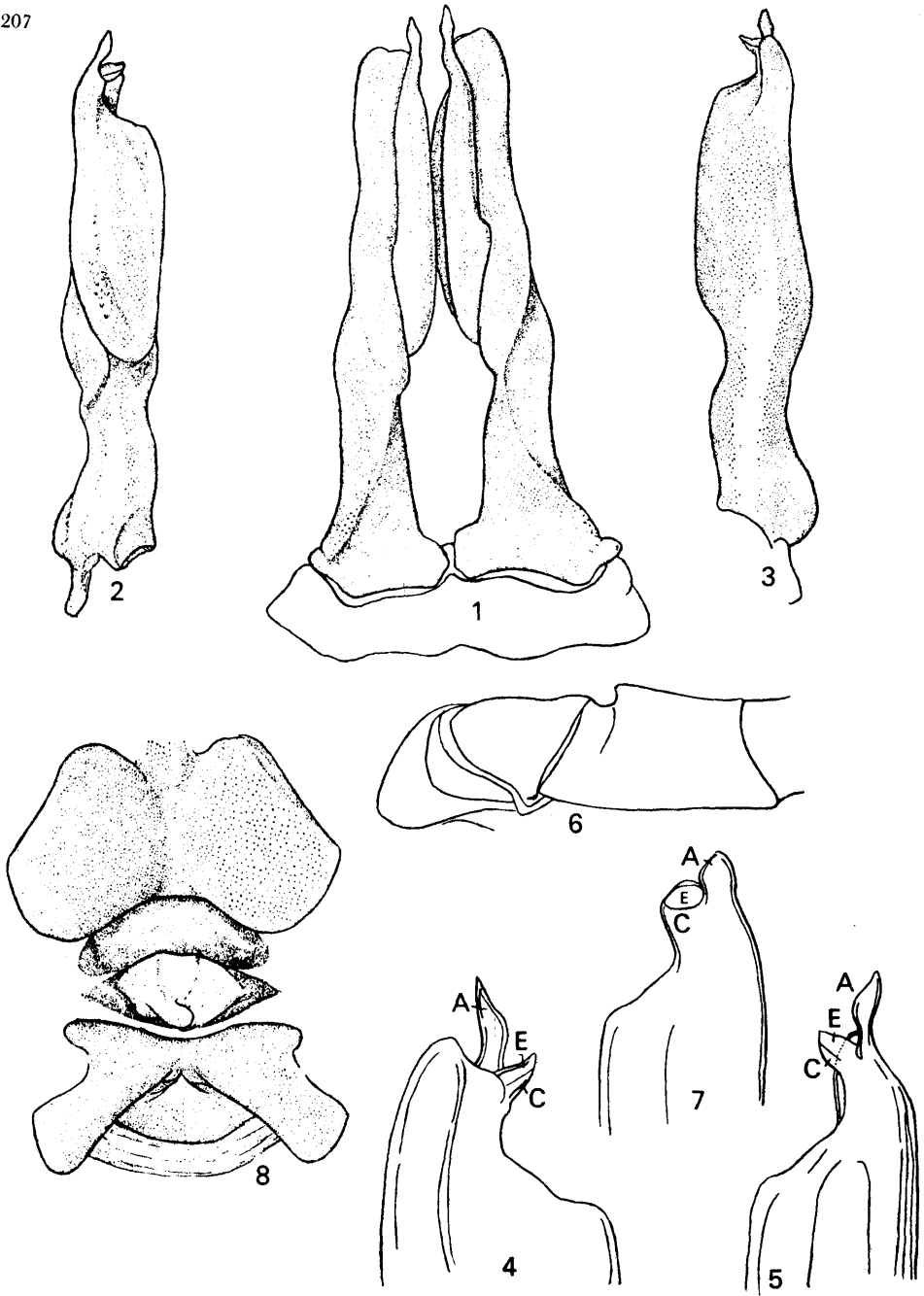


Plate 45. *Procambarus ruthveni zapoapensis* Villalobos. Male, Form I.

1, caudal view of the first pair of pleopods; 2, mesial view; 3, lateral view; 4, lateral view of the apical part of the same; 5, mesial view of the apical part; 6, ischiopodite of the third pereiopod of the male Form II; 7, apical region of the first pleopod of the male, Form II (A, mesial process; CE, central projection); 8, *annulus ventralis*.

flattened laterally, straight, quadrangular at its base and triangular at the apex. In the mesial region of the appendage, there is a ridge which extends from the basal region of the mesial process and is prolonged to the subapical region of the central projection; here on this ridge the cephalic process should be found but there is no structure to denote its existence. In the apical part of the caudolateral surface, there is a cephalocaudally flattened prominence which continues mesially with the apical margin of the central projection; this prominence overreaches in height the central projection and reaches half the length of the cephalic process.

208 **Male, form II.** In the juvenile specimens, the carapace is considerably smoother than in the male, form I, and in the gastric region there are widely dispersed, very small punctations; the areola is slightly wider than in the adult specimen; the postorbital ridges terminate in spines sharper than in the adult; the spines of the carapace are also very sharp; the rostrum is subplane but slightly concave in the anterior part; the rostral margins are almost straight and very convergent; the anterolateral angles are obtuse and the acumen is rather short and very narrow at its base; the acuminal spine is sharp and projects to the distal third of the third article of the antennular peduncle.

The epistome does not exhibit an anteromedian emargination but in this site there is a median angular structure; however, two small prominences may be observed, one on each side and very near the anteromedian angle.

The abdomen is completely smooth over its entire surface, and the distolateral angle of the first section of the telson exhibits two spines, without counting the external spiniform angle typical of this section of the telson.

The chelae of the first pair of pereopods are very small but unequal in size; the external margin of the chela is slightly concave; the fingers are cylindrical and the cutting borders exhibit exceedingly small teeth. The palmar region is completely covered with tubercles.

The ischiopodites of the third pair of pereopods exhibit a semi-circular emargination proximally, beyond which arises a rudiment of the hook which has the form of an angular structure of 45° (Plate 45, fig. 6).

The first pair of pleopods exhibit a shoulder with the same declivity as that in the male, form I, but it is nearer the apical region; the mesial process is a rhomboidal plate narrowly united to the central projection which resembles a hemispherical tubercle with a line that divides it into basal and apical parts; this line is continuous with the cephalic margin of the mesial process (Plate 45, fig. 7).

Female. The carapace is apparently smoother than in the male, form I; the anterior part of the gastric region completely lacks

punctations; the posteromedian part of the hepatic region has tubercles; the lateral spines of the carapace are strong, sharp, and slightly curved inward. The areola is very narrow. The postorbital ridges are convergent and terminate in a spiniform tubercle. The apical spine of the rostrum reaches the distal third of the third antennular article; the rostral margins are weakly convergent and terminate anteriorly in an angular, almost spiniform structure; the acumen is very narrow at its base; the rostral surface is distinctly grooved and smooth.

The epistome is triangular in shape, flat, and lacks the anterior spiniform prominences.

The abdomen, as in all females, is wider anteriorly than the posterior region of the cephalothorax; the surface of the somites is very smooth, except for a few punctations in the pleural regions of each. The lateral margins of the first part of the telson are parallel and two spines are present in each of its distolateral angles.

The spine of the antennal scale reaches the middle part of the third article of the antennular peduncle.

The chelae of the first pair of pereopods are usually small but equal in size. The surface of the palmar region exhibits fewer tubercles than the chela of the male. The cutting border of the fingers is armed with tubercles that are disposed as in the male (Plate 44, fig. 8).

The *annulus ventralis* (Plate 45, fig. 8) is tuberculiform, cleft in its median portion by a longitudinal depression in the major axis of the body. The groove is disposed in the caudal region of the *annulus*, beginning in the apical part and terminating in the basal portion. Between the fifth pereopods of the female there is a tubercle terminating in a small spiniform process.

Measurements in millimeters

	Male, Form I	Male, Form II	Female
Total length	70.0	59.0	51.7
Length of carapace	35.0	29.5	25.0
Anterior part of carapace	22.7	19.7	17.0
Length of areola	12.3	9.8	8.0
Width of areola	0.4	0.4	0.4
Length of abdomen	35.0	29.5	26.7
Posterior width of rostrum	5.0	4.4	3.8
Length of rostrum	8.0	7.4	6.2
Length of major chela	26.2	11.7	13.7
Length of minor chela	21.5	11.0	13.0
Length of movable finger of major chela	14.2	6.3	8.4
Length of movable finger of minor chela	11.0	6.3	8.3

Locality, Zapopan de Cabana, 11 km S.S.E. of Catemaco, Veracruz. Rio Papaloapan Basin. Altitude 500 m above sea level.

210 **Relationships.** *Procambarus ruthveni zapoapensis* has close affinities with *Procambarus ruthveni* (Pearse), evident both in their morphology and geographic distribution.

The characteristics that lead us to consider this a subspecies of *P. ruthveni* are the following :

<i>P. ruthveni zapoapensis</i>	<i>P. ruthveni</i>
I. Rostral margins convergent.	I. Rostral margins little convergent.
II. Areola narrow, never obliterated.	II. Areola very narrow, sometimes obliterated.
III. Epistome with its anterolateral margins distinctly convex; anterolateral spines very far apart.	III. Epistome with its anterolateral margin straight; anterolateral spines less far apart.
IV. Chelae of first pair of pereopods unequal in size in males.	IV. Chelae of first pair of pereopods equal in size in males.
V. Apex of hooks on ischiopodites of third pair of pereopods of male considerably overreaching articulation of ischium with basipodite.	V. Apex of hooks on ischiopodites of third pair of pereopods of male barely overreaching articulation of ischium with basipodite.
VI. Declivity of shoulder of first pair of pleopods of male smooth, in form of plateau slightly inclined laterally.	VI. Declivity of shoulder of first pair of pleopods of male with hump or prominence.
VII. Mesial process foliaceous, directed distally or slightly inclined laterally.	VII. Mesial process narrow, recurved and inclined laterally.
VIII. <i>Annulus ventralis</i> slightly cleft in its apical part.	VIII. <i>Annulus ventralis</i> deeply cleft in its apical part.

Procambarus mirandai Villalobos

1954b *Procambarus mirandai* Villalobos, An. Inst. Biol. de la Univ. Nal. A. de México, Vol. XXV, pp. 355 – 363.

Diagnosis. Areola broad; carapace without lateral spines; single branchiostegal spine. Rostrum slightly grooved; rostral margins subparallel, converging at anterior extremity; angular structures in place of lateral spines; acumen short. Anterior part of telson with three spines in each distolateral angle. Eyes reduced; cornea slightly depigmented. Chelae of first pair of pereopods of male slender and rather long.
212 Ischiopodite of third pair of pereopods with hooks. First pair of pleopods of male, form I, slender; mesial process spiniform, recurved and inclined laterally; shoulder well developed. *Annulus ventralis* small, tuberculiform, and cleft in cephalic part.

Male, form I. Of regular size. The carapace is clearly wider than the abdomen; the surface is finely punctate; the punctations are more apparent in the dorsal region of the thoracic portion and almost imperceptible in the dorsal region of the cephalic part; the lateral

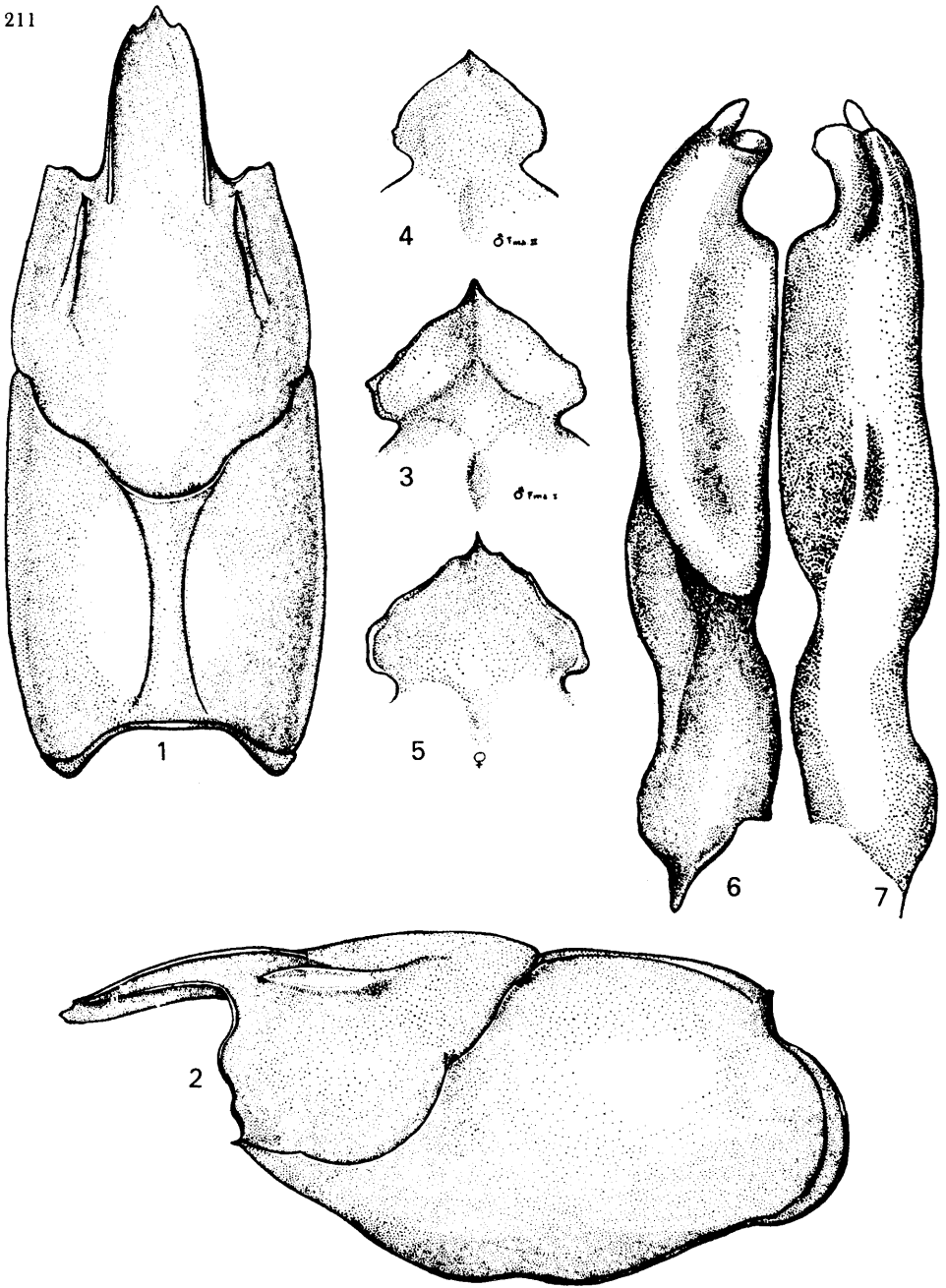


Plate 46. *Procamburus mirandai* Villalobos. Male. Form I.

1, dorsal view of the carapace; 2, lateral view of the same; 3, epistome; 4, epistome of the male, Form II; 5, epistome of the female; 6 and 7, mesial and lateral views of the first pleopod of the male, Form II.

regions exhibit tubercles, the size of which increases on the lower part of the carapace. There are no lateral spines on the carapace; at times a small tubercle similar in form to those of the surface of the carapace, but slightly larger, may be located in the site normally occupied by the lateral spine.

The branchiostegal spine is conical and sharp, located posterior to the cephalic groove, but very near it. The postorbital ridges are convergent and terminate anteriorly in a short, sharp, spiniform process.

The rostrum is wide throughout its entire length; only in the apical region does it become narrow; the surface of the rostrum is slightly grooved and smooth; there are no lateral spines or angular structures on the rostrum; at times any irregularity is so little apparent in this part of the rostral margins that they appear to continue insensibly with the acumen; the latter is broad at its base, short in length, and the acuminal spine reaches the anterior third of the second antennular article. The ventral keel of the rostrum has no dentiform processes (Plate 46, figs. 1 and 2).

The areola is broad, its surface is slightly depressed and provided with punctations which are sparse in the anterior region but abundant in the posterior.

The epistome is pentagonal in form; the margins that originate in the apical region are long, the sides near the base being very short; the surface of the epistome is slightly concave, rather, the margins are elevated above it (Plate 46, fig. 3).

The sternite between the first and second pairs of pereopods exhibits a keel with two or three tuberculiform processes of which two are rather prominent. The tubercle on the sternite between the second and third pereopods is very reduced.

The proportions between the different parts of the carapace are the following: the length of the areola is almost exactly half the length of the cephalic portion; the width of the areola is seven times less than the length; the length of the rostrum is one-fourth that of the carapace; the
214 posterior width of the rostrum is seven and one-half times less than the length of the carapace and three times less than the anterior width.

The antennal scale (Plate 47, fig. 1) is wide; the external margin is slightly convex in its proximal half and slightly concave in the distal. The greatest width of the scale occurs at midlength, and is equivalent to a little less than half the distance between the base and the spine; the latter is short, conical, and slightly inclined to the side. The antennal flagellum is as long as the space between the anterior extremity of the rostrum and the sixth abdominal somite.

The first pair of pereopods exhibit large flattened chelae (Plate 47, fig. 2); conspicuous is the great increase in length of the propodus and

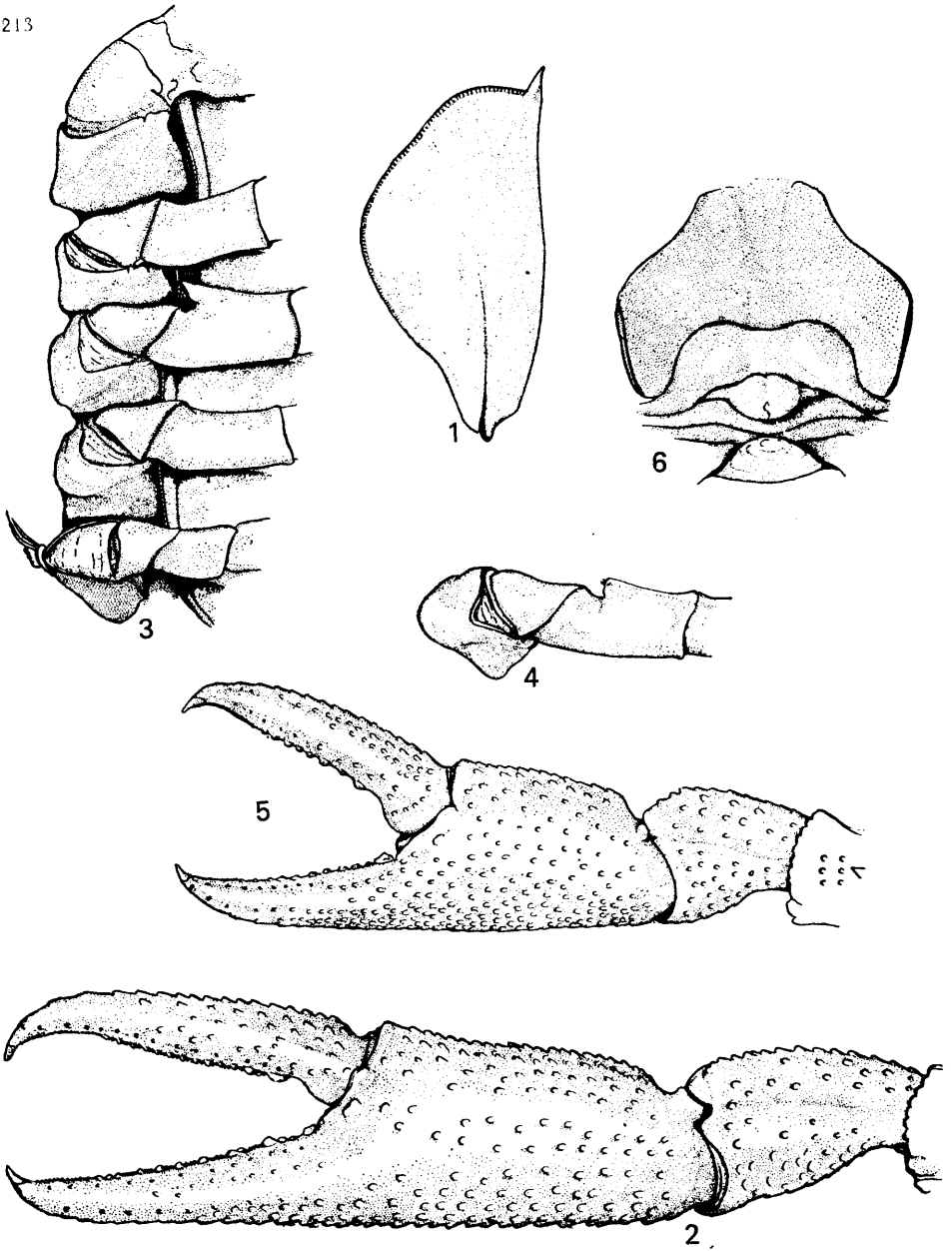


Plate 47. *Procambanus mirandai* Villalobos. Male. Form I.

1, antennal scale; 2, chela; 3, pereiopods I to V; 4, ischiopodite of the third pereiopod of the male, Form II; 5, chela of the female; 6, *annulus ventralis*.

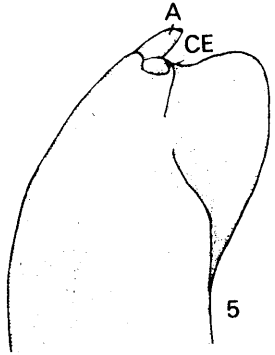
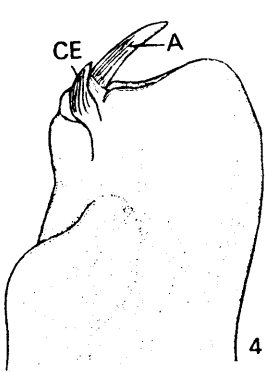
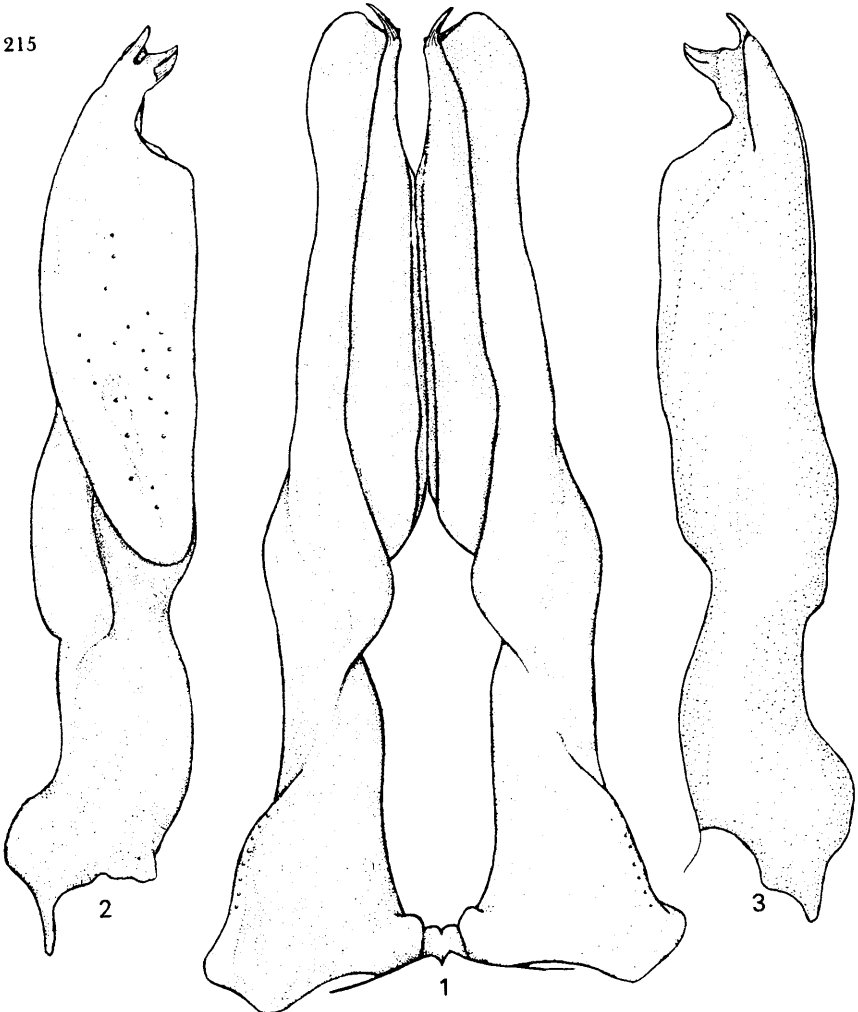
of the dactylopodite. The total length of the appendage, projected over the body, reaches the sixth abdominal somite. All of the surface of the chela is densely covered with small tubercles of more or less the same form, although those that are implanted on the margins are a little more elevated. Such tubercles are also located on the upper face and proximal region of the fingers, along almost the entire length of the internal border of the dactylopodite, and on the external margin of the immovable finger. The internal margin of the propodus is inclined from in front to behind, the greatest width being in the distal region of the palm. The immovable finger is broader at the base than the dactylopodite; on the upper face, one hardly notices a ridge or rib; the cutting margin exhibits teeth along its entire length, the larger ones situated near the base; the teeth of the distal third of the finger are arranged in a double row. The dactylopodite is slender, slightly incurved at the free extremity; on the surface there is no trace of a ridge or rib; the lack of tubercles is noticeable only in the distal half. The cutting border exhibits dentiform tubercles disposed similar to those of the immovable finger. The length of the dactylopodite is equal to that of the palm and half the length of the carpopodite. The carpopodite has the form of an inverted truncate cone; its surface is covered with tubercles except for a band that runs longitudinally on the upper face of the article; the tubercles on the internal region are more prominent than those on the external. On the other hand, there is a notable reduction in the sharpness of the spiniform processes that are normally found on the anterior articular border. The greatest width of the carpus is exactly half the greatest width of the propodus. The upper border of the meropodite exhibits a surface provided with tubercles that are
216 arranged in transverse series, and subterminally one spiniform tubercle is prominent; the lateral faces are smooth in their proximal two-thirds; the lower border exhibits conical, spiniform, forwardly directed tubercles, the size of which increases distally; near the anterior articular border there is one that is larger than the others.

