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Crayfishes of Mexico (Crustacea: Decapoda)

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

ALEJANDRO VILLALOBOS, M. en C.B.

Mexico, 1955

Translated from Spanish

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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

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 trogloxenes 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 rodriguezi* 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
3 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: 1 st, 2 nd, 3 rd, 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	Friday, 24 November 1950
Gruta de Zapatula [= Zapaluta]	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 trogloxenes.

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:

Catalogue Number

Scientific name . . . .

Determined by

State

Town or Municipality

______________ Males I

Number in jar. . . . .

______________ Males II

Locality

______________ Females

Collector

______________ Immature Females

Collection

______________ Females with eggs

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
6 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 pereiopods 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.

With regard to the family Astacidae, two subfamilies have been
7 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 pereiopods, 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 corres-
8 ponds 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.

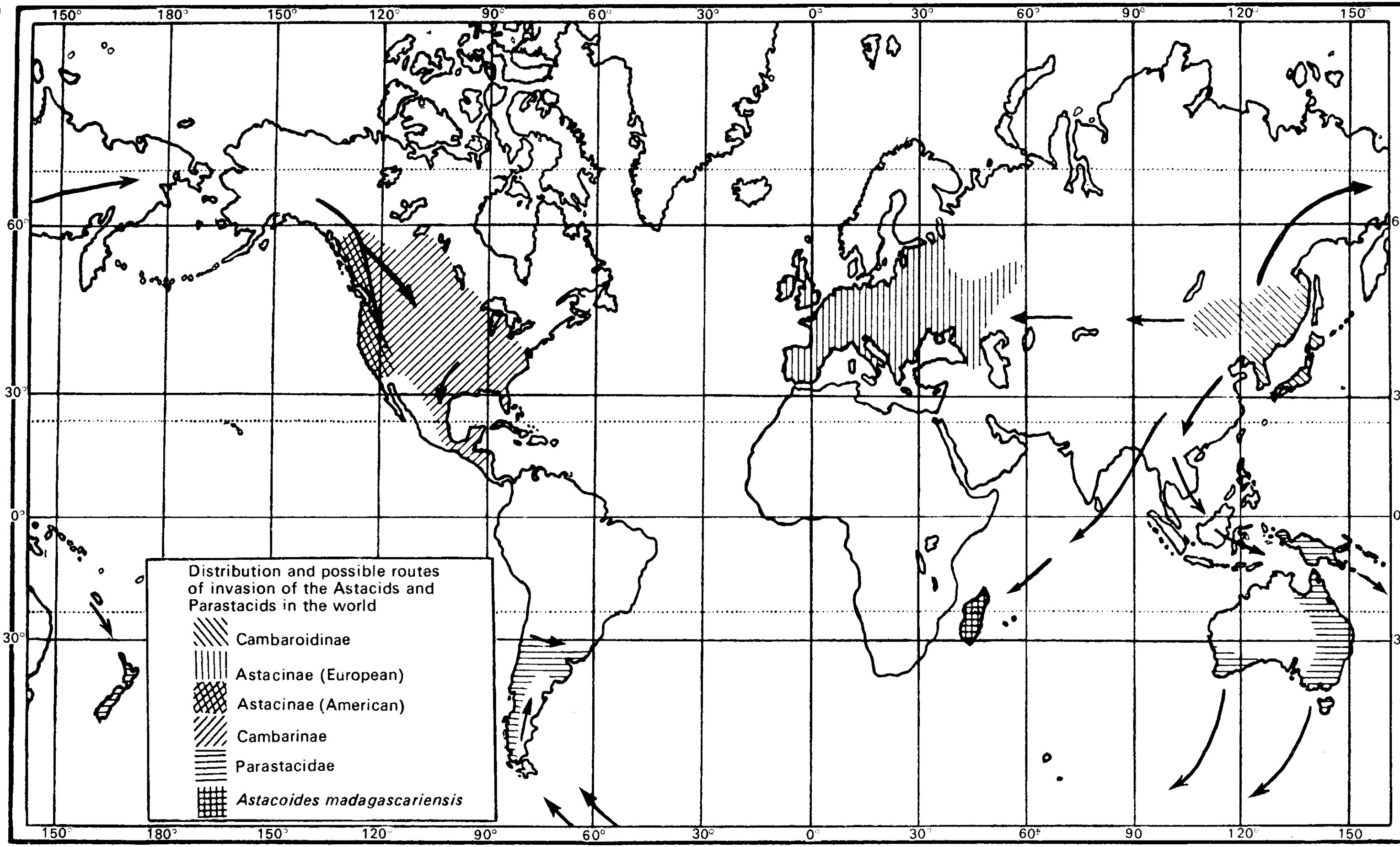

Distribution and possible routes of invasion of the Astacids and Parastacids in the world
Cambaroidinae
Astacinae (European)
Astacinae (American)
Cambarinae
Parastacidae
Astacoides madagascariensis
150°
180°
150°
120°
90°
60°
30°
0°
30°
60°
90°
120°
150°
60°
30°
0°
30°

Plate 1.

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 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 Archihelenes 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 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 Diguet 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	Ortmann 1905 – 6	Fowler 1911	Faxon 1914	Creaser 1933	Lyle 1938	Generic names recognized in this work
Group III in part		*Procambarus*	*Procambarus*	Group I			
Group III in part	Group I			Group II		*Girardiella*	*Procambarus*
		Cambarus	*Ortmannicus*				
Group I in part	Group II			Group III			
....	....	*Paracambarus*	*Paracambarus*	Group IV			*Paracambarus*
....	Group V	*Cambarellus*	*Cambarellus*	Group V			*Cambarellus*
Group II	Group IV	*Faxonius*	*Faxonius*	Group VI	*Faxonius* as a generic name		*Orconectes*
Group III in part	Group III	*Bartonius*	*Cambarus*	Group VII			*Cambarus*
....	....	....	....	....	....	....	*Troglocambarus*

* 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.

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 toltecae* and *Procambarus rodriguezi*, 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 pereiopods 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 Juarez, 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 pereiopods 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. alvarezi*. 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 Mexico. In this were
22 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.

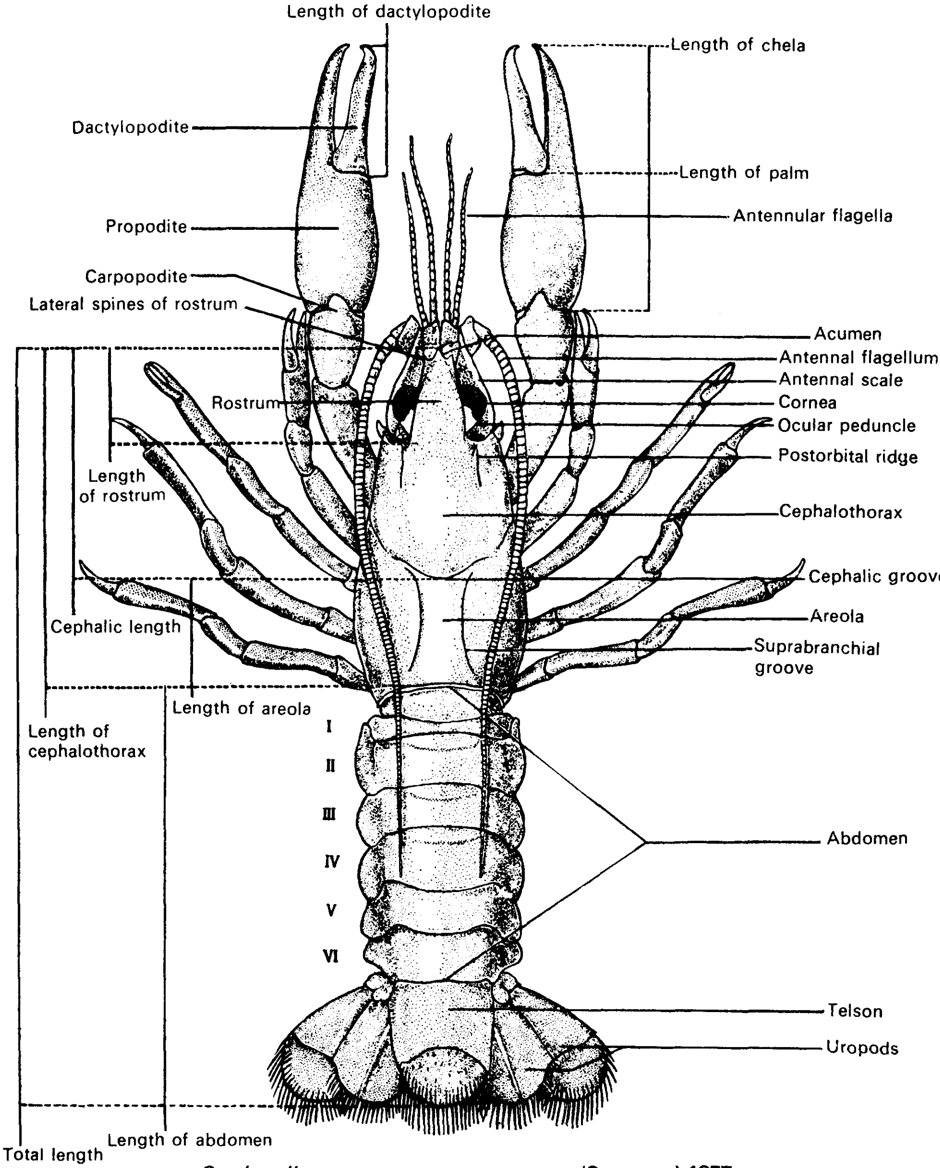
Monographic Study of *Cambarellus montezumae montezumae* (Saussure) (Plate 2)

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
23 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.

24 **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.

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**

Plate 2.

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 "Especes 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 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
26 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 pulmose 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
28 and the other two small; all of them are strongly chitinized, especially 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

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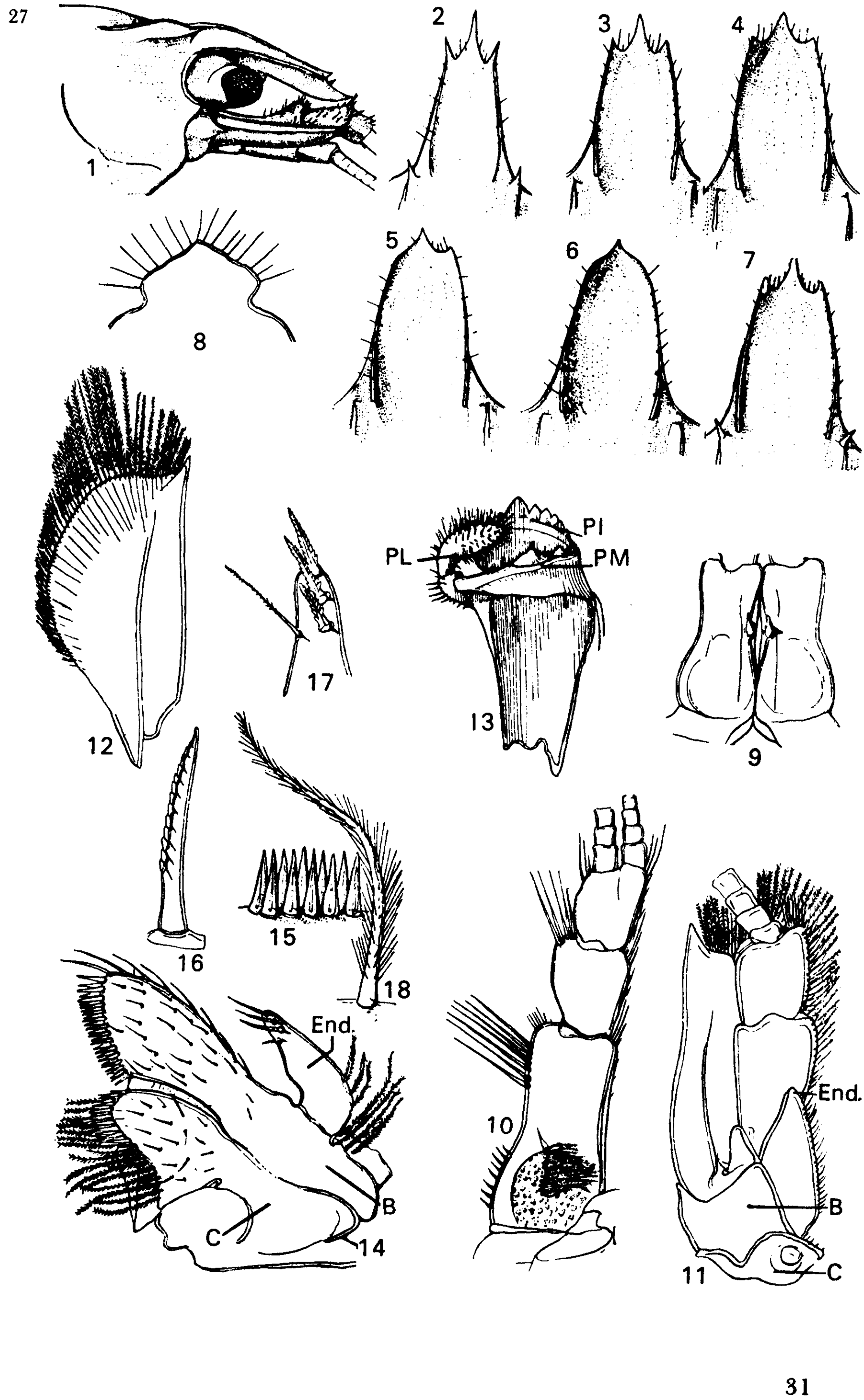
Plate 3. *Cambarellus montezumae montezumae* (Saussure).

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.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1
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PI
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End.
B
C

(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 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 expodite 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

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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.

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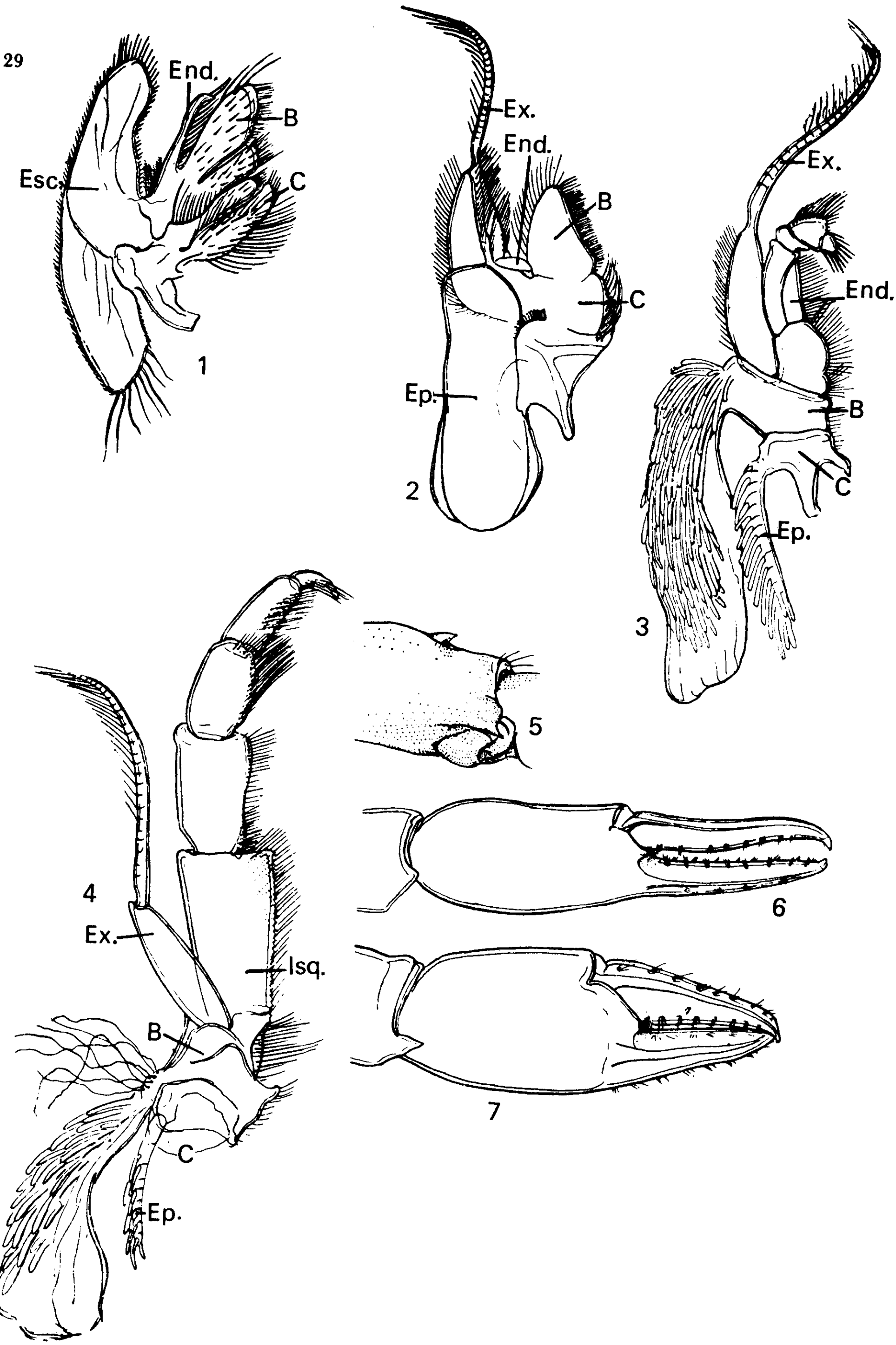

broad emargination which decreases the width of the exopodite; from this notch, the exopodite broadens, assuming the form of a triangular pyramid, with setae on the external margin; on the internal region, it exhibits another series of setae arranged in a row very close to the internal surface.

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
31 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 pereiopods. The coxopodite is short and bears a podobranch and two arthrobranchs. 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 dactylopodite 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.