The ischiopodite of the third pereopods exhibits a hook the form of which is a cone depressed in the anteroposterior plane; its apical region distinctly overreaches the articulation of the basipodite with the ischiopodite (Plate 47, fig. 3).

Among the lot of specimens collected in Cerro Hueco, Chiapas, we have found two males, form I, in which the ischiopodites of the second

Plate 48. *Procambarus mirandai* Villalobos. Male, Form I.

1, caudal view of the first pair of pleopods; 2, mesial view; 3, lateral view; 4, cephalic view of the apical region; 5, cephalic view of the apical part of the first pleopod of the male, Form II.



and third pairs of pereopods are provided with a hook. As we know, normally the species of the *mexicanus* Section exhibit hooks only on the ischiopodites of the third pair. Taking into consideration the fact that there may be variability in some species in regard to the number and position of such hooks, we believe that this phenomenon should be taken as an anomaly of the species, a rule which in the cases mentioned by Hobbs, the tendency is to reduce the normal number and in this case to be augmented to two pairs, as they exist in the species of the genus *Cambarellus*. On the other hand, it is pertinent that the abnormal specimens were found in the same locality.

The apical region of the first pair of pleopods reaches the posterior part of the coxopodites of the third pair of pereopods. The shoulder is well developed; the declivity has an inclination of approximately 40°, and its profile with the cephalic margin is an obtuse angle, the vertex of which is more or less rounded (Plate 48, figs. 1, 2, and 3); the mesial process is relatively short, almost spiniform, recurved, and gently inclined laterally (Plate 48, fig. 4A); the central projection is directed in such a manner that its surfaces remain oriented toward the sides; its apical part is a little recurved toward the end of the appendage (Plate 48, fig. 4CE). A character of the first pair of pleopods of the male, form I, that I consider to be important is a zone situated on the lower part of the mesial face in which the chitin is thinned in such a manner as to make it transparent.

Male, form II. In these specimens, the distance between the two anterolateral angles of the rostrum is much shorter than in the male, form I. The carapace is smooth.

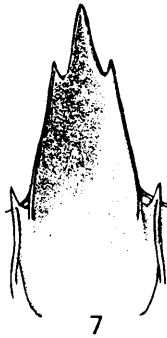
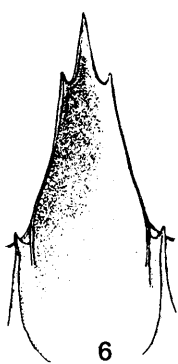
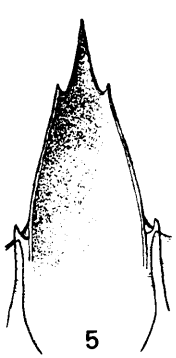
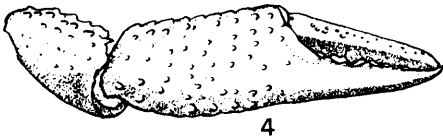
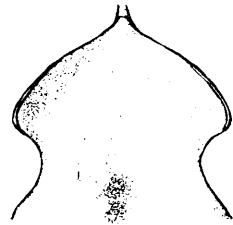
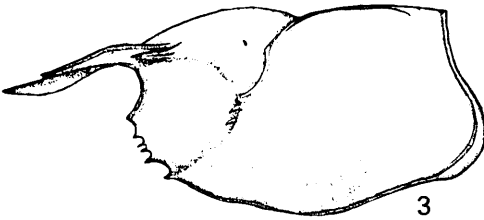
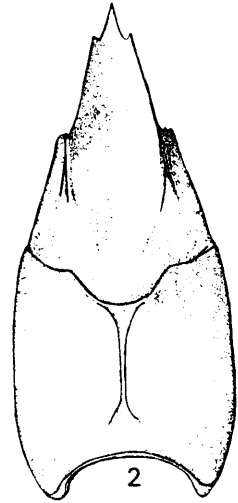
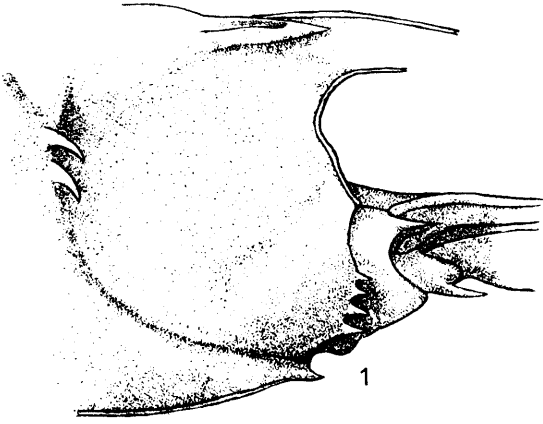
The borders of the epistome are more rounded although it does not differ in its general form (Plate 46, fig. 4)

217 The chelae of the first pair of pereopods are more slender than those of the male, form I; the greatest width of the carpopodite is greater than half the width of the chela; the length of the dactylopodite is equal to that of the palm of the chela and the proximal third of the carpopodite. The lower margin of the meropodite exhibits a well defined spine situated approximately at midlength of the article.

The ischiopodite of the third pair of pereopods exhibits a much reduced hook, the proximal extremity of which is sharp, resembling, for the most part, the general form of the hook in the adult male (Plate 47, fig. 4).

Plate 49. *Procambarus acanthophorus* Villalobos. Male, Form I.

1, lateral view of the anterior part of the carapace; 2, dorsal view of the carapace; 3, lateral view of the same; 4, chela; 5, rostrum of the male, Form II; 6, rostrum of the female; 8, ischiopodite of the third pereopod of the male, Form I; 9, antennal scale of the same; 10, epistome of the same.



The first pair of pleopods exhibit blunt apical structures, thus the mesial process is conical and short; the central projection resembles a tubercle in which the centrocaudal and centrocephalic processes may be seen (Plate 48, fig. 5).

Female. The rostrum is similar to that of the male, form II, although the surface is flatter. The surface of the areola is more deeply depressed in the median portion, the suprabranchial grooves appearing as true ridges.

The chelae of the first pair of pereiopods are clearly smaller than in those of either form of the male; however, the proportion of the dactylopodite in relation to the palmar region of the chela and the carpopodite is equal to that in the male, form I (Plate 47, fig. 5).

The *annulus ventralis* is tuberculiform, rhomboidal in section at its base; it is excavate in almost all of its cephalic portion, but the groove is restricted to the caudal region and has the form of an S (Plate 47, fig. 6).

Between the fifth pereiopods, there is a tubercle, the apical part of which is slightly sharp.

Measurements in millimeters

	Male, Form I	Male, Form II	Female
Total length	51.0	53.2	41.6
Length of carapace	25.9	26.3	23.0
Anterior part of carapace	17.3	18.0	15.3
Length of areola	8.6	8.3	7.7
Width of areola	1.2	1.2	0.9
Length of abdomen	25.1	26.9	18.6
Posterior width of rostrum	3.5	3.6	3.6
Length of chela	25.2	19.5	13.8
Length of movable finger	14.2	11.5	7.7

218 **Locality.** Cerro Hueco, 4 km S.E. of Tuxtla Gutierrez, Chiapas. Approximately 750 m above sea level. The specimens were collected in a cave which is the exit of a subterranean river.

Relationships. In spite of the distinct cavernicolous habitat of this species, the relationships that might exist with *Procambarus rodriguezii* are difficult to establish; nevertheless, in certain characteristics that are not products of convergence, the two species coincide with one another. But by the form of the rostrum, of the hooks on the ischiopodites of the third pair [of pereiopods], of the shoulder on the first pair of pleopods and of the apical parts of the appendage, as well as by the width of the areola, *P. mirandai* is completely distinct from *P. rodriguezii*.

Procambarus mirandai has no characteristics that are as markedly troglobitic as *P. rodriguezii*, but worthy of taking into account are the depigmentation of the body, the relative reduction of the ocular

peduncle, the slight depigmentation of the cornea, and the slender form of the chela of the first pair of pereopods.

Procambarus acanthophorus Villalobos

- 1948 *Procambarus acanthophorus* Villalobos, An. Inst. Biol. de la Univ. Nal. A. de México, Vol. XIX, No. 1, pp. 175 – 182, 2 pls.
1954b *Procambarus acanthophorus* Villalobos, An. Inst. Biol. de la Univ. Nal. A. de México, Vol. XXV, pp. 363 – 364.

Diagnosis. Crayfish with long rostrum bearing lateral spines. Carapace with two lateral spines on each side; five branchiostegal spines; areola narrow. Chelae pubescent. Ischiopodite of third pair of pereopods with hook. First pair of pleopods of male with shoulder; mesial process short and recurved; cephalic process present; central projection little developed. *Annulus ventralis* small. Tubercle between fifth pereopods of female blunt.

Male, form I. It is of average size; the cephalothorax is broader than the abdomen; the surface of the carapace bears punctations that are more abundant in the dorsal region; by their size, they are divisible into three groups: the first characterized by numerous, very small punctations; the second consists of slightly larger and less numerous ones than the preceding; finally, there are groups of pits of large size but much less common. In the lower part of the pleural regions, numerous homogeneously distributed subsquamous tubercles are located. The hepatic region is almost smooth, but there are a few punctations. The anterior margin of the cephalic groove is ornamented by a kind of network formed by irregular depressions limited by ridges that do not reach in height the general surface of the carapace.

The rostrum is long, its surface distinctly grooved and without punctations. The rostral margins are convergent and terminate anteriorly in a chitinous lateral spine directed to the side. Behind this spine follows the acuminal region of the rostrum which is triangular and grooved; the acuminal spine is conical and sharp (Plate 49, fig. 5).

The postorbital ridges are parallel, we defined, and terminate in a conical, sharp, spiniform structure, bent slightly to the side.

The cephalic groove is deep and discontinuous on the sides; the part of the groove that limits the hepatic region posteriorly exhibits two sharp spines that are very close together and directed forward and downward. In addition to the branchiostegal spine, there are four other spiniform structures, decreasing in size upward, that are implanted between the antennal angle of the carapace and the branchiostegal spine, but nearer the latter (Plate 49, figs. 1 and 3).

The areola is very narrow, and the margins that delimit it disappear

in the posterior region. The median part of the areolar space lacks punctations, but these appear in the anterior and posterior regions (Plate 49, fig. 2).

The proportions that exist between the different regions of the carapace are the following: the length of the areola is exactly half the length of the cephalic portion; the greatest width of the rostrum is five and one-half times less than the total length of the carapace; the length of the rostrum is three times smaller than the length of the carapace.

The abdomen is narrower than the cephalothorax; the dorsal surface of the somites as well as the pleural regions are smooth except for punctations which are sparsely scattered. A single spine is present on the distolateral angles of the first section of the telson. The distal margin of the last section of the telson is almost straight.

The epistome is small, of regular form, and terminates anteriorly in an angular prolongation. The lateral margins are gently elevated (Plate 49, fig. 10).

221 The antennal scale is long with a deep groove which extends longitudinally along its surface; the greatest width of the scale is between the proximal and second third (Plate 49, fig. 9).

The first pair of pereopods have small chelae that are densely covered with setae; the latter occur distal to the subsquamous tubercles that stud the surface of the chela. The palmar section of the chela is ovoid, and its greatest width is located in the middle portion. The surface is covered with somewhat numerous, small, subsquamous tubercles; the fingers of the chela are short and straight; their cutting borders are armed with dentiform prominences which may be observed only when the setae which occur in the region are removed.

The carpopodite is slightly wider than the proximal region of the hand; it has the form of a truncate comb, and the external and superior lateral surfaces exhibit tubercles that diminish in number and size ventrally. Also, on the upper surface there is a certain development of the setae that gives this region a slightly pubescent aspect (Plate 49, fig. 4).

The meropodite is elongate with a spiniform tubercle on the dorsal margin. The internal side is scaly and the external rather smooth. The lower border exhibits conical spines inclined forward and arranged in two rows, one of them straight and bearing numerous spines, the other incurved and with a smaller number of spines; the space between the two rows contains abundant short setae.

The ischiopodites of the third pair of pereopods bear hooks; these are clawlike spiniform prominences that are borne on the distal extremity of the article, and their apices extend to the level of the proximal articulation. The hooks are gently recurved in the same direction as the article (Plate 49, fig. 8).

The coxopodites of the fifth pereopods exhibit small conical prominences on the internal part of the article.

The apical extremity of the first pair of pleopods reach the coxopodites of the fourth pair of pereopods. They are somewhat symmetrical, and the distal extremity is flattened cephalocaudally. The mesial process is short, slightly chitinized, recurved, gently inclined laterally, and flattened cephalocaudally; its terminal part is very sharp (Plate 50, figs. 1, 2, 3, 4A, and 5A). The cephalic process is small, pyramidal in form, and one of its vertices is continuous with the central projection (Plate 50, figs. 4 and 5B). The latter (Plate 50, figs. 4 and 5Z) has a trapezoidal contour, although observing the pleopod from the cephalic region, it presents a triangular appearance; its two elements are clearly distinguishable. The shoulder is little inclined and in the form of a slightly concave plateau (Plate 50, fig. 6).

Male, form II. The specimen selected for our description is as robust as the male, form I. The surface of the carapace is smooth. The rostral margins are more convergent and consequently the apical region appears sharper. The rostral surface is deeply grooved and smooth (Plate 49, fig. 6). The space between the branchiostegal spine and the antennal angle of the anteroinferior margin of the carapace presents only two spines, the inferior the larger. The two lateral spines of the carapace are present.

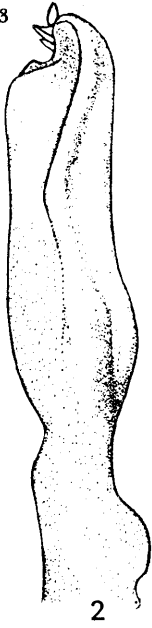
The chelae are smaller and less pubescent. The ischiopodites of the third pair of pereopods exhibit a very weakly developed prominence implanted on more or less the median part of the article.

In general aspect, the first pair of pleopods are similar to those of the male, form I, but a closer examination of the apical region reveals a lack of chitinization in the mesial process, which is shorter and more inclined; the cephalic process is absent; the central projection, in contrast, appears as a more or less hemispherical structure in which the two constituent parts may be seen. The shoulder is more inclined and is nearer the apical region (Plate 50, figs. 6 and 7).

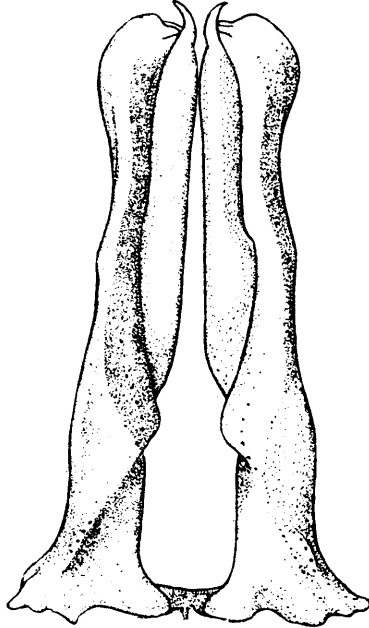
Female. It exhibits a carapace somewhat wider than the abdomen; its surface is smooth; the areola is narrow with a row of small punctations. There are two spines on each side of the carapace, as in the male. The number of branchiostegal spines is the same as that in the male, form I, but the superior one is very small. The rostrum is broader than that of the males, and the acuminal spine is enlarged (Plate 49, fig. 7).

The chelae are small, only slightly pubescent; the setae of the dactylar portion are large and more abundant. The carpopodite is almost the same width as the middle part of the chela.

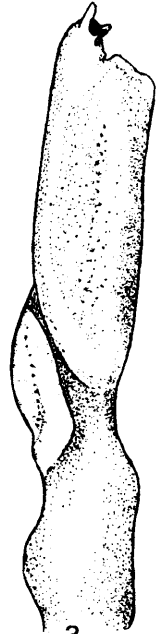
The *annulus ventralis* is very small, measuring 1.9 mm in width and 0.8 mm in length. It has a rhomboidal contour, and the groove begins



2



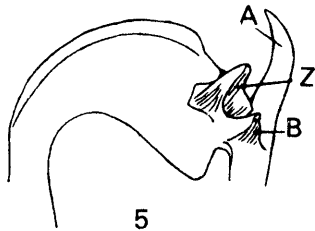
1



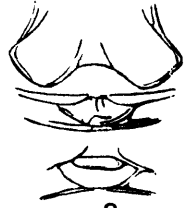
3



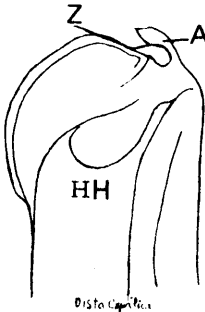
4



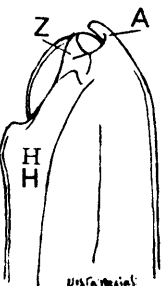
5



8



6



7



9

224 in the subapical region of the cephalic face, from which it is directed obliquely in the caudal portion; in the basal region of the cephalic face there are two ridges separated by a more or less deep cavity; these disappear in the apical portion; the position of the ridges is slightly displaced to the left, and because of this the *annulus* is a little asymmetrical. There is a fusiform tubercle between the fifth pereopods which lacks a spiniform structure on the apical portion (Plate 50, figs. 8 and 9).

Measurements in millimeters

	Male, Form I	Male, Form II	Female
Total length	60.0	61.3	62.6
Length of carapace	30.3	30.0	30.5
Anterior part of carapace	20.4	20.6	20.6
Length of areola	9.6	9.4	9.9
Width of areola	0.4	0.4	0.4
Length of abdomen	29.7	30.7	32.7
Posterior width of rostrum	4.6	4.9	4.9
Length of rostrum	9.2	10.3	8.9
Length of chela	22.3	17.9	13.8
Length of palm	12.0	9.3	5.8
Length of movable finger	11.4	9.4	8.6

Localities. El Castillo, 4 km W. of Tuxtepec, Oaxaca. The specimens were collected in a small lake which at times becomes dry. Arroyo Cojinillo, Tierra Blanca, Veracruz. La Laja, Cuatotolapan, Veracruz (Pearse). Laguna de Catemaco, Veracruz (Pearse). Paso del Toro, Veracruz. Espagoyan, marsh which occurs on the shore of Laguna de Catemaco, Catemaco, Veracruz. Arroyo Novara, on the Rancho Novara, Cosamaloapan, Veracruz.

Relationships. *Procambarus acanthophorus* has close affinities with *P. llamasi* and *P. pilosimanus*, illustrated by the pilose character of the chelae and the lateral spines of the carapace, as well as by the branchiostegal spines.

Procambarus acanthophorus is the only species which exhibits a clearly distinguishable cephalic process. According to the apical contour of the

Plate 50. *Procambarus acanthophorus* Villalobos. Male, Form I.

1, caudal view of the first pair of pleopods; 2, lateral view; 3, mesial view; 4, cephalic view of the apical region of the first pleopod; 5, cephalomesial view of the same; 6 and 7, cephalic and mesial views of the apical part of the first pleopod of the male, Form II (A, mesial process; B, cephalic process; Z, central projection); 8, sternite of the fourth and fifth pereopods of the female; 9, *annulus ventralis*.

first pleopod of the male, form I, it is allied with those species that occupy the southern part of the Mexican Republic.

Procambarus llamas Villalobos

1954b *Procambarus llamas* Villalobos, An. Inst. Biol. de la Univ. Nal. A. de México, Vol. XXV, pp. 364 – 371.

225 **Diagnosis.** Crayfishes of large size, total length 81 to 85 mm. Carapace with two lateral spines on each side. As many as four branchiostegal spines, normally three. Rostrum wide at base; margins convergent; lateral spine present; acuminal spine long and sharp-pointed, reaching distal articular margin of third antennular article. First pair of pereiopods as long as body, dactylar portion of chela covered with setae; hook on ischiopodites of third pair of pereiopods. First pleopods of male, form I, with mesial process flattened cephalo-caudally; central projection weakly developed; shoulder with sharp declivity. *Annulus ventralis* of female with cephalic portion incised by sulcus. Tubercle between fifth pereiopods of female conical.

Male, form I. The carapace is compressed, particularly so in the anterior part; the surface is very finely punctate in the cephalic region and on the dorsal part of the thorax; the branchial regions are provided with minute tubercles, distinguishable only with a hand lens. The lateral spines are present in the upper part of the groove that marks the posterior limit of the hepatic region; they are conical in form and the apex is directed forward and downward; usually there are three branchiostegal spines although there may be four, one of them situated posterior to the cephalic groove. In the lateral region of the carapace, there is a colorless stripe extending from one extremity to the other; posteriorly it is narrow, and its widest part a little anterior to the cephalic groove; in this region the inferior limit of the stripe is prolonged in a kind of lobule (Plate 51, fig. 1).

The areola is narrow; the suprabranchial margins that limit it are parallel along most of their lengths.

The rostrum is decidedly channeled and its surface smooth. The rostral margins are high, gently convex to the side, convergent forward, and they terminate in an angle that ends in a conical spine. The acuminal spine is long and sharp; its dorsal surface is similar in general form to that of the rest of the rostrum, and its apex reaches the distal articular margin of the third article of the antennular peduncle.

The proportions of the different parts of the carapace are as follows: the length of the areola is exactly one-half that of the cephalic portion; the posterior width of the rostrum is six and one-half times less than that of the carapace; the length of the abdomen is slightly less than the length of the carapace.

226 The postorbital ridges are slightly convergent anteriorly, terminating in a short conical spine (Plate 51, fig. 2).

The posterolateral angles of the first part of the telson bear two spines, not counting the spiniform angle which is very sharp.

The epistome is heptagonal, rather symmetrical; in some individuals, the margins of the epistome are irregularly notched by a few emarginations, the positions of which vary from one specimen to another (Plate 51, fig. 3).

On the sternite, there is a keel extending between the first and second pairs of pereopods; its free margin is provided with a series of small tubercles, of which there may be as many as four. The tubercle on the sternite between the second and third pairs of pereopods is greatly reduced.

The antennal scale is long (Plate 51, fig. 4); the external margin is slightly concave at the distal extremity, and the antennal spine is small; the latter is directed to the side and very slightly overreaches the anterior lobule of the lamellar part of the scale; the greatest width is slightly posterior to midlength. The antennal flagellum, extending over the surface of the body, reaches the ultimate portion of the telson.

The first pair of pereopods are very long, and the articles that are most lengthened are the meropodite and propodite (Plate 52, fig. 8). The internal margin of the ischiopodite is armed with small blunt tuberculiform processes. The entire surface of the meropodite is provided with numerous, small, more or less hemispherical prominences; those on the internal surface are most massive, and those of the inner inferior border are conspicuous by their large size. Near the distal extremity of the upper margin, there is a conical spine directed forward. On the external part of the lower margin, toward the middle of the article, there are two distinct conical spines that are directed forward, their tips the color of dark coffee; the space between them is equivalent to that between the anterior spine and the margin of the distal articular emargination; a sharp, conical spine is present on both the internal and external side of this emargination.

228 The carpopodite is a little less than one-third of the length of the chela. It is conical in form, with two emarginations on the distal articular margin. All of the surface of this article is provided with tubercles very similar to those of the propodus; they are more prominent on the internal region. On the internal articular margin of the distal extremity, there are two small spines. On the upper surface, there are minute tubercles in the longitudinal groove, which is hardly defined.

The chela is subcylindrical in its palmar portion, slightly flattened dorsoventrally, with the internal and external margins almost parallel, blunt in the proximal portion and very sharp toward the fingers. All of

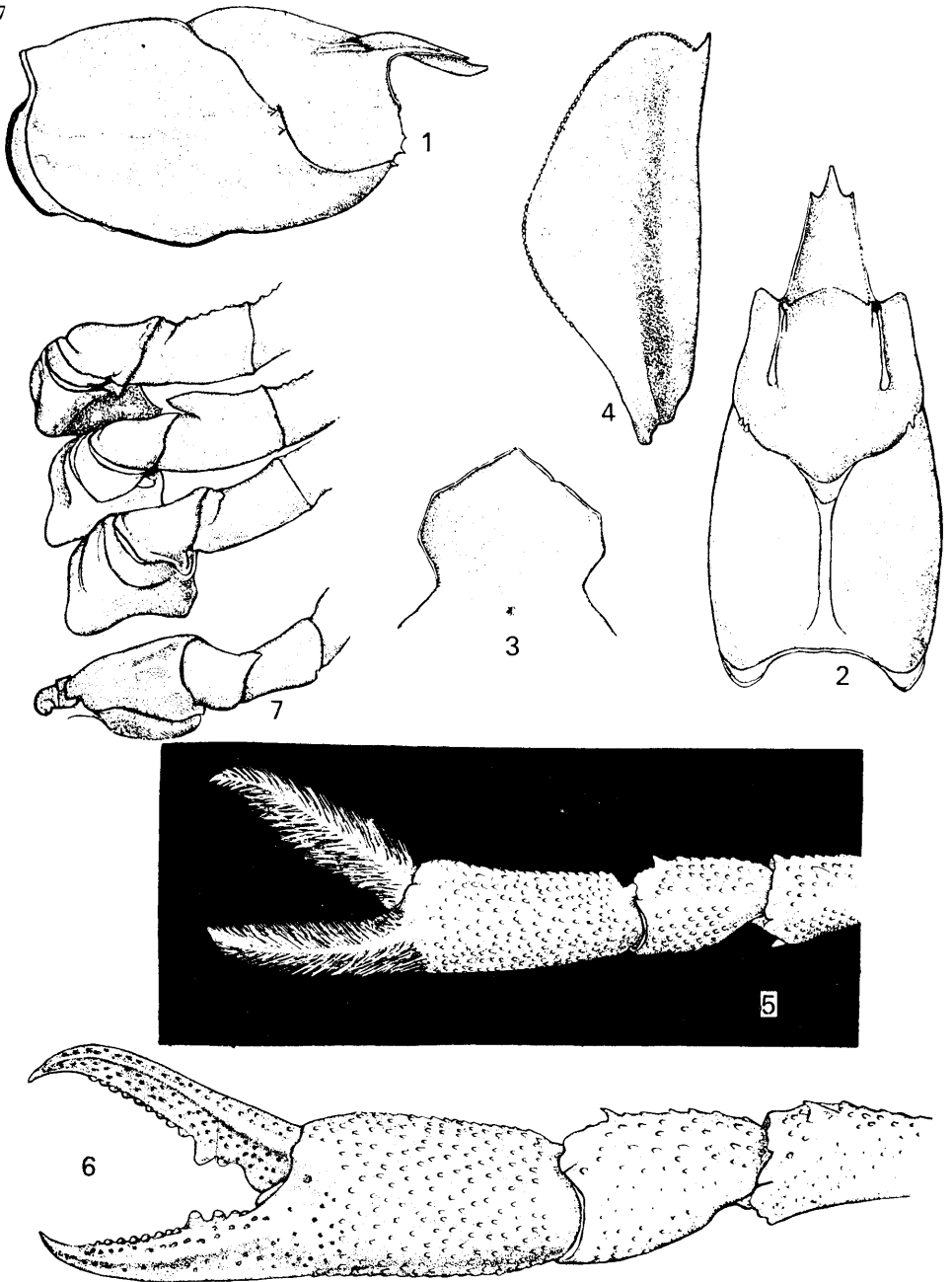


Plate 51. *Procambarus llamasii* Villalobos. Male, Form I.

1, lateral view of the carapace; 2, dorsal view of the same; 3, epistome; 4, antennal scale; 5, chela showing the pubescence of the fingers; 6, chela with setae removed; 7, pereiopods II to V.

the palmar surface is provided with the same kind of tubercles that we described for the surface of the other articles, but very abundant and subsquamous dorsally; whereas in the outer ventral region they are small, they are unlike those of the ventral internal region where the tubercles are similar in form to those of the dorsal surface. The dactylar region of the chela is covered with setae that give the fingers a pilose appearance. Both the immovable finger and the dactylopodite exhibit a dorsal ridge which extends the total length of each. The cutting border of the immovable finger is armed with dentiform tubercles of which two proximal ones are conspicuous because of their size. The dactylopodite, or immovable finger, exhibits a single tubercle larger than the others present along almost the entire length of the cutting border; this tubercle is also proximal in position. The length of the dactylopodite is equal to the length of the palmar region (Plate 51, figs. 5 and 6).

The ischiopodites of the third pair of pereopods are armed with a strong, conical hook, the apex of which clearly overreaches the articulation of the basipodite with the ischiopodite (Plate 51, fig. 7).

The first pair of pleopods are straight, and their apical portions reach the anterior part of the coxopodite of the fourth pair of pereopods. They are flattened laterally; also the distal region is broadened laterally (Plate 52, figs. 9, 10, and 11). The mesial process is straight and directed distally; it is flattened anteroposteriorly and is short and rounded terminally (Plate 52, fig. 12A). The central projection is very reduced and trapezoidal in form (Plate 52, fig. 12CE); the centrocaudal process is sharp (C); the centrocephalic (E) is quadrangular. The ridge that bears the cephalic process limits the central projection basally and is continuous with the centrocaudal process.

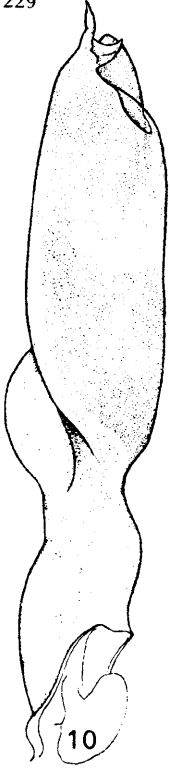
The shoulder is strongly inclined, and in the declivity there is a shallow depression; in mesial and lateral views of the pleopods, the shoulder is hardly noticeable.

Male, form II. The surface of the carapace is smooth. It exhibits only two branchiostegal spines on each side, the cephalic groove
230 ending between them. The lateral margins of the rostrum are decidedly convergent, convex to the side in their posterior portion; lateral spines are well developed, conical in form; the acuminal spine is narrow and sharp. The surface of the rostrum is concave, a character accentuated in the middle part.

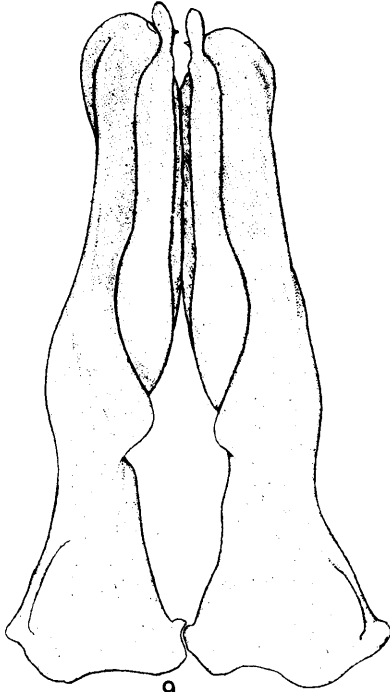
The epistome is broad, its margins rounded, thus rather different in contour from the epistome of the male, form I.

The keel of the sternite between the first and second pairs of pereopods has a dentiform tubercle which, as was pointed out for the male, form I, is larger than the other tuberculiform ones.

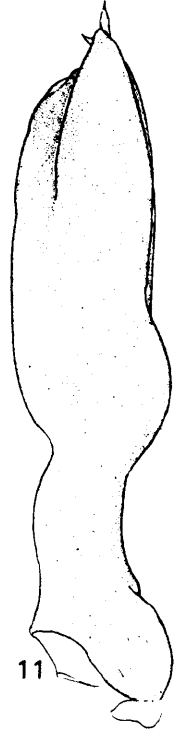
The ischiopodite of the third pereopods bears a mammiform process.



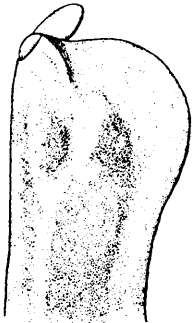
10



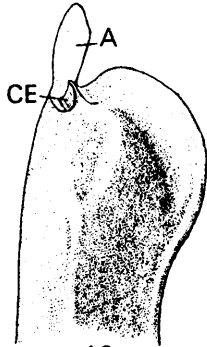
9



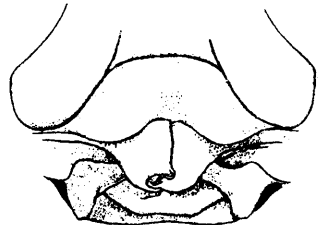
11



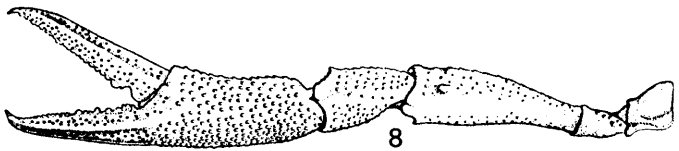
13



12



14



8

The first pair of pleopods are slenderer. The mesial process is slightly angular and is inclined over the lateral apical region. The central projection is hemispherical. The cephalic process or cephalic ridge is situated below the central projection (Plate 52, fig. 13). The posterior angles of the first section of the telson exhibit two spines on each side, lacking the median one.

Female. Some female specimens are larger than the males. Taking as a base a female specimen, the length of which is 84 mm, we observed the following characteristics: the carapace is densely punctate; the punctations of the branchial region have a very small tubercle the size of which increases in the lower part.

The rostrum is decidedly grooved, deeper in the middle third; the rostral margins are slightly convex to the side, but definitely convergent toward the anterior, and terminate in robust spines. The acuminal spine is sharp.

The first pair of pleopods are shorter than in the male. The length of the chela projected over the body reaches the middle of the fifth abdominal somite. The meropodite has the same spines described for the male, form I, but the two on the lower border are better developed; the external surface of this article is almost smooth. The chela is shorter than in the male, and its length is two and one-half times greater than the length of the carpopodite. The palmar portion of the propodite is rather depressed; its external and internal margins are convergent toward the proximal extremity; the surface of the palmar region exhibits subsquamous tubercles with the same form and frequency as in the male. The dactylar portion of the chela is less pilose than in the males, the margins of the fingers being free of setae. The proximal region of the cutting border of the immovable finger exhibits three very
231 large teeth; the length of the dactylopodite is a little greater than the length of the palmar region; the cutting border of this article has a very large dentiform process on its proximal part.

The *annulus ventralis* is rhomboidal in contour at its base, with depressions on the anterolateral faces; its median part is cut by the groove which is directed obliquely toward the apical region, or its direction may be straight; there it forms a figure S, inclined from right to left; sometimes this S may be inverted as in the figure (Plate 52, fig. 14).

Plate 52. *Procambarus llamasii* Villalobos. Male, Form I.

8, first pereopod; 9, caudal view of the first pair of pleopods; 10, mesial view; 11, lateral view; 12, cephalic view of the apical region (A, mesial process; CE, central projection); 13, cephalic view of the apical region of the first pleopod of the male, Form II; 14, *annulus ventralis*.

Measurements in millimeters

	Male, Form I	Male, Form II	Female
Total length	81.4	68.9	81.4
Length of carapace	40.9	31.8	40.5
Anterior part of carapace	28.1	21.5	27.0
Length of areola	12.8	10.0	13.5
Width of areola	1.0	0.4	1.0
Length of abdomen	40.5	37.1	40.9
Posterior width of rostrum	6.0	5.4	6.0
Length of chela	37.1	9.5	26.1
Length of movable finger	19.4	10.7	18.8

Locality. Santa Rita, 47 km E. of Escárcega, Campeche. These specimens were collected in a culvert on the Escárcega-Champotón highway. This locality corresponds to the "escurridero" of the Laguna de Silvituj.

This species is widely distributed inasmuch as specimens were collected in Escárcega and in the Estación Haro, some 70 km from Escárcega.

Relationships. *Procambarus llamas* has close affinities with *Procambarus pilosimanus*, from the southern part of Chiapas, and with *Procambarus acanthophorus* from the southern part of Veracruz.

Procambarus pilosimanus (Ortmann)

- 1906 *Cambarus* (*Procambarus*) *pilosimanus* Ortmann, Proc. Wash. Acad. Sci., Vol. VIII, pp. 6 – 10, fig. 2.
- 1911 *Cambarus pilosimanus* (Ortmann). Pearse, Thirteenth Rept. Michigan Acad. Sci., p. 110.
- 1914 *Cambarus pilosimanus* (Ortmann). Faxon, Mem. Mus. Comp. Zool., Harvard Coll., Vol. XL, No. 8, p. 362.
- 1954b *Procambarus pilosimanus* (Ortmann). Villalobos, An. Inst. Biol. de la Univ. Nal. A. de México, Vol. XXV, pp. 371 – 378.

232 **Diagnosis.** Smaller than *P. llamas*. Carapace broad; two weakly developed lateral spines on each side; two branchiostegal spines. Areola narrow. Rostrum less concave than in *P. llamas*, broader at base; lateral spines of rostrum present, very short. Acumen short, its apex reaching proximal third of last antennular article. First pair of pereopods shorter than length of body; chelae totally pubescent. Ischiopodites of third pair of pereopods of male with hooks. First pair of pleopods with shoulder poorly defined; central projection quadrangular. *Annulus ventralis* with groove restricted to apical region.

Male, form I. The carapace (Plate 53, figs. 1 and 2) is clearly

broader than the abdomen. The surface exhibits two types of punctations, some large and limited in number and the others small and numerous; some of the former have a very small angular prominence, hardly visible with a hand lens. The dorsal surface of the thoracic region is flattened. The cephalic groove is relatively deep. The two lateral spines of the carapace are conical, sharp, and slightly curved downward; only two branchiostegal spines are present, one in front and the other behind the groove that limits the hepatic region. The areola is very narrow, less than one millimeter wide; the areolar surface is smooth but with the aid of the microscope several rows of punctations may be seen. The postorbital ridges are convergent forward; the posterior extremity is very prominent, whereas the anterior terminates in a short, conical spine gently inclined to the side. The rostrum is broad; the rostral margins are almost straight but a little convex to the side; the lateral spines are short, farther apart than in *P. llamasi*; the acumen is triangular, not very sharp, and its apical extremity reaches the proximal third of the ultimate antennular article. The ventral keel of the rostrum is smooth.

The proportions of the different parts of the carapace are the following: the length of the areola is very little less than half of the cephalic portion; the posterior width of the rostrum is six and one-third times less than the length of the carapace; the length of the rostrum is three and one-half times less than the length of the carapace; the length of the cephalothorax is a little less than that of the abdomen.

234 The lateral margins of the first portion of the telson are subparallel, slightly convex in the posterior region; the distolateral angles of this portion bear one spine on each side although sometimes they may have two, but this is very infrequent (the spiniform angles of this section of the telson are not included in this character). The distal margin of the ultimate portion is rather straight.

The epistome (Plate 54, fig. 1) is approximately triangular, and the anterolateral margins are straight; the apex stands out clearly between the two emarginations. The margins are elevated slightly above the plane surface. Sometimes one of the anterior emarginations is deeper than the other.

The antennal scale (Plate 53, fig. 3) is narrow when compared with that of *P. llamasi*. The external margin is straight, and the spine of the scale is small, conical, and directed distally. The greatest width is located a little behind the middle of the scale and is equal to a little less than half of its length. The length of the antennal flagellum is almost equal to the total length of the body.

There is only one conical tubercle on the sternite between the fifth pereopods. The tubercle on the sternite between the second and third pairs of pereopods is absent.

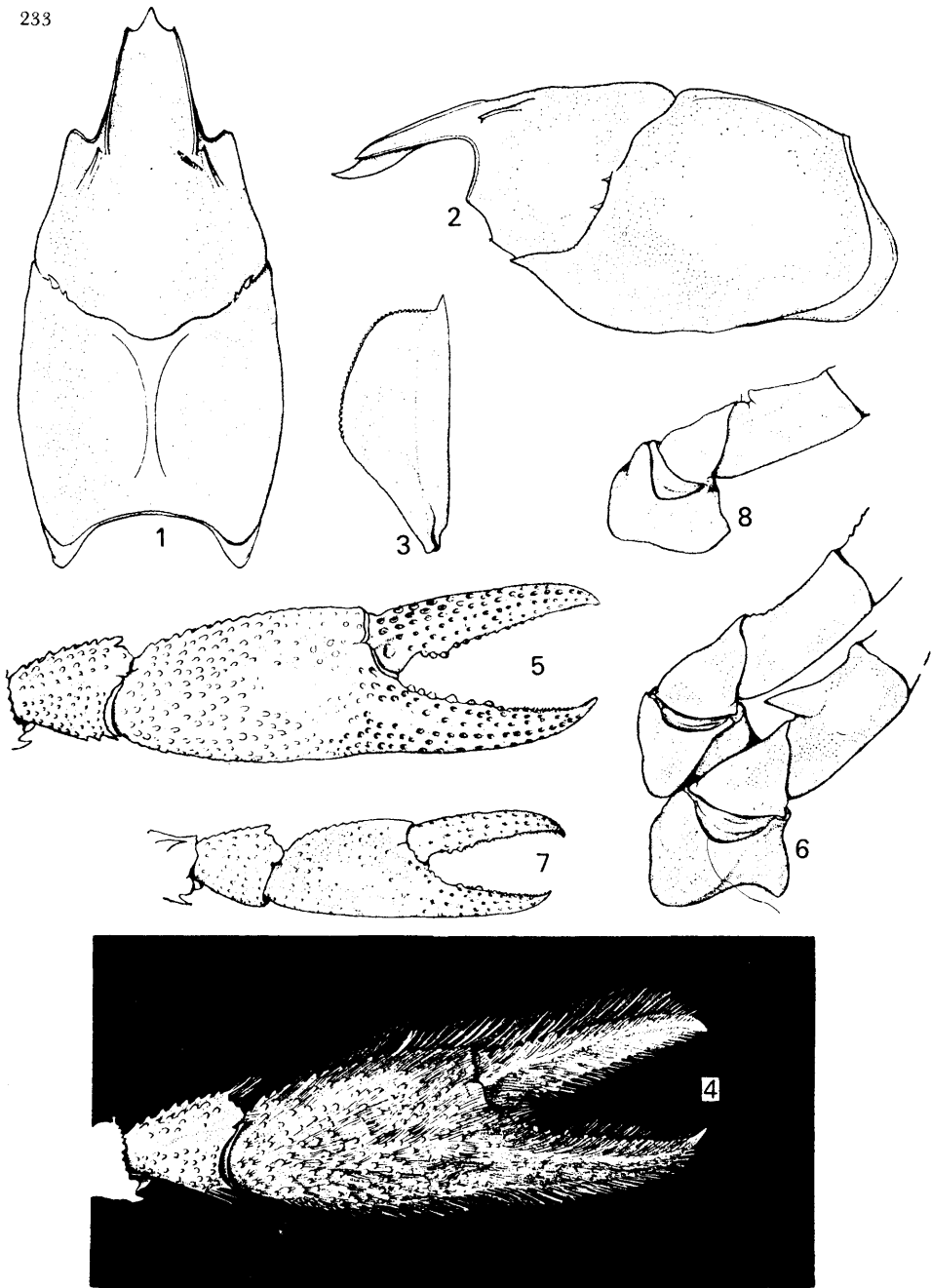


Plate 53. *Procambarus pilosimanus* (Ortmann).

1, dorsal view of the carapace; 2, lateral view of the same; 3, antennal scale; 4, chela showing the pubescence; 5, chela with setae removed; 6, second and third pairs of pereopods; 7, chela of the female; 8, ischiopodite of the third pereopod of the male, Form II.

The length of the first pair of pereopods is less than that of the body. The tubercles on the external and internal surfaces of the meropodite are very sparse; these are very small and are located mostly on the anterior part of the article; on the posterior these are very widely dispersed; the upper margin is provided with abundant tuberculiform prominences, the forms of which are much like those of the distolateral ones; a conical process much larger than the others in the area is present near the articular margin; the lower border is armed with conical tubercles the size of which gradually increases distally; it may be recognized that these structures are arranged in two rows, an internal and an external, and the surface between them is scabrous; two of these processes stand out in the external series; the posterior is smaller than the anterior, and the latter is located very near the articular emargination. The carpopodite is almost rectangular; its entire surface is covered with tubercles of the same kind as those on the meropodite; those that cover the internal surface are better developed; the upper surface exhibits a straight, shallow groove that extends almost the entire length of the article. The chela is completely covered with setae (Plate 53, fig. 4) that present a pilose aspect for which the species is named. The setae of the proximal portion of the propodus are very short, and, for this reason, this area seems relatively denuded. The length of the setae increases in the middle part of the chela, diminishing on the extremity of the fingers. The palm is depressed, the internal and external margins are gently convergent proximally. The surface of the palm is uniformly studded with small tubercles (Plate 53, fig. 5). The surface of the immovable finger is covered with large punctations from which arise the setae of this part of the chela; moreover, there is a rib or ridge which runs the entire length of the finger; the external profile of the finger exhibits a double ridge in the trough of which the setae are implanted; the cutting border exhibits dentiform processes which are arranged essentially in two series except in the proximal extremity where there are only two or three of them, very large in relation to the size of the others. The dactylopodite is straight and also exhibits a ridge or rib; the surface is similar to that of the immovable finger; the teeth of the cutting border have a similar disposition, but the proximal tooth is larger. The length of the dactylopodite is notably greater than the palmar length.

The third pair of pereopods exhibit a hook on the ischiopodal article, the apex of which decidedly overreaches the articulation of the basipodite and ischiopodite. Its form is that of a cone compressed in the same plane as that of the ischiopodite (Plate 53, fig. 6).

The first pair of pleopods are straight; their apical regions reach the caudal portion of the coxopodites of the third pair of pereopods. They are flattened laterally in their distal middle part and cephalocaudally in

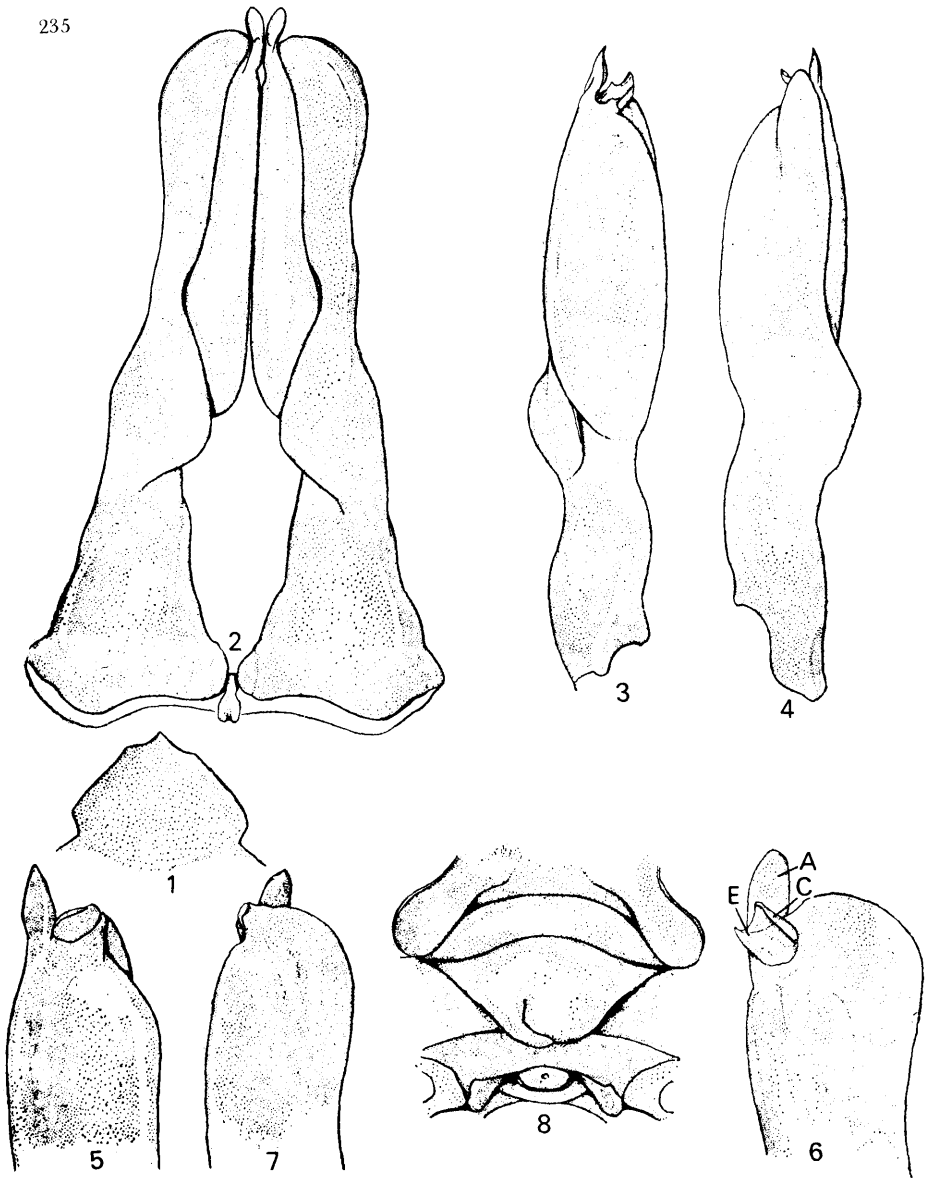


Plate 54. *Procambarus pilosimanus* (Ortmann). Male, Form I.

- 1, epistome; 2, caudal view of the first pair of pleopods; 3, mesial view; 4, lateral view; 5, mesial view of the apical part of the pleopod; 6, caudal view of the same; 7, lateral view of the apical part of the first pleopod of the male, Form II; 8, *annulus ventralis*.

the apical portion. The shoulder is very poorly developed; it is better to say that it is absent inasmuch as the declivity is so great that in mesial or lateral view of the pleopod this characteristic structure of the *mexicanus* group is not evident; instead, the cephalic margin is insensibly continuous all along the side of the appendage (Plate 54, figs. 2, 3, and 4). The mesial process (Plate 54, figs. 5 and 6A) is flattened anteroposteriorly; its contour is elliptical and slightly grooved. The central projection (Plate 54, figs. 5 and 6CE) is better developed than in *P. llamasii*; its contour is rectangular, and the free border a little concave; the centrocaudal process (C) is narrow at its base, and its distal part is slightly recurved; the centrocephalic process (E) is wide and less chitinized than the former.

237 **Male, form II.** The rostrum is broader and the surface more excavate. The punctations of the carapace are less apparent than in the male, form I. The cephalic groove is deep dorsally, and the surface of the thoracic region is not flattened. The posterior prominence of the postorbital ridges is lower. The two lateral spines of the carapace are small. Of the two branchiostegal spines, the posterior is larger than the anterior. The first pair of pereopods are shorter; its length projected over the dorsal region of the body reaches the third abdominal somite. The chelae are small and weakly pubescent, moreover, narrow and the surface less scabrous. The dentiform processes of the cutting borders of the fingers are small, but the proximal ones predominate by their size; they also conserve the disposition in two series with a very narrow intermediate zone provided with small plaquettes the color of dark coffee. The meropodite exhibits a single spine that is larger in size than the others on the lower border.