Remaining pereiopods. The ischiopodites of the second and third pairs of pereiopods bear hooks, which are thornlike. Although the
32 hooks of both pairs of pereiopods 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 pereiopods; 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

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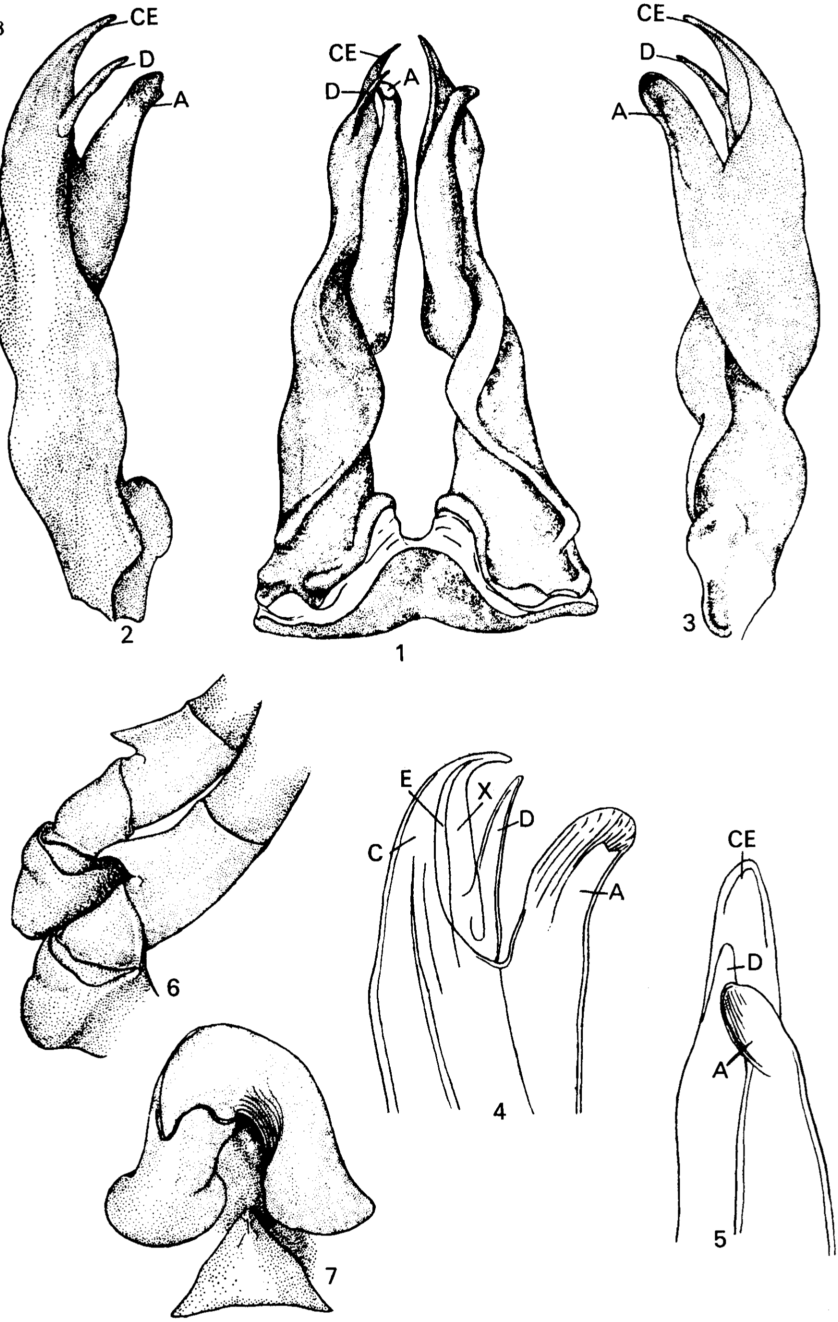

rami makes it asymmetrical; the other ramus bears a transverse groove very near the arc. It is important to observe that the groove at times appears on the left side and at others on the right. Between the fifth pereiopods, there is a spiniform process with a broad base, the vertex of which coincides 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

34

	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 pereiopods of the male, Form I; 7, *annulus ventralis.*

Nymphaea ampla, N. mexicana, Lemna minor, Limnobium stoloniferum, Eichhornia crassipes, Wolfia 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. lemnarum* (Stern),
36 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* Gigliogli, 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

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

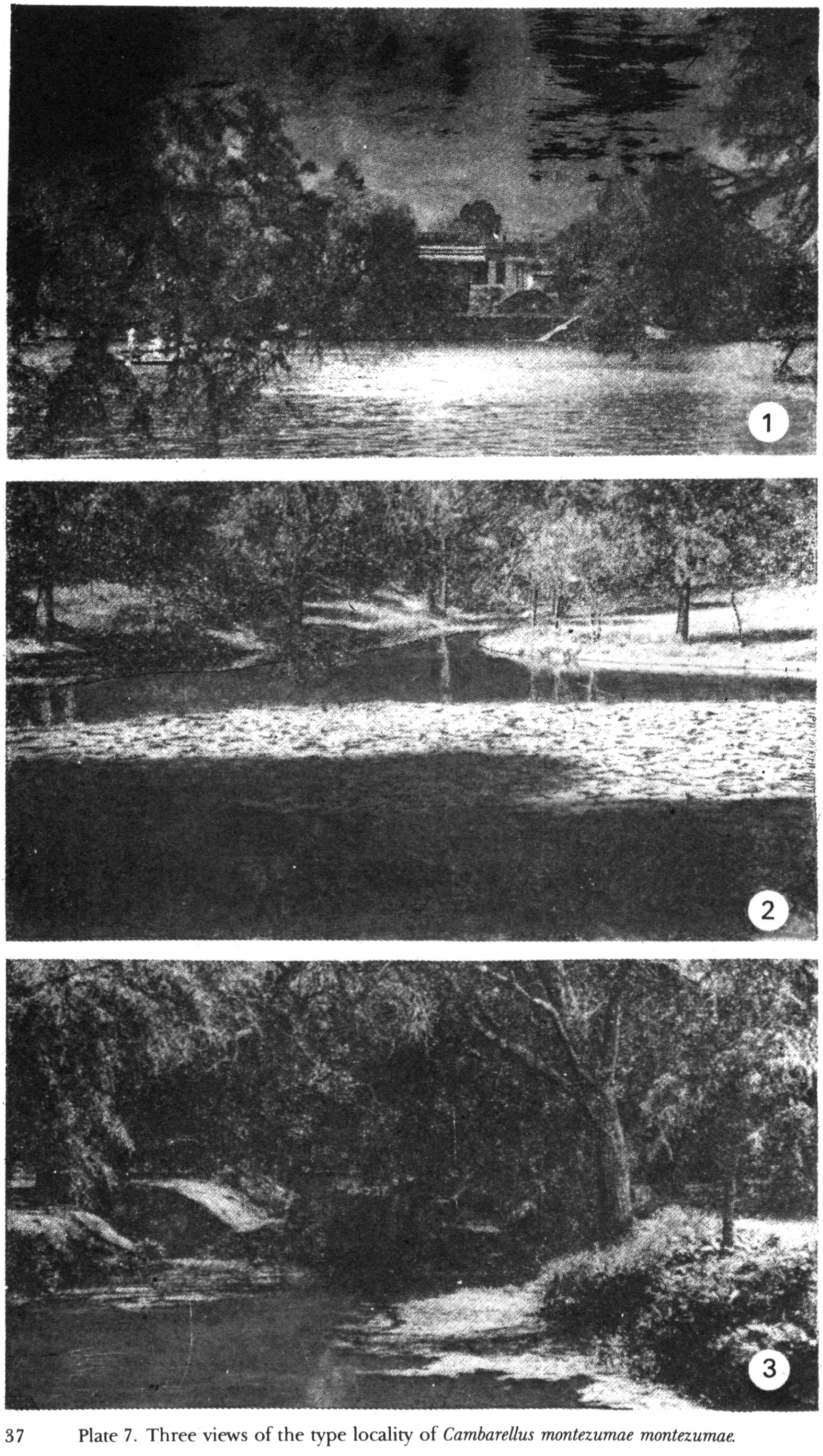

Plate 7. Three views of the type locality of *Cambarellus montezumae montezumae.*

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 pereiopods 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 pereiopods 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 pereiopods,
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]).

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 suprabranchial 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,
42 considered in the narrowest part; and the length, measured from the 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

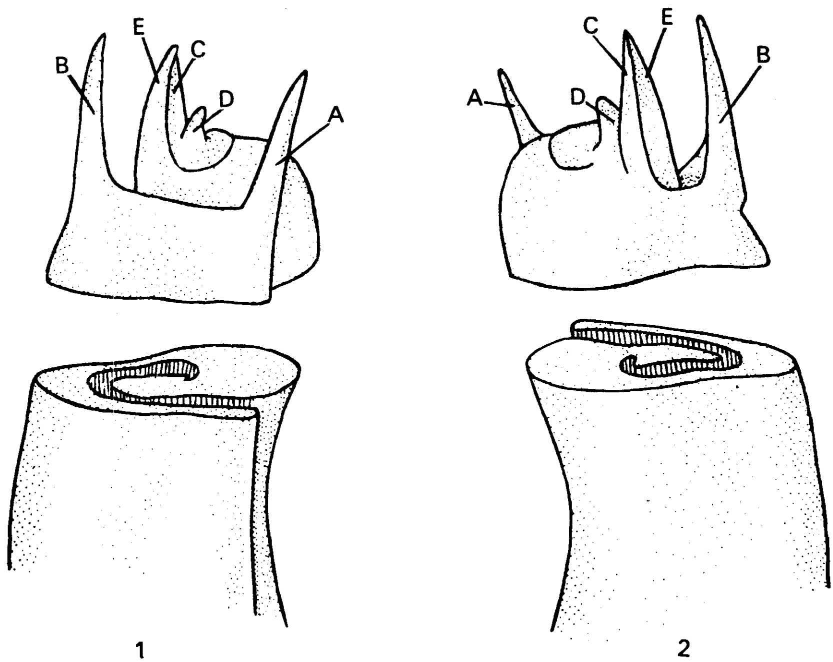

Plate 8. Schematic representation of the first pair of pleopods of the male, Form I (after Hobbs).

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 pereiopods, 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 pereiopods 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 pereiopods.

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 pereiopods only, never on those of second pair 4

3′ Hooks present on ischiopodites of second and third pairs of pereiopods . . . . *Cambarellus*

4 (3) Process between fifth pereiopods of female present or absent; if present, never compressed laterally . . . . *Procambarus*

4′ Process always present between fifth pereiopods 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, 1905b (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 pereiopods; in latter case, those of third pair sometimes vestigial; or hooks present only on fourth pair of pereiopods. 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 pereiopods.

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 bouvieri*

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 pereiopods with emargination in proximal part of cutting edge of dactylopodite. Tubercle on ischiopodite of third pair of pereiopods. 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 antero-lateral 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 pereiopods 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

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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 pereiopods of the male, Form I; 8, ischiopodite of the pereiopod of the male, Form II; 9, *annulus ventralis*.

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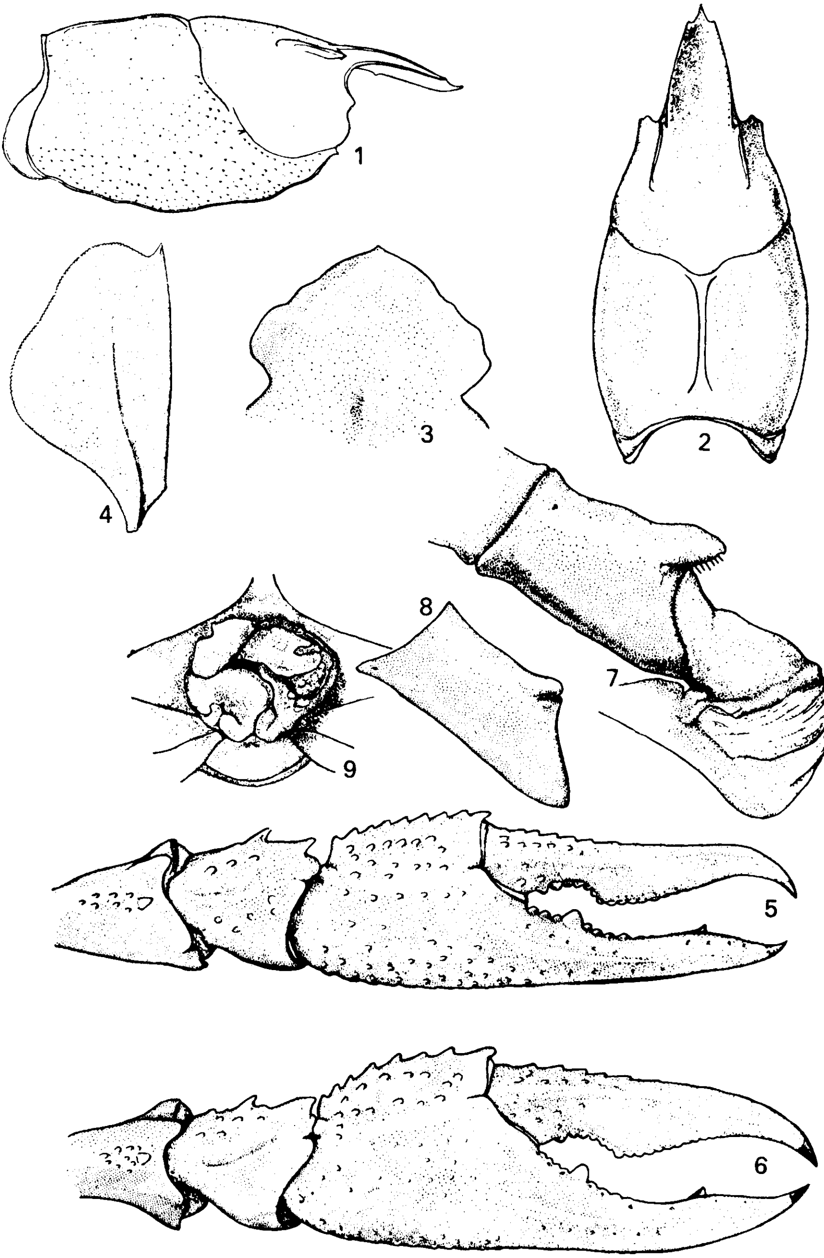

of the cutting margin; the ultimate or distal tooth is noticeably larger than the others; there is a broad concavity on the cutting border distal to the last tooth that ends in the second third, precisely where a triangular dentiform process with a broad base is located. The movable finger, or dactylopodite, 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 pereiopods 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

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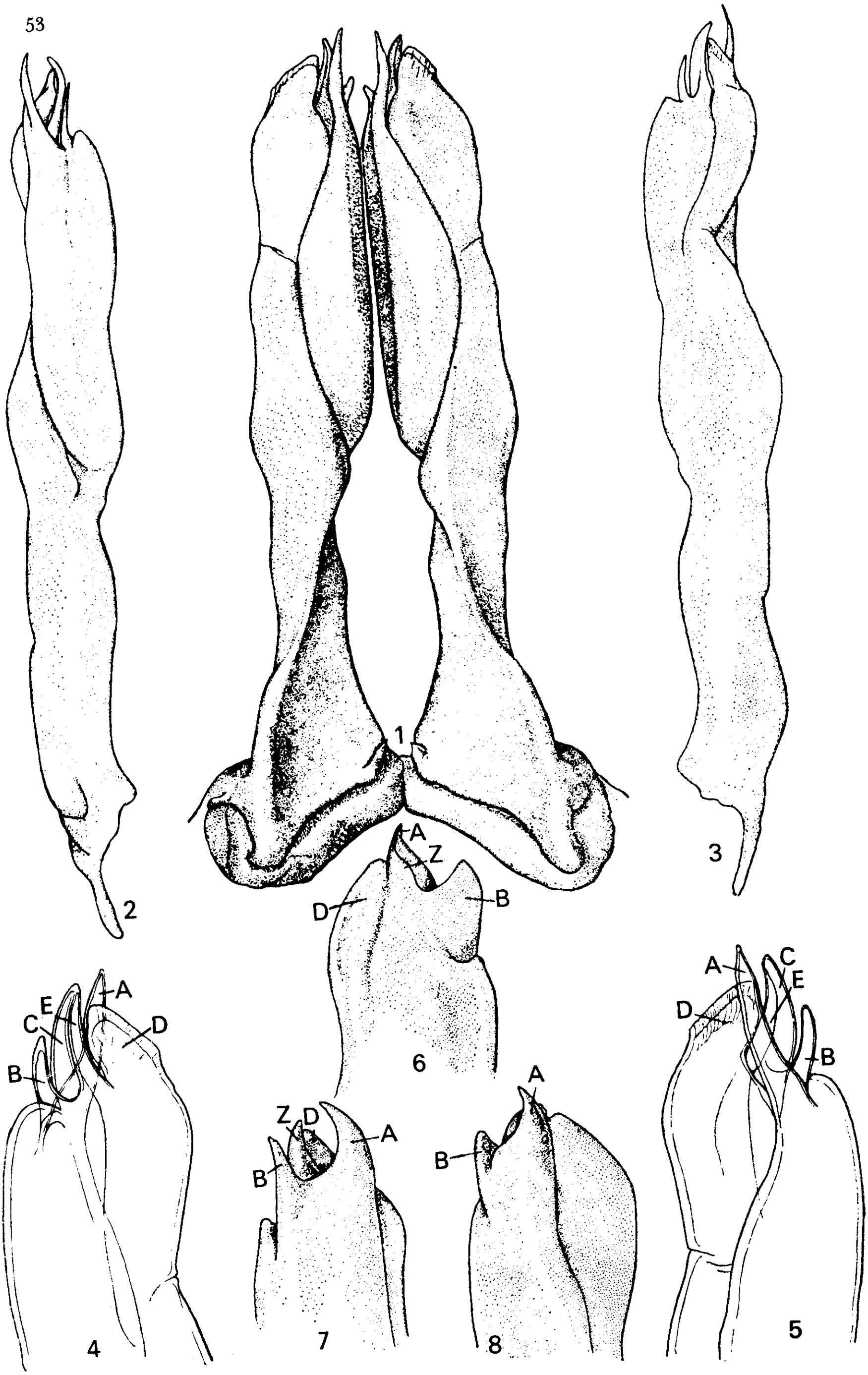


lateral spines of the carapace are present. The granulations of the anteroventral part are heavy.

The epistome is as in the first form male.

The chelae of the first pair of pereiopods (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.

The *annulus ventralis* (Plate 9, fig. 9) is more or less circular in outline,
54 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 pereiopods, 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

Procambarus simulans regiomontanus	*Procambarus simulans simulans* (Faxon), from Texas	*Procambarus simulans simulans,* 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 semicircular 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.

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 pereiopods]. 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 pereiopods 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.

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
58 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 pereiopods 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 pereiopods. 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).

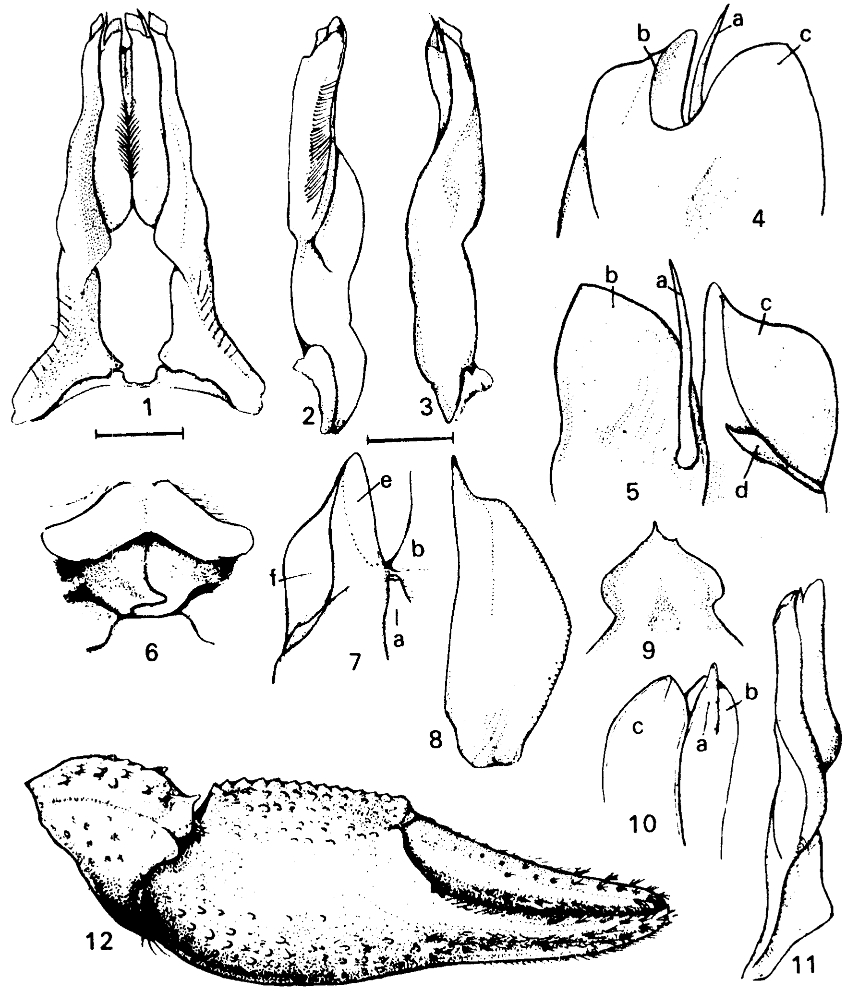
Male, form II. In the young form II males, the carapace is of the same width as the abdomen. The surface of the cephalothorax is very weakly punctate; the areola is wide and complete; the cephalic groove is slightly undulate; lateral spines are present.

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

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

The chelae are slender; the surface is smooth and covered with
60 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.