The ischiopodite of the third pair of pereopods exhibits only one small tuberculiform prominence (Plate 53, fig. 8). The first pair of pleopods are similar in form to those of the adult male except the central projection is not so well developed, although the triangular form of the centrocaudal process is already evident and the centrocephalic has the form of a conical tubercle, the vertex of which is slightly turned toward the distal portion. The mesial process preserves the shape already mentioned for the male, form I, but its apex is more or less sharp.

Female. The margins of the rostrum are more convergent than in the male, form II; the rostral surface is less concave than in either form of the male; the lateral spines of the rostrum are well developed in the young females, but as the size increases, these spines become shorter; the acumen is sharp. The spines of the postorbital ridges are sharp and diverge forward; the posterior extremity of each ridge is somewhat prominent. The lateral spines of the carapace are unequal; the inferior is larger.

The chelae of the first pair of pereopods (Plate 53, fig. 7) are proportionately much wider than those of the male; in regard to the pubescence, it is similar to that of the male. The length of the dactylopodite is equal to the palmar length plus one-half the length of the carpopodite; the teeth of the cutting border of this article and those of the immovable finger are arranged in a single row.

The apical region of the *annulus ventralis* (Plate 54, fig. 8) is truncate. The subapical part of the cephalic surface is slightly cleft by a groove which is curved in an arc in the caudal portion. Between the fifth pereopods, there is a tubercle terminating in a short spiniform structure.

Measurements in millimeters

	Male, Form I	Male, Form II	Female
Total length	72.2	45.0	58.8
Length of carapace	36.0	21.7	29.2
Anterior part of carapace	24.0	14.5	19.5
Length of areola	12.0	7.2	9.7
Width of areola	0.3	0.3	0.3
Length of abdomen	36.2	23.3	28.6
Posterior width of rostrum	6.6	3.4	5.0
Length of chela	28.2	13.4	17.5
Length of movable finger	16.0	7.3	10.5

Localities. Types and cotypes of Ortmann, collected in Coche, on the Coban River, Guatemala. Exped. du Mexique (Mus. Paris, 10 males I, 3 males II, 9 females). With respect to this locality, Ortmann made the following statement: "I have not been able to locate this place, nor a river 'Coban'; but Coban is the well-known capital of the province of Alta Vera Paz. The river at Coban is called Rio Cahabon. Coban, Alta Vera Paz, is the locality for a species of *Cambarus* mentioned by Huxley (1878)."

Belize, Honduras Británica. Exped. du Mexique (Mus. Paris, 1 male I, Ortmann).

Campo Menzel, 36 miles from the mouth of Río Hondo, in the territory of Quintana Roo, México (MCZ No. 7405), Mr. J. L. Peters, 1 young female, 35 mm in length. By the characteristics recorded by Faxon (1914), we think that it is *P. pilosimanus*.

Gruta de Zapaluta, 30 km S. of Comitán, Chiapas. The collection was made in the cave in a secondary tunnel that turns to the left approximately 300 meters from the entrance. These crustaceans were found in the small depression where there is water; in such circumstances, the capture was relatively simple. Considering the site where they were taken being distinctly dark, none of its characteristics denote

an adaptation to this kind of situation; for this reason they may be considered to be troglloxenes that took refuge in the pools within the cave while the conditions outside were unfavorable. These specimens were those that served for our observations.

Another locality. Villa Margaritas, 18 km E.N.E. of Comitán, Chiapas. The specimens were collected in the canals of a marsh. In these we noted a depigmented stripe on the carapace very similar to that in *P. llamasì*

239 According to the localities cited, *P. pilosimanus* occurs in the northern part of Guatemala, Belize, and the southern part of Chiapas and Quintana Roo.

Relationships. According to Ortmann, *P. pilosimanus* has definite affinities with *P. williamsoni* (Ortmann) in its geographic distribution. It is pertinent to note that the presence of two lateral spines on the carapace establishes a certain similarity between these species. We find more resemblance with *P. llamasì* and *P. acanthophorus* in the pilosity of the chela and in the general form of the first pair of pleopods of the male, form I. Among the differences pointed out by Ortmann between *P. pilosimanus* and *P. williamsoni* are the following:

<i>P. pilosimanus</i>	<i>P. williamsoni</i>
Pilosity well marked in adult individuals.	Chelae not pubescent.
Two branchiostegal spines.	One branchiostegal spine.
Shoulder hardly visible on first pair of pleopods of male.	Shoulder prominent.

Conclusions. The problem presented to us by *Procambarus mexicanus* (Erichson) is relatively simpler than that we faced in the case of *Procambarus weigmanni* [sic] (Erichson), notwithstanding that in these two cases, the specimens considered to be types were lost from the Berlin Museum. The first species, that is *P. mexicanus*, is interpreted according to his description by differences from *Procambarus aztecus* described by Saussure eleven years later. We ventured to affirm the former because we believe that Saussure did not have an opportunity to observe Erichson's types. At that time, the key structure for considering the similarity between *P. mexicanus* and *P. aztecus* was the hook on the ischiopodites of the third pair of legs present in these two species. The differences, in contrast, such as the form of the chelae and the spines on the internal part of the carpopodite, were considered of sufficient taxonomic value for separating these species. They are not the same interpretations as those of Hagen and Faxon [who did not agree with this], but as we have noted, they always considered *P. mexicanus* and *P. aztecus* synonyms and *P. consobrinus* a synonym of *P. cubensis*.

Despite the fact that the original description of Erichson is too sketchy and even could be considered to be superficial (this in addition

to a lack of illustrations and definite locality), *P. mexicanus* may well be the species occurring in the area of Jalapa, Veracruz, described by Hagen and Faxon. Hagen studied a female identified by him as *Procambarus weigmanni* [sic]; except for the characteristics of this specimen, based on photographs obtained in the Academy of Natural Sciences of Philadelphia, catalogue number 4176, it belongs to a species of the *mexicanus* group. Later, Ortmann completed the description of *P. weigmanni* [sic] made by Hagen with the study of a male of a completely different species. Consequently we should consider that the female described by Hagen is the first specimen of *P. mexicanus* that was recorded after Erichson's description was published, even though Hagen used the name *P. weigmanni* [sic]. The locality "Mexico," however, is so imprecise that we cannot consider it as representing the [type-locality of the] neotype of the species.

The description that Faxon made of a male specimen deposited in the Academy of Natural Sciences of Philadelphia and obtained from "El Mirador," Veracruz, seems to us more suitable for representing *P. mexicanus*, because apart from having a precise locality, there exists the coincidence that Von Deppe¹, who surely also collected the *P. mexicanus* described by Erichson, carried on his work in the region of Jalapa, Veracruz, an area considered to be very similar to that of "El Mirador" of the same State.

Genus *Paracambarus* Ortmann 1906 (S. Hobbs 1942b)

Diagnosis. First pleopod of first form male terminating in three distinct parts; mesial process long and robust, directed caudally at 60° angle to principal axis of appendage; cephalic process small and in form of claw partly covering central projection; latter somewhat resembling beak of bird; rudiment of caudal process visible near apex where evident in lateral aspect. Shoulder lacking on anterior margin of appendage. Male with hooks on ischiopodites of fourth pereopods only. Third maxilliped of normal size, bearing row of teeth on internal margin of ischiopodite.

Paracambarus paradoxus (Ortmann)

1906 *Cambarus* (*Paracambarus*) *paradoxus* Ortmann, Proc. Wash. Acad. Sci., Vol. VIII, pp. 3 – 6, fig. 1.

¹Von Deppe came to México accompanying Christian Julius Wilhelm Schiede in 1828, and, leaving Veracruz, they explored the environs of Jalapa, ascended Orizaba, and in the cold season they visited Papantla and Misantla. (*La Naturaleza — Bosquejo de la Historia de la Exploración Botánica de México*, by W. B. Hemsley — This important article, that has been translated for *La Naturaleza*, is taken from the Cuaderno XXII of the *Botánica Central Americana*. London, March 1887.)

- 1942b *Paracambarus paradoxus* (Ortmann). Hobbs, Amer. Midl. Nat., Vol. 28, No. 2, pp. 337, 340, 341, 344.
- 241 1947a *Paracambarus paradoxus* (Ortmann). Villalobos, An. Inst. Biol. de la Univ. Nal. A. de México., Vol. XVIII, No. 1, pp. 233 – 240, pls. 1 – 2.

Diagnosis. Rostrum short with high margins and without lateral spines. Areola narrow. Male with hooks on fourth pair of pereopods; ischiopodites of third pair of pereopods with rudiment of hook. First pair of pleopods unequal; mesial process conical, chitinous, very well developed and directed caudodistally. Female with spiniform process, laterally flattened in apical region, between fifth pereopods.

Male, form I. The cephalothorax is compressed laterally and has a width more or less equal to that of the first abdominal segment; the surface of the carapace exhibits numerous punctations which are more clearly visible in the cephalic region; the branchial regions are finely punctate and the hepatic regions exhibit small tuberculiform prominences.

The rostrum is short, grooved, and the surface smooth; the rostral margins are heavy, straight, and convergent; the rostrum lacks lateral spines and in the place where they are usually found, an angle is present at the base of the broad, short acumen; the acuminal spine has the form of a blunt tubercle directed upward and forward. On the lower face of the rostrum there is a carina which, beginning at the apical tubercle, runs the total length; in the posterior region of this keel there is a group of three tubercles implanted in an elevation of the carina (Plate 55, fig. 1).

The postorbital ridges begin a short distance in front of where the rostral margins end; they are parallel and end anteriorly in an exceedingly small spiniform process.

The cephalic groove is deep and with ample margins; laterally it becomes less deep and its continuity with the groove, which limits the hepatic region posteriorly, disappears (Plate 55, fig. 1).

The areola is narrow, weakly marked by the suprabranchial grooves; the areolar surface exhibits small punctations which are more noticeable in the area adjacent to the cephalic groove (Plate 55, fig. 2).

The proportions of the different regions of the carapace are the following: the length of the areola is slightly greater than one-half that of the cephalic region of the carapace; the posterior width of the rostrum goes into the total length of the carapace six times; the length of the rostrum is a little more than one-fifth the total length of the carapace (Plate 55, fig. 2).

- 242 The first segment of the abdomen is approximately the same width as the posterior part of the cephalothorax. The somites are almost smooth in the dorsal region with only a few isolated punctations; in contrast, the

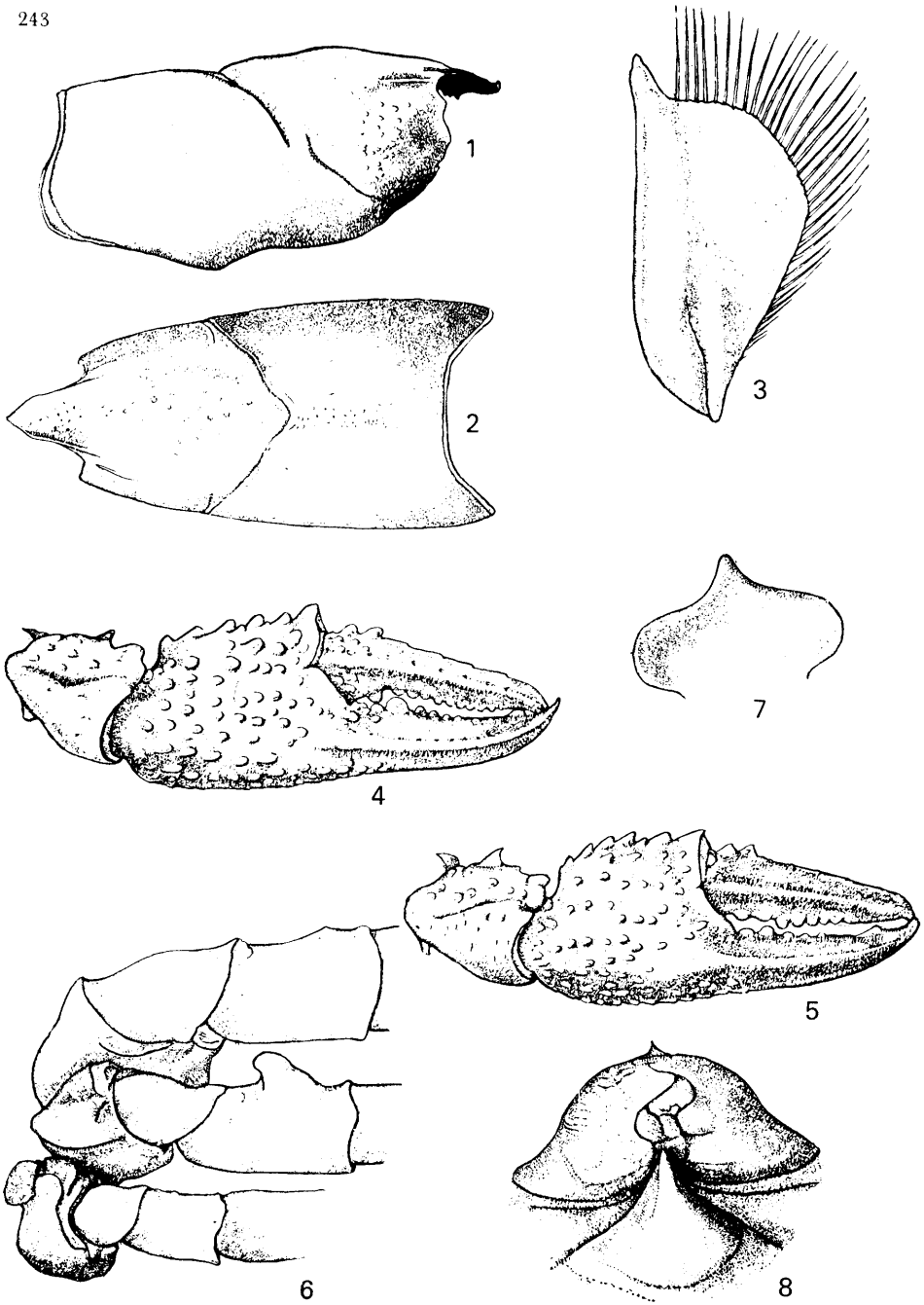


Plate 55. *Paracambarus paradoxus* (Ortmann). Male, Form I.

1, lateral view of the carapace; 2, dorsal view of the same; 3, antennal scale; 4, chela; 5, chela of the female; 6, ischiopodites of pereopods III to V of the male, Form I; 7, epistome of same; 8, *annulus ventralis*.

pleural regions as well as the telson and the two rami of the uropods have abundant punctations. The first section of the telson exhibits two or three spines on each side of its distal portion; the distal border of the ultimate portion is semicircular.

The epistome is symmetrical and scutiform with a median anterior angular prominence prolonged toward the dorsal region in a keel or crest; the contours are entire, rounded, and slightly elevated above the surface (Plate 55, fig. 7). The basal article of the antennules exhibits a robust spine on the lower internal margin; it is conical in form and slightly inclined forward.

The antennae exhibit a scale (Plate 55, fig. 3) with a strong spine which has a chitinized apex; the greatest width of the scale is anterior to its midlength; the latter is exactly double the former; the antennal flagellum hardly exceeds the length of the carapace when projected over it.

The first pair of pereiopods are robust; the meropodite is almost smooth along the entire length of the dorsal margin, exhibiting only a group of small tubercles near the articulation; among them one is conspicuous by its larger size; the inferior margin of this article exhibits two rows of tubercles united only near their extremities but clearly separated in the middle part of the length of the article; the spines of the internal margin are conical in form and are directed forward; the distal spine of this row is the largest and those that follow decrease in length toward the proximal end [of the podomere]; the spines of the external row are more tuberculiform; among them there is one large one located in the middle part of the row; the lateral regions of the meropodite are smooth. The external surface of the carpopodite is provided with setiferous punctations; the dorsal region exhibits a groove extending the total length of the article; the internal surface is provided with subsquamous tubercles. The chela is slightly depressed and the palm much shorter than the fingers; the dorsal face of the chela is provided with heavy subsquamous tubercles that continue onto the first third of the immovable finger. These prominences reach their greatest size on the margins; those of the internal border give it the appearance of an
244 indented crest which may be composed of as many as six tubercles, all of them directed forward. The external margin is rounded, different from the internal which is cristiform. The major part of the ventral face of the palmar region is smooth with a few tubercles very near the internal margin. The immovable finger is more robust than the dactylopodite and exhibits on each of its faces a ridge that runs the entire length; these ridges are limited laterally by coarse setiferous punctations; the teeth of the cutting border are distributed in the following manner: proximally there are two small teeth, then a large one, and following is a series of eight or nine teeth which diminish in

size progressively toward the distal extremity; moreover, there is another dentiform process on the subterminal region of the finger implanted on the lower part of the cutting border. The dactylopodite is less robust, slightly curved, with a ridge on both faces limited by punctations similar to those found on the immovable finger; the cutting border exhibits more dentiform tubercles than does the immovable finger; of them, one is conspicuously larger than the others (Plate 55, fig. 4).

The ischiopodite of the third pair of pereopods lacks hooks; however, in the distal region of the article there is a small conical prominence flattened in the same plane as the ischiopodite. The appearance and position of this structure leave no doubt that it represents a very reduced hook, corresponding to the ischiopodites of the third pair of pereopods, a generic characteristic of *Procambarus* (Plate 55, fig. 6).

The ischiopodite of the fourth pair of pereopods has a large tubercle in the form of a spoon, the concave surface of which is directed within and bears numerous short setae; the tubercle originates directly from the distal margin of the article, and its apical region terminates in a blunt surface. On the coxopodite of this same appendage, a spindle-shaped prominence is located on the internal part.

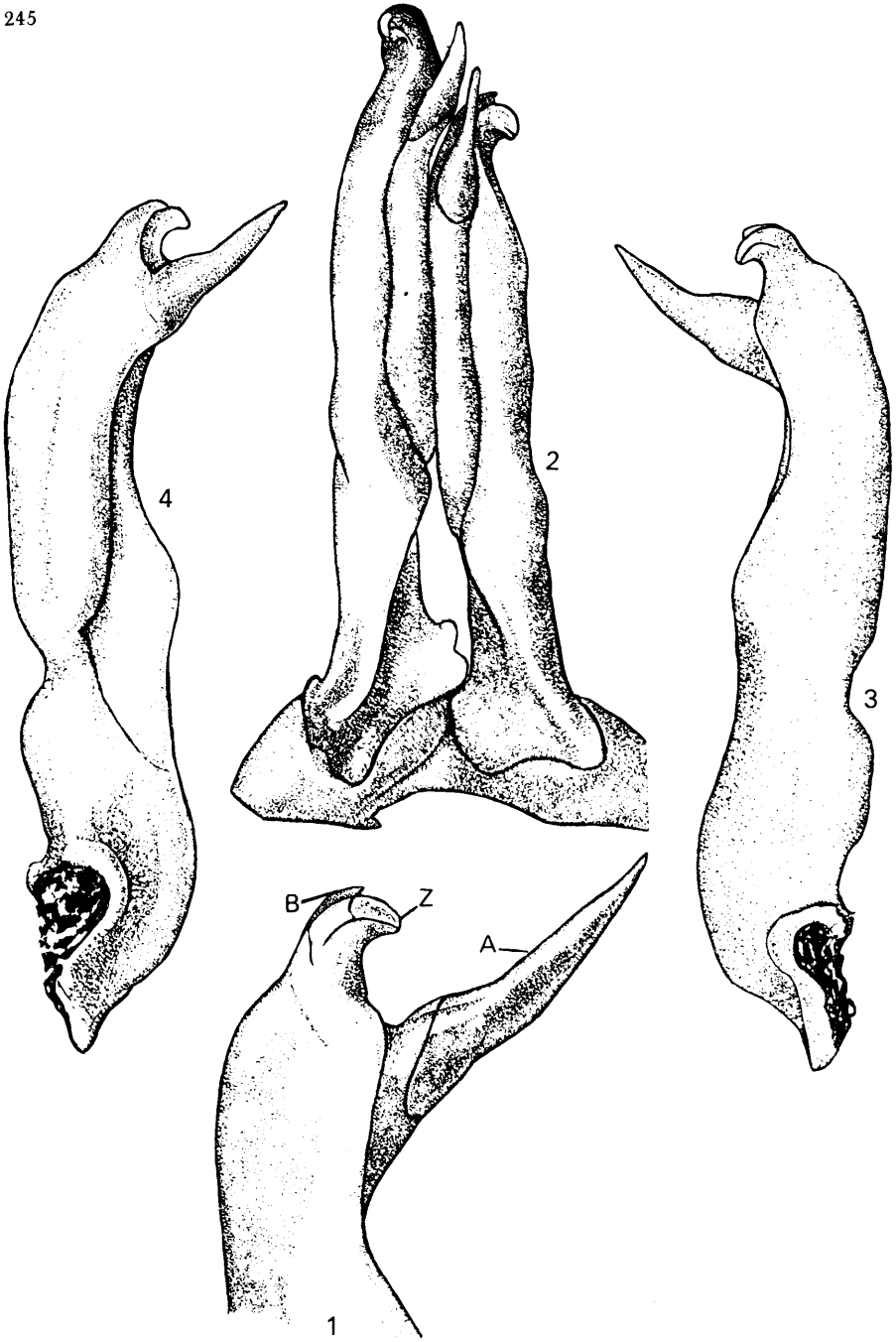
The coxopodites of the fifth pair of appendages exhibit a semi-circular plate with a smooth margin situated on the posterodistal part of the article (Plate 55, fig. 6).

246 The apical parts of the first pair of pereopods reach the middle section of the coxopodites of the third pair of pereopods; they are relatively short and robust, their distal portions extending clearly toward the caudal region and slightly laterally; they are unequal in size (that of the right is larger), which gives place to an asymmetry that is manifested mainly in the basal region of the appendages; the internal part of the right pleopod exhibits two prominences on its internal part that are located above the corresponding prominences of the left pleopod (Plate 56, fig. 2). The mesial process is large, strong, and chitinous; it is not straight; instead it is gently bent, permitting a slight deflection toward the distal region; at its insertion with the rest of the appendage, it forms an angle of approximately 135°; the extremity of this process overreaches the apical part of the appendage (Plate 56, figs. 3 and 4).

The cephalic process has an apical anterior position; its appearance

Plate 56. *Paracambarus paradoxus* (Ortmann). Male, Form I.

1, lateral view of the apical region of the first pleopod (A, mesial process; B, cephalic process; Z, central projection); 2, caudal view of the first pair of pleopods; 3, lateral view; 4, mesial view.



is that of a triangular plate, the vertex of which is directed distolaterally (Plate 56, fig. 1B).

The central projection is clearly chitinized, resembling in form the beak of a bird, and is curved caudolaterally; on it is a central line which starting from the vertex divides the structure into two portions that correspond to the centrocaudal process and the centrocephalic process (Plate 56, fig. 1Z).

Male, form II. The differences that may be noted with respect to the form I are principally in the hooks on the ischiopodites of the fourth pair of pereopods and in the appearance of the first pair of pleopods.

In the first case, we observe that the hooks on the ischiopodite of the fourth pair of pereopods vary according to the sexual stage which here seems to be less advanced. Correspondingly, the small process which appears so clearly on the ischiopodites of the third pair of pereopods is smaller and disappears completely in the younger males.

With regard to the first pair of pleopods, they exhibit little chitinization in the apical region. The difference in size between the appendages persists even in the very young forms. The mesial process is not chitinized, is conical in form, almost straight, but retains its caudal position. The platelike aspect of the cephalic process persists although it is thicker. With regard to the central projection, it exhibits a conspicuous difference from that of the form I; it resembles a very small conical tubercle and is partly covered by the cephalic process.

Female. The chelae of the first pair of pereopods are short; their length in respect to the rest of the articles reaches the proximal margin of the basipodite; both the immovable finger and the dactylopodite are slender and their cutting borders differ little from those of the chela of the male (Plate 55, fig. 5).

247 Anteriorly, the *annulus ventralis* has a semicircular contour. The groove begins in the anteromedian part very near the junction of the *annulus* with the body, describes two curves, and forms an S between the arcs of which arise prominences that are derived from the elevated margins that limit the groove (Plate 55, fig. 8).

The spiniform tubercle found between the fifth pereopods is well developed; it is conical at its base, and the apex is flattened laterally; the vertex touches the caudal part of the annulus.

Measurements in millimeters

	Male, Form I	Male, Form II	Female
Total length	56.5	56.0	51.0
Length of carapace	27.5	28.0	26.2
Anterior part of carapace	18.0	18.0	17.5
Length of areola	9.5	10.0	9.3

Width of areola	3.0	2.5	3.0
Length of abdomen	31.0	30.5	26.5
Posterior width of rostrum	4.3	5.0	5.0
Length of rostrum	6.2	6.0	6.5
Length of chela	20.5	21.5	18.0
Length of palm	7.2	7.2	7.2
Length of movable finger	13.0	12.0	11.0

Locality. Tetela de Ocampo y La Cañada, 35 km N.E. of Zacapoaxtla, Puebla (type locality).

Relationships. The general considerations concerning the phylogenetic affinities are placed at the end of the description of *Paracambarus ortmannii*.

Paracambarus ortmannii Villalobos

1949 *Paracambarus ortmannii* Villalobos, An. Inst. Biol. de la Univ. Nal. A. de Mexico, Vol. XX, pp. 332 – 339, pls. 1 and 2.

Diagnosis. Size rather small. Rostrum without lateral spines. Hooks only on ischiopodites of fourth pair of pereopods of male. First pair of pleopods unequal in length, with their apical regions turned toward caudal region; mesial process not overreaching apical part which formed only by central projection. Basal region of right pleopod with two processes very close together on internal part of appendage. *Annulus ventralis* with cleft in caudal region, laterally flattened spiniform process between fifth pereopods of female.

248 **Male, form I.** The body is small and narrow. The carapace is long and compressed; its surface is punctate and the larger punctations are located in the dorsal region, especially on the posterior part of the rostrum; the lateral regions have punctations, but these are small and provided with from two to five setae which adhere to the surface and which are disposed in a divergent manner; the hepatic regions have small subsquamous tubercles disposed in concentric semicircles. The areola is marked by punctations that have lost their circular contour and become elongated in the plane of the suprabranchial grooves which in this instance are not visible; the surface of the areola is covered with punctations.

The rostrum is rather short, triangular in form, and without lateral spines; its surface is slightly concave and covered with punctations; the acumen ends in a small conical chitinized spine, its apex elevated. The ventral keel of the rostrum exhibits a series of four dentiform processes on the proximal region of which the smallest occurs at the base of the rostrum.

The postorbital ridges are almost parallel; they lack spines on the anterior part.

The cephalic groove is deep without pronounced undulations; the part of the groove that limits the hepatic region posteriorly is less profound and almost circular except for a smooth undulation in the lower part; the groove ends in a small branchiostegal spine.

The proportions that exist between the different parts of the carapace are the following: the length of the areola goes into the length of the cephalic portion two and one-third times; the posterior width of the rostrum goes into the total length of the carapace a little more than six times; the length of the rostrum is almost four and one-half times shorter than the total length of the carapace (Plate 57, figs. 1 and 2).

The abdomen is narrower than the carapace; the surface of the somite is slightly punctate with the number of punctations increasing in the pleural regions; the two ultimate segments still retain the setae which are so characteristic of the punctations of this type that we described earlier. The telson appears decidedly pubescent; the posterolateral angles of the first section exhibit only two spines.

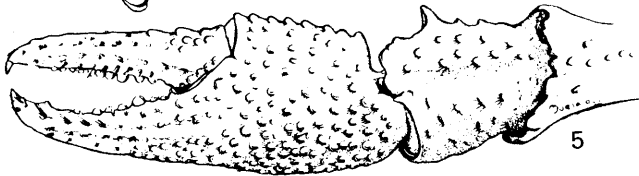
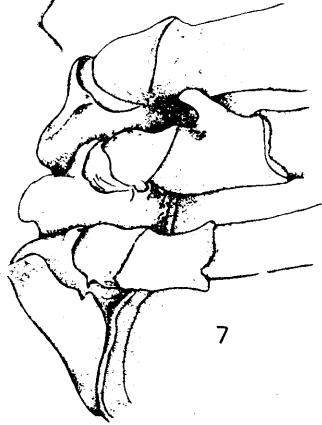
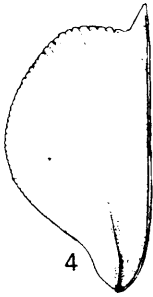
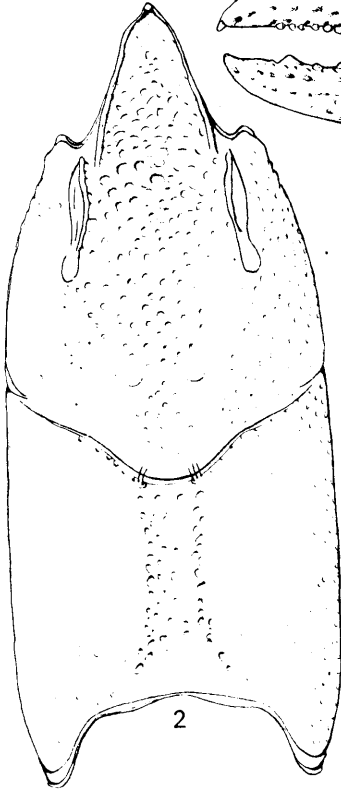
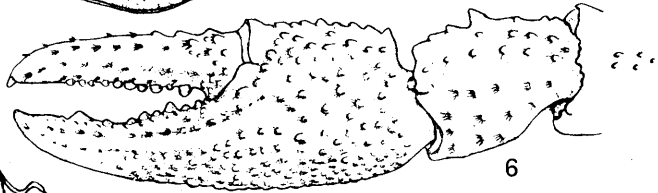
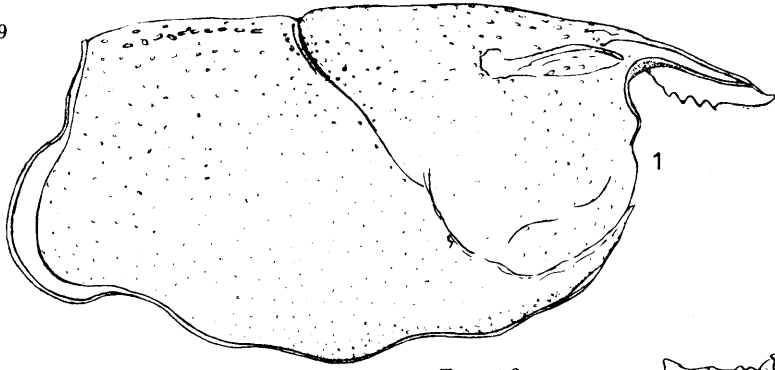
In the specimen that is described, the epistome is asymmetrical but in the other specimens tends to retain a heptagonal contour; the margins are elevated, terminating anteriorly in a central apex (Plate 57, fig. 3).

250 The antennal scale is short; the spine slightly overreaches the anterior extremity of the rostrum; the greatest width is exactly half the length (Plate 57, fig. 4).

The first pair of pereiopods are well developed; the meropodite exhibits subsquamous tubercles on the superior and anterior part, but are more prominent in those of the chela; on the inferior margin we find the conical spines so characteristic of this article in the crayfishes; the internal row consists of nine spines of which the smallest are the proximal ones; the external row has fewer of these structures, being larger but of unequal size; of this series first there are four small spines, then a large one followed by four other small ones; these latter are implanted on the articular border and the series converges with the spines of the internal row. The carpopodite is one and one-half times less than the length of the dactylopodite; the upper surface is scabrous and exhibits a somewhat deep groove which separates this surface into two portions, an external provided with punctations and an internal armed with subsquamous tubercles; the emargination of the articular border over that which flexes the chela is armed with four conical

Plate 57. *Paracambarus ortmanni* Villalobos. Male, Form I.

1, lateral view of the carapace; 2, dorsal view of the same; 3, epistome; 4, antennal scale; 5, chela; 6, chela of the female; 7, ischiopodites of pereiopods III to V of the male, Form I.



spines, two large ones, and between them two small ones; moreover, on the external side of the distal extremity there are two processes, one of them triangular in form and larger than the other.

In regard to the chela, we may say that the fingers are short and robust and the palm is ovate in outline. The internal border of the movable finger, or dactylopodite, exhibits two tubercles that stand out clearly very near the articular region; in the proximal and upper region of this same article, there is a series of prominences clustered in an irregular manner, but one row of four of the prominences is arranged along the length of the articular margin. The cutting border of the immovable finger is armed with small teeth which are disposed in the following manner: proximally first there are two slightly separated teeth, then a series of four teeth the size of which decreases distally; thereafter, there is a tooth somewhat separated from this group, and finally a series of three small teeth close together. The immovable finger is slightly shorter and more robust than the movable finger; the cutting border is concave and exhibits teeth similar in form to those of the opposite finger, but which are arranged in a different manner; in the same order as the former: there are first two small teeth, next a large one which stands out from all of them, followed by three small teeth more or
251 less close together, and finally another also small but slightly separated from the others. A little before the extremity there is a triangular spiniform process (Plate 57, fig. 5).

The third pair of pereopods lack tubercles on the ischiopodites.

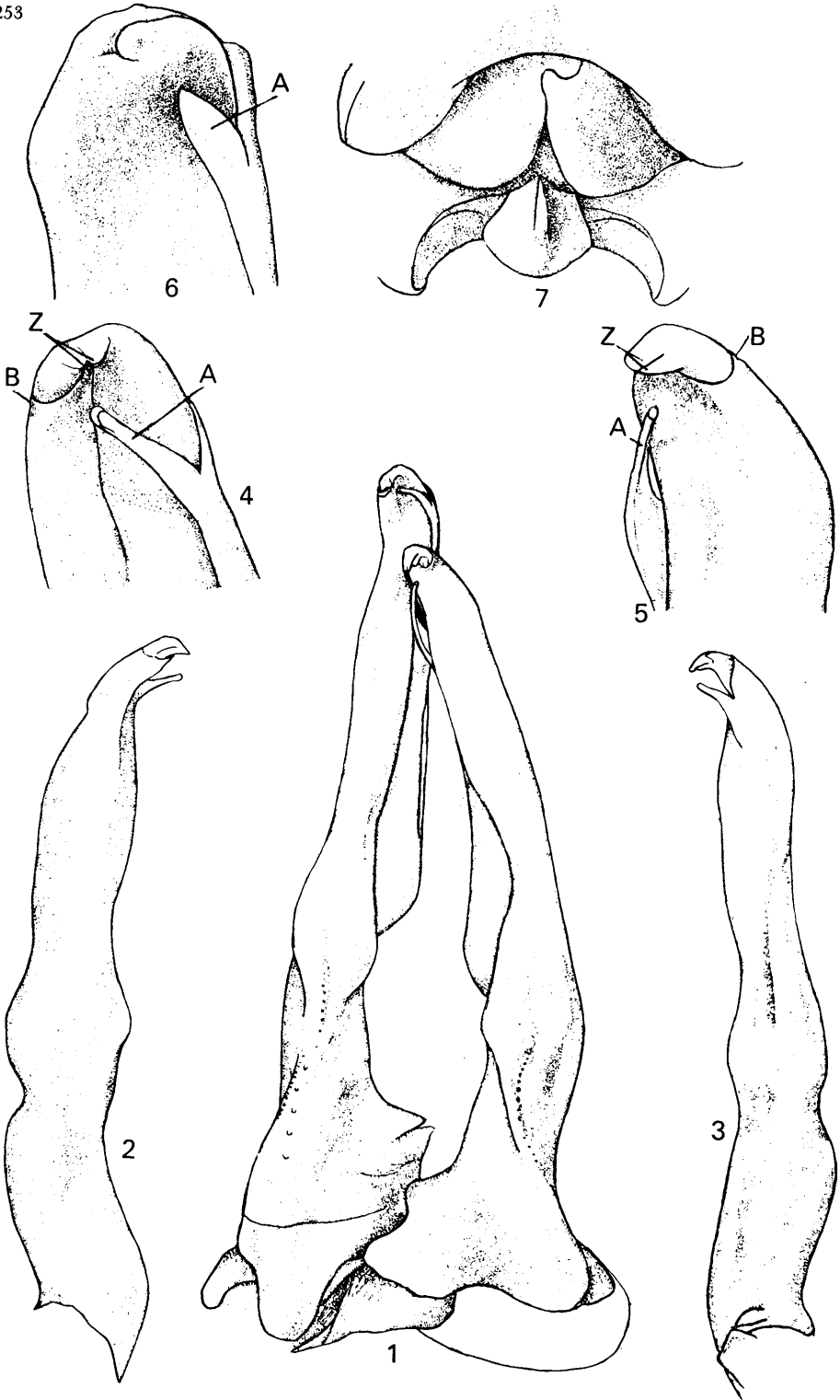
The coxopodites of the fourth pair of pereopods have a process similar to that described in *Paracambarus paradoxus*, but, in this case, the inferior extremity does not project freely. The hook on the ischiopodite is well developed and its terminal part has the form of a mitten; at its insertion, it occupies almost the entire length of the article (Plate 57, fig. 7).

The coxopodites of the fifth pair of pereopods have a small semicircular laminate process disposed perpendicular to the major axis of the body.

The apical regions of the first pair of pleopods touch the coxopodites of the third pair of pereopods; they are slender, convergent distally, and the apical parts are directed toward the caudal region. The right pleopod exhibits two more or less conical processes on the internal part of the basal region, their vertices very close together. The

Plate 58. *Paracambarus ortmanni* Villalobos. Male, Form I.

1, caudal view of first pair of pleopods; 2, lateral view; 3, mesial view; 4, caudal view of the apical region of the first right pleopod; 5, caudolateral view of the apical part of the first left pleopod (A, mesial process; B, cephalic process; Z, central projection); 6, caudal view of the apical part of the first pleopod of the male, Form II; 7, *annulus ventralis*.



left pleopod is smaller and is curved gently within (Plate 58, figs. 1, 2, and 3).

With respect to the elements that constitute the apical part, there are four the mesial process, the two processes of the central projection, and the cephalic process (Plate 58, figs. 4 and 5).

The mesial process is small and little chitinized, attenuated at its extremity, and flattened in the basal region; its extremity clearly shows an aperture which on the left pleopod is circular whereas that on the right exhibits two small lips (Plate 58, figs. 4. and 5A). The central projection is the most conspicuous part of the appendage; it is bent at an angle toward the caudal region, and the two structures that normally constitute it may be clearly distinguished (Plate 58, figs. 4 and 5Z).

The cephalic process is no more than a chitinized ridge which, like a collar, extends all along the external part of the base of the central projection (Plate 58, figs. 4 and 5B).

Male, form II. In this case, it is larger than the male, form I. The carapace is smoother, the rostrum wider and almost flat. The gastric region exhibits circular punctations that are more abundant in the median line; the branchial regions are also punctate, although not so densely as in the male, form I.

252 The third and fourth pairs of pereopods are very similar to those of the male, form I, but in this specimen the hook on the ischiopodite of fourth pair is very reduced in size.

The first pair of pleopods, except for the apical regions, are very similar to those of the form I, with the following exceptions: the tubercles of the internal basal region of the right pleopod are not sharp-pointed but rather blunt at their apices. In the basal region of the left pleopod, there is a small conical spiniform process situated exactly in the middle internal region of the pleopod. The apical parts are also slightly turned toward the caudal region; of the apical structures, only the mesial process is distinct; it is shorter, robust, and conical in form; it marks the beginning of a ridge which turns in a spiral and in the center of the ridge terminates in a prominence which represents the central projection (Plate 58, fig. 6).

Female. The specimen is also more robust than the male. The carapace is punctate over most of its surface; in the cephalic region these punctations are more visible.

The rostrum is subtriangular with a flat surface; the rostral margins do not have lateral spines, and they are more elevated in the apical region.

The postorbital ridges are elevated and lack spines on the anterior end.

The chelae are large, the entire surface covered with subsquamous tubercles. The fingers are slightly shorter and more robust than those of

the male. The carpopodite has four conical teeth on the articular emargination, one of which is very small. The two rows of teeth on the lower border of the meropodite appear very distinct from those that we described for the male, form I: the difference exists in that these rows are almost parallel in the female; the internal row comprises twelve teeth and the external, seven (Plate 57, fig. 6).

The *annulus ventralis* is typical of the genus *Paracambarus* and very similar to that of *P. paradoxus*; it is almost symmetrical, with an angular emargination in the caudal region. The groove is small and skewed to the left side (Plate 58, fig. 7).

Between the fifth pereopods, there is a spiniform, laterally flattened structure, the anterior border of which intrudes into the caudal margin of the *annulus ventralis* (Plate 58, fig. 7).

Measurements in millimeters

	Male, Form I	Male, Form II	Female
Total length	43.2	46.5	48.3
Length of carapace	20.8	22.9	23.5
Anterior part of carapace	14.2	15.2	16.0
Length of areola	6.6	7.7	7.5
Width of areola	2.1	2.3	2.4
Length of abdomen	22.4	23.6	24.8
Posterior width of rostrum	3.4	3.7	3.7
Length of rostrum	4.5	4.9	...
Total length of chela	15.5	16.4	15.9
Length of palm	7.4	7.2	8.0
Movable finger	8.9	9.3	9.4

Locality. Los Estajos, 6 km N.E. of Zihuateutla, Puebla. Collected in a small stream which runs along the right side on the way to the Rancho El Mirador. In the same locality, we found two other species, *Procambarus hoffmanni* and *P. erichsoni*.

Relationships. This species is similar to *P. paradoxus* in the following characteristics:

I. The apical parts of the first pair of pleopods of the male, form I, are turned toward the caudal region.

II. The mesial process is borne subdistally.

III. It has tuberculiform processes on the basal internal region of the first right pleopod.

IV. The apical region of the process between the fifth pereopods is flattened laterally.

The differences that we found for separating *Paracambarus ortmannii* are as follows:

I. The basal region of the right first pleopod of the male, form I, exhibits two tubercles that are very close together.

II. The cephalic process of the male, form I, has the form of a subapical ridge. The mesial process is very slender and little chitinized.

III. The caudal portion of the *annulus ventralis* bears an angular emargination.

IV. The ischiopodite of the third pair of pereopods lacks a trace of a tubercle.

The genus *Paracambarus* has close affinities with *Procambarus*; the characters of the two unique species clearly point out its possible phylogenetic ascendancy with those of the *blandingii* Subgroup; *Procambarus caballeroi* and *Procambarus tolteca* are intermediate species that exhibit strong similarities to members of the genus *Paracambarus*.

At one time, we considered that the unique existence of hooks on the fourth pair of pereopods should be the character for grouping all of those species that exhibit it in the genus *Paracambarus*. Later, we amended this taxonomic criterion and broadened the generic diagnosis of *Procambarus* in reference to the situation and number of hooks on the pereopods of the male. Consequently, the species of *Paracambarus* that possess hooks only on the ischiopodites of the fourth pair of pereopods should not be grouped with those *Procambarus* that possess this same character, instead with the species of the *blandingii* Subgroup, already mentioned, with which they share many other characters such as the features of the first pair of pleopods of the male, form I, and the coxopodites of the fourth pair of pereopods.

From a geographic point of view, *Paracambarus* is situated in the same general geographic territory in which the species of the *riojae* Section are distributed, but this is no more than the result of an invasion toward the south by the *blandingii* Subgroup, and if we consider that from this group the genus *Paracambarus* was derived, this logically results in the localization of *Paracambarus paradoxus* and *Paracambarus ortmannii* in the region.

Genus *Cambarellus* (Ortmann 1905a) S. Hobbs 1942b

Diagnosis. First pleopods of first form male terminating in three distinct parts, cephalic process always absent; terminal structures spiniform, somewhat truncate, spatulate, or grooved. In male, hooks present on ischiopodites of second and third pairs of pereopods. Very small crayfishes rarely attaining length of five centimeters. Third maxillipeds proportionately of normal size, with row of teeth along internal margin of ischiopodite.

Hobbs (1945b) has established three sections for this genus which he separated by the following key :

- 1 Terminal elements of first pleopods of first form male straight . . .
 *shufeldtii* Section
- 256 1' Terminal elements of first pleopod of first form male curved
 (directed caudadistally) 2
- 2(1') Mesial process of first pleopod of first form male grooved . . .
 *montezumae* Section
- 2' Mesial process of first pleopod of first form male not grooved but
 truncate or spiniform *schmitti* Section

MONTEZUMAE SECTION

[*Cambarellus montezumae montezumae* (Saussure)]

- 1857 a *Cambarus montezumae* Saussure, Rev. et Mag. Zool., 2nd Ser., Vol. IX, p. 102.
- 1858 *Cambarus montezumae* Saussure, Mém. Soc. Phys. Hist. Nat., Geneve, Vol. XIV, p. 459, fig. 22.
- 1870 *Cambarus mexicanus* (Erichson). Hagen, Mem. Mus. Comp. Zool., Harvard Coll., No. 3, p. 85.
- 1884 *Cambarus montezumae* (Saussure). Faxon, Proc. Amer. Acad. Arts and Sci., Vol. XX, p. 149.
- 1885 a *Cambarus montezumae* (Saussure). Faxon, Mem. Mus. Comp. Zool., Harvard Coll., Vol. X, No. 4, pp. 121 – 123, Pl. 2, fig. 6; Pl. 10, figs. 7, 7', 7a, 7a'.
- 1898 *Cambarus montezumae* (Saussure). Faxon, Proc. U.S. Nat. Mus., Vol. XX, p. 660.
- 1902 *Cambarus montezumae* (Saussure). Ortmann, Proc. Amer. Phil. Soc., Vol. XLI, p. 278.
- 1905 a *Cambarus (Cambarellus) montezumae* (Saussure). Ortmann, Proc. Amer. Phil. Soc., Vol. XLIV, pp. 97, 106, 127, Pl. 3.
- 1906 *Cambarus (Cambarellus) montezumae* (Saussure). Ortmann, Proc. Wash. Acad. Sci., Vol. VIII, pp. 19 – 20.
- 1914 *Cambarus montezumae* (Saussure). Faxon, Mem. Mus. Comp. Zool., Harvard Coll., Vol. XL, No. 8, pp. 371, 416.
- 1942 a *Cambarus (Cambarellus) montezumae* (Saussure). Hobbs, Proc. Fla. Acad. Sci., Vol. V, p. 57, Pl. 2, figs. 6, 7.
- 1942 b *Cambarellus montezumae* (Saussure). Hobbs, Amer. Midl. Nat., Vol. 34, No. 2, p. 340.
- 1943 *Cambarellus montezumae* (Saussure). Villalobos, An. Inst. Biol. de la Univ. Nal. A. de México, Vol. XIV, No. 2, pp. 587 – 599, Pl. 1.
- 1945 b *Cambarellus montezumae* (Saussure). Hobbs, Amer. Midl. Nat., Vol. 34, No. 2, p. 467.

- 1950 *Cambarellus montezumae* (Saussure). Hobbs, Proc. Biol. Soc. Wash., Vol. LXIII, p. 89.
- 1952 *Cambarellus montezumae* (Saussure). Villalobos, An. Inst. Biol. de la Univ. Nal. A. de México, Vol. XXII, No. 2, p. 531.

257 **Diagnosis.** Small crayfishes. Male with carapace same width as abdomen; length of carapace projected over abdomen reaching sixth abdominal somite. Rostrum with lateral spines; acuminal spine slightly exceeding second article of antennular peduncle. Postorbital ridges terminating anteriorly in short, blunt process. Carapace without lateral spines. Areola broad (width six and one-half times less than length of carapace). Posterolateral angles of first section of telson with spine. Sexual dimorphism in chelae. Ischiopodites of second and third pairs of pereopods with hooks. First pair of pleopods of male, form I, subequal in length; mesial process membranous and excavate. *Annulus ventralis* in form of U, with articulation in either of its rami. Spiniform process between fifth pereopods of female.

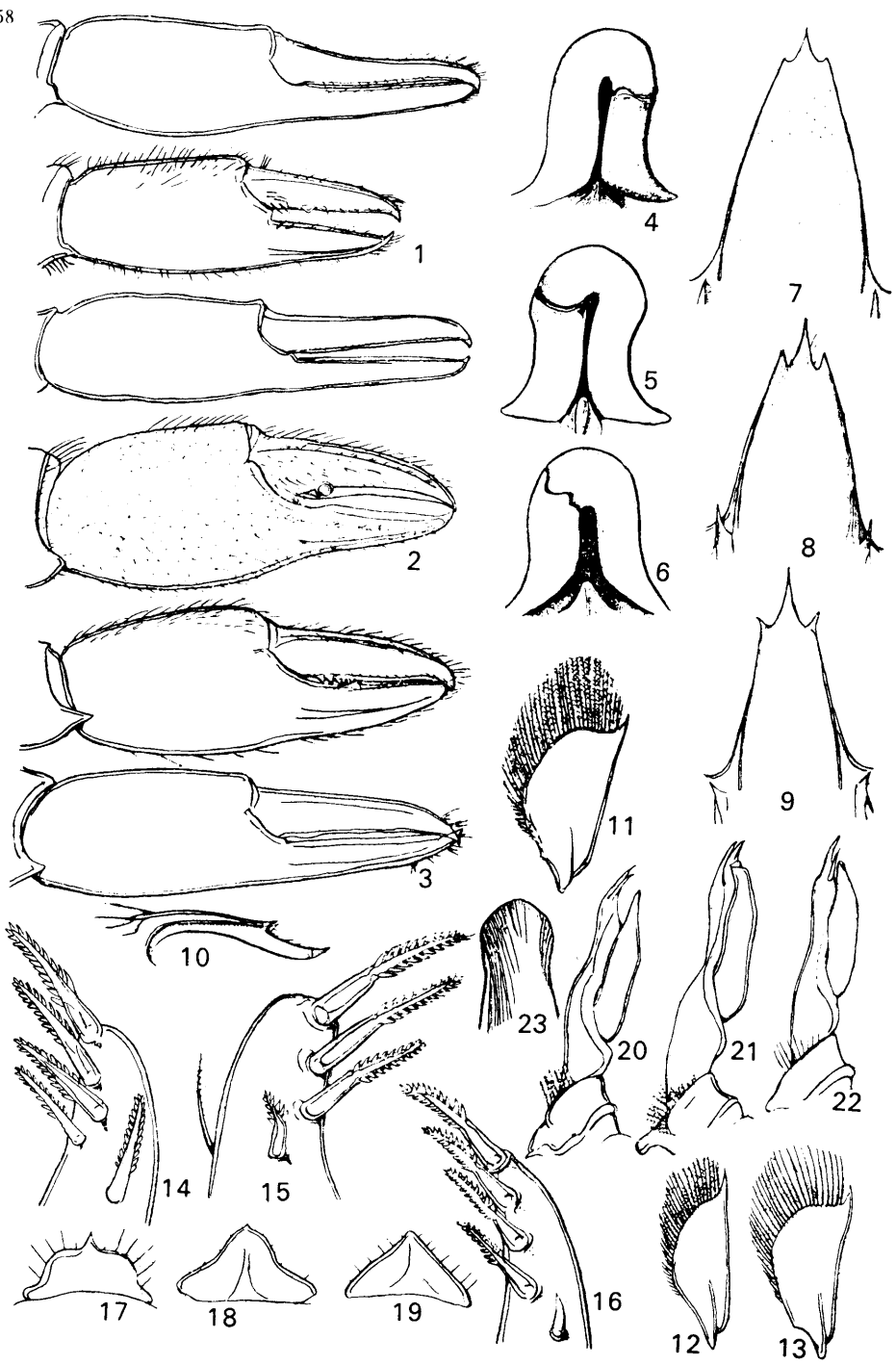
Cambarellus montezumae zempoalensis Villalobos

- 1943 *Cambarellus montezumae* Fma. *zempoalensis* Villalobos, An. Inst. Biol. de la Univ. Nal. A. de México, Vol. XIV, No. 2, pp. 601 – 603, Pl. 2, figs. 2, 4, 7, 13, 16, 17, 20.