59 Plate 11. *Procambarus digueti* (Bouvier).

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 pereiopods 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 pereiopods, 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. Duges). 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 pereiopods; 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.

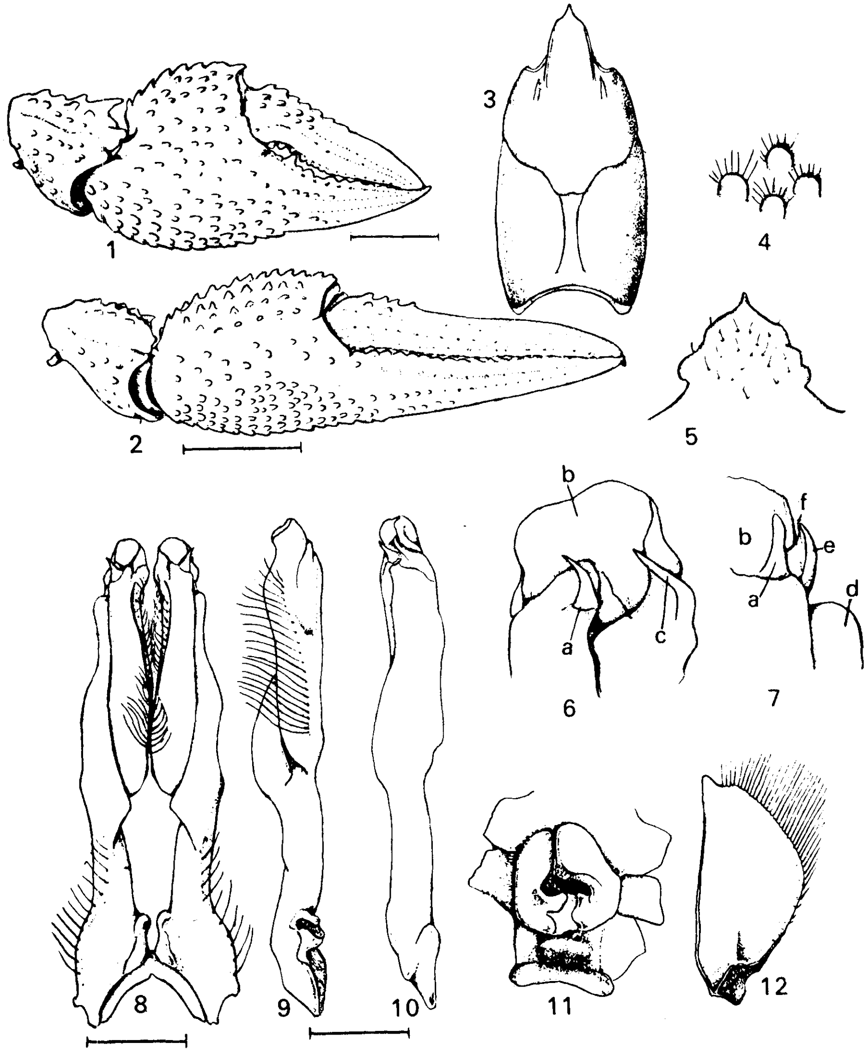
The proportions of the different parts of the cephalothorax are: the length of the cephalic part is almost double the length of the areola; the width of the areola is seven times less than the length; the posterior width of the rostrum is exactly half the length of the areola; the length of the rostrum 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 pereiopods 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



63 Plate 12. *Procambarus bouvieri* (Ortmann).

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 pereiopods 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 pereiopods, 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 7 a). The cephalic process resembles a plate in the form of a "horsehoof" situated in the cephalic part (Plate 12, figs. 6 and 7 b). 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 7 c) 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. 7 e) which is narrow and gently recurved from behind forward, and the centrocephalic process (fig. 7 f) 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. 7 d) 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 pereiopods 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 pereiopods 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 pereiopods (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.

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
67 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 pereiopods, 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. Diguet). Presa del Ahorcado, Uruapan, Michoacán (Villalobos).

Relationships. Without doubt, *Procambarus bouvieri* 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 regiomontanus* 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 regiomontanus*. 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 no represent a continuity of relationship with those that populate the Atlantic slope, a fact that provides other data supporting our opinion.

69 BLANDINGII SECTION

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 pereiopods.

blandingii Section
  blandingii Group
    blandingii Subgroup — *Procambarus blandingii cuevachicae*
      Procambarus caballeroi
      Procambarus toltecae
    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°
70 to principal axis of appendage. Cephalic process spiculiform. Caudal process very reduced, in form of spine .... *Procambarus toltecae*

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*

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. toltecae*); mesial process spiculiform or in form of narrow plate; cephalic process never spiculiform, but in form of claw or plate (except in *P. toltecae* 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)

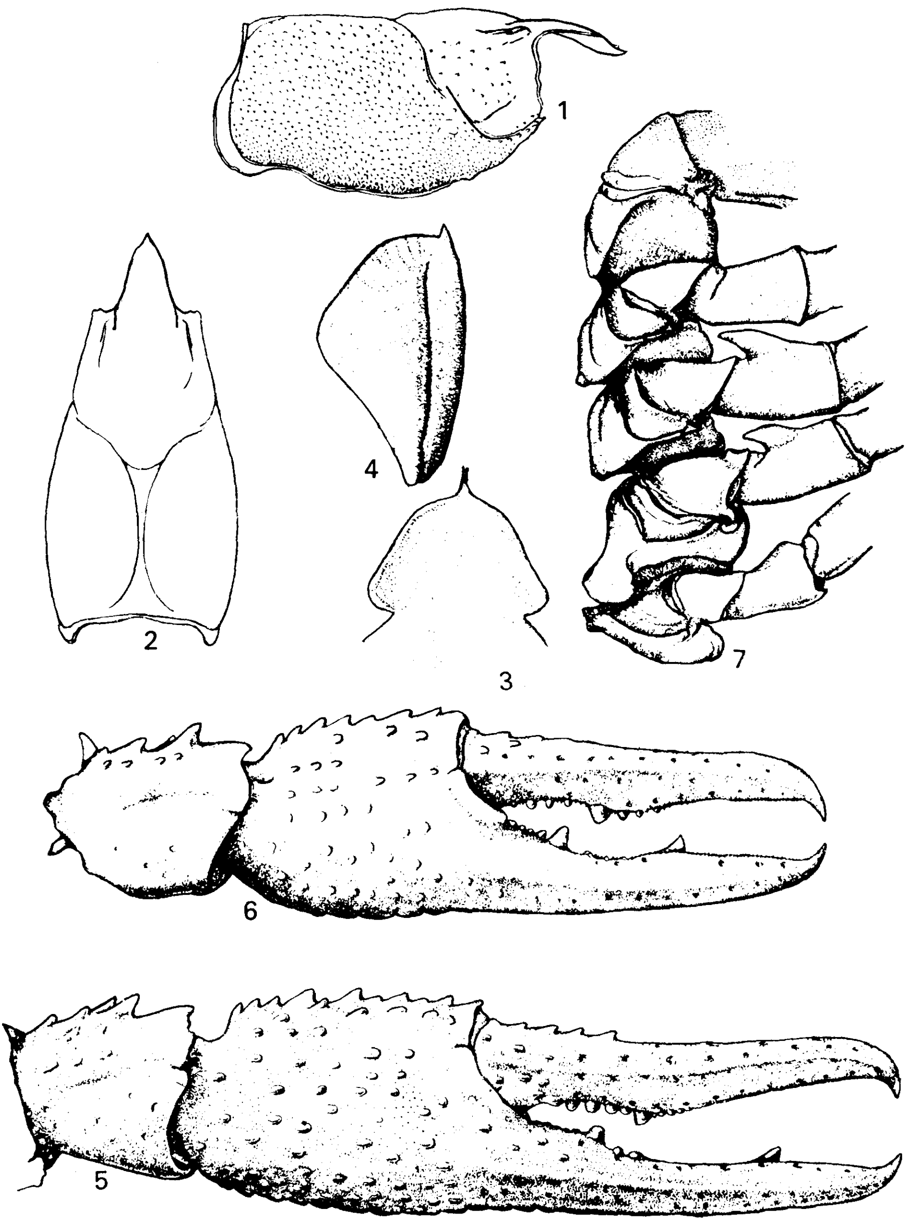
1941 *Cambarus blandingii cuevachicae* Hobbs, Zoologica, N. Y. Zool. Soc., Vol. XXVI, Pt. 1, Nos. 1 and 2, pp. 1 – 4, Pl. 1.

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 pereiopods. 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 pereiopods in female with tuberculi-
72 form 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.

The areola is narrow, particularly in the median part. The surface of the areola is deep and almost smooth, only presenting punctations in
73 the posterior and anterior regions. The limits of the areola are well marked, although disappearing in the posterior part (in the specimens from Cruecero 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 Potosí, 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 pereiopods 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.

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
75 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 pereiopods (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 pereiopods 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 pereiopods 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 pereiopods.

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 pereiopods. 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

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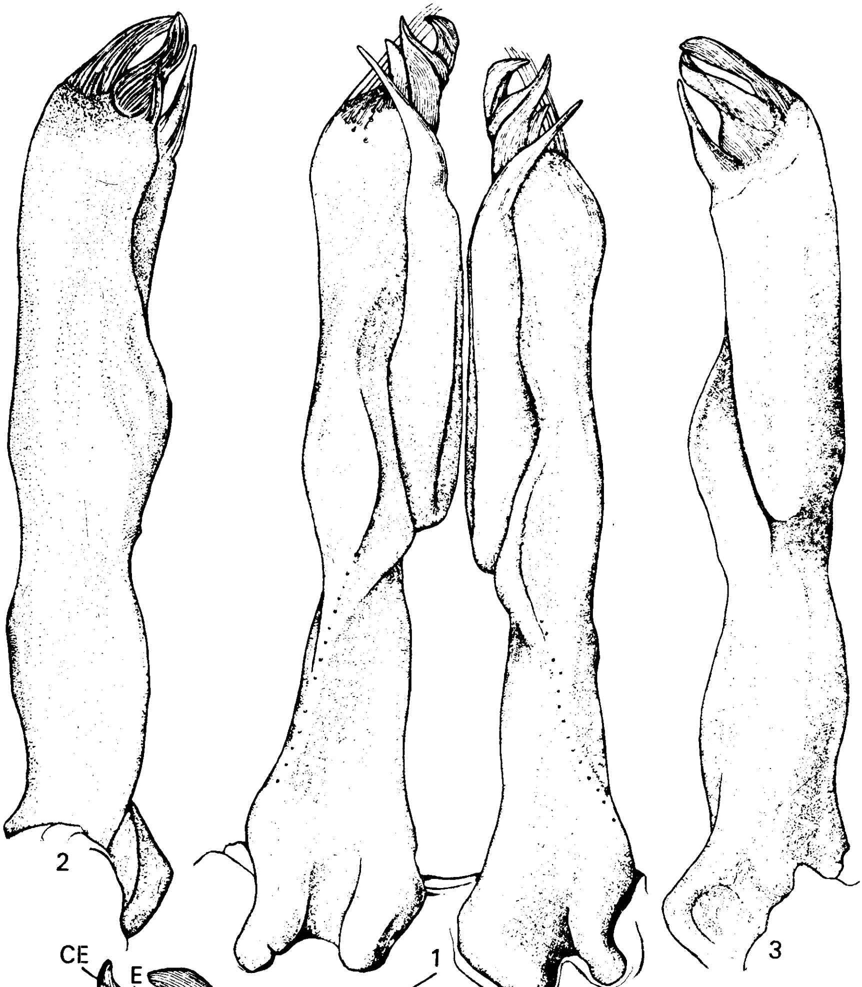

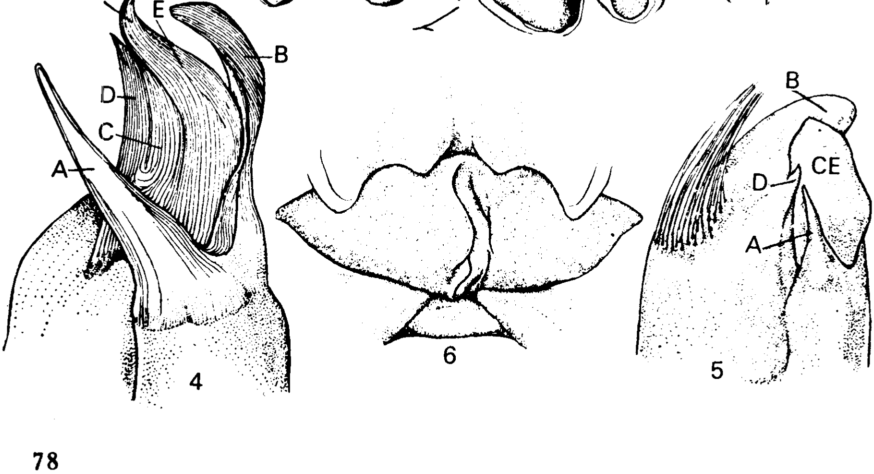

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antennal spine is small and the greatest width of the scale is situated slightly proximal to midlength.

78 The chelae of the first pair of pereiopods 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 pereiopods 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 pereiopods. 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 pereiopods 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

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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.*

subspecies is the sternite of the fourth pair [of pereiopods] of the very mature females, the posterior border of which forms two slightly asymmetrical tuberculiform prolongations over the anterior part of the
79 *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. 1	Loc. 2	Loc. 3	Loc. 1	Loc. 2	Loc. 3	Loc. 1	Loc. 2	Loc. 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 Potosi (Hobbs). Mi Ranchito, 4 km E. of Aquismon, km 419 de la carretera Mexico-Valles, San Luis Potosi (Villalobos). Los Naranjos, km 420 de la carretera México-Valles, San Luis Potosi. (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 toltecae Hobbs

1943 *Procambarus toltecae* 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 pereiopods]; basipodite of fourth pair of pereiopods 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 pereiopods 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 pereiopods].

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.

The postorbital ridges are short and prominent, terminating
82 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 pereiopods 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 pereiopods 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 pereiopods] exhibits a kneelike tubercle on the basal internal portion which almost rests on the coxopodite of the fifth pereiopod; 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 pereiopods]; 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 pereiopods 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 pereiopods 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 Potosi (Villalobos).

Relationships. *Procambarus toltecae* 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 toltecae* exhibit marked resemblances to the
86 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

1944 b *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 pereiopods with hooks. Tubercle on distal articular border of basipodite of fourth pair; coxopodite of same pereiopods 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 pereiopods in female cleft in median line posteriorly. *Annulus ventralis* small and partly protected by posterior prolongations of sternite of fourth pair of pereiopods; without spiniform tubercles between fifth pereiopods.

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

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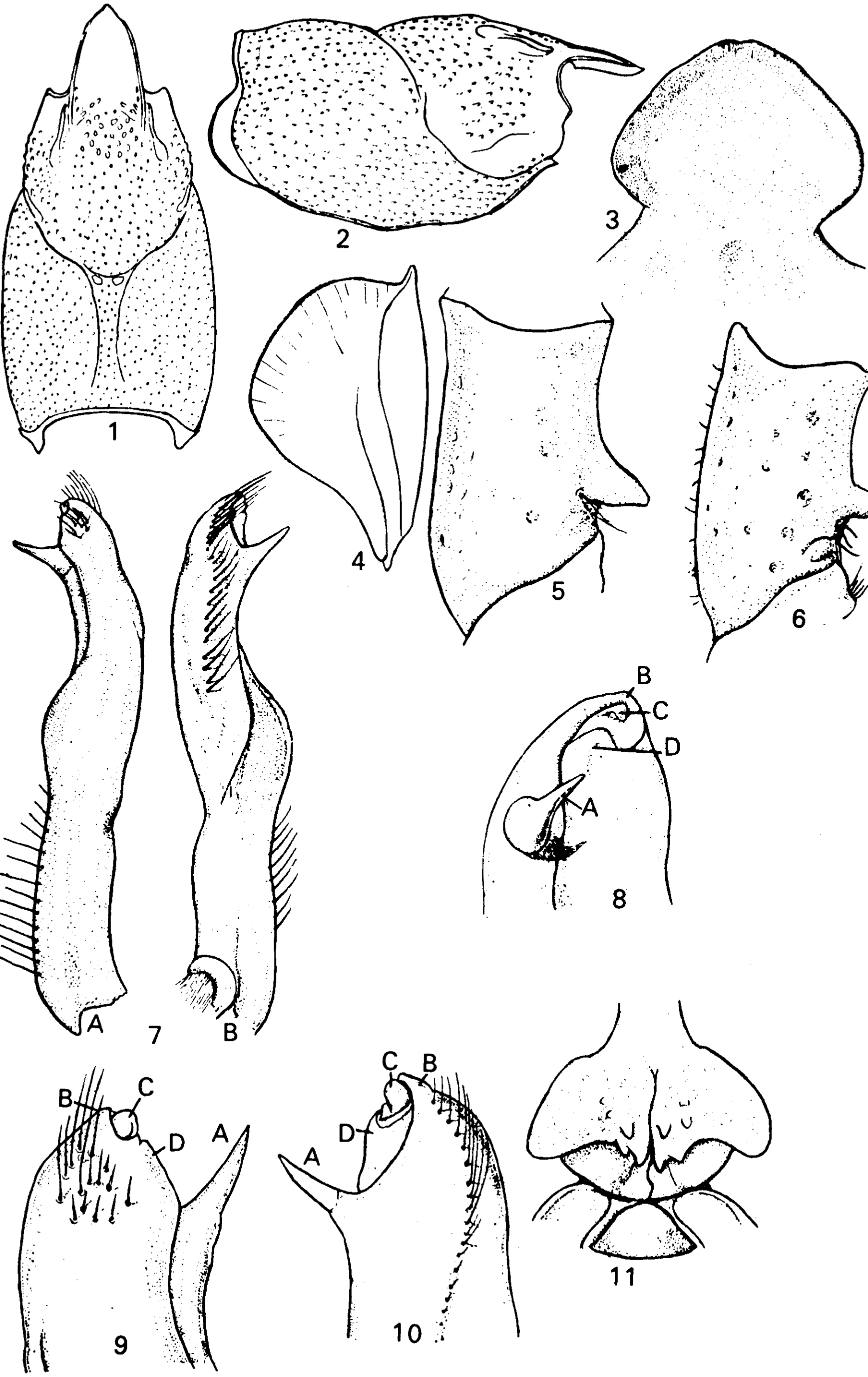
Plate 15. *Procambarus caballeroi* (Villalobos). Male, Form I.

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 pereiopods, respectively; 7 a 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.*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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 pereiopods 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 pereiopods 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 pereiopods 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 pereiopods. 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 15 A) 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 toltecae.*

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 pereiopods 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 pereiopods 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 pereiopods 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).

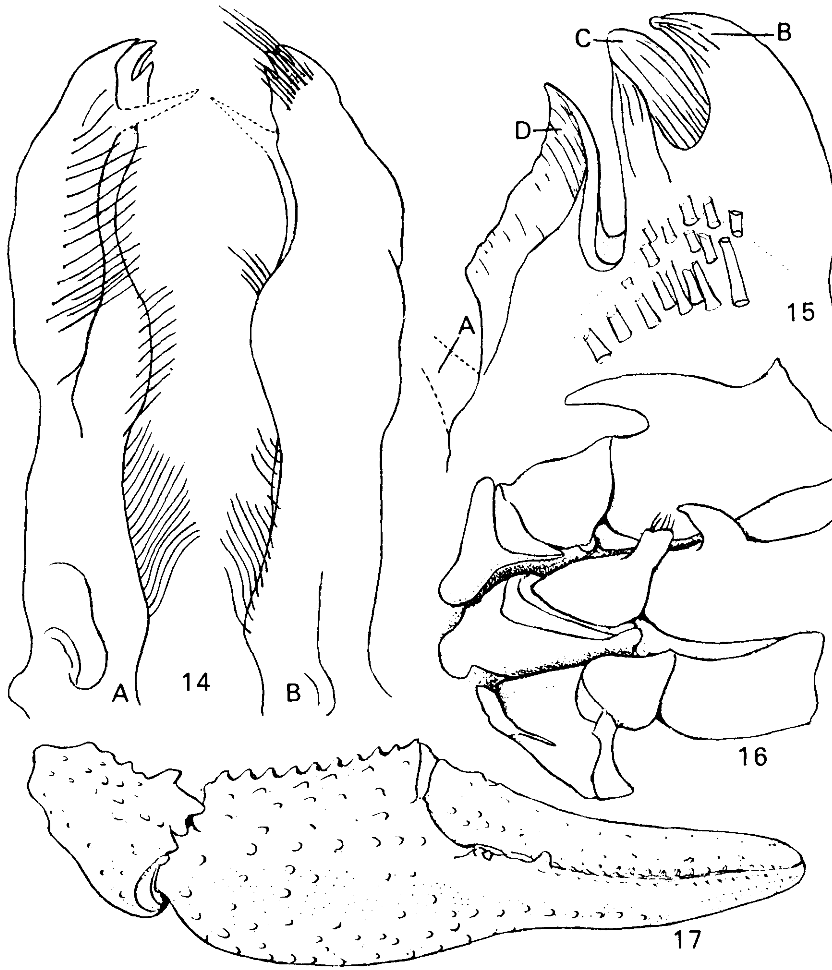
The cephalic process (B) is little developed, but it may be observed clearly when the pleopod is viewed laterally; it has the form of a vertex
92 formed by a dihedral angle, which in its distal region acquires the form of a hood; the tuft of hairs which was described in the male, form I, is found in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



91 Plate. 16. *Procambarus caballeroi* (Villalobos). Male, Form I.

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 pereiopods 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 pereiopods 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 toltecae* Hobbs.

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

P. caballeroi	*P. toltecae*
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 pereiopods of the female with a symmetrical posterior emargination.	III. Sternite of the fourth pereiopods 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. toltecae*.

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. toltecae* (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 pereiopods, he leaned more toward relationship with the *blandingii* Section. The other features, such as the
94 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. toltecae*.

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. toltecae*, 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. toltecae*, notwithstanding the existence of two distinct diagnostic characteristics: the hump in the cephalic region, and the subspiculiform 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. toltecae* 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. toltecae*, 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. toltecae*, 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. toltecae* 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 pereiopods. Hooks vestigial or absent on ischiopodites of third pair of pereiopods; hooks well developed on ischiopodites of fourth pair of pereiopods.

riojae Group
- *Procambarus riojae*
- *Procambarus hoffmanni*
- *Procambarus hortonhobbsi*
- *Procambarus teziutlanensis*
- *Procambarus tlapacoyanensis*

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 tlapacoyanensis*
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)

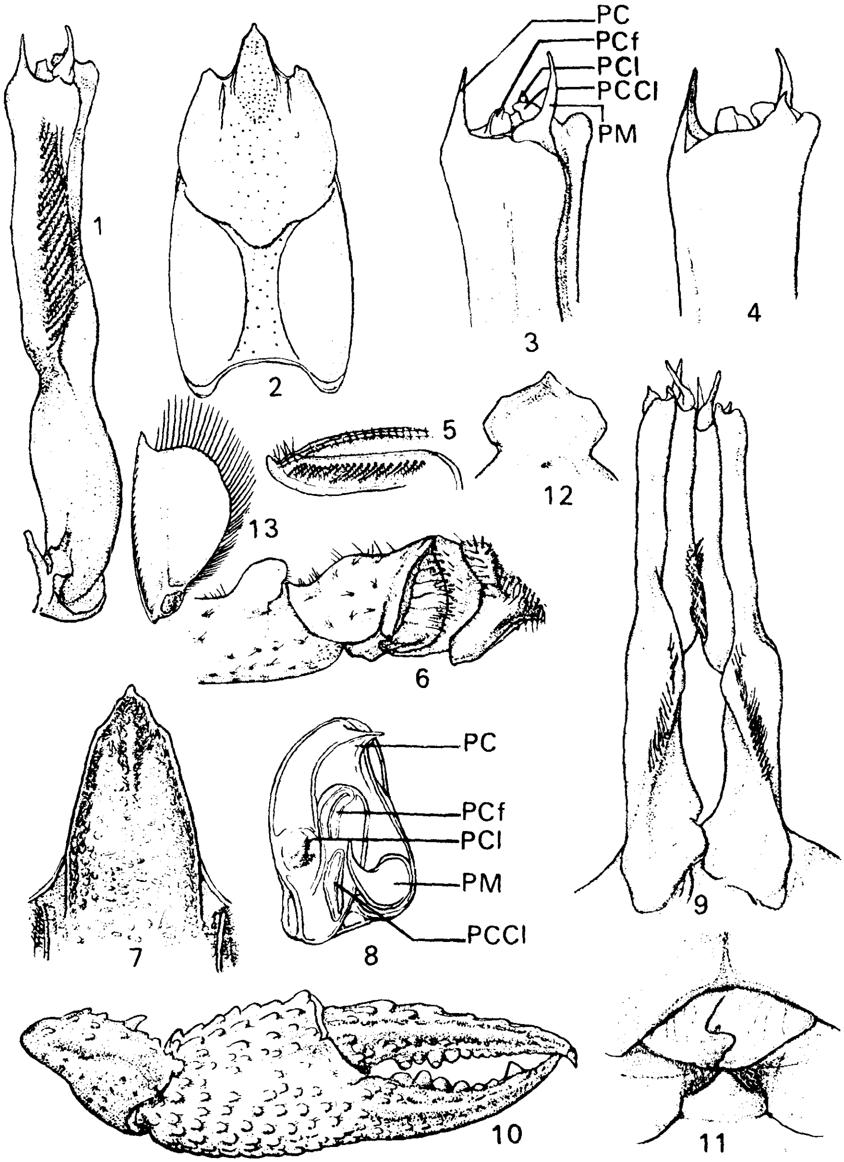
1944a *Paracambarus riojae* Villalobos, An. Inst. Biol. de la Univ. Nal. A. de México, Vol. XV, No. 1, pp. 161 – 169, Plate 1.

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 pereiopods; 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



97 Plate 17. *Procambarus riojae* (Villalobos). Male, Form I.

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; PCCl, caudal process; PCl, 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 suprabranchial 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
99 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 pereiopods does not have a hook, and there is hardly an angular structure.

The ischiopodite of the fourth pair of pereiopods 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 pereiopods. 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 pereiopods bears a small hemispherical tubercle near the proximal articular border; the characteristic tubercle of the coxopodite of the same pair [of pereiopods] 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 pereiopods 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 pereiopods, 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 pereiopods, and moreover have a tubercle between the fifth pereiopods 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 pereiopods 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 pereiopods lacking tubercle but possessing small emargination near proximal articulation of article. Ischiopodites of fourth pair of pereiopods 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 pereiopods 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
104 provided with a short seta inserted on the posterior margin and adhere 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.

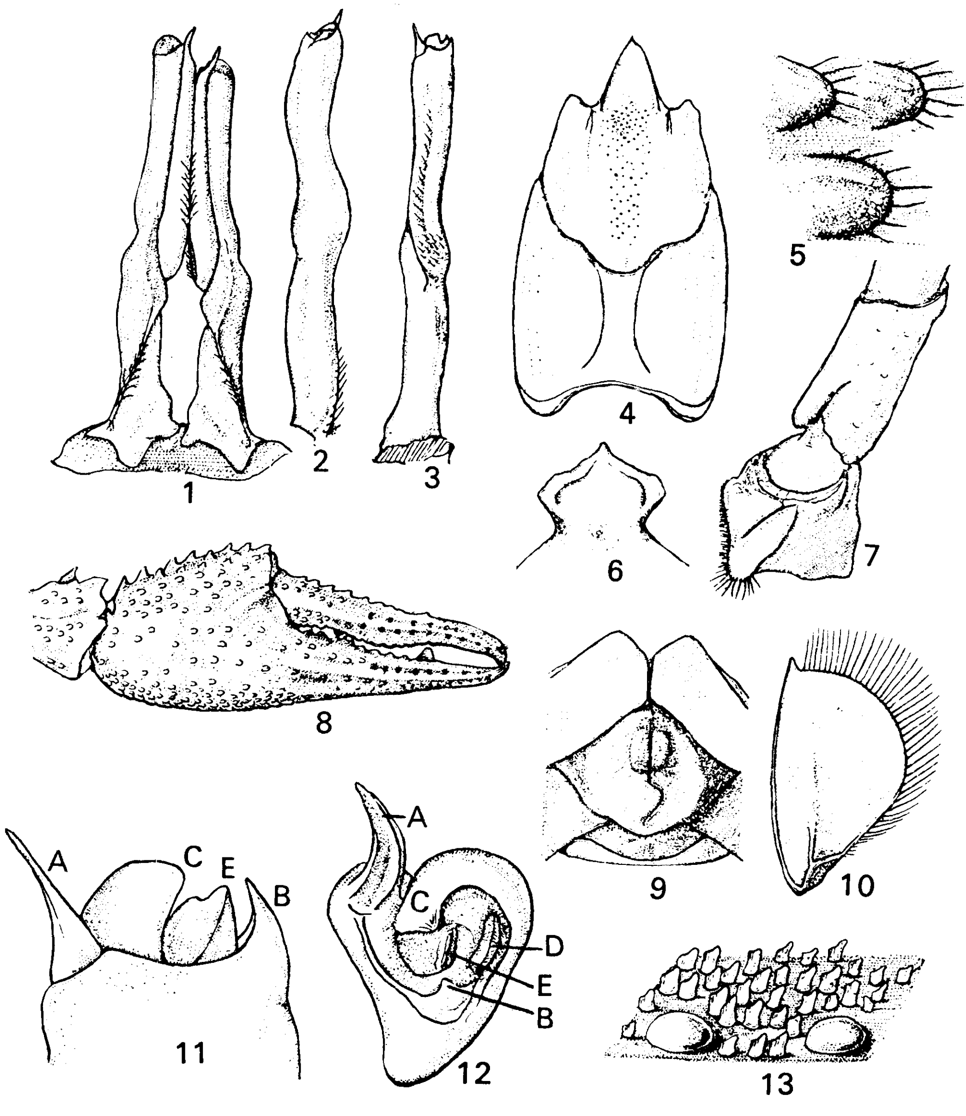
The epistome is heart-shaped but at times is polygonal, and its margins are elevated (Plate 18, fig. 6).

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 adbominal 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 pereiopods is robust, its surface covered with subsquamous tubercles that are more numerous dorsally. On the



103 Plate 18. *Procambarus hoffmanni* (Villalobos). Male, Form I.

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,
105 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
106 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 pereiopods. 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 pereiopods 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 pereiopods 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 pereiopods 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 pereiopods 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.

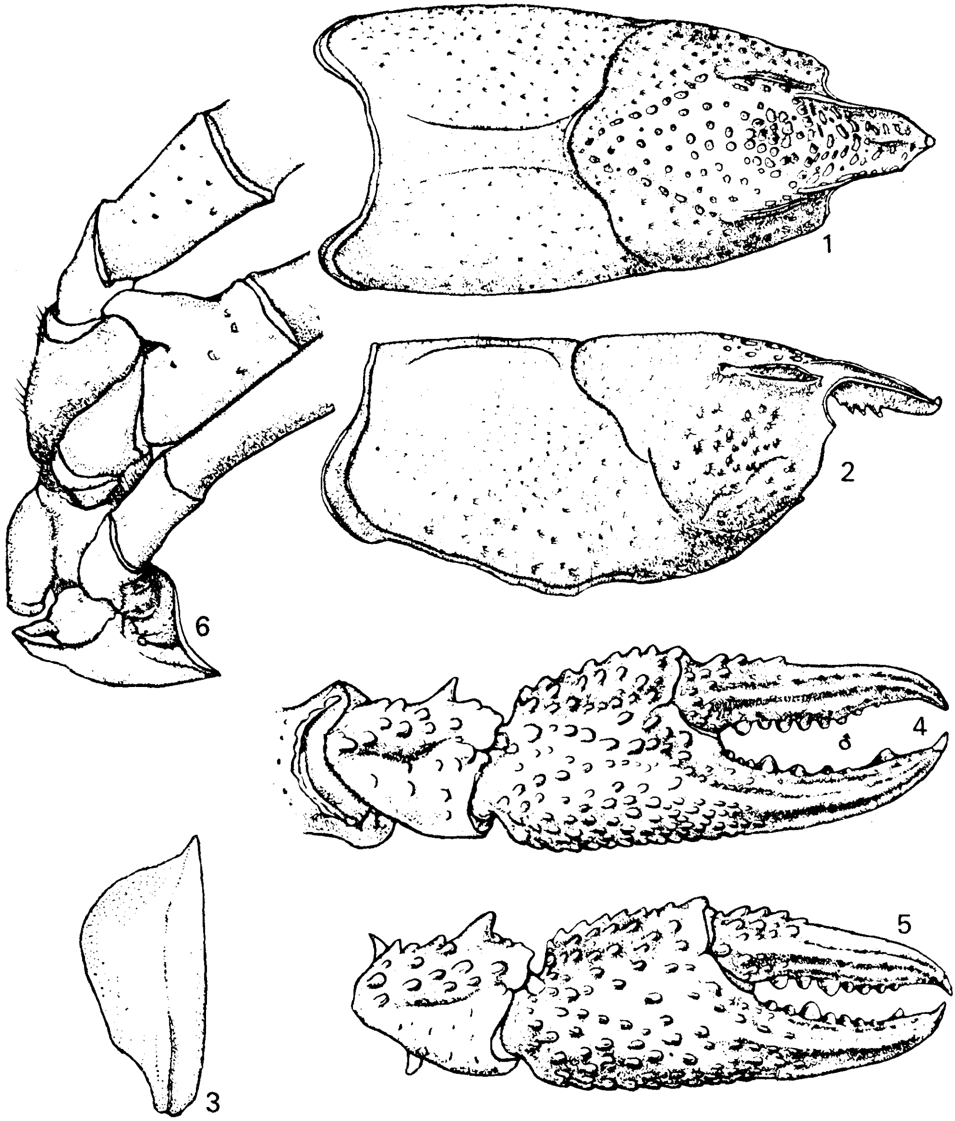
The rostrum lacks lateral spines; the apical spine is represented by a blunt apical tubercle that is directed forward and upward; the lateral margins are strong in the anterior portion, becoming attenuated toward the distal extremity of the rostrum; the margins are convergent but exhibit two smooth angulations, 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.

The areola is moderately wide; the suprabranchial margins are
109 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.

The different parts of the carapace exhibit the following proportions: the length of the areola is a little greater than half the length of
110 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 pereiopods 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 pereiopods 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 dactylopodite 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 dactylopodite, 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).

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

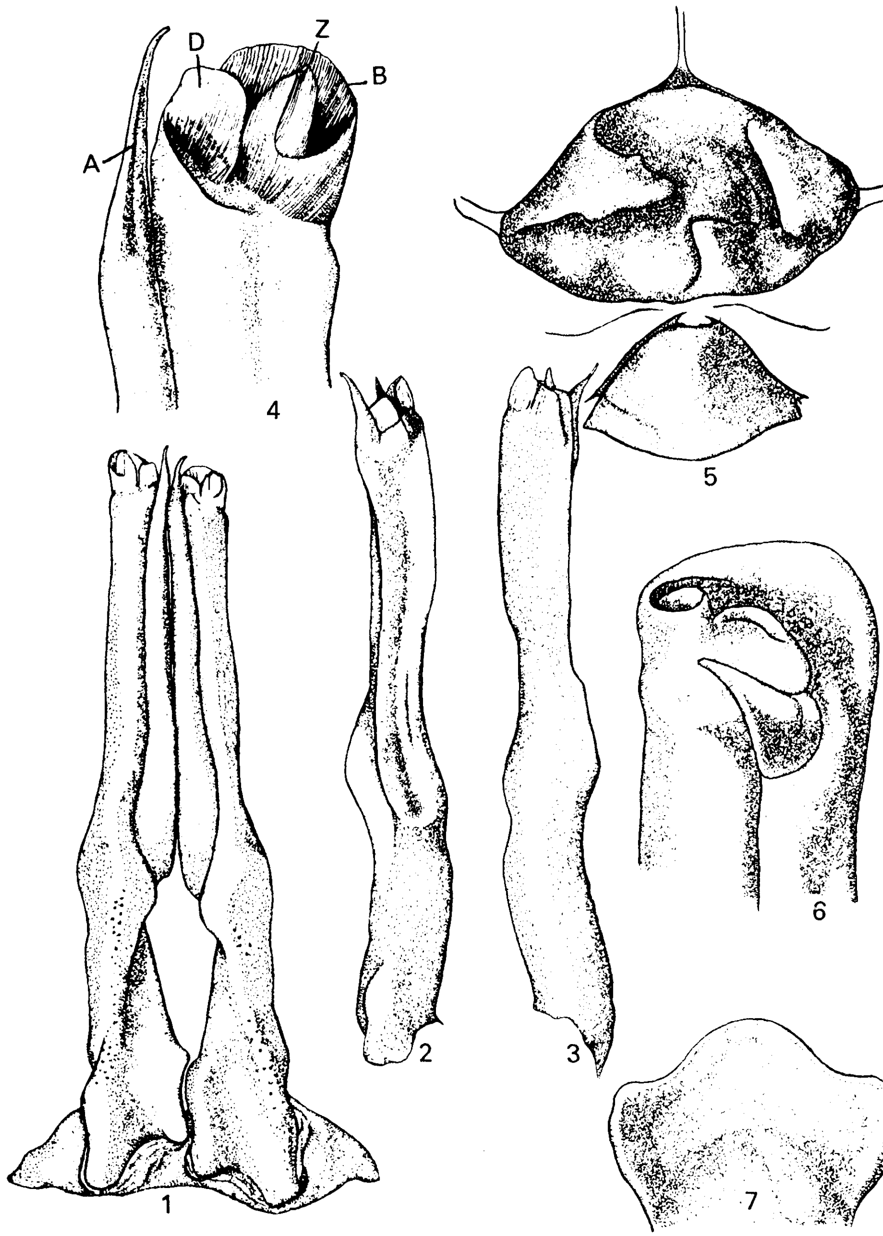
The coxopodites of the fourth pair of pereiopods exhibit a more or less fusiform tubercle on the posteroinferior angle. The ischiopodites are provided with a hook which is inserted on the proximal part of the article and terminates in a strong spine, the apical part of which is gently curved backward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

The coxopodites of the fifth pair of pereiopods 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 pereiopods. They are straight, unequal in length, the right larger than the left. The mesial process (Plate 20, fig. 4 A) 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. 4 B). The central projection (Plate 20, fig. 4 Z) 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. 4 D). 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.

The anterior part of the epistome ends in an angle.

The chelae are small.

The ischiopodites of the third pair of pereiopods do not exhibit a trace of tubercles. The coxopodites of the fourth pair of pereiopods 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 pereiopods 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 pereiopods; 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 pereiopods 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 pereiopods 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 pereiopods 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.

de la Univ. Nal. A. de México, Vol. XXI, No. 2, pp. 372 – 373, Plate 1, fig. 3.