Diagnosis. Areola moderately broad, three and one-half times shorter than length, with punctations dispersed on its surface. Rostrum broad at base, very narrow at apex; rostral margins convex and very convergent; lateral spines present, very close together; space between them equal to length of acumen; latter reaching distal articular border of second antennular article. Hooks on ischiopodites of second and third pairs of pereopods in male, neither bituberculate. Apices of first

Plate 59.

1, chelae of the male and of the female from Lago de Pátzcuaro; 2, chelae of the male and of the female from Lagunas de Zempoala; 3, chelae of the male and of the female from Río Lerma; 4, *annulus ventralis* of a female from Lagunas de Zempoala; 5, *annulus ventralis* of a female from Río Lerma; 6, *annulus ventralis* of a female from Lago de Pátzcuaro; 7, rostrum of a specimen from Lerma; 8, rostrum of a specimen from Zempoala; 9, rostrum of a specimen from Pátzcuaro; 10, lateral view of the rostrum of a specimen from Pátzcuaro; 11, antennal scale of a specimen from Lerma; 12, antennal scale of a specimen from Pátzcuaro; 13, antennal scale of a specimen from Zempoala; 14, maxillular endopodite of a specimen from Lerma; 15, maxillular endopodite of a specimen from Pátzcuaro; 16, maxillular endopodite of a specimen from Zempoala; 17, epistome of a specimen from Zempoala; 18, epistome of a specimen from Lerma; 19, epistome of a specimen from Pátzcuaro; 20, first pleopod of a specimen from Lerma; 21, first pleopod of a specimen from Pátzcuaro; 22, first pleopod of a specimen from Zempoala; 23, superior part of the mesial process of the first pleopod of a specimen from lago de Pátzcuaro.



pair of pleopods reaching posterior part of coxopodite of third pair [of pereopods], and terminating in three distinct parts; distal region of mesial process very narrow and excavate; central projection slightly recurved caudally; caudal process inclined caudally at angle of approximately 135° and shorter than central projection. *Annulus ventralis* slightly asymmetrical; suture on distal extremity of one of its rami disposed perpendicularly; cristiform process between fifth pereopods.

259 **Male, form I.** Generally it is smaller than the females. The carapace is slightly compressed, especially in the cephalic region since the branchial region is decidedly convex; the width of the carapace at the level of the caudal margin of the cephalic groove is less than the height; the greatest width is located at the level of the anterior part of the areola.

The areola is moderately broad and three and one-half times less than its length. The surface exhibits punctations located principally in the anterior half.

The postorbital ridges are subparallel and terminate anteriorly in a spine directed forward.

The surface of the carapace is provided with very few punctations of which the largest are located on the suprbranchial margins. The suborbital angle is approximately 90° and exhibits a rounded vertex.

The rostrum is broad at the base, narrow at the apex, and moreover gently flexed downward. The rostral margins are convex and convergent; the lateral spines are very short and are directed forward. The acumen is triangular and relatively short; its length is equal to the distance between the two lateral spines, whereas its apex reached the distal articulation of the second article on the antennular peduncle. The major part of the surface of the rostrum is flat, but slightly excavate at the level of the lateral spines (Plate 59, fig. 8).

The epistome is subtriangular or scutiform, with the anterolateral margins convex (Plate 59, fig. 17).

The abdomen is slightly longer than the carapace; the length of the latter reaches the posterior part of the cephalic section of the telson. In the posterolateral angles of the cephalic part of the telson there are one or two spines the length of which is less than that of the lateral spiniform process of that part of the telson.

The flagellum of the antennae reaches the first abdominal segment. The antennal scale is broad with the anterointernal margin almost perpendicular to the major axis of the body; the spine of the scale is long and sharp, the apex slightly overreaching the distal articular margin of the second article of the antennular peduncle (Plate 59, fig. 13).

The palm of the chela of the first pair of pereopods is almost cylindrical and very heavy in the proximal region, but compressed distally; the dactylar region is extremely slender. The surface of the chela

is completely smooth. The length of the dactylar region is greater than that of the palm, reaching the distal fourth of the carpopodite. The immovable finger, as well as the dactylopodite, is very slender and the cutting borders are devoid of teeth; the setiferous punctations of these
260 margins are close together and the bundles of setae are short. The internal margin of the dactylopodite is almost straight (Plate 59, fig. 2).

The ischiopodites of the second and third pairs of pereiopods exhibit hooks; the hook of the second pair, which is implanted on the middle part of the margin of the article, is flattened and its apex rounded; the axilar margin is almost straight but slightly excavate in the proximal region; the hook of the third pair is implanted on the distal two-thirds of the margin of the article; it is sharp and its vertex is slightly recurved; the axilar margin is concave with a small prominence on the middle part.

The apical parts of the first pair of pleopods reach the coxopodites of the third pair of pereiopods. The apical processes are slightly inclined toward the caudal region. The mesial process is membranous, narrow, and rectangular in its terminal part, and moreover grooved; its extremity reaches the subapical region of the caudal process. The central projection is sharp apically and very wide at the base, and regularly curved in a caudal direction. The caudal process is spiniform, straight, and inclined at an angle of approximately 135° with respect to the appendage; its length is slightly less than that of the central projection (Plate 59, fig. 22).

Male, form II. The rostrum is subplane and the margins are very little elevated above the surface; moreover, they are decidedly convergent; the lateral spines of the rostrum appear as two short processes; the acumen is very broad and short, its apex overreaching the second third of the second article of the antennular peduncle. The postorbital ridges exhibit very small spines. The width of the areola has the same proportion with respect to the length as that mentioned for the male, form I.

The chelae are a little more compressed and the fingers broader and shorter than in the male, form I.

The distal extremity of the first pair of pleopods slightly overreach the anterior region of the coxopodites of the fourth pair of pereiopods. Their apical parts are short and flattened laterally. The mesial process is semicircular in contour, the central projection triangular, and the caudal process subcylindrical, slightly sharp at the apex.

Female. Reaches a size greater than that of the males. The rostrum is subplane, the lateral margins convergent and slightly convex; the lateral spines are very short, and the distance between them is greater than the length of the acumen; the latter is very broad at the base and very short, its apex reaching the first third of the third antennular

261 article. The postorbital margins are quite parallel and the anterior spine hardly evident. The areola is four and one-half times narrower than the length.

The chelae of the first pair of pereopods are very broad and compressed; their surfaces are totally covered with small setae. The dactylopodite is equal in length to the palmar region, and its cutting margin is provided with two dentiform tubercles that are very close together and situated at the end of the proximal third. The immovable finger has only one tooth, at midlength of the cutting border.

The *annulus ventralis* exhibits the form of an inverted U with its distal extremity asymmetrical, which coincides with the presence of the groove; the latter is situated at the extremity of one of the rami, is sinuous, its position perpendicular to the major axis of the ramus. Between the fifth pereopods, there is a cristiform process which is insinuated between the rami of the *annulus*.

Measurements in millimeters

	Male, Form I	Male, Form II	Female
Total length	29.9	22.0	35.9
Carapace			
Height	7.3	4.6	8.4
Width	6.6	4.8	8.6
Length	13.6	10.2	12.1
Areola			
Length	4.6	3.5	6.1
Width	2.7	0.9	1.4
Rostrum			
Length	3.8	2.9	4.7
Width	2.0	1.6	2.4
Right chela			
Length of internal margin of palm	4.6	2.85	4.35
Greatest width of palm	2.8	1.85	3.5
Length of external margin of chela	10.4	11.7	9.2
Length of dactylopodite	5.1	3.6	4.6

Locality. Lagunas de Zempoala; these are contiguous reservoirs belonging to the same lacustrine basin, with probable communications between them, located in the mountains in the northern part of the State of Morelos at 2800 or 3000 meters above sea level. Surely these lakes had a volcanic origin. The vegetation is typically alpine.

262 **Relationships.** *Cambarellus montezumae zempoalensis* has close affinities with *C. montezumae lermensis* because possibly they have a common origin in *C. montezumae montezumae* and because of the Mio-Pliocene volcanism leaving them isolated and evolving independently.

Cambarellus montezumae lermensis Villalobos

1943 *Cambarellus montezumae* Fma. *lermensis* Villalobos, An. Inst. Biol. de la Univ. Nal. A. de Mexico, Vol. XIV, No. 2, pp. 603 – 607, Pl. 2, figs. 3, 5, 11, 14, 18, 20.

Diagnosis. Areola narrow, its width almost one-fourth of its length, with punctations dispersed and two or three transverse folds on anterior surface. Postorbital ridges parallel and terminating anteriorly in two small spiniform processes. Rostrum with surface plane; rostral margins weakly convergent and almost straight, slightly elevated above surface; lateral spines small, short processes; acumen very broad at base, but extremely slender at apex, latter reaching distal articulation of second article of antennular peduncle. Hooks on ischiopodites of second and third pairs of pereiopods, neither bituberculate. Apical portions of first pair of pleopods of male, form I, reaching posterior part of coxopodites of third pair of pereiopods; distal processes directed caudodistally; mesial process membranous, excavate, and slightly recurved caudolaterally; caudal process spiniform, straight, and inclined caudally at angle of 135°; central projection very wide at base, whereas apex slender, flattened in cephalocaudal plane, and moreover slightly flexed caudally. *Annulus ventralis* of regular form with groove in distal region of one of its rami.

Male, form I. The size is little less than that of the female. The carapace is oval in contour and slightly compressed in the anterior part. Its width at the level of the caudodorsal margin of the cervical groove is equal to the height. The greatest width of the carapace is at the level of the middle part of the areola.

The width of the areola is four times less than the length. The surface is provided with widely dispersed punctations and moreover two or three thin transverse folds in the anterior half.

263 The rostrum is broad at the base and relatively narrow at the level of the lateral spines; the rostral surface is flat and the margins, which are straight and slightly convergent, are elevated a little over it, although at the anterior extremity the surface is deeper. The lateral spines are very small and the distance between them is slightly greater than the length of the acumen; the latter is broad at its base and very sharp at the apex, which reaches the distal articulation of the second antennular article (Plate 59, fig. 7).

The postorbital ridges are parallel and terminate anteriorly in a small spiniform tubercle.

The surface of the carapace is smooth and the suborbital angle obtuse with the apex relatively sharp.

The abdomen is longer than the carapace and its length projected over the latter reaches the middle part of the cephalic section of the

telson. The posterolateral angles of this section of the telson exhibit a single spine.

The epistome is subtriangular with its anterolateral margin distinctly concave (Plate 59, fig. 18).

The antennal flagellum reaches the fourth or fifth abdominal somite. The anterointernal margin of the antennal scale (Plate 59, fig. 11) is perpendicular to the external margin; the spine of the scale is long and acute; it is directed distally and its apex reaches the distolateral articular margin of the third article of the antennular peduncle.

The palm of the chela of the first pair of pleopods is subcylindrical, but more compressed in the distal region. The dactylar region is longer than the palm, reaching the anterior third of the carpopodite. The fingers are relatively robust and are devoid of dentiform tubercles on the cutting border. The internal margin of the dactylopedite is straight (Plate 59, fig. 3).

The ischiopodites of the second and third pairs of pereopods exhibit hooks. The hook of the second is small; it is implanted on the middle part of the margin of the article and is gently curved inward. The hook of the third pair is better developed, inserted between the second and proximal part of the distal third; its apex is sharp and slightly incurved; the axial margin is provided with a prominence in the form of a spur.

The apical region of the first pair of pleopods reaches the posterior margin of the coxopodite of the third pair of pereopods, and the distal extremity terminates in three parts: the mesial process, which is relatively broad and of membranous consistency, is slightly inclined in a caudolateral direction, its extremity reaching the subapical region of the caudal process; the central projection is very broad at the base, and its distal extremity is slightly flexed in a caudal direction; and the caudal process, which is straight, very slender, and sharp, slightly overreaches the mesial process and is inclined at an angle of approximately 135° (Plate 59, fig. 21).

Male, form II. The rostrum is short and the margins straight and convergent. The lateral spines are hardly perceptible. The base of the acumen is much wider and the acuminal spine is slightly longer and overreaches the distal articulation of the second article of the antennular peduncle. The areola is narrower. The postorbital ridges lack spines on the anterior part.

The chelae of the first pair of pereopods are more flattened, and the dactylar portion is robust and of the same length as the palmar part.

The first pair of pleopods are straight; only their apical processes are slightly turned caudally. The mesial process is of the same length as the other two processes.

Female. The size is slightly greater than that of the male, form I.

The rostrum is very broad and short; the rostral margins are convergent and convex. The lateral spines are very close together; as a result, the base of the acumen is narrower than in the males.

The postorbital ridges are slightly convergent forward, and the anterior spiniform process is very small.

The areola has the same width as that of the male.

The chelae of the first pair of pereopods are broad, compressed, and pubescent, mainly along the margins. The dactylar portion is slightly longer than the palm; the cutting border of the dactylopodite has two teeth that are very close together in the subarticular region; the cutting border of the dactylopodite exhibits a single tooth toward the middle portion (Plate 59, fig. 3).

The *annulus ventralis*, as in the previous species, has the form of an inverted U. In this case, this structure has a regular form and the groove is located in the distal region of one of its rami, but the proximal margin is heavier than the distal, and it seems that one of the rami of the arc penetrates the terminal portion of the corresponding ramus. Between the fifth pereopods, there is a cristiform tubercle.

Measurements in millimeters

	Male, Form I	Male, Form II	Female
Total length	26.5	20.2	30.5
Carapace			
Height	6.5	4.7	8.0
Width	6.5	4.2	7.2
Length	12.1	9.3	14.1
265 Areola			
Length	4.1	2.9	4.9
Width	1.0	0.8	1.2
Rostrum			
Length	3.1	2.3	3.5
Posterior width	1.9	1.5	2.1
Right Chela			
Length of inner margin of palm	4.1	2.4	3.9
Greatest width of palm	2.3	1.4	1.8
Length of outer margin of chela	9.1	5.5	7.3
Length of dactylopodite	4.9	3.0	4.3

Locality. Swamps, lakes, and canals that surround the town of Lerma, formed in the area by the Rio Lerma. Height above sea level 2,573 m.

Relationships. *Cambarellus montezumae lermensis* is an intermediate form between *C. montezumae* and *C. chapalanus*, although we are inclined to think that it is more closely related to the species of Lago de Chapala.

Cambarellus montezumae patzcuarensis Villalobos

1943 *Cambarellus montezumae patzcuarensis* Villalobos, An. Inst. Biol. de la Univ. Nal. A. de México, Vol. XIV, No. 2, pp. 607 – 611, Pl. II, figs. 1, 6, 9, 12, 15, 19, 21, 23.

Diagnosis. Areola broad, exactly two and one-half times narrower than long; areolar surface with punctations and transverse grooves, latter dispersed in anterior two-thirds. Postorbital ridges terminating anteriorly in long, sharp spines broadly diverging cephalically. Rostrum long and narrow with surface gently concave; lateral spines of rostrum long and slightly divergent; acumen very long, sharp, and conical, its apex reaching median portion of third article of antennular peduncle. Hooks on ischiopodites of second and third pairs of pereopods, neither of them bituberculate. Terminal region of first pair of pleopods of first form male reaching midlength of coxopodites of third pair of pereopods; apical structures gently inclined caudally (angle with body of appendage approximately 175°). Central projection slightly exceeding caudal process; in male, form II, this structure equal in length to caudal process and much more inclined caudally. *Annulus ventralis* with sinuous suture on distal extremity of one of its rami.

Male, form I. The general size is smaller than that of the females. The carapace is distinctly compressed; the width at the level of the caudodorsal margin of the cephalic groove is noticeably less than the height. The greatest width of the carapace occurs at midlength of the areola.

The width of the areola is two and one-half times less than the length; the surface is provided with punctations dispersed here and there; moreover, in the anteromedian part, a few transverse wrinkles of the chitin are present that disappear in front of the cephalic groove.

The rostrum is narrow, and the rostral margins are slightly convergent and a little convex at the level of the cornea of the eye; the lateral spines are long, very sharp, and project forward but very slightly to the side; the acumen is quite narrow at the base and sharp and conical at the apex, which reaches the middle part of the third article of the antennular peduncle. The rostral surface is slightly excavate and without setiferous punctations (Plate 59, fig. 9).

The postorbital ridges are subparallel; anteriorly they terminate in spiniform processes that are sharp and distinctly divergent, and which at times clearly overreach the anterior margin of the carapace.

The surface of the carapace is very finely punctate, but larger punctations may be observed in the dorsolateral parts of the gastric region and on the suprbranchial margins. The suborbital angle is 90° and its vertex slightly rounded.

The abdomen is longer than the carapace. The lateral borders of the

cephalic section of the telson are convergent behind, and its posterolateral angles exhibit a single spine, the length of which is less than half that of the spiniform angular process of the cephalic section of the telson.

The epistome is triangular with the anterolateral margins straight or slightly concave (Plate 59, fig. 19).

267 The flagella of the antennae are moderately long and reach the second or third abdominal somite; the antennal scale is narrow, and the anterointernal margin is distinctly inclined; the spine of the scale is very long and acute, and slightly overreaches the distal articulation of the third antennular article (Plate 59, fig. 12).

The palm of the chela of the first pair of pereopods is more robust and cylindrical in the proximal region, but slightly compressed in the distal; its surface is completely smooth. The dactylar region is almost equal in length to that of the palm; the fingers are very slender and cylindrical in section; they are completely devoid of dentiform tubercles, but on the sides of the cutting borders are series of setiferous punctations with tufts of long setae; moreover, other widely spaced long setae are located on the surface of the fingers. The internal margin of the dactylopodite is slightly concave from its articulation to the subterminal anterior part (Plate 59, fig. 1).

The ischiopodites of the second and third pairs of pereopods exhibit hooks; that of the second pair is implanted on the proximal part of the margin and is flattened in the same plane as the article; it is broad and blunt at the apex, and the axilar margin exhibits a small emargination; the hook of the third pair has the form of a spur; it is implanted on the middle part of the margin of the article and is also flattened; its apical portion is sharp and curved inward; the axilar margin exhibits a small angular prominence more or less at midlength which separates two undulating emarginations on this margin.

The apical parts of the first pair of pleopods reach the middle part of the coxopodites of the third pair of pereopods, and the distal extremity ends in three distinct parts. The mesial process is borne at the end of the second third of the appendage; it is broad at the base and narrow in the terminal part, which reaches the middle portion of the caudal process and is grooved; its consistency is membranous; the caudal process is distinctly chitinized; it is sharp and is slightly inclined toward the mesial region and in a caudal direction at an angle of approximately 145° with the principal body of the appendage; the apical extremity of this process hardly overreaches the central projection. The latter is broad at its base, its major part directed distally; only the apical region is slightly flexed caudally (Plate 59, fig. 21).

Male, form II. The male, form II, differs from the form I in the following characters: the margins of the rostrum are subparallel and the

lateral spines are more divergent; the rostral surface is subplane. Although the anterior spines of the postorbital ridges are divergent at the base, the apical portions project in a distal direction.

The chelae of the first pair of pereopods are less slender and the dactylar portions longer than the palm; the section of the palm is oval and the fingers are compressed and wide.

The apical region of the first pair of pleopods exhibits very short processes that are not chitinized and which are inclined caudally at an angle of approximately 120°; these processes terminate almost at the same level; the mesial process is very wide.

Female. The size is larger than that of the males. The rostral margins are more convergent, and consequently the lateral spines are closer together. The acumen is longer than in the males and reaches the distal articulation of the third article of the antennular peduncle. The spines of the postorbital region are shorter. The chela of the first pair of pleopods is shorter and broad; its palmar section is oval, and the surface is covered with setae which are more abundant on the external and internal margins; the fingers are straight, broad, and compressed; their length is greater than that of the palmar region; the cutting border of the dactylopodite exhibits a single tooth on the proximal third that is inclined forward; the cutting border of the immovable finger also exhibits a dentiform process which is smaller and located a little more forward than the tooth on the movable finger.

The *annulus ventralis* has the form of an inverted U and is almost regular in contour. The groove or suture is located on the distal part of one of its rami, in this case the right, but may be found also on the left ramus. Between the fifth pereopods, there is a pyramidal process, the vertex of which is applied between the two rami of the *annulus* (Plate 59, fig. 6).

Measurements in millimeters

	Male, Form I	Male, Form II	Female
Total length	27.7	22.3	35.5
Carapace			
Height	5.4	5.0	7.3
Width	6.1	4.8	7.2
Length	12.4	11.5	16.8
Areola			
Length	4.1	3.4	5.3
Width	2.7	1.3	1.8
Rostrum			
Length	3.9	4.0	5.8
Posterior width	2.85	1.5	2.2
Right chela			
Length of internal margin of palm	4.5	2.7	3.7

269	Greatest width of palm	2.0	1.3	1.8
	Length of external margin of chela	9.75	6.3	9.0
	Length of dactylopodite	5.1	3.3	4.7

Locality. Shoreline of Lago de Pátzcuaro, Michoacán.

Relationships. Among the localities that were cited by Faxon for this species, *Cambarellus chapalanus*, he included Lago de Pátzcuaro, but the crayfish from this locality which are described here show very clear differences that are pointed out following the description of *C. chapalanus*.

The differences between *C. montezumae patzcuarensis* and *C. montezumae montezumae* are pointed out in the comparative table that follows:

<i>Cambarellus montezumae montezumae</i>	<i>Cambarellus montezumae patzcuarensis</i>
I. Length of apical spine of rostrum less than distance between lateral spines.	I. Length of apical spines of rostrum greater than distance between marginal spines.
II. Width of antennal scale equal to [one-half] length of external border including spine.	II. Width of antennal scale almost one-third length of external border including spine.
III. Distal region of mesial process very broad.	III. Distal region of mesial process narrow.
IV. Epistome pentagonal.	IV. Epistome triangular.

SCHMITTI SECTION

Cambarellus alvarezi Villalobos

1952 *Cambarellus alvarezi* Villalobos, An. Inst. Biol. de la Univ. Nal. A. de México, Vol. XXII, pp. 525 – 531, pls. I and II.

Diagnosis. Areola broad, slightly less than half length; surface with few very fine and almost imperceptible punctations. Hooks on ischiopodites of second and third pairs of pereopods not bituberculate; hook of second pair curved toward caudal region. Palm of chela smooth. Postorbital ridges without spines. Carapace without lateral spines. First pair of pleopods of first form male with apical region reaching midlength of coxopodite of third pair of pereopods and exhibiting three spiniform processes directed caudally at angle of approximately 120°; central projection and caudal process equal in length and not exceeding length of mesial process. First pair of pleopods of second form male exhibiting in inclination of apical region little more open angle; central projection and mesial process of same length; caudal process shorter and conical.

Male, form I. The carapace is compressed laterally in the anterior region, subovate in the posterior; its surface is smooth with a few scattered setae. The cephalic groove is slightly angular in the dorsal region, shallow and discontinuous with the part that limits the hepatic region; it has neither lateral spines nor tuberculiform prominences where they are normally found. There are no branchiostegal spines; the postorbital ridges terminate in a straight angle and consequently lack terminal spines (Plate 60, figs. 1 and 2).

The rostrum is subplane, only slightly excavate in the anterior part; the rostral margins are convergent, little elevated, and end in two very short angular structures that correspond to the lateral rostral spines. The apical portion is short, forming an angle of more or less 45° and terminating in a short conical process which is equivalent to the apical spine; the rostrum reaches the distal internal margin of the second antennular article.

The areola is broad, marked by a transparency but not by supra-branchial grooves; in the posterior region its limits are imprecise. The areolar surface is smooth but very small punctations may be distinguished, each provided with a slender seta. The width of the areola is 44 percent of its length (Plate 60, figs. 1 and 2).

The epistome is broad and short, nearly symmetrical, and the anterior margins elevated (Plate 61, fig. 5).