116 **Diagnosis.** Rostrum without spines. Ischiopodites of third pair of pereiopods of male, form I, without hooks, those of fourth pair provided with strong tubercle. Coxopodites of fourth pair of pereiopods 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 pereiopods 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

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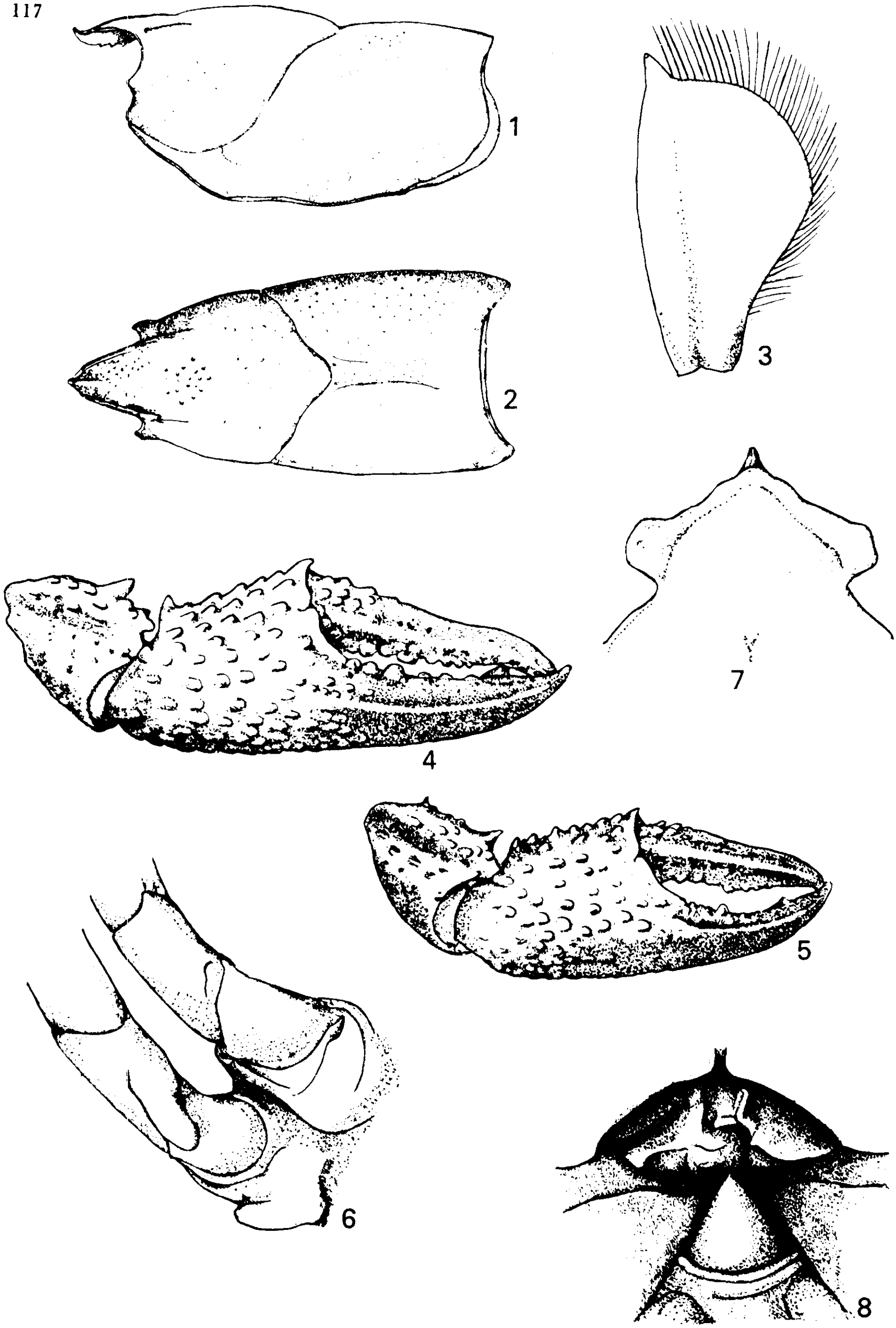

posterior width of the rostrum goes into the entire length of the carapace exactly five and one-half times; the length of the rostrum is a little more than four and one-half times less than the length of the carapace.

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 pereiopods 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 pereiopods III and IV of the male, Form I; 7, epistome of the same; 8, *annulus ventralis*.

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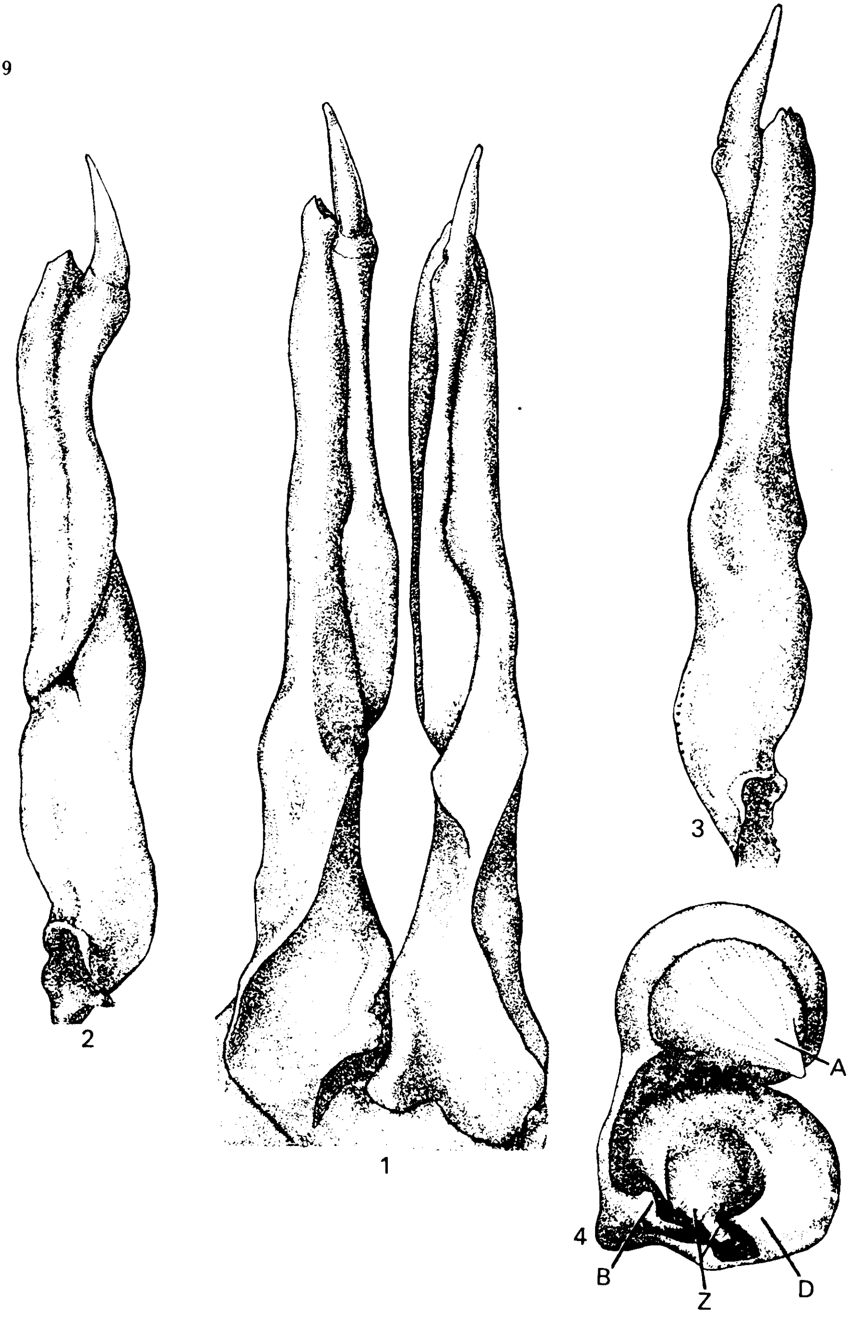


The propodus is slightly robust; its surface is totally covered with subsquamous tubercles which are most visible on the dorsal region of the palm where each of them is distinguished from the surface by a darker color. On the internal border of the chela, the tubercles are elevated and acquire the character 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 periopods do not exhibit a trace of a tubercle, not even in the fully adult specimens.

The ischiopodites of the fourth pair of pereiopods 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 pereiopods 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 pereiopods. 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. 4 A). The caudal process is an angular prominence, its apical part flat and chitinized (Plate 22, fig. 4 D). The central projection, with the two structures composing it, evidently, exceeds the height of the caudal process (Plate 22, fig. 4 Z). 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. 4 B).

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 pereiopods 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 pereiopods 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 Colón, 10 to 12 km N.W. of Heuytamalco, 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 pereiopods 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.

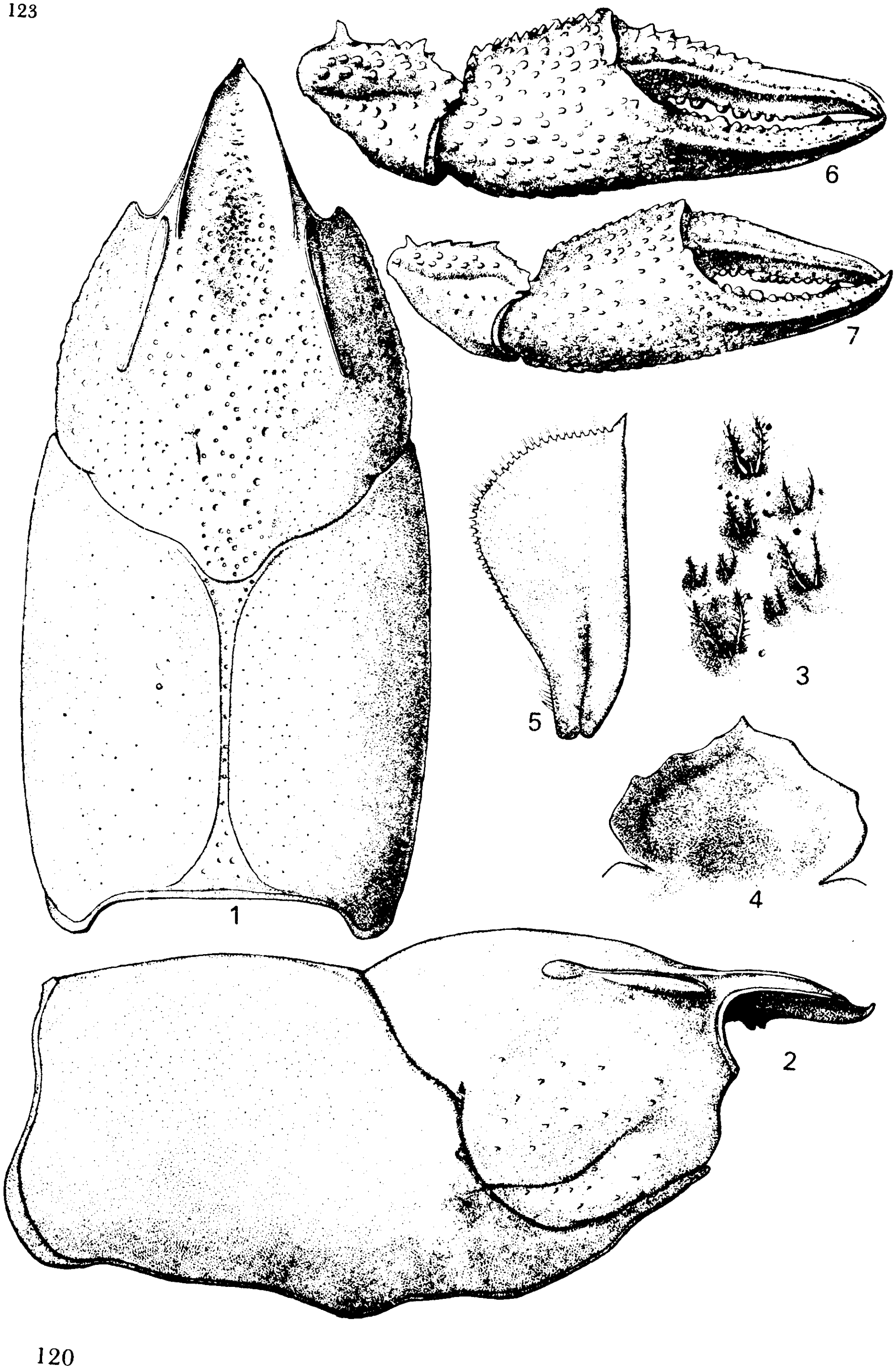
Procambarus tlapacoyanensis (Villalobos)

1947b *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 pereiopods 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
124 developed much more than the other. The female exhibits a tuberculiform process with a blunt apex between the fifth pereiopods.

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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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

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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 anteromedian 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 pereiopods 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.

The ischiopodites of the third pair of pereiopods 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 pereiopods exhibit a
128 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 pereiopods 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 pereiopods; 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. 5 D). 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

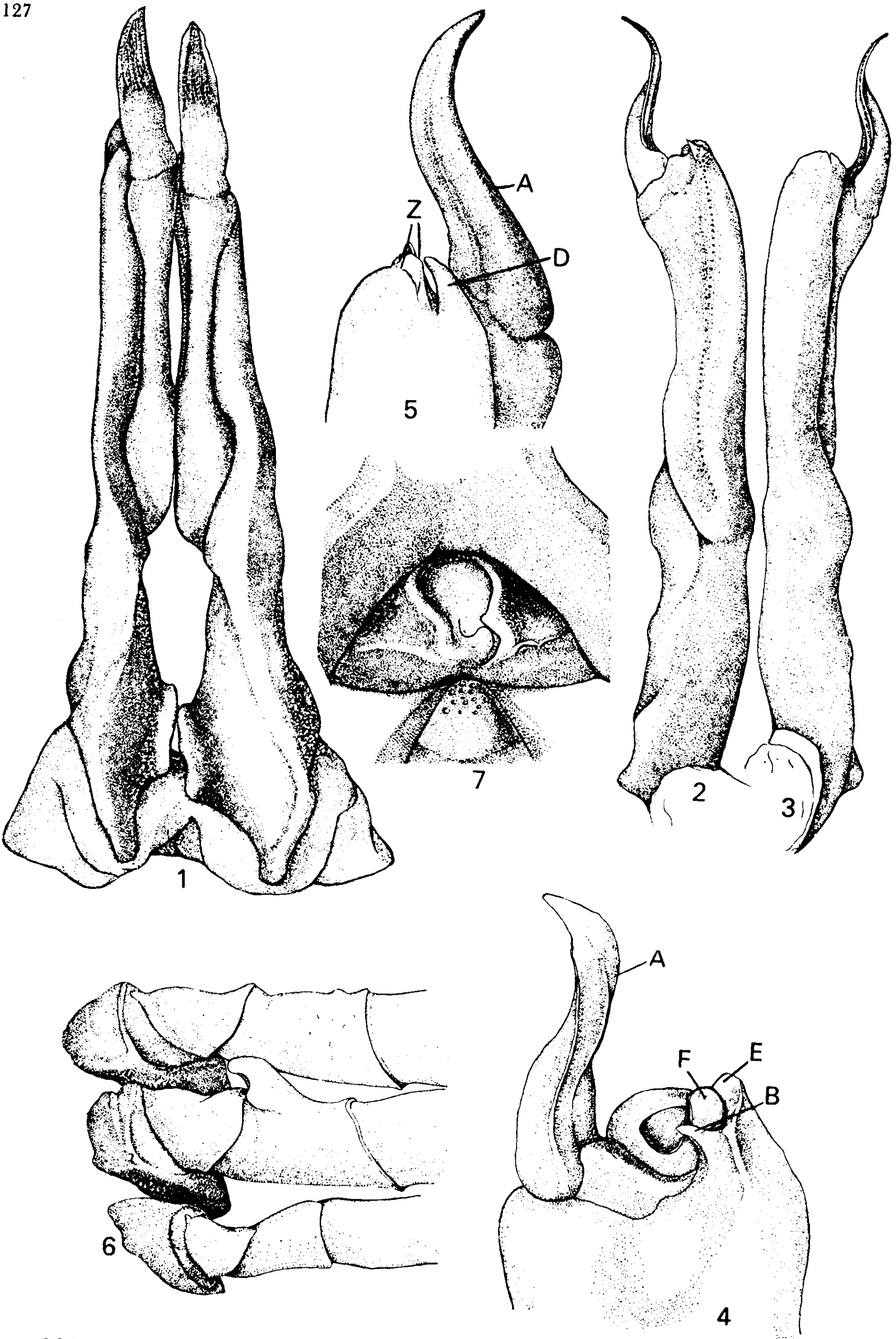
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Plate 24. *Procambarus tlapacoyanensis* (Villalobos). Male, Form I.

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.

The first pair of pleopods are slender and straight, and the mesial process is conical, pale, pliable, and turned gently toward the caudal
129 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 teziu-*
130 *tlanensis* 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:*

	Procambarus tlapacoyanensis		*Procambarus teziutlanensis*
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.	*Annulus ventralis* with two well formed ridges. Groove in the form of an S perpendicular to the major axis of the body.	VI.	*Annulus ventralis* 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 pereiopods 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
132 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 posteriorly 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

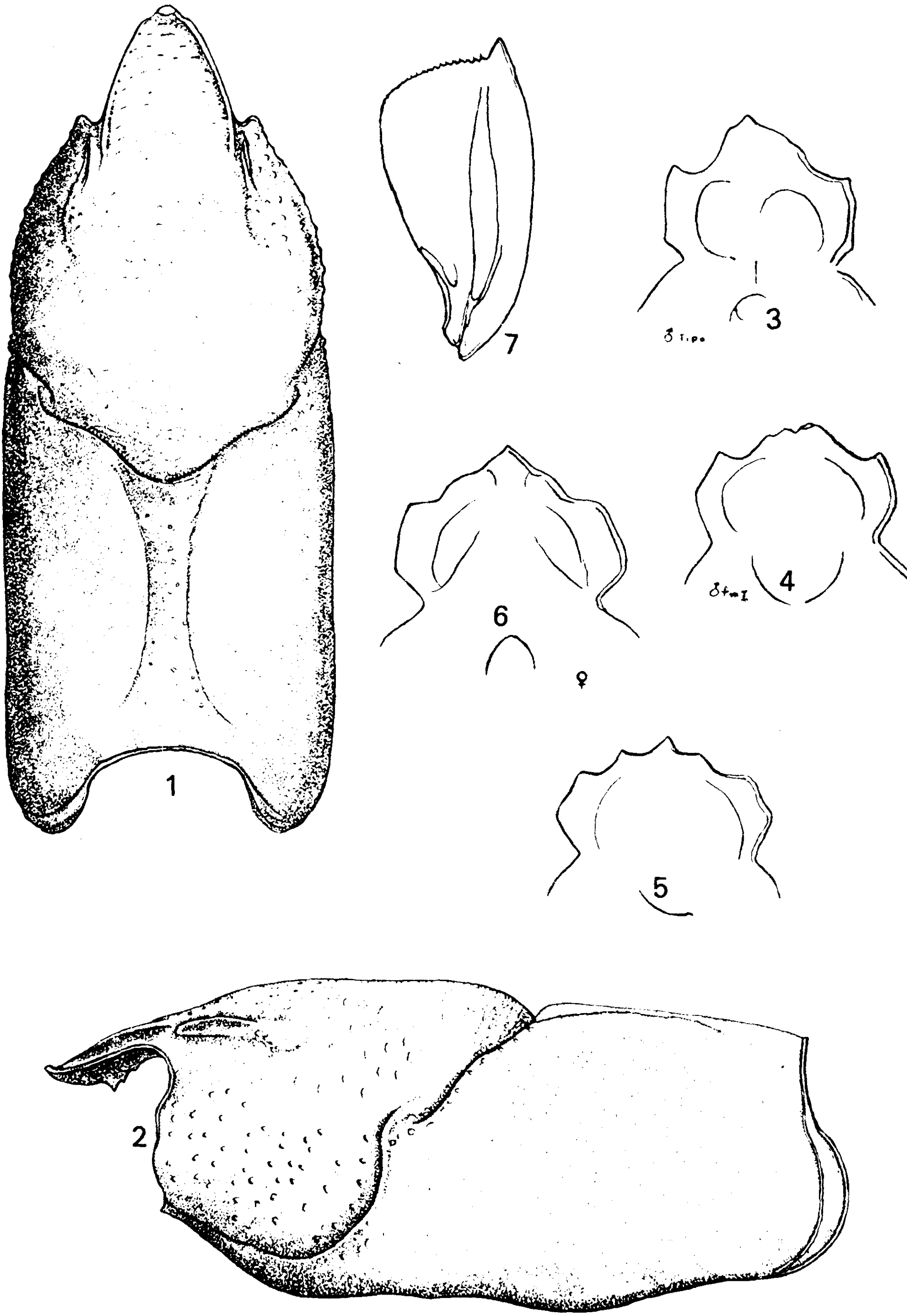

Plate 25. *Procambarus erichsoni* (Villalobos).