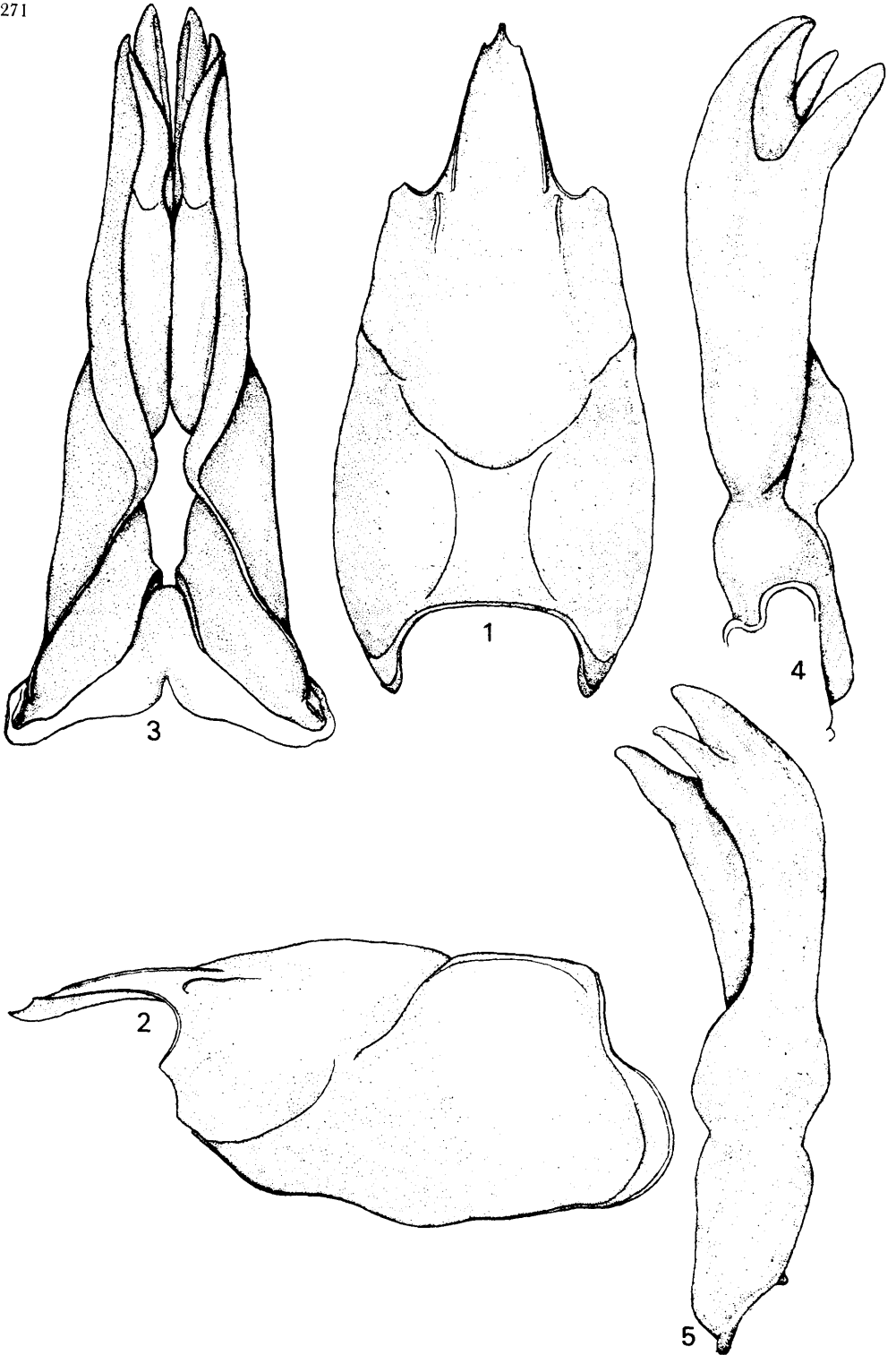
The abdomen is longer than the cephalothorax and its anterior portion exhibits a width equal to that of the branchial portion of the carapace. The anterior part of the telson exhibits two spines on each side of its distal margin, one of which corresponds to the spiniform process terminating the cephalic part of the telson.

The antennal flagellum, projected over the dorsal region of the body, reaches the middle of the fifth abdominal segment; the greatest width of the antennal scale is near its midlength. The spine of the scale is straight in relation to the external border, conical and sharp (Plate 61, fig. 6).

On the first pair of pereopods, we find that the meropodial article is smooth on the surface and its lower border does not exhibit spiniform tubercles, but only a ridge standing out clearly from the article and provided with setae. The carpopodite is smooth without a groove on the dorsal region, and its greatest length is three and one-half times shorter than the length of the propodus, including the dactylar portion; on the distal margin and on the lateral part, there is a broad angular plate.

Plate 60. *Cambarellus alvarezi* Villalobos.

1, dorsal view of the carapace of the male, Form I; 2, lateral view of the same; 3, caudal view of the first pair of pleopods of the male, Form II; 4, mesial view of a pleopod of the same pair; 5, lateral view of the same.



The chela is subcylindrical in the proximal part of the palmar region whereas it is flattened distolaterally; the surface is smooth, bearing very slender setae, the majority of which recline over the surface, but others are elevated almost perpendicularly; the immovable finger is straight, shorter than the movable one; its cutting border is convex and is devoid of teeth but on the sides exhibits groups of setae along its entire length; the terminal tooth is short and almost hemispherical; the dactylopodite, or movable finger, is equal in length to that of the palm; its cutting border is gently concave in the terminal portion, without teeth, and with groups of setae similar in form and disposition to those of the immovable finger; the terminal tooth is well developed and conical in form (Plate 61, fig. 7).

The ischiopodites of the second and third pairs of pereopods exhibit hooks. The hook on the ischiopodite of the second pair is more or less triangular, flattened anteroposteriorly, and curved toward the caudal region; it is implanted on the proximal region of the article, and the apex overreaches the articulation of the ischiopodite with the basipodite. The hook on the ischiopodite of the third pair is sharper than the former and the apex is bent toward the basipodite (Plate 61, fig. 4).

The coxopodite of the fourth pair of pereopods lacks a ventral prominence.

The apices of the first pair of pleopods in normal position reach the middle part of the coxopodite of the third pair [of pereopods]; the apical region is turned toward the caudal region and flattened laterally, terminating in three distinct, slender, long parts (Plate 61, fig. 1). The mesial process overreaches the other two structures; it is conical at its base and flattened at the apex; its consistency is membranous and forms an angle of approximately 120° with the principal body of the appendage (Plate 61, figs. 2 and 3A). The caudal process is spiniform, becoming abruptly narrower along the distal third and slightly curved (Plate 61, figs. 2 and 3D). The central projection is distinctly chitinous, sharp, and curved toward the caudal region, forming an angle of approximately 40° to the mesial process; its length slightly overreaches the caudal process (Plate 61, figs. 2 and 3Z). The centrocaudal process, a component of the central projection (Plate 61, figs. 2C and 3), is broad at the base and sharp at the apex; the centrocephalic process maintains more or less the same width throughout its length (Plate 61, figs. 2E and 3).

274 **Female.** Unknown; there are no individuals of this sex among the specimens at our disposal for this study.

Male, form II. The carapace is more compressed than the abdomen. The rostrum is broader than in the male, form I, and the rostral margins are almost parallel, slightly incurved in the distal part;

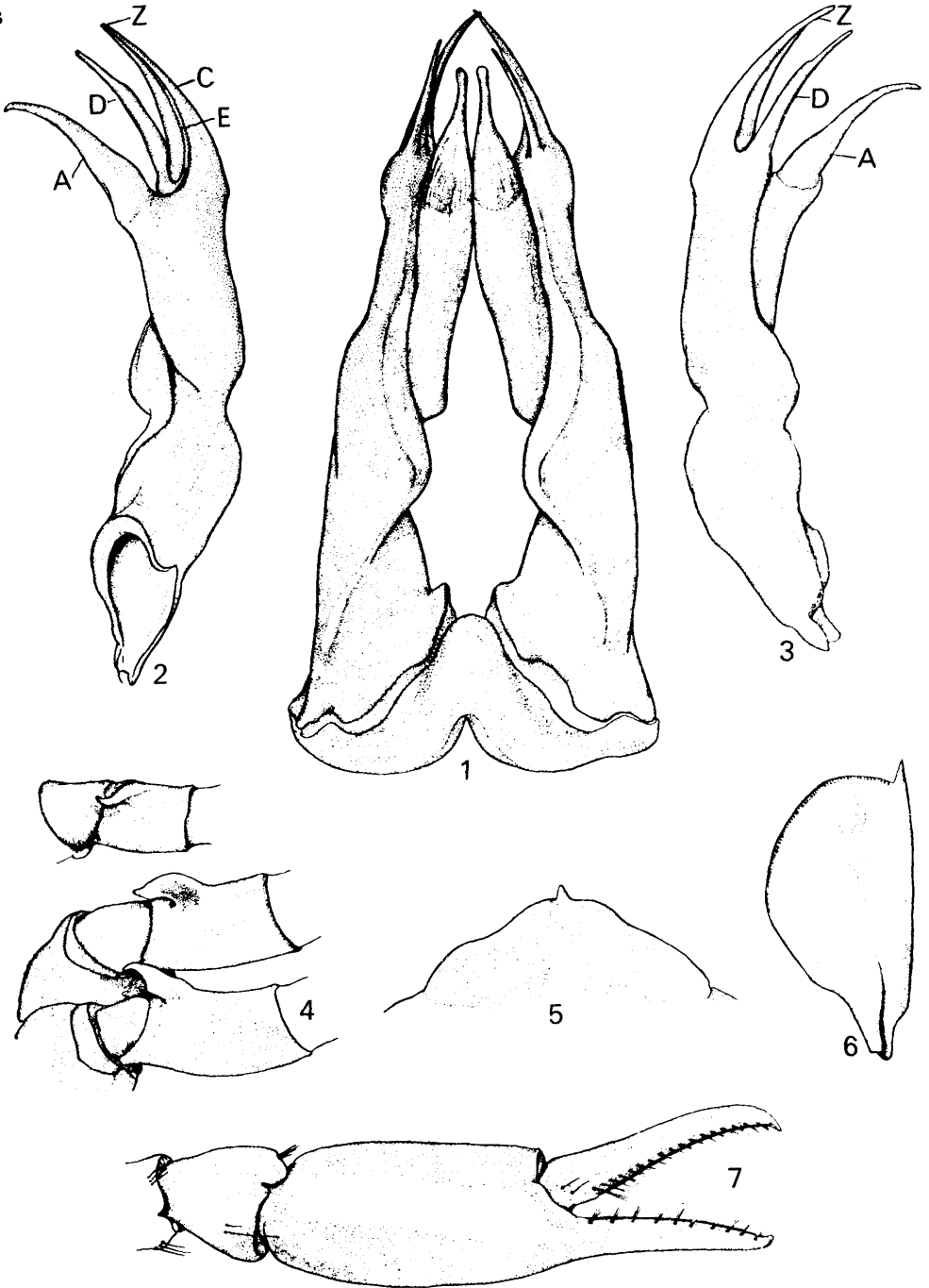


Plate 61. *Cambarellus alvarezii* Villalobos. Male, Form I.

1, caudal view of the first pair of pleopods; 2, mesial view; 3, lateral view; 4, ischiopodites of pereopods II and III; 5, ventral view of the hook on the ischiopodite of the second pereopod; 6, antennal scale; 7, chela.

the lateral spines are short and angular; the apical region is shorter than in the male, form I. The postorbital ridges lack spines; the areola is broader than in the male, form I.

The chelae of the first pair of pereopods are more slender.

The hooks on the ischiopodites of the second pair of pereopods are short and do not overreach the proximal ischiopodal articulation; the hooks on the ischiopodites of the third pair are also short, but in them the prominence of the dorsal or axilar border is more acute, and the apical region does not overreach the proximal articulation of the article.

The first pair of pleopods are distinctly flattened in the distal region, and the inclination toward the caudal region is less marked; the aspect of the mesial process is that of a broad plate at the base but not sharp at its end. The caudal process is shorter and conical in form. The central projection is broad and slightly curved; all of these structures are membranous (Plate 60, figs. 3, 4, and 5).

Measurements in millimeters

	Male, Form I	Male, Form II	Female
Total length	33.2	28.3	—
Carapace			
Length	15.0	8.8	—
Width	8.3	6.5	—
Height	8.2	7.0	—
Areola			
Length	4.5	3.7	—
Width	1.98	2.4	—
[?]	4.2	2.4	—
Chela			
Anterior width	0.8	0.9	—
Posterior width	2.8	2.0	—
Abdomen			
Length	19.7	17.0	—
Right chela			
Length of internal margin of palm	6.4	4.9	—
Width of palm	3.6	2.6	—
Length of external margin of palm [chela ?]	12.3	9.3	—
Length of dactylopodite	6.4	4.3	—

275 **Locality.** Potosí, Nuevo Leon, 23 km N.W. of Galeana. Collection obtained in body of water in a closed basin situated in the northern part of Valle Salado.

Relationships. Taking as a point of reference the classification of Hobbs (1945 b), *Cambarellus alvarezii* is placed within the *schmitti* Section

because we consider that the terminal part of the mesial process of our species, although slightly flattened, lacks the grooved form that we find in the same process of *Cambarellus montezumae montezumae* (Saussure). The hook on the ischiopodite of the third pair [of pereopods] is not double because the angular structure which it shows on the axial border has neither the characteristics nor the position of the accessory tubercle of *C. puer*, *C. diminutus*, or *C. ninae*.

The length of the mesial process, which in *C. alvarezii* overreaches the caudal process, and that of the central projection give us a unique combination of characters for our species.

The discovery of a new crayfish in the northern region of the Mexican Republic establishes another link in the chain with the fauna of the United States regarding the cited subfamily; *Cambarellus alvarezii* exhibits a clear affinity with the same genus of the neighboring country; in contrast, it stands completely apart from the species which exist in the central part of Mexico and which are related to *C. montezumae*.

Due to the shortage of time for presenting this work and the lack of adequate material, the various species and subspecies of the genus *Cambarellus* are left for a later study in which a careful revision will be necessary; consequently we confine ourselves to treating them in the following manner:

Cambarellus montezumae var. *tridens* (Von Martens)

1872 *Cambarus montezumae* var. *tridens* Von Martens, Archiv Für Naturgeschichte, Vol. XXXVIII, p. 130.

This form was described by Von Martens from crayfish material sent to the Berlin Museum from Puebla, Puebla. The principal characteristic is the presence of lateral spines on the rostrum, which as we know is a characteristic that Saussure did not mention in the original description of *C. montezumae*. Faxon and Ortmann considered it a synonym of Saussure's species.

276 *Cambarellus montezumae dugesii* (Faxon)

1890 *Cambarus montezumae* Faxon, Proc. U.S. Nat. Mus., Vol. XII, p. 633.

1898 *Cambarus montezumae dugesii* Faxon, Proc. U.S. Nat. Mus., Vol. XX, p. 660, Pl. XLVI, fig. 1.

1906 *Cambarus (Cambarellus) montezumae dugesii* (Faxon). Ortmann, Proc. Wash. Acad. Sci., Vol. VIII, p. 20.

1914 *Cambarus montezumae dugesii* Faxon, Mem. Mus. Comp. Zool., Harvard Coll., Vol. XL, No. 8, p. 416.

Diagnosis. Surface of rostrum plane; margins elevated, convergent;

acumen slightly longer than in *C. montezumae*; lateral spines on rostrum more strongly developed. Postorbital ridges with anterior spine. Chela broader and more hirsute than in *C. montezumae*; fingers pointed with claw more conspicuously yellow in color. Length 38 mm. (After Faxon.)

Locality. State of Guanajuato. Col. A. Dugés.

Types in the U.S.N.M. No. 16087.

Cambarellus montezumae areolatus (Faxon)

- 1885a *Cambarus montezumae* var. *areolata* Faxon, Mem. Mus. Comp. Zool., Harvard Coll., Vol. 10, p. 123.
1898 *Cambarus montezumae areolatus* Faxon, Proc. U.S. Nat. Mus., Vol. XX, p. 661, Pl. LXVI, fig. 2.
1906 *Cambarus* (*Cambarellus*) *montezumae areolatus* (Faxon). Ortmann, Proc. Wash. Acad. Sci., Vol. VIII, p. 23.
1914 *Caambarus* [sic] *montezumae areolatus* Faxon, Mem. Mus. Comp. Zool., Harvard Coll., Vol. XL, No. 8, p. 416.

Diagnosis. Form of rostrum similar to that of *C. m. dugesii*, but lateral margins not very elevated; lateral spines of rostrum and acuminal spine similar to those of *C. m. dugesii*. Areola very short but quite wide. (After Faxon.)

Locality. Parras, Coahuila.

Types in the Mus. Comp. Zool. No. 3650.

Cambarellus montezumae occidentalis (Faxon)

- 1898 *Cambarus montezumae occidentalis* Faxon, Proc. U.S. Nat. Mus., Vol. XX, p. 661, Pl. LXVI, figs. 3, 4.
1906 *Cambarus* (*Cambarellus*) *montezumae occidentalis* (Faxon). Ortmann, Proc. Wash. Acad. Sci., Vol. VIII, p. 23.
1914 *Cambarus montezumae occidentalis* Faxon, Mem. Mus. Comp. Zool., Harvard Coll., Vol. XL, No. 8, p. 416.

277 **Diagnosis.** Surface of rostrum plane; margins slightly elevated above it, converging gradually from base to apex, without lateral spines clearly delimiting acumen, overreaching distal extremity of second antennular article. Postorbital ridges without spines. (After Faxon.)

Locality. Mazatlan, Sinaloa.

Types in the Mus. Comp. Zool. No. 3652.

Cambarellus chapalanus (Faxon)

- 1898 *Cambarus chapalanus* Faxon, Proc. U.S. Nat. Mus., Vol. XX, p. 661, Pl. LXVII, figs. 1, 2.

1914 *Cambarus montezumae chapalanus* (Faxon), Mem. Mus. Comp. Zool., Harvard Coll., Vol. XL, No. 8, p. 416.

Diagnosis. Similar to *C. montezumae*, but differing from it in following characters: body more slender and more cylindrical; rostrum longer and narrower, reaching extremity of antennular peduncle, somewhat hirsute, armed with pair of sharp and straight lateral spines; acumen long and spiniform. Postorbital ridges terminating anteriorly in strong spiniform tooth. Antennal scale much longer and narrower, armed with very long apical spine.

Surface of rostrum plane, with lateral margins slightly elevated. Sides of rostrum convex, distinctly convergent anteriorly before reaching lateral spines. Chelae and first pair of pleopods similar to those of typical form of *C. montezumae*.

In some respects, *C. montezumae dugesii* shows certain similarities to this species, but there should be no confusion between them if the slender form, the length of the rostral spines, etc., of *C. chapalanus* are taken into account. *Cambarellus shufeldtii* is distinguished from *C. chapalanus* by the presence of lateral spines on the carapace, the broader rostrum, and the different form of the first pair of pleopods of the male.

Locality. Chapala, Jalisco.

Types in the U. S. Nat. Mus., 1 male, No. 17698; topotypes, U. S. Nat. Mus., 3 males, No. 16294.

General Considerations Concerning the Present Distribution of the Crayfishes of Mexico

278 The geographical distribution of the currently known Mexican crayfishes and the natural groups that they comprise have many peculiarities. We should indicate that our collections have been made in the eastern part of Mexico, and for that reason the conclusions that are presented here will be modified as material is obtained from new localities, especially in the western region, in which for a lack of adequate explorations we cannot be sure of the non-existence of these crustaceans. Because of the ecological conditions that exist in western México, however, surely the crayfish fauna must be relatively poorer than that existing on the Atlantic slope.

In the present monograph, we have adopted a theory concerning the origin of the Mexican crayfish fauna, that in certain respects opposes the theory of Ortmann; "Are we right?"; this is something that the specialists of the group will decide.

It is admitted that the cambarines constitute a highly specialized group of the family Astacidae, and seem to have originated from a lower type very similar to the genus *Astacus*, from which they arose by the suppression of the only pleurobranch and by the advanced development of the first pair of pleopods in the male.

According to Ortmann and Marc André, the center of origin of the crayfishes should be in southeastern Mexico, and the immigration that carried the most primitive crayfishes to the United States could have originated on the Mexican plateau moving northeastward during the early Eocene to the eastern parts of North America.

According to Marc André, the cambarines originated early in the Cenozoic Era from a stock of *Astacus* that invaded the south through the western part of the Mexican Republic.

We think that if the primitive form of American *Astacus* had access to the western part of North America, using the intercontinental bridge that existed from early in the upper Cretaceous to late in the Tertiary, and that temporarily joined Alaska with Siberia, the separation of the stock of cambarines could have been effected in the upper Cretaceous,

279 precisely in the region of northwestern America. Immigrating to the southeast and occupying the eastern plateaus of the United States, where, sheltered by conditions of the environment which should have been very favorable, they evolved and became widely distributed. Concomitantly, the original stocks of *Astacus* continued their immigration to the south, following the route of migration between the Rocky Mountains and the west coast of North America.

We think that the Mexican cambarine fauna was derived from that of the United States, by emigrations in different geological periods, and, following two principal routes of invasion, they became established in regions suitable for them to exist.

Possibly the older route was across the central plains; concomitantly, the other, more modern, was progressing along the coastal plain of the Gulf, which, as a result of recent emersion, provided more favorable conditions, and explains why there is a greater variety of forms of cambarines in this zone.

A) Species that originated from the possible immigration across the central plain:

The geographic localization of the Mexican species of the *barbatus* Section and its discontinuous distribution, induces us to believe that it became established approximately during the Eocene. The following species are included in this section: *Procambarus digueti*, *P. bowvieri*, and a new subspecies of *P. simulans*, *P. simulans regiomontanus*.

Procambarus digueti, the primitive characteristics of which were pointed out by Ortmann, is located in the tributaries of the Río Santiago, near Chapala, Jalisco, and in Puruándiro and Jacona, Michoacán. It lives in localities where the currents are very slow, or even in standing water where there is an abundance of aquatic vegetation, at an altitude of 1400 to 1600 meters above sea level. These localities are situated in the western portion of the central part of Mexico (Plate 62, 1).

Procambarus bowvieri has been collected only in Uruapan, Michoacán, in creeks of slow currents or in standing water, the altitude of which is approximately 280 meters above sea level (Plate 62, 1').

None of the species previously mentioned has close affinities with the species of the east coast, and their isolation indicates that they were established long ago, representing remnants of the invading group that crossed the central plain. The only connection that we are able to establish, through morphological characteristics, is with *P. simulans regiomontanus*, located in Monterrey, Nuevo León, at an approximate
280 altitude of 500 meters above sea level (Plate 62, 1''). Another possible subspecies of *P. simulans* was found in Ciudad General Bravo, in the northern part of the State of Tamaulipas. The original species, *Procambarus simulans*, is located in Kansas and New Mexico in the United States, and all seem to indicate that probably this species extends

through Texas to the southeastern border with Mexico. According to Faxon this crayfish exhibits very primitive characteristics.

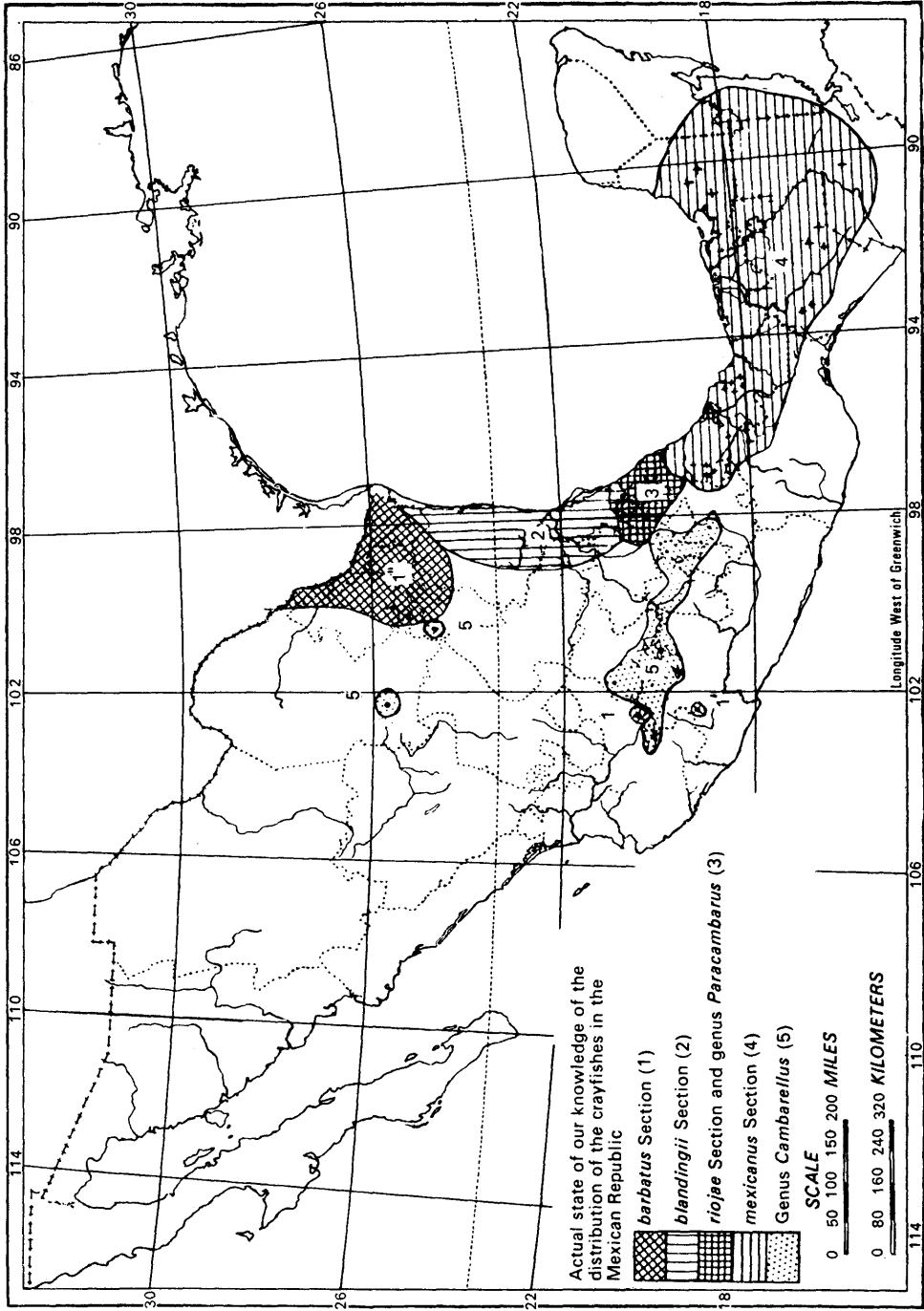
The genus *Cambarellus* is characterized also because its species exhibit a discontinuous geographic distribution, located principally in the closed basins in typical lotic habitats, and all of them are situated in the central plain; all of this seems to indicate that the route of invasion could be the same as that of the species of the *barbatus* Section, but possibly at a more modern time, that is in the Miocene, and they became established as far as the southern part of the central plain during the Pliocene; they were stopped in the northern part of the Sierra Volcánica Transversal (Plate 62, 5). In Parras, Coahuila, and in the State of Nuevo León, there are two species that have no connection with those of the south, but correspond in certain aspects with the species of the United States.