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.

The spine of the antennal scale reaches the distal half of the third
134 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 pereiopods 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 pereiopods exhibit a small ridge which represents the rudiment of the corresponding hook. The coxopodite of the fourth pair of pereiopods has a very well developed

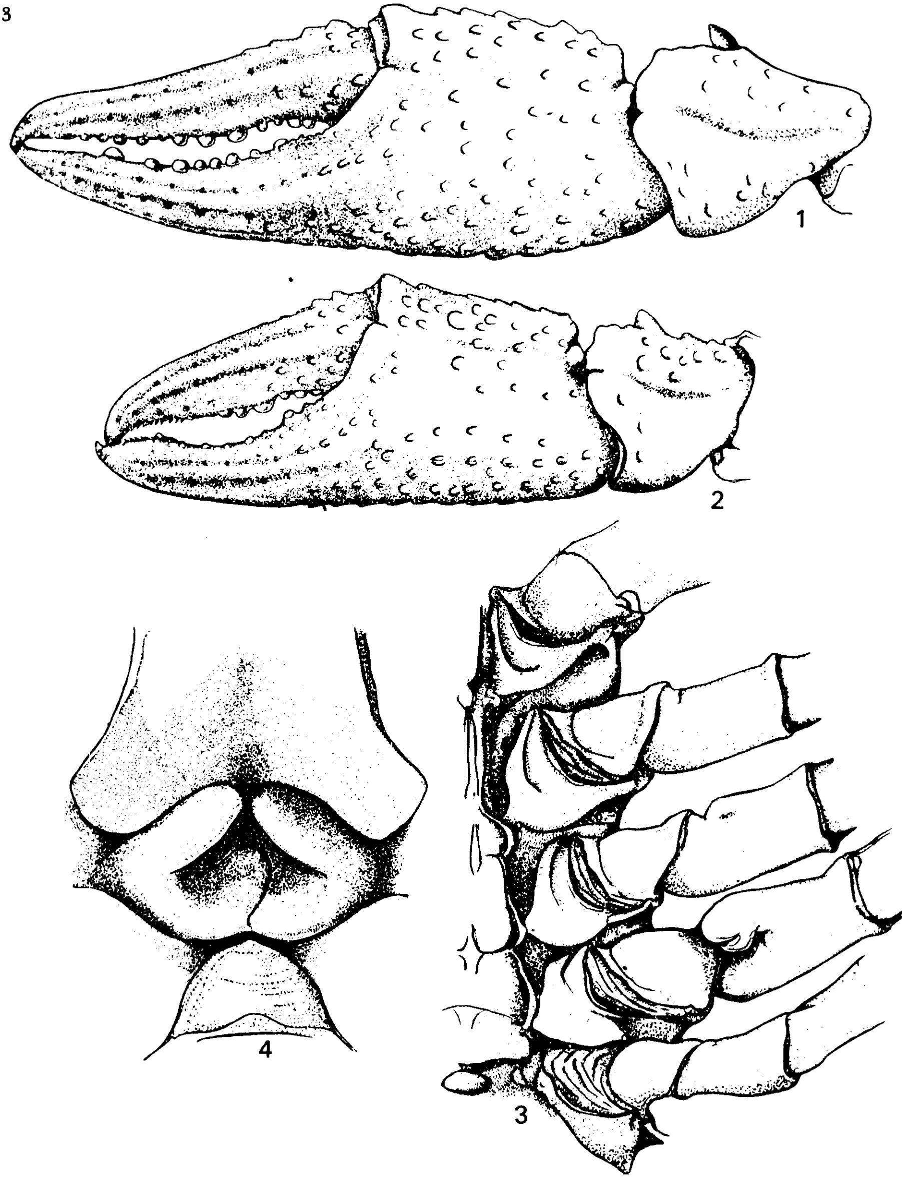

Plate 26. *Procambarus erichsoni* (Villalobos).

1, chela of the male, Form I; 2, chela of the female; 3, ischiopodites of pereiopods 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 pereiopods 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 pereiopods 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.

The first pair of pleopods are straighter than in the male, form I, and
136 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 pereiopods 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 pereiopods there is a somewhat pyramidal
138 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

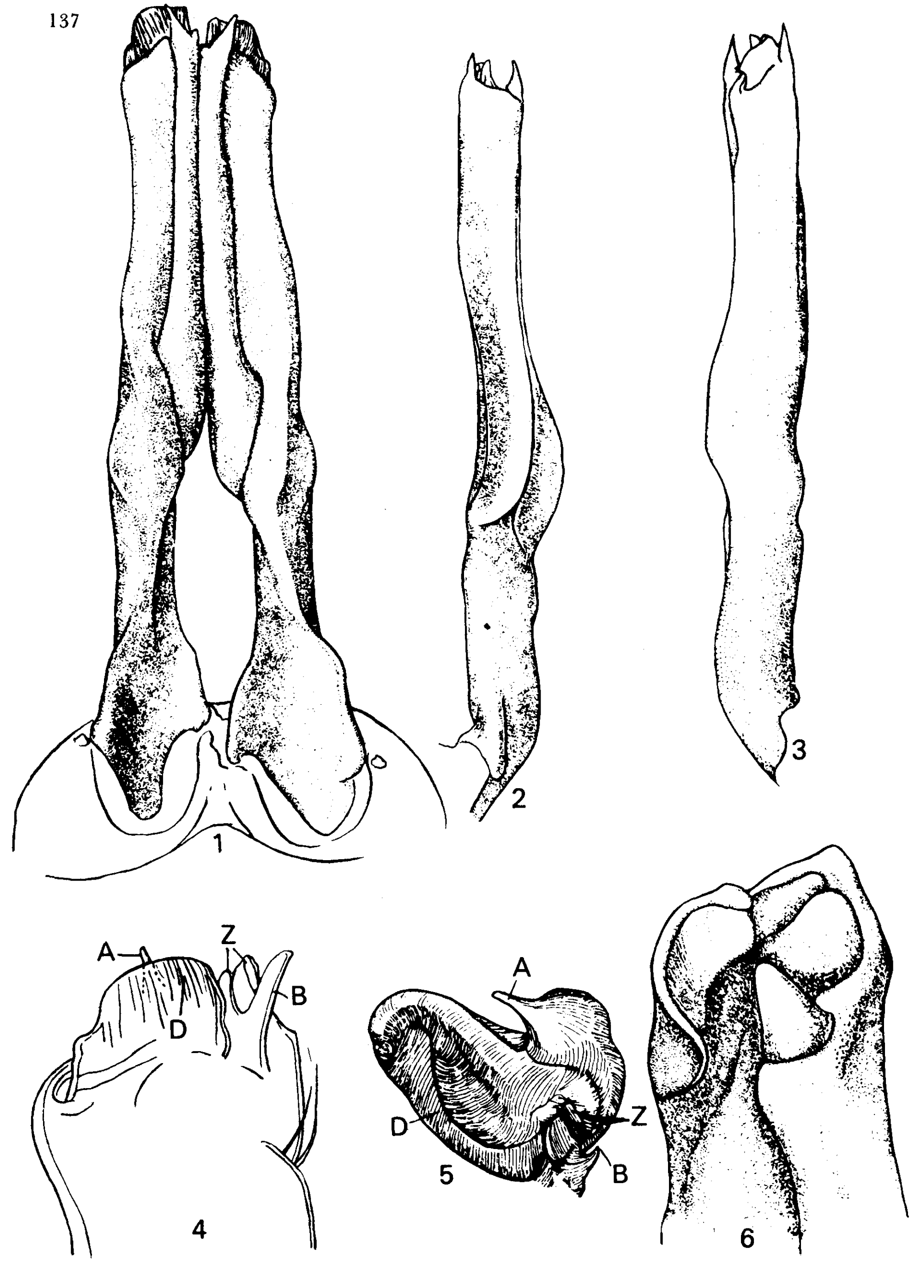

Plate 27. *Procambarus erichsoni* (Villalobos). Male, Form I.

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.

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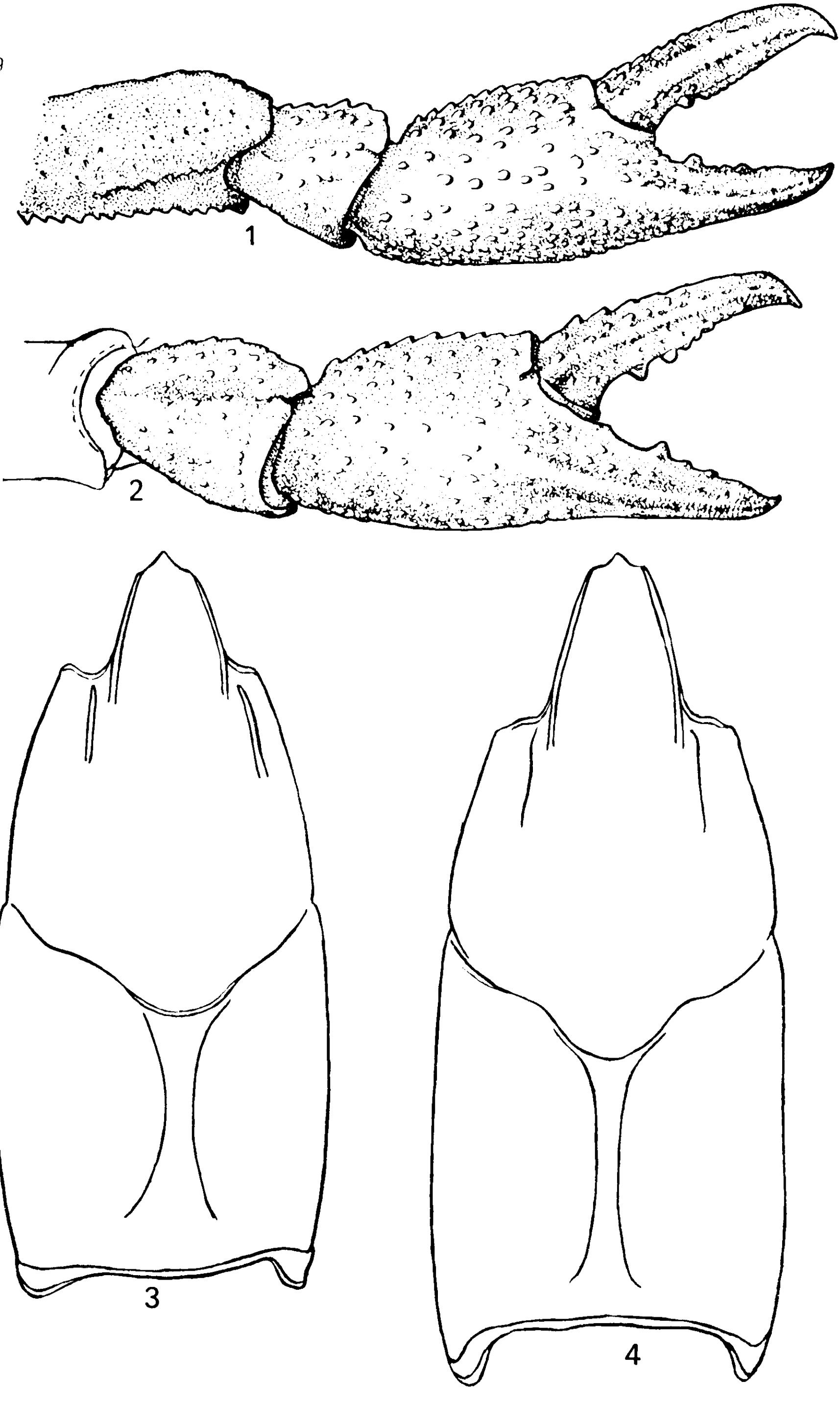


C. Weigmanni [sic] and *C. Mexicanus,* could not be found in the Berlin Museum, either by Hagen, who examined the collection in September 1870, or by Von Martens (Arch. Naturgesch., 1872, p. 131). *C. Weigmanni* [sic] alone of the known Mexican species belongs to the *C. Blandingii* group, with hooks 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 whit [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 pereiopods 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

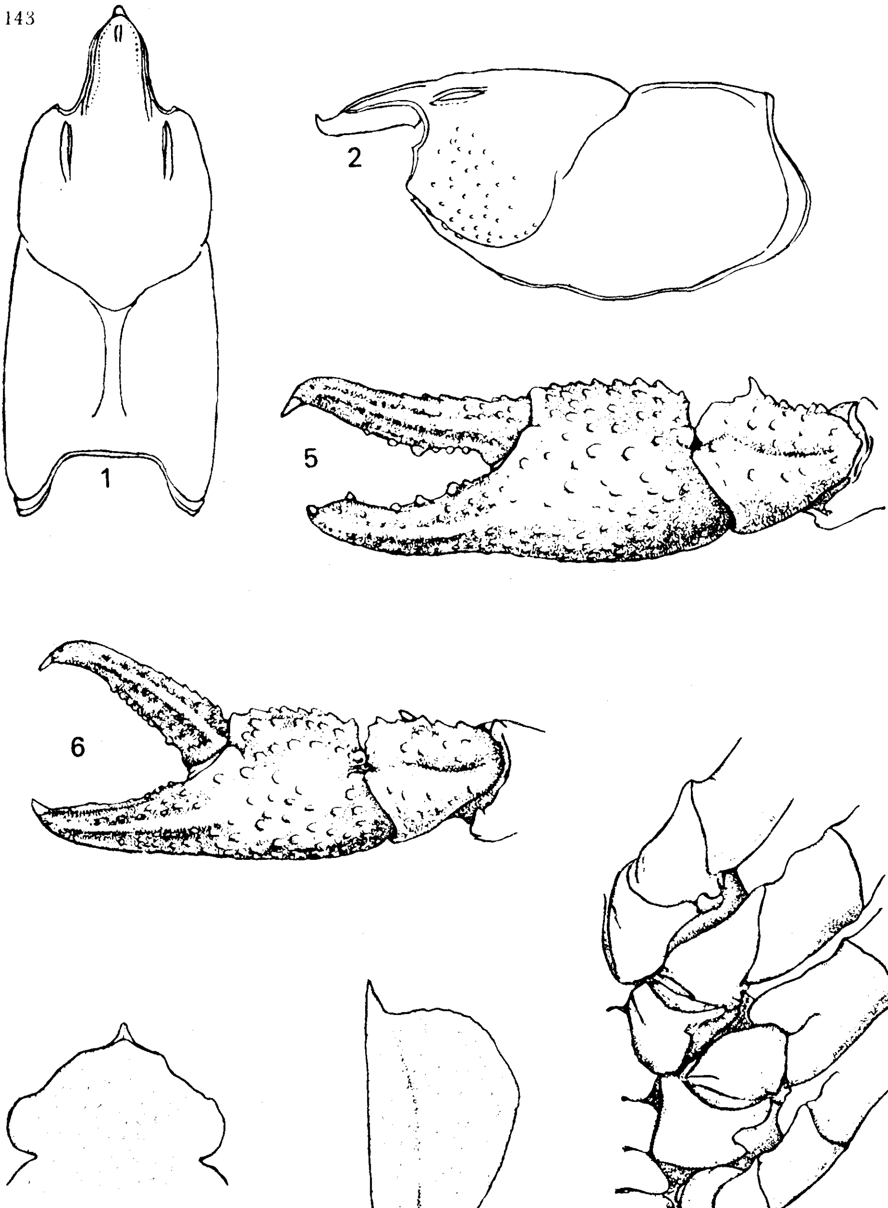


Plate 29. *Procambarus contrerasi* (Creaser). Male, Form I.

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 pereiopods 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 pereiopods exhibits a crestlike protuberance.

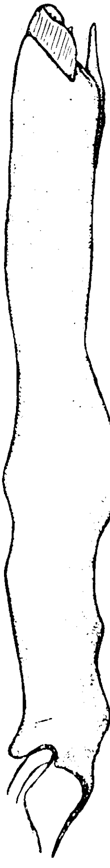
The ischiopodite of the fourth pair of pereiopods is armed with a well developed tubercle that is implanted in the proximal region of the article and its free extremity is broadened and occasionally exhibits an emargination which gives it the appearance of a mitten. The coxopodite bears a spiniform tubercle 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 4 A). The cephalic process is very small and rather conical; it is situated in the mesial region very near the caudal process (Plate 30, fig. 4 B). 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. 4 D). 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. 4 Z).

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*.



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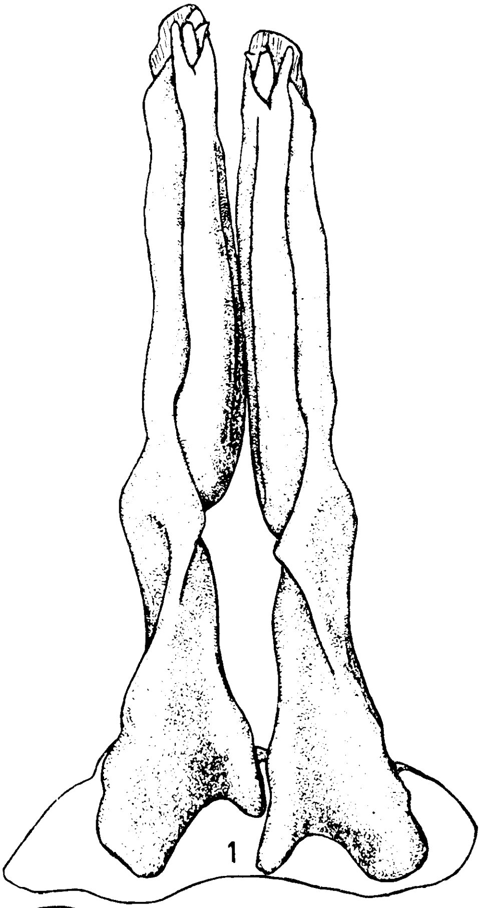

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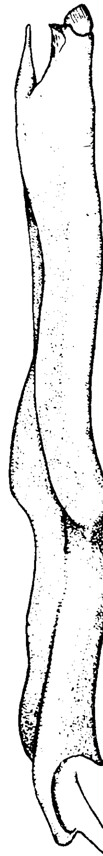

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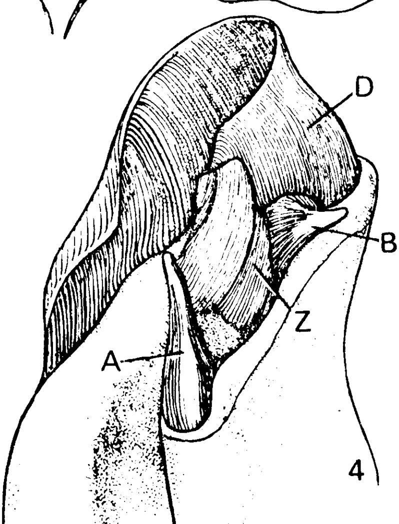

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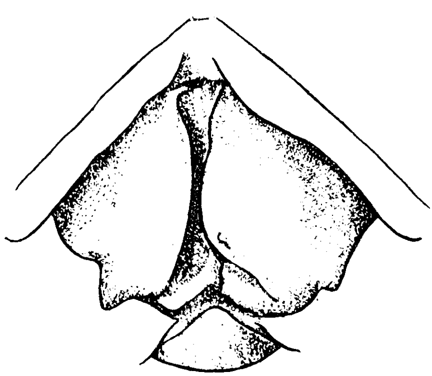

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The chelae of the first pair of pereiopods are a little less well developed than in the male, form I, but they are as tuberculate. The dactylopodite is straighter and slenderer; the teeth on the cutting margin of the fingers are more closely grouped.