We must consider *Cambarellus chapalanus* as the representative stock from which the other species of the *montezumae* Section are derived. *Cambarellus patzcuarensis* and *Cambarellus montezumae dugesii* have closer geographic and morphological relations with *C. chapalanus* than with *C. montezumae*. The latter species, which we consider as typical of the genus *Cambarellus*, might have originated from the immigration of the ancient form of *C. chapalanus* that was moving to the southeast, across the Rio Santiago, becoming established in the Valley of Mexico; later it was isolated when the south end of the valley was closed by the volcanic upheavals of the Miocene-Pliocene. The subspecies *C. montezumae lermensis* and *C. montezumae zempoalensis* are forms isolated by the geographic accidents that brought about the closure of the Valley of Mexico; *C. montezumae lermensis* could be the representative of the invading form that populated the Valley of Mexico.

B) Species that originated from the possible emigration through the coastal plain of the Gulf of Mexico:

The retreating of the waters from the Atlantic coast probably began in the Pliocene, and should have produced very favorable ecological conditions for the emigration of the cambarines coming from the northeastern part of North America. This could have taken place toward the end of the Pliocene, and be correlated with the beginning of the Glacial period of the Quaternary, and we think that the decreasing temperature and other climatic changes influenced in this aspect the faunistic displacement, as has been shown in other animals.

The northeastern region of the Republic is populated by the species of the *blandingii* Section of the genus *Procambarus*, which are recognized as direct descendants of the cambarine fauna of the United States (Plate 62, 2). These species entered into the geographic range of the *riojae* Section (Plate 62, 3), which could have been derived from the *blandingii* Section.



The genus *Paracambarus* and the *riojae* Section occupy almost the same area, that situated between the 19° and 21° parallels on the Atlantic slope (Plate 62, 3).

The *mexicanus* Section occupies an extensive zone which extends from the south of the Volcánica Transversal to Guatemala and Cuba, but possibly there are other representatives in the southern part of Central America and northeastern South America (Plate 62, 4).

The Mexican forms of the *blandingii* Section are represented by *Procambarus blandingii cuevachicae*, *Procambarus caballeroi*, and *Procambarus toltecaae*.

Procambarus blandingii cuevachicae is distributed from Valles, San Luis Potosí, to the northern part of the State of Puebla, and in all of the localities we found the ecological conditions more or less similar. It lives in still or in very slowly flowing water at elevations between 60 and 300 m above sea level. The presence of this subspecies in a cavernicolous situation (Cueva Chica, San Luis Potosí, type locality) is only circumstantial, because in the specimens from this place there are no characteristics that denote an adaptation to cave life; consequently, we may consider them as troglonexes. The morphological study of the specimens collected in the northern part of Puebla resulted in the establishment of certain differential characteristics, but these are not considered to be of sufficient magnitude of variation to designate them subspecies.

Procambarus caballeroi is found in the southern part of Villa Juárez in places where the water is standing and at an altitude of 1000 m above sea level. This species is located in the geographic territory of the *riojae* Section; it is interesting that the localities in which *P. caballeroi* is found are sometimes separated from places where *Procambarus hoffmanni* lives by only a few meters, but never are they together. The relationships of *P. caballeroi* with *P. blandingii cuevachicae* are very close, not only in the form and disposition of the hooks on the third and fourth pairs of pereopods, but also by the appearance of the apical structures of the first pair of pleopods of the first form male. With reference to the *annulus ventralis*, it is a character that permits the establishment of the relationship between *P. blandingii cuevachicae* and *Procambarus toltecaae*.

Procambarus toltecaae is a very peculiar species in that the apical region of the first pair of pleopods is inclined in a caudal direction, a character that we see only slightly developed in *P. caballeroi* and that is typical of the species of the genus *Paracambarus*, with which we are able immediately to establish a connection. Also it is necessary to point out the form and disposition of the caudally inclined mesial process with which another similarity is established with *Paracambarus*. *Procambarus toltecaae* was collected near Tamazunchale, and the species most closely related

to it, although belonging to another genus, is *Paracambarus ortmanni* [sic] which is located in the geographic area of the *riojae* Section, providing additional proof that the *blandingii* Section migrated toward the south. The locality of *P. tolteca*, in Tamazunchale, is a stream of clear water that sometimes develops a swift current. Other collections of the same species from Xilitla, San Luis Potosí, indicate to us that its range is that part of the Atlantic slope of the Sierra Madre Oriental lying at an altitude of between 110 and 400 m above sea level.

The *riojae* Section is a complex of species which because of its quantity and restricted distribution presents interesting ecological and biological problems. The species united in this section have a common denominator, the presence of well developed hooks on the fourth pair of pereopods, whereas those of the third pair may be absent or reduced. Moreover, the first pair of pleopods in the first form male are straight and unequal in length; on the other hand, the apical structures of the pleopods vary within the range of a fixed type, but with a tendency to enlarge the mesial process, correlated with the reduction of the others.

Included in the *riojae* Section are the following species: *Procambarus riojae*, *P. hoffmanni*, *P. hortonhobbsi* [sic], *P. teziutlanensis*, *P. tlapacoyanensis*, which compose the *riojae* group *Procambarus erichsoni*, *P. contrerasi*, and *P. zihuateutlensis* which form the *erichsoni* group.

Procambarus riojae has been collected in Huachinango, Necaxa, Honey, and Zacatlán, in the State of Puebla, at altitudes that vary between 1500 and 2000 m above sea level. These localities are humid and relatively cold and located on the Atlantic slope of the Sierra Madre Oriental. They inhabit small brooks and streams that have more or less rapid currents and clear water. The characteristics of the terminal processes of the first pair of pleopods of the first form male agree almost completely with the scheme of the hypothetical pleopod given by Hobbs, exhibiting moreover a small adventitious process. There is an equal development of those processes, with the mesial and cephalic processes having the same length.

Procambarus hoffmanni is closely related to *P. riojae*, but the length of the cephalic process is reduced. This species has been found in Villa Juárez, Puebla, at approximately 1200 m above sea level, but its range extends from the Río Necaxa Basin to Coyutla and Papantla, Veracruz, where the altitude is approximately 30 to 40 m above sea level. It lives in clear brooks and streams with more or less rapid currents. Among the species of the *riojae* Section, this is one that exhibits a great adaptability.

Procambarus hortonhobbsi has been collected in a single locality, Arroyo El Coyular, 7 km N.E. of Zihuateutla, Puebla, in which there is a more or less rapid current and clear water; the height above sea level is approximately 400 m. This species is characterized by exhibiting a

platelike cephalic process while the mesial process remains more or less spiniform, considered a connecting link between the *riojae* and *erichsoni* groups.

Procambarus teziutlanensis and *P. tlapacoyanensis* are very closely allied but differ in the form of the mesial process of the first form male: in *P. teziutlanensis* it is conical and straight, whereas that of *P. tlapacoyanensis* is flattened and somewhat sinuous. These species are found in the southernmost part of the geographic range of the *riojae* Section, and possibly the *mexicanus* Section could have been derived from ancestral forms closely allied to them. These species frequent streams of clear water and have been collected in the Rio Nautla Basin. *Procambarus teziutlanensis* is found at an altitude of approximately 2000 m; *P. tlapacoyanensis* occupies a lower zone (500 m above sea level), which receives cold winds from the higher elevations, as a result of which the environment is very similar to that of Teziutlán, Puebla.

The species of the *erichsoni* Group differ from those of the *riojae* Group in the reduction of the mesial process, in that the caudal process is platelike and displaced centrally or cephalically, and moreover, the cephalic process is reduced and spiniform while the central projection is well developed.

285 *Procambarus erichsoni* now replaces *Procambarus weigmanni* [sic] (Ortmann); this change has resulted from a taxonomic adjustment. *Procambarus erichsoni* has been found in the region of Tenango de Doria, State of Hidalgo, at an altitude of 1400 m above sea level, which is the westernmost part of the range of the *riojae* Section. It inhabits clear streams in which the current is more or less rapid. The apical parts of the first pair of pleopods of the first form male exhibit certain similarities to those of *P. Hoffmanni* [sic].

Procambarus contrerasi has been found in the northern part of Puebla marking the northern limit of the geographic range of the *riojae* Section; there it is found in localities very near those occupied by *P. blandingii cuevachicae*, at altitudes between 300 and 50 m above sea level. The apical processes have certain resemblances to those of *P. erichsoni*, but it [*P. contrerasi*] seems to have a closer similarity to *P. zihuateutlensis*.

Procambarus zihuateutlensis is completely limited to the geographic range of the *riojae* Section. It was collected along with *Procambarus hoffmanni* and *Paracambarus ortmanni* [sic], surprisingly, because never before have we obtained three different species in the same place. This locality encompasses streams in the town of Zihuateutla. It is related to *P. contrerasi* and *P. erichsoni* as is indicated by the similarity in the *annulus ventralis* and by certain homologies between the apical processes of the first pair of pleopods of the first form male.

The genus *Paracambarus* has been maintained in this study as a

taxonomic entity in spite of the fact that as the phylogenetic relationships have been more deeply investigated the species comprising it seem to belong in the genus *Procambarus*.

Paracambarus paradoxus and *P. ortmanni* [sic] occur within the range of the *riojae* Section and are related in certain respects to the *blandingii* Section of the genus *Procambarus*. The relationship of *Paracambarus ortmanni* [sic] to *Procambarus toltecaae* has already been mentioned.

Paracambarus paradoxus has been collected in Tetela de Ocampo, in the Siera de Zacapoaxtla, Puebla, at an altitude of approximately 1900 m above sea level, marking the southwestern limit of the range of the *riojae* Section, which coincides with the region of Teziutlán, Puebla, where *Procambarus teziutlanensis* occurs.

286 *Procambarus ortmanni* [sic] has been collected in a single locality: in Los Estajos, Municipality of Zihuateutla, in the eastern part of the State of Puebla, at an altitude of approximately 1200 m above sea level. In the same place where it was collected, *Procambarus hoffmanni* and *P. zihuateutlensis* were found.

The *mexicanus* Section is a natural group of species with very uniform characteristics; its range extends from northern Jalapa to Guatemala and Cuba, occupying all of the coastal plain and the lower parts of the Atlantic slope (Plate 62, 4). The number of currently described species, its ecology, and its special environmental adaptations indicate to us that it [the Section] is undergoing a full period of evolution.

The characteristics that are diagnostic of this section are as follows: shoulder present on the cephalic surface at some distance from the apical part of the first pair of pleopods of the first form male, which may be reduced but never absent; dispositions of the central projection and mesial process; and hooks present only on the ischiopodites of the third pair of pereopods of the male.

We have separated the species of the *mexicanus* Section into two groups:

The *mexicanus* group with eight species that do not have pubescent chelae, that have a single branchiostegal spine, and that exhibit a mesial process projecting distinctly beyond the apical region and directed distally or distolaterally.

The *pilosimanus* group, comprising three species, with the chelae partly or totally pubescent, with more than one branchiostegal spine and more than one lateral spine on the carapace; and finally, with the mesial process scarcely projecting beyond the apical region, almost always directed laterally.

The distribution of the *mexicanus* group embraces the area from Misantla, Veracruz, to the southern part of the same State, but possibly extends to the southern part of Chiapas, almost to the Guatemala

border, while that of the *pilosimanus* group has been found from southern Veracruz, Tabasco, Campeche, Quintana Roo, part of Yucatán, and Guatemala.

The data that we present will be completed with the study of the material in our collection, obtained from the southern part of the Republic.

The accumulation of a large number of forms in the geographic region 3 (Plate 62), between the 19° and 21° parallels, presents an important ecological and biological problem.

From an ecological point of view, it is possible that an important natural barrier, possibly the Sierra Volcánica Transversal, arrested the immigration of the crayfishes toward the south; [the crayfish stock] without losing its evolutionary potential, unfolded into the species of the *riojae* Section and those of the genus *Paracambarus*; those groups possibly were derived from the *blandingii* Section with which they share certain corresponding characteristics. However, only one stock of the *riojae* Section, near *P. teziutlanensis* and *P. tlapacoyanensis*, could have crossed the natural barrier already mentioned to give rise to the species of the *mexicanus* Section which were broadly distributed in the southeastern part of the Republic, Guatemala, and possibly all Central America. The bridge that united Central America with the Antilles could have been the route of invasion of these crayfishes of the *mexicanus* Section to the Island of Cuba.

From the purely biological point of view, the large variety of forms of the *riojae* Section may be explained by a series of mutations arising in a very short time; but in a broad view, in this case, we must not overlook the possibility that the geographic conditions forced those new and multiple forms to remain in a very restricted area. The same explanation could be given for the *mexicanus* Section, but in this case without some natural barrier, the species acquired a very broad range in relation to the distribution of the other sections. It is important to note that no species other than those belonging to the *mexicanus* Section has been found in the southern part of the Republic.

Bibliography

- 288 ANDRÉ, M., 1936 – 37. Géonémie des Ecrevisses. XII Congrès International de Zoologie. Sección V, pp. 1009 – 1032, 5 figs.
- ARELLANO, A. R. V., 1953, Estratigrafía de la Cuenca de México. Memoria del Congreso Científico Mexicano (Commemorativo del IV Centenario de la Fundación de la Universidad de Mexico), vol. 3, pp. 3 – 17, 1 map, 1 appendix.
- BALDWIN, H. W., 1918. Fresh Water Biology. John Wiley and Sons, N. Y.
- BOTT, R., 1950. Die Flusskrebse Europas (Decapoda, Astacidae). Abhandl. Senckenberg. Naturf. Ges., No. 483, 36 pages, 25 figs., 6 plates.
- BOUVIER, E. L., 1897. Sur les *Cambarus* Recueillis au Mexique par M. Diguët. Bull. Mus. Hist. Nat., vol. 3, No. 6, pp. 224 – 228.
- CREASER, E. P., 1931. Three New Crayfishes (*Cambarus*) from Puebla and Missouri. Occ. Pap. Mus. Zool., Univ. Mich., No. 224, pp. 1–10, 17 figs.
- ERICHSOHN, W. F., 1846. Uebersicht der Arten der Gattung *Astacus*. Arch. für Naturgeschichte (Berlin), Vol. 12, No. 1, pp. 86 – 103.
- FAXON, W., 1884. Descriptions of New Species of *Cambarus*, to Which is Added a Synonymical List of the Known Species of *Cambarus* and *Astacus*. Proc. Amer. Acad. Arts and Sci., vol. 20, pp. 107 – 158.
- _____. 1885a. A Revision of the Astacidae, Part I. The Genera *Cambarus* and *Astacus*. Mem. Mus. Comp. Zool., Harvard Coll., vol. 10, No. 4, pp. 1 – 186, 10 pls.
- _____. 1885b. A List of the Astacidae in the United States National Museum. Proc. U. S. Nat. Mus., vol. 8, No. 23, pp. 356 – 361.
- _____. 1890. Notes on North American Crayfishes, Family Astacidae. Proc. U. S. Nat. Mus., vol. 12, No. 785, pp. 619 – 634.
- _____. 1898. Observations on the Astacidae in the United States National Museum and in the Museum of Comparative Zoology, with Descriptions of New Species. Proc. U. S. Nat. Mus., vol. 20, No. 1136, pp. 643 – 694, pls. 62 – 70.
- _____. 1914. Notes on the Crayfishes in the United States National Museum and the Museum of Comparative Zoology, with Descriptions of New Species and Subspecies to Which is Appended a Catalogue of Known Species and Subspecies, etc. Mem. Mus. Comp. Zool., Harvard Coll., vol. 40, No. 8, pp. 351 – 427, 13 pls.

- HAGEN, H. A., 1870. Monograph of the North American Astacidae. Illus. Cat. Mus. Comp. Zool., Harvard Coll., No. III, pp. 1 – 109, pls. I – XI.
- HOBBS, H. H., JR., 1941. A New Crayfish from San Luis Potosi, Mexico (Decapoda, Astacidae). *Zoologica*, vol. 26, pt. 1, pp. 1 – 4, 1 fig.
- . 1942a. On the First Pleopod of the Male Cambari (Decapoda, Astacidae). *Proc. Fla. Acad. Sci.*, 1940, vol. 5, pp. 55 – 61, 2 pls.
- . 1942b. A Generic Revision of the Crayfishes of the Subfamily Cambarinae (Decapoda, Astacidae) with the Description of a New Genus and Species. *Amer. Midl. Nat.*, vol. 28, No. 2, pp. 334 – 357, pls. 1 – 3.
- . 1942c. The Crayfishes of Florida. *Univ. Fla. Pub., Biol. Sci. Ser.*, vol. III, No. 2, pp. v + 179, 24 pls.: 346 figs.
- . 1943. Two New Crayfishes of the Genus *Procambarus* from Mexico (Decapoda, Astacidae). *Lloydia*, vol. 6, pp. 198 – 206, pls. I – II.
- . 1945a. Notes on the First Pleopod of Male Cambarinae (Decapoda, Astacidae). *Quart. Journ. Fla. Acad. Sci.*, vol. 8, No. 1, pp. 67 – 70, 15 figs.
- . 1945b. Two New Species of Crayfishes of the Genus *Cambarellus* from the Gulf Coastal States, with a Key to the Species of the Genus (Decapoda, Astacidae). *Amer. Midl. Nat.*, vol. 34, No. 2, pp. 466 – 474, 26 figs.
- . 1950. A New Crayfish of the Genus *Cambarellus* from Texas (Decapoda, Astacidae). *Proc. Biol. Soc. Wash.*, vol. 63, No. 18, pp. 89 – 96, 17 figs.
- HUXLEY, TH., 1879. On the Classification and the Distribution of the Crayfishes. *Proc. Zool. Soc. London*, 1878, pp. 751 – 788, 7 figs.
- . 1880. L'Ecrevisse. Introduction a L'Etude de la Zoologie. *Bibliothèque Scientifique Internationale*, vol. 36, pp. 1 – 256, 81 figs.
- ORTMANN, A. E., 1902. The Geographical Distribution of Fresh-Water Decapods and its Bearing upon Ancient Geography. *Proc. Amer. Phil. Soc.*, vol. 41, No. 171, pp. 267 – 400, figs. 1 – 8.
- . 1905a. The Mutual Affinities of the Species of the Genus *Cambarus*, and Their Dispersal Over the United States. *Proc. Amer. Phil. Soc.*, vol. 44, No. 180, pp. 91 – 136, pl. III.
- . 1905b. *Procambarus*, a New Subgenus of the Genus *Cambarus*. *Ann. Carnegie Mus.*, vol. 3, No. 3, pp. 435 – 442, 3 figs.
- . 1906. Mexican, Central American and Cuban Cambari. *Proc. Wash. Acad. Sci.*, vol. 8, pp. 1 – 24, figs. 1 – 4.
- . 1909. Une Ecrevisse Nouvelle du Mexique, *Cambarus (Cambarus) bouvieri* nov. sp. *Ann. Sci. Nat., new series*, vol. 7, pp. 159 – 166, figs. 1 – 4.

- PEARSE, A. S., 1911. Report on the Crustacea Collected by the University of Michigan-Walker Expedition in the State of Vera Cruz, Mexico. Mich. Acad. Sci., Thirteenth Report, pp. 108 – 113, 4 figs.
- RIOJA, E. L., 1940a. Estudios Carcinológicos V. Morfología de un Ostrácodo Epizoario Observado Sobre *Cambarus* (*Cambarellus*) *montezumae* Sauss. de México, *Entocythere heterodonta* n. sp. y Descripción de Algunos de sus Estados Larvarios. An. Inst. Biol. de la Univ. Nal. A. de México, vol. 11, No. 2, pp. 593 – 609, pls. I – III.
- . 1940b. Un Caso de Biocenosis observado sobre *Cambarus* (*Cambarellus*) *montezumae* (Saussure), de Mexico. Rev. Chilena de Historia Natural, vol. 44, pp. 57 – 59.
- ROBLES, R. R. 1942. Orogenesis de la república Mexicana en Relación con su Relieve Actual. Irrigación en México. Mayo-Junio, pp. 7 – 61.
- SAUSSURE, H. DE 1857a. Note carcinologique sur la famille des *Thalassides* et sur celle des *Astacides*. Rev. et Mag. Zool. Pure et Appliquée, ser. 2, vol. 9, pp. 99 – 102.
- . 1857b. Diagnoses de quelques crustacés nouveaux de l'Amérique tropicale. Rev. et Mag. Zool. Pure et Appliquée, ser. 2, vol. 9, pp. 501 – 505.
- . 1858. Mémoire sur divers crustacés nouveaux des Antilles et du Mexique. Mém. Soc. d'Hist. Nat., Genève, vol. 14, pp. 417 – 496, 6 pls. [Reprint: Mém. pour servir a L'Hist. Nat. du Mexique, des Antilles et des Etats-Unis, vol. I, Premier Mémoire, pp. 1 – 82, 6 pls.]
- VAN STRAELEN, V., 1942. A Propos de la Distribution des Ecrevisses, des Homards et des Crabes d'Eau Douce. Bull. Mus. Royal Hist. Sci. Nat. Belgique, vol. 18, No. 56, pp. 1 – 11.
- VILLALOBOS, A. F., 1943. Estudios de los Cambarinos Mexicanos I. Observaciones Sobre *Cambarellus Montezumae* (Saussure) y Algunas de sus Formas, con Descripción de una Subespecie Nueva. An. Inst. Biol. de la Univ. Nal. A. de México, vol. 14, No. 2, pp. 587 – 611, 2 pls.
- . 1944a. Estudios de los Cambarinos Mexicanos, II. Dos Especies Nuevas del Género *Paracambarus*. An. Inst. Biol. de la Univ. Nal. A. de México, vol. 15, No. 1, pp. 161 – 174, pls. I – II.
- . 1944b. Estudios de los Cambarinos Mexicanos, III. Una Especie Nueva de *Procambarus*, *Procambarus caballerouï* [sic] n. sp. An. Inst. Biol. de la Univ. Nal. A. de México, vol. 15, No. 1, pp. 175 – 184, pls. I – II.
- . 1946. Estudios de los Cambarinos Mexicanos, IV. Consideraciones Acerca de la Posición Sistemática y Redescripción de *Procambarus digueti* (Bouvier) y *Procambarus bouvieri* (Ortmann). An.

- Inst. Biol. de la Univ. Nal. A. de Mexico, vol. 17, Nos. 1 and 2, pp. 215 – 230, pls. I – II.
- FAXON, W., 1947a. Estudios de los Cambarinos Mexicanos, V. Redescrpción de *Paracambarus paradoxus* (Ortmann) y Descripción de una Nueva Especie del mismo Género. An. Inst. Biol. de la Univ. Nal. A. de México, vol. 18, No. 1, pp. 233 – 247, pls. I – III.
- _____. 1947b. Estudios de los Cambarinos Mexicanos, VI. Descripción de una Nueva Especie del Género *Paracambarus*. An. Inst. Biol. de la Univ. Nal. A. de México, vol. 18, No. 2, pp. 537 – 546, pls. I – II.
- _____. 1948. Estudios de los Cambarinos Mexicanos, VII. Descripción de una Nueva Especie del Género *Procambarus*, *Procambarus acanthophorus* n. sp. An. Inst. Biol. de la Univ. Nal. A. de México, vol. 19, No. 1, pp. 175 – 182, pls. I – II.
- _____. 1949. Estudios de los Cambarinos Mexicanos, VIII. Descripción de una Nueva Especie del Género *Paracambarus*. An. Inst. Biol. de la Univ. Nal. A. de México, vol. 20, Nos. 1 and 2, pp. 331 – 339, pls. I – II.
- _____. 1950. Contribución al Estudio de los Cambarinos Mexicanos, IX. Estudio Taxonómico de un Grupo de Especies del Género *Procambarus*. An. Inst. Biol. de la Univ. Nal. A. de México, vol. 21, No. 2, pp. 367 – 413, pls. I – XI.
- _____. 1952. Estudios de los Cambarinos Mexicanos X. Una Nueva Especie del Género *Cambarellus* del Estado de Nuevo León. An. Inst. Biol. de la Univ. Nal. A. de México, vol. 22, No. 2, pp. 525 – 532, pls. I – II.
- _____. 1953. Distribución Geográfica y Notas Ecológicas de los Cambarinos Mexicanos. Mem. del Cong. Científico Mexicano, VII. Ciencias Biológicas, IV Centenario de la Universidad de México, vol. 7, p. 343 – 374, 5 figs.
- _____. 1954a. Estudios de los Cambarinos Mexicanos, XI. Una Nueva Subespecie de *Procambarus simulans* del Estado de Nuevo León. An. Inst. Biol. de la Univ. Nal. A. de México, vol. 25, Nos. 1 and 2, pp. 289 – 298, pls. I – II.
- _____. 1954b. Estudios de los Cambarinos Mexicanos, XII. Parte 1. Revisión de las Especies Afines a *Procambarus mexicanus* (Erichson), con Descripción de Nuevas Formas. An. Inst. Biol. de la Univ. Nal. A. de México, vol. 25, Nos. 1 and 2, pp. 299 – 379, pls. I – XIX.
- WILLIAMS, AUSTIN B., and A. B. LEONARD. 1952. The Crayfishes of Kansas. Univ. Kansas Sci. Bull., vol. 34, Pt. II, No. 15, pp. 961 – 1012, pls. 1 – 7.