The crestlike structure of the coxopodites of the third pair of pereiopods 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 pereiopods 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 148 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 pereiopods.

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 Fría, Puebla. Arroyo de San Diego, 3 km S.W. of Agua Fría, Puebla. La Magdalena, 3 km from La Unión, Municipality of Zihuateutla, Puebla. La Union, 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 pereiopods 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.

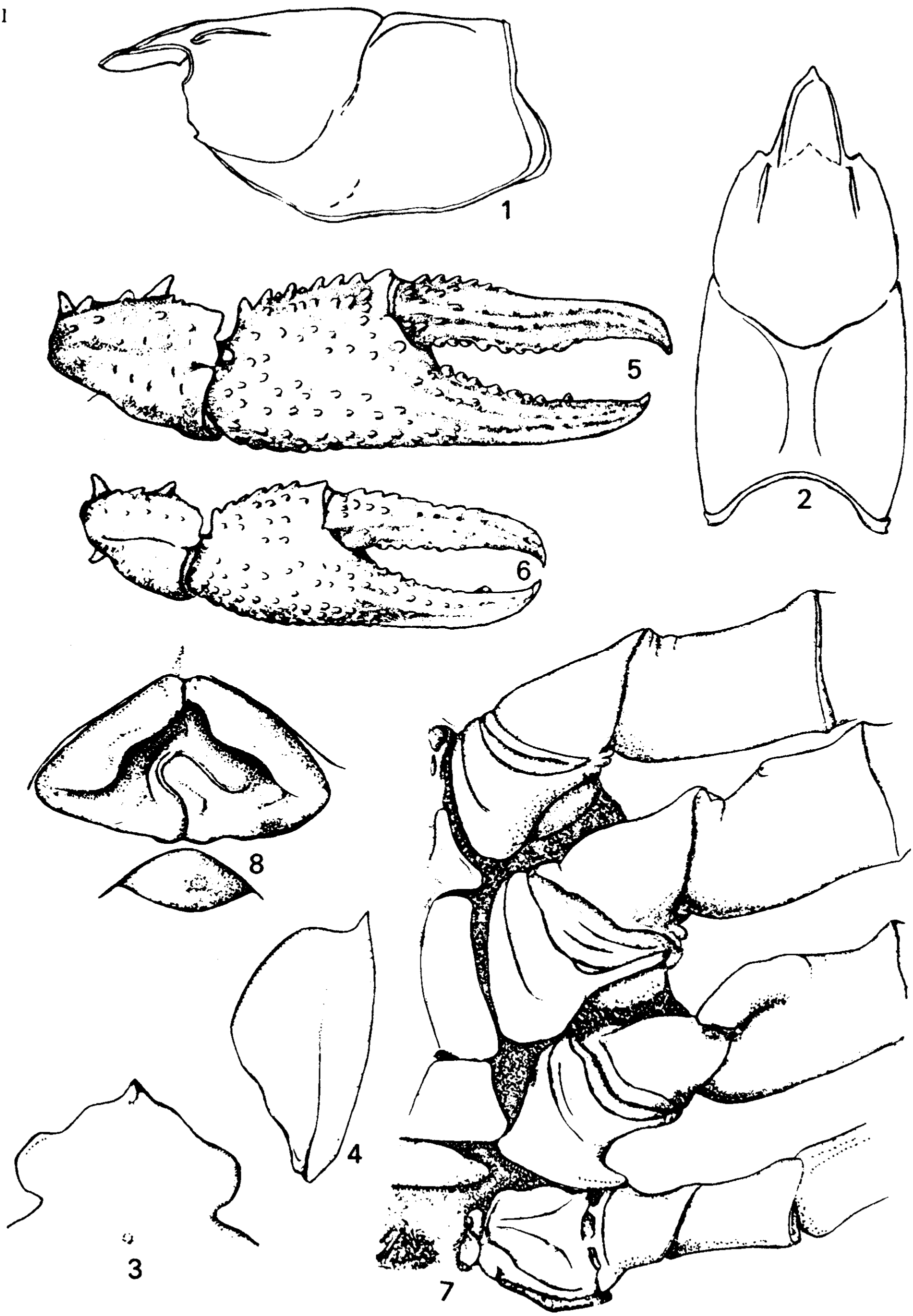
The apex of the rostrum reaches midlength of the distal article of the antennule. The lateral margins are only slightly convergent, lacking spines, and in the place where they normally occur, the margins are interrupted and then converge to the anteromedian extremity; the margins are pigmented in a characteristic 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 pereiopods II to V of the male, Form I; 8, *annulus ventralis*.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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 pereiopods 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 pereiopods exhibits no peculiar structure; it is very similar to that of the second pair.

The ischiopodite of the third pair of pereiopods 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 pereiopods is armed with a strong tubercle.

The ischiopodite of the fourth pair of pereiopods 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 pereiopods 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 pereiopods (Plate 32, figs. 1, 2 and 3). The mesial process (Plate 32, fig. 5 A) is pyramidal in form, curved outward, and its tip does not exceed the extremity of the appendage. The cephalic process (Plate 32, fig. 5 B) 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. 5 Z) 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. 5 D) 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

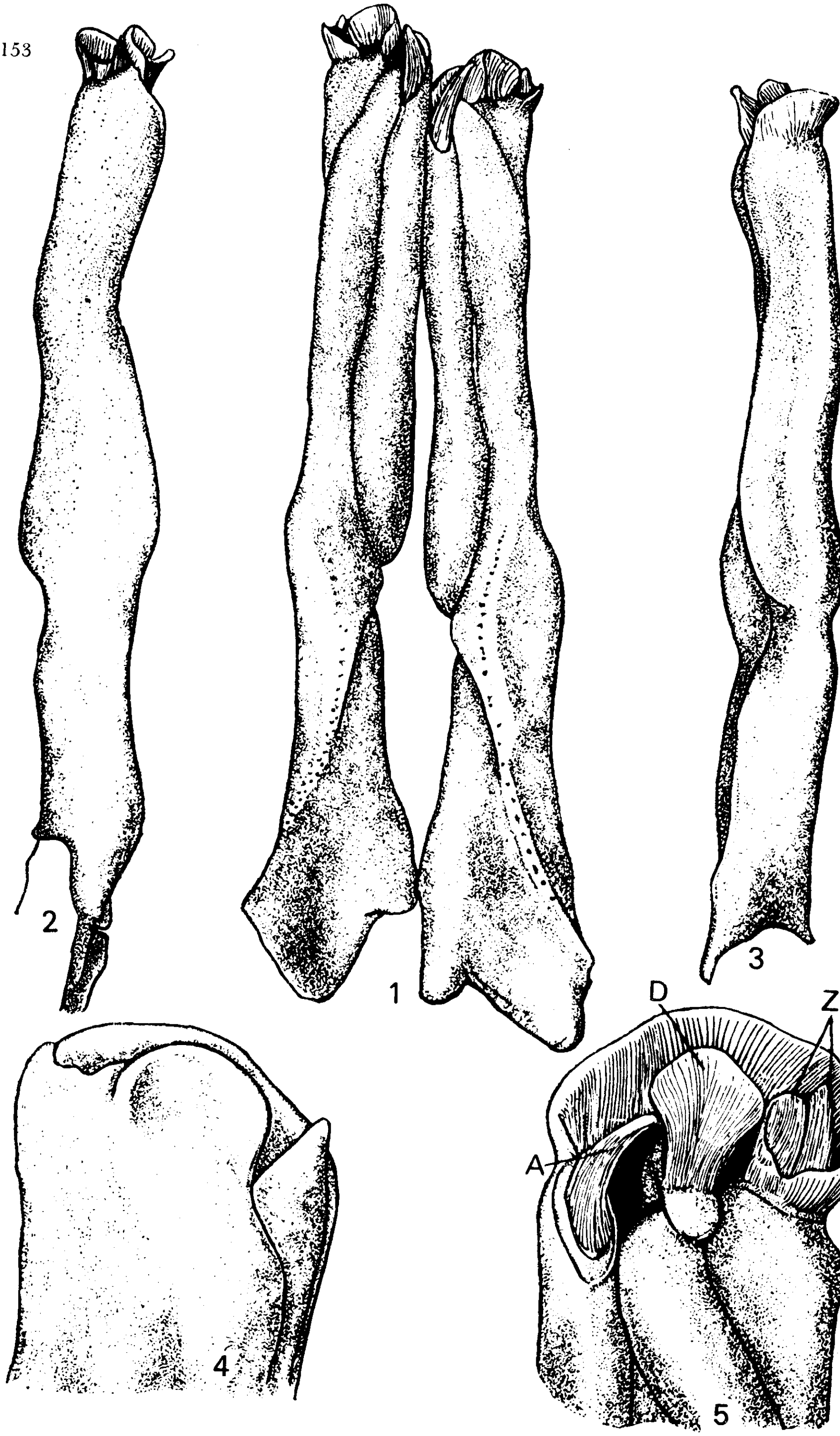
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Plate 32. *Procambarus zihuateutlensis* (Villalobos). Male, Form I.

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).

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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 pereiopods have no trace of a tubercle; in its place there is only a slight, almost insignificant, angle.

The coxopodites of the fourth pair of pereiopods 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 pereiopods 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 pereiopods 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 pereiopods; the first pair of pleopods of the male are straight, unequal in length, and their apical
156 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 pereiopods 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
158 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*,

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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 zihuateutlensis*; 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
159 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 Cazones, 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 pereiopods. *Annulus ventralis* cloven by longitudinal depression in cephalic portion. Spiniform tubercle generally present between fifth pereiopods 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 pereiopods, the absence of lateral spines on the rostrum, and also because of other characters.

Faxon (1885a) included *P. mexicanus* in his group II (type *C. advena*),
160 also taking as the basis, the character of the position of the hooks on the ischiopodites of the third pair of pereiopods. 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 llamasi*

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 Jarhrgang 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.

Plate 34. *Procambarus mexicanus* (Erichson). Male, Form I.

1, dorsal view of the carapace; 2, lateral view of the same; 3, epistome; 4, antennal scale; 5, chela; 6, third and fourth pereiopods; 7, ischiopodite of the third pereiopod 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
164 and third pair of pereiopods.

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.

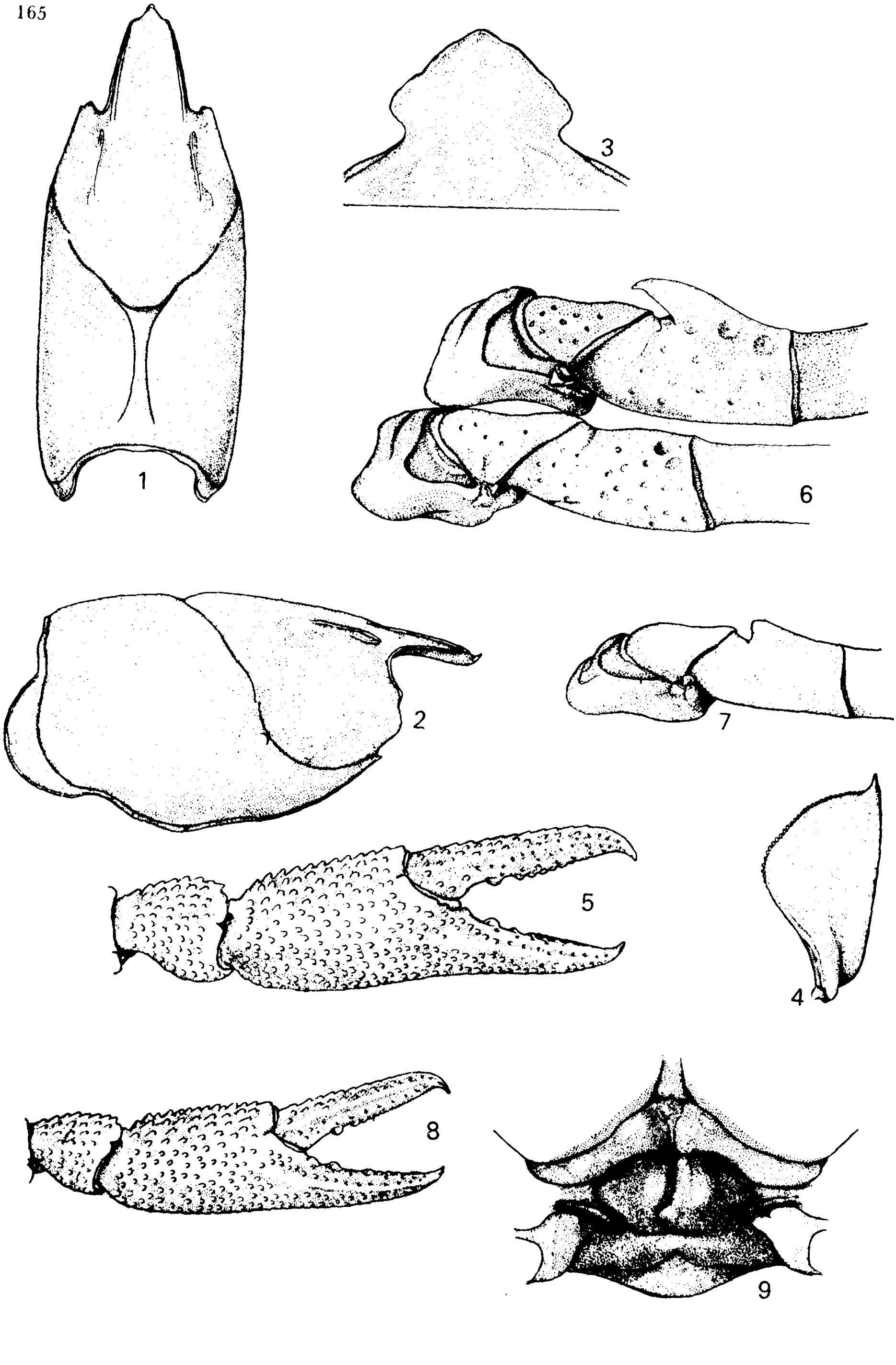
The antennal scale is very broad in its median portion; the external margin is gently convex and the spine of the scale is very reduced (Plate 34, fig. 4).

The first pair of pereiopods 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: $\dfrac{\text{Thickness} \times 100}{\text{Greatest width}}$

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.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armed with conical tubercles; only the lower surface exhibits a few subsquamous structures (Plate 34, fig. 5).

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
166 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).

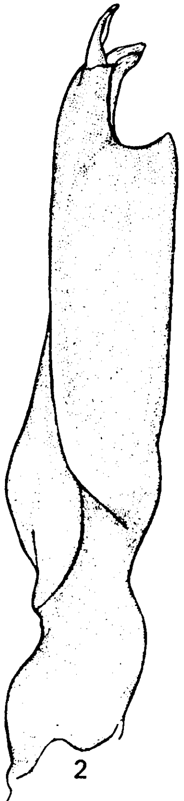
Male, form II. The carapace is less broad than the abdomen and is densely covered with punctations. The rostrum is subplane, the margins convergent, and the anterior angles rounded.

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. *Procambarus 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).



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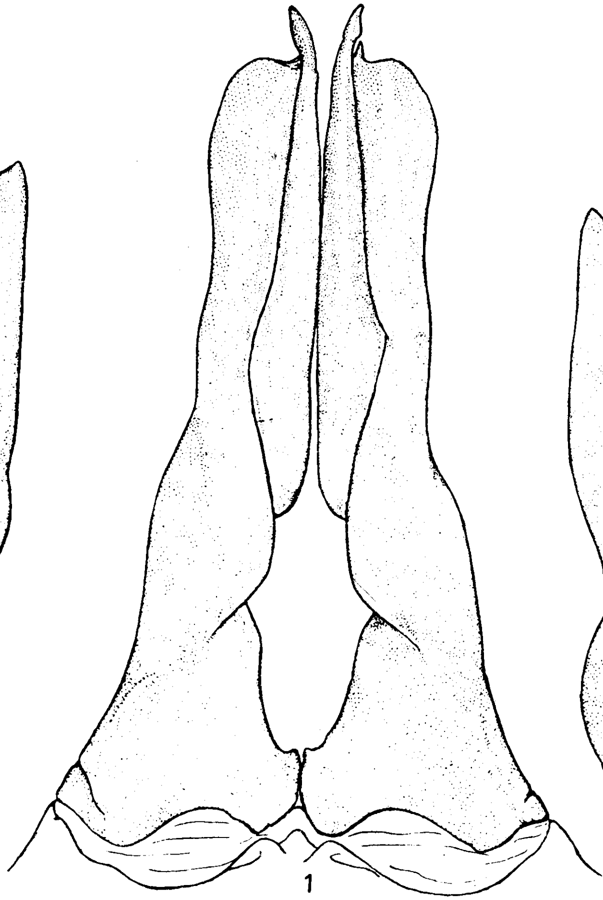

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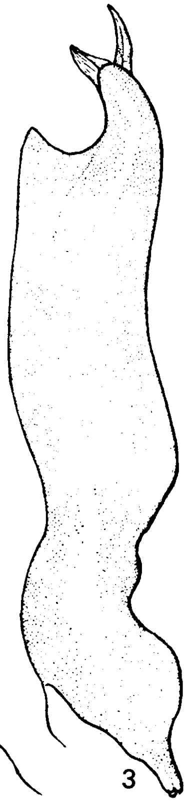

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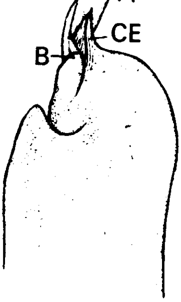

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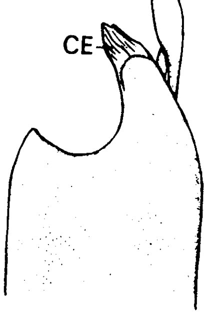

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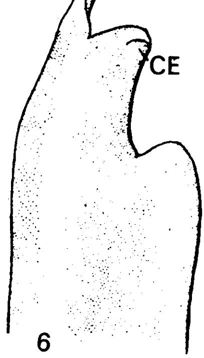

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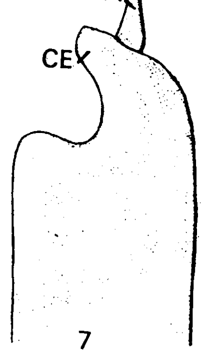

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The apical processes of the first pair of pleopods are scarcely defined. The shoulder is less angular; the central projection has the form of a blunt projection resembling a bird-beak, and in it may be seen the line which separates the two constituent structures; the mesial
168 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 pereiopods (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 pereiopods 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 pereiopods 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 pereiopods 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 pereiopods 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 pereiopods 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 pereiopods 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 sparce; 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 pereiopods.

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

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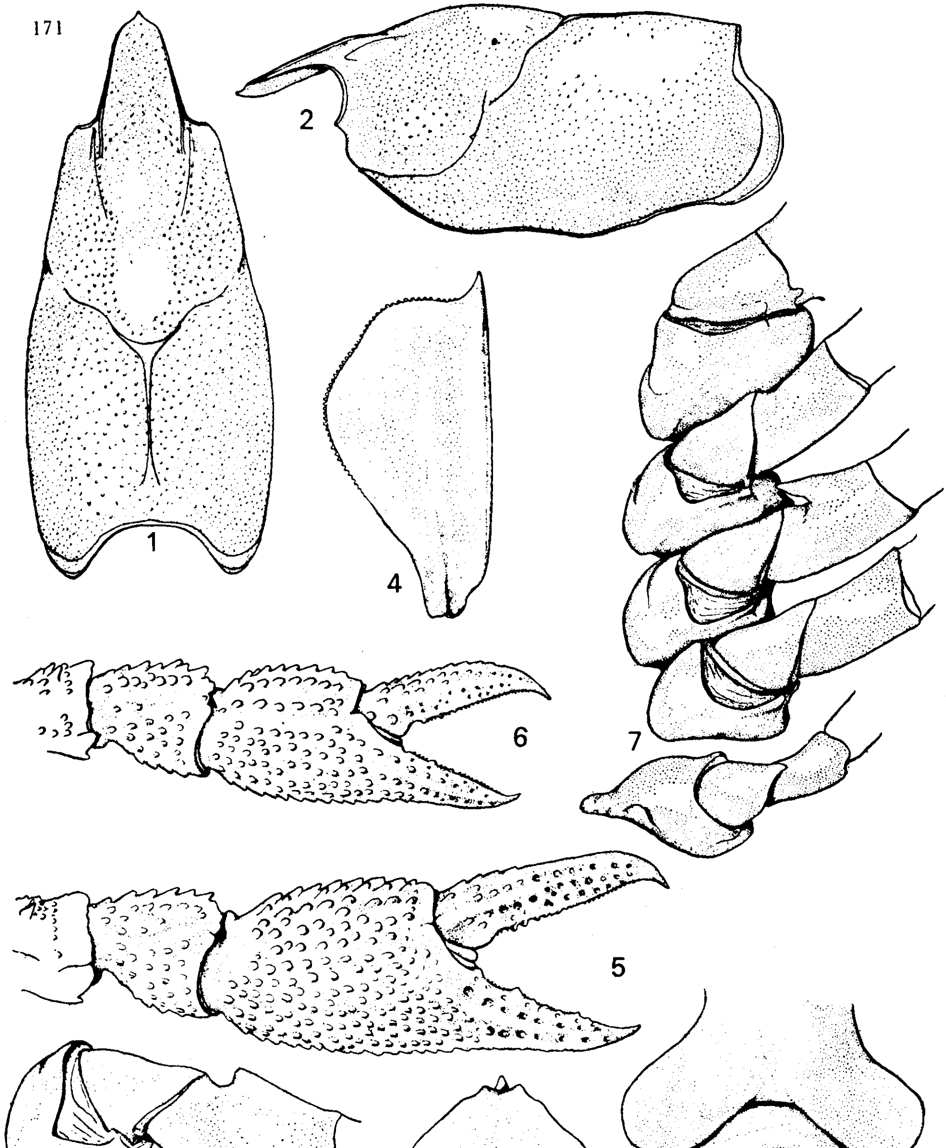

Plate 36. *Procambarus aztecus* (Saussure). Male, Form I.

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, pereiopods I to V of the male, Form I; 8, ischiopodite of the third pereiopod 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 pereiopods 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 $\left(\mathrm{I.P.} = \frac{\text{Thickness} \times 100}{\text{Greatest width}}\right)$; 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
173 margin; in addition to the teeth, there are numerous small plaquettes arranged along the entire length of the cutting border. The dactylopodite, 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 pereiopods 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.

The chelae of the first pair of pereiopods 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
174 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 pereiopods 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 pereiopods 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 pereiopods, there is a tubercle terminating in a
176 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. Tomatlán, 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

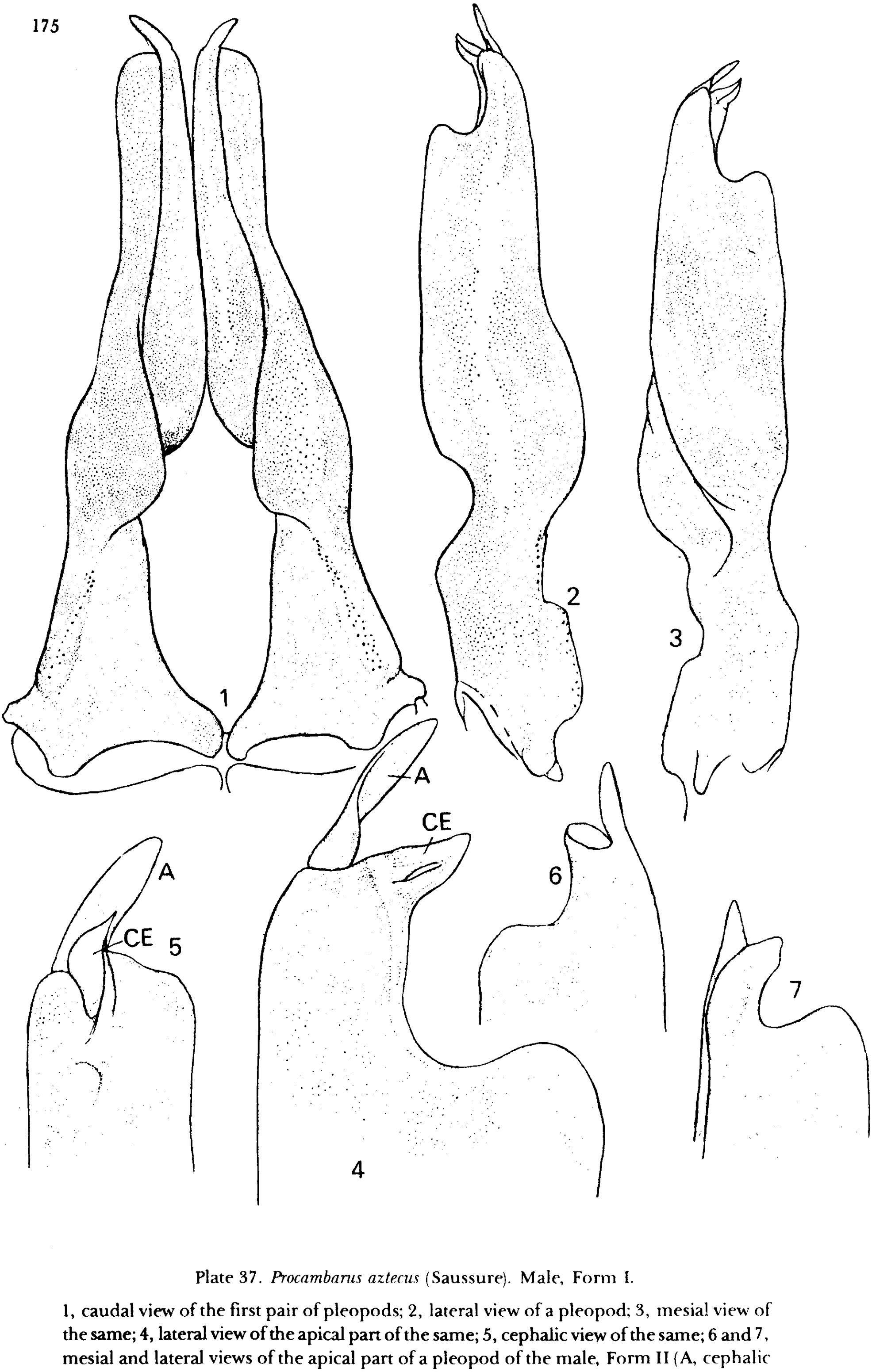

Plate 37. *Procambarus aztecus* (Saussure). Male, Form I.

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 rodriguezi Hobbs

1943 *Procambarus rodriguezi* Hobbs, Lloydia, Vol. VI, pp. 203 – 206, Pl. II.

1954b *Procambarus rodriguezi* 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 pereiopods of male slightly longer than body; meropodite very long and slender, slightly greater in length than dactylopodite; 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 pereiopods 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 pereiopods; 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.

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
178 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 subapical region of mesial face and continuing onto caudal portion. Tuberculiform process between fifth pereiopods 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 rodriguezi* 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 pereiopods. 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. rodriguezi* 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 pereiopods not pubescent but completely covered with subsquamous

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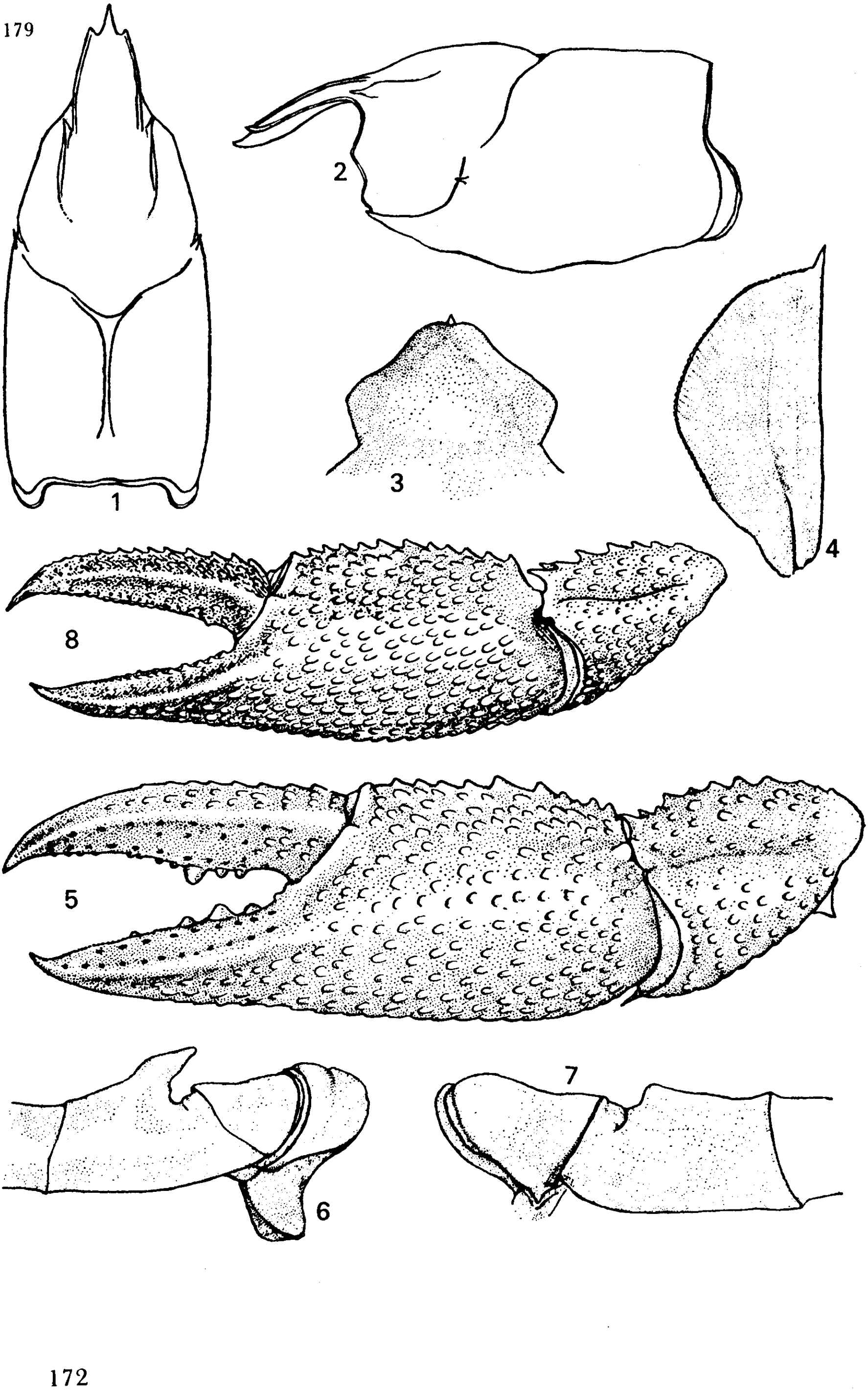

tubercles; palmar index of chela of male 63.9. Hook on ischiopodites of third pair of pereiopods with apex distinctly overreaching articulation
180 of ischiopodite with basipodite. First pair of pleopods of first form male reaching anterior part of coxopodites of fourth pair of pereiopods; shoulder with 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 pereiopods 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 pereiopods, 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

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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?] pereiopod; 7, ischiopodite of the third pereiopod of the male, Form II; 8, chela of the female.

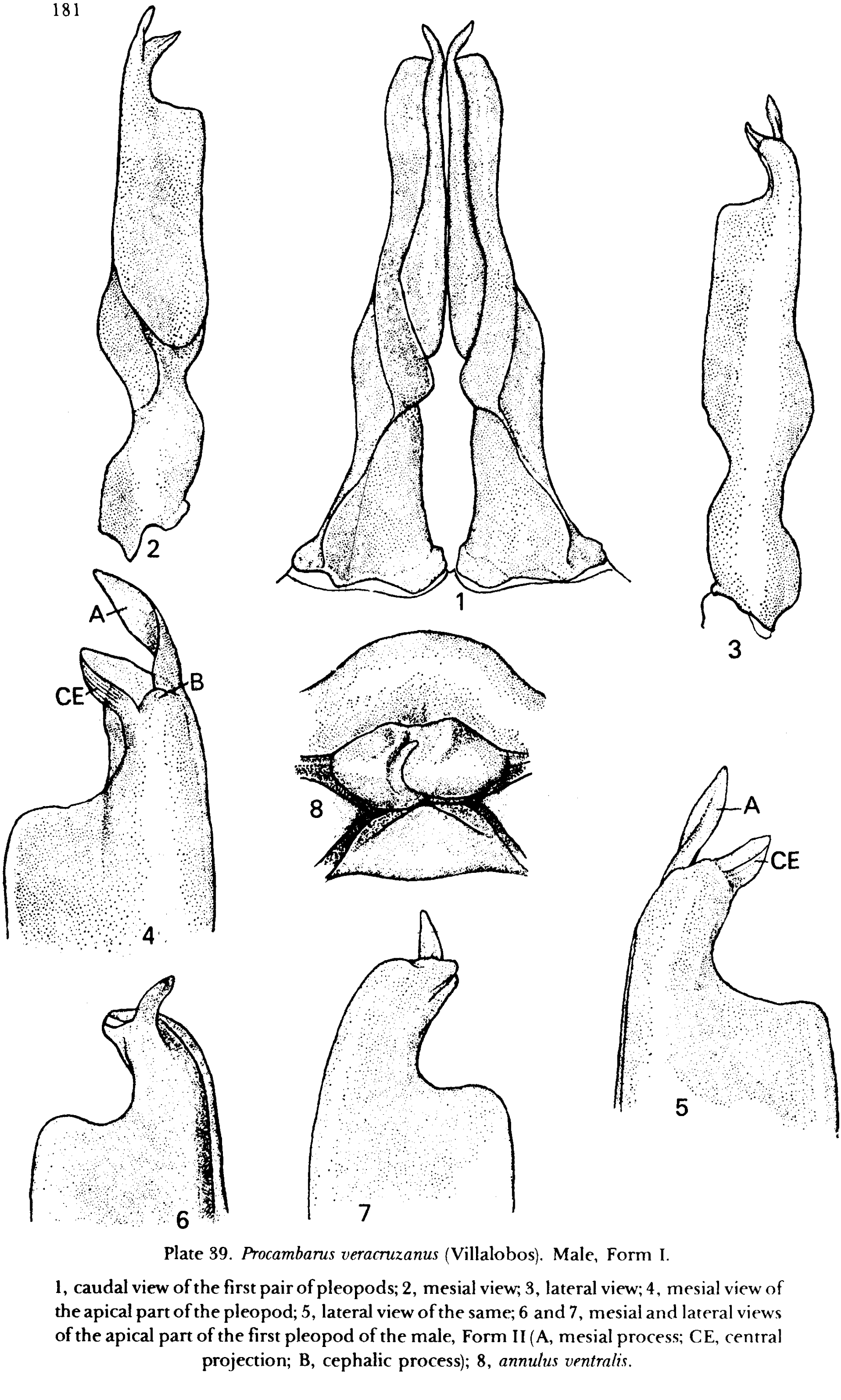

Plate 39. *Procambarus veracruzanus* (Villalobos). Male, Form I.

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*.

slightly overreaches the distal articular margin of the third article of the
182 antennular peduncle. The greatest width of the scale is at midlength (Plate 38, fig. 4).

The first pair of pereiopods 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 midlength 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 pereiopods 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.

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
183 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
184 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 pereiopods with short fingers. Ischiopodites of first [should be third] pair of pereiopods 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 pereiopods 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
185 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 pereiopods, 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
186 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

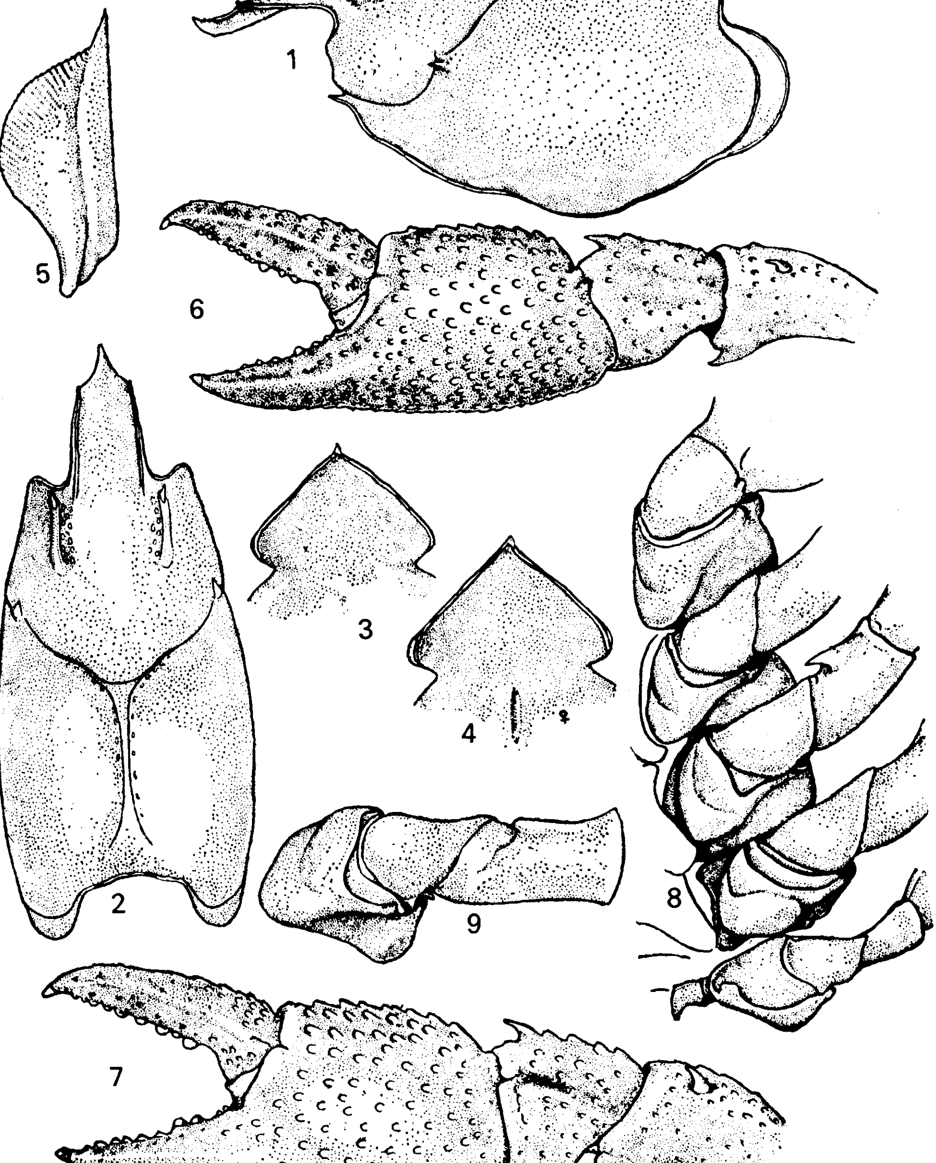

Plate 40. *Procambarus vazquezae* (Villalobos). Male, Form I.

1, lateral view of carapace; 2, dorsal view of same; 3, epistome; 4, epistome of the female; 5, antennal scale of the male, Form I; 6, chela; 7, chela of the female; 8, pereiopods 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 pereiopods 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 pereiopods; [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
188 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 lateromesially 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 pereiopods 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 pereiopods of the male